# A Systematic Review of the Effectiveness of Dietary and Physical Activity Mobile Health Applications among Adults with Chronic Disease

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## Abstract

**Problem:** In the United States, six in ten adults have a chronic disease. One affordable self-care resource for patients with chronic disease to reduce complications is to track diet and physical activity using mobile health (mHealth) applications (apps). However, it is unknown how effective mHealth apps are for improving health outcomes.

**Purpose:** The purpose of this systematic review was to examine the effectiveness of interventions that used dietary and/or physical activity mHealth apps to improve health outcomes among adults living with chronic disease or high risk for developing chronic disease.

**Search Strategy:** A total of six databases were searched to identify studies published between the years of 2015 to 2020 using the PRISMA guidelines. Studies were eligible if they were conducted with adults (18 and older), diagnosed with chronic disease or at high risk for chronic disease, and used a smartphone app to improve health outcomes. Outcomes that were measured were activity level, weight, blood pressure, glucose, cholesterol, calorie intake, and fruit or vegetable intake. Two reviewers independently reviewed studies for eligibility.

**Results of Literature Search:** The initial search identified 131 studies. After removing duplicates and assessing the full text papers, a total of eight studies met the search criteria. The mean age of the participants was 51 years, the duration of studies ranged from 2-12 months, and the majority (*n*= 6) were conducted in a healthcare setting. Seventy-five percent of the studies (*n*= 6) had a large sample size (>90) and included both diet and physical activity tracking features in the app. Overall, interventions with apps using a multicomponent approach for tracking diet and physical activity (*n*= 4) were more effective than alternative interventions.

**Synthesis of Evidence:** This review provides evidence suggesting multicomponent interventions using apps with both diet and physical activity features for six months or longer, are effective to increase activity levels in adults living with or at risk for chronic disease. However, the evidence is lacking for which app is the best to be integrated into routine clinical practice and how many features are needed for long-term engagement.

**Implications for Practice:** This study highlights the potential health benefits for reducing inactivity and improving diet in patients living with chronic disease by using multicomponent interventions that use apps with both diet and physical activity features.

**A Systematic Review of the Effectiveness of Dietary and Physical Activity Mobile Health Applications among Adults with Chronic Disease**

In today's society, chronic disease is a global issue that is continuing to grow at an alarming rate. According to the National Center for Chronic Disease Prevention and Health Promotion (2019), a chronic disease is defined as a condition lasting one year or longer that requires ongoing medical attention and often limits activities of daily living. Globally, in 2012, 52% of all adult deaths under the age of 70 were linked to chronic diseases (World Health Organization, 2015). Furthermore, 75% of these deaths were caused by chronic respiratory disease, cardiovascular disease, diabetes, or cancer (World Health Organization, 2015). Currently, in the United States (US), six in ten adults have at least one chronic disease (National Center for Chronic Disease Prevention and Health Promotion, 2019). Prevention of chronic diseases and premature death currently focuses on behavior change via wellness strategies that include healthy eating, engaging in physical activity, avoiding tobacco products and excessive drinking, and participating in regular health screenings (National Center for Chronic Disease Prevention and Health Promotion, 2019). Patients suffering from chronic disease are often asked to change their lifestyle through engaging in diet control and participating in regular physical activity to slow the progression of chronic disease.

One affordable resource for patients with chronic disease to track diet and physical activity in real-time is the use of mobile health (mHealth) applications (apps). The use of mHealth apps is of increasing interest to those throughout healthcare, as mHealth apps have the potential to promote patient-provider communication, disease management, patient education, and self-health tracking for calorie intake and physical activity. In 2019, an estimated 96% of Americans owned a cellphone, and 81% of these Americans owned a smartphone (Pew Research

Center, 2019). Furthermore, 59% of mobile phone users have previously downloaded a mHealth app (Krebs & Duncan, 2015). Mobile health apps are continuing to gain popularity as adequate means to track and evaluate health outcomes. However, it is unknown how effective these mHealth apps are for the management of chronic diseases, such as cardiovascular disease (Fakih El Khoury et al., 2019). Therefore, evaluating the effectiveness of mHealth technology in preventing and managing chronic disease remains a critical next step in combating this growing pandemic.

Previous research has demonstrated that the use of mHealth apps compared to current standards of care (printed education materials) has led to significant decreases in weight, waist circumference, and energy intake in adults with chronic disease (Fakih El Khoury et al., 2019). Mobile health apps have demonstrated potential for increasing fruit and vegetable intake in individuals 16-71 years old regardless of health status (Mandracchia et al., 2019). In addition, most studies (65.4%) included in a systematic review examining current mHealth interventions in China used mobile apps to target patient education and behavior change as ways to improve patient health (Yang & Kovarik, 2019). However, some literature indicates there is no strong evidence in support for the effectiveness of mobile apps for improving health behaviors because few studies found significant differences between the app intervention group and the control group (Milne-Ives et al., 2020). Mobile health apps may be an enticing and applicable option for people in need of resources for the management of chronic disease. Yet, the extent of data available demonstrating the clinical benefits of mHealth app interventions in the context of chronic disease remains unclear. Currently, there is a gap in the literature identifying the use of mHealth apps as an adequate intervention to manage chronic disease and determine the long-term efficacy of app interventions in the management of chronic disease. The purpose of this systematic review was to examine the effectiveness of interventions that used dietary and/or physical activity mHealth apps to improve diet and physical activity health outcomes (activity, weight, blood pressure, glucose, cholesterol, calorie intake, and fruit or vegetable intake) among adults living with chronic disease or at high risk for developing chronic disease.

# Methods

## Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to guide the completion of this systematic review (Moher et al., 2009).

## Data Sources

The systematic review was conducted for the years 2015 to 2020 using six electronic databases: PubMed, CINAHL, Cochrane Library, PsycINFO, Scopus, and MEDLINE. The search phrase or keywords used to review these databases was ([mobile applications OR apps OR mobile apps OR smartphone] AND [diet OR nutrition OR food habit OR eating habit] AND [chronic disease OR chronic illness OR long-term conditions OR chronic conditions] AND [adults OR adult OR aged OR elderly]).

## Study Selection

The following criteria were used for inclusion in the review: (1) conducted with adults 18 years of age and older with a chronic disease or at high risk for chronic disease (physically inactive and consumed a diet low in fruit and vegetables), (2) used a smartphone app to improve diet and/or physical activity health outcomes, (3) randomized controlled trial, (4) pre/post design, (5) peer-reviewed, and (6) published in the English language. The following exclusion criteria were used: (1) healthy adults, (2) phone calls only, (3) interventions that did not include a dietary or physical activity component, (4) qualitative studies, (5) reviews of the literature, (6) secondary data analyses, (7) case studies, (8) dissertations, and (9) theses.

### Data Extraction and Study Quality Assessment

First, duplicate records were removed. Next, the first author screened titles and abstracts and excluded studies not meeting eligibility criteria. Next, remaining records were reviewed in full by two independent authors. The original agreement rate for inclusion versus exclusion was 63%. Discrepancies were resolved by discussion until 100% agreement was achieved. Both authors evaluated the levels of evidence and bias using CONSORT guidelines (Schulz et al., 2010) and the Cochrane Collaboration tool (Higgins et al., 2011). Specifically, random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, completeness of outcome data, selective reporting, and other sources of bias were evaluated. Each area was rated as *high* (met all criteria), *low* (not all criteria were met), or *unsure* (unable to determine). Each author reviewed the quality of the studies separately. Disagreements were resolved by discussion until agreement was met.

## Results

As shown in Figure 1, 131 articles were identified and 79 remained after removing duplicates. The remaining 79 titles and abstracts were screened, which resulted in 57 exclusions. The 22 remaining articles were retrieved, and the full text was reviewed. Eight articles met eligibility criteria and were included in the review (see Figure 1).

### Overview

Our review included five randomized controlled trials (Alonso-Dominguez et al., 2019, Mummah et al., 2017, Recio-Rodriguez et al., 2018, Spring et al., 2018, 2017) and three studies with pre/post-test designs (Doyle et al., 2019, Lv et al., 2017, Sittig et al., 2020). The average age of the participants in the studies was 51 years. Each study was examined to identify outcomes for activity, weight, blood pressure, cholesterol, calorie intake, and fruit or vegetable intake. The majority (*n* = 6) of the reviewed studies included mHealth apps that provided both a physical activity and diet tracking component (Alonso-Dominguez et al., 2019, Lv et al., 2017, Recio-Rodriguez et al., 2018, Sittig et al., 2020, Spring et al., 2018, 2017). One study included only physical activity (Doyle et al., 2019), and one study included only diet (Mummah et al., 2017). The sample size in the reviewed studies ranged from 20-833 participants. The duration of the reviewed studies ranged from 2-12 months, and the majority of the studies (*n* = 5) were conducted in the US (Lv et al., 2017, Mummah et al., 2017, Sittig et al., 2020, Spring et al., 2018, 2017). No studies used consumer-based apps, but rather custom-built apps designed for the study population. Six of the included studies examined adults with a confirmed diagnosis of chronic disease, including hypertension (Lv et al., 2017), obesity (Mummah et al., 2017, Spring et al., 2017), kidney disease (Doyle et al., 2019), and type 2 diabetes (Alonso-Dominguez et al., 2019, Sittig et al., 2020). Two of the included studies assessed adults at high risk for developing chronic disease as evidenced by low fruit and vegetable consumption, high fat intake, and physical inactivity. (Recio-Rodriguez et al., 2018, Spring et al., 2018).

**Activity**

Improvements in activity were found in four studies (Alonso-Dominguez et al., 2019, Doyle et al., 2019, Lv et al., 2017, Sittig et al., 2020) for mean daily steps, exercise knowledge, improvement in the 6-minute walk test (6MWT), and minutes of daily physical activity. Participants with type 2 diabetes who received a multifactorial intervention with an app called, EVIDENT II to record diet and physical activity and participated in heart healthy walks (30 minute walks) at least one time per week, had a significant increase in daily steps at 12 months (intervention *M* daily steps 1353, 95% CI [646, 2061]; compared to the control group (control *M* daily steps 211, 95% CI [-556, 979], $p < .05$) (Alonso-Dominguez et al., 2019). This study also found a mean difference between intervention and control for aerobic steps (*M* = 918, 95% CI [89, 1746] $p < .05$) and total physical activity measured in metabolic equivalents (METs)-min/week (*M* = 1065, 95% CI [319,1811] $p < .05$) over the 12 months for the intervention compared to the control that received standardized counseling about diet and physical activity (Alonso-Dominguez et al., 2019). Yet, in another study participants with type 2 diabetes who were classified as high and mid users of an app called capABILITY ($n = 14$) experienced a significant increase in the health survey measure for exercise knowledge (pretest *M* = 1.54, *SD* 2.14; post-test *M* = 2.75, *SD* 1.86, $p = .01$, Cohen $d = 0.60$) (Sittig et al., 2020). Over nine weeks, the high users' ($n = 7$) total time spent using the capABILITY app ranged from 71 to 117 minutes, and the mid users' ($n = 7$) total time spent using capABILITY ranged from 21 to 70 minutes.

Adults diagnosed with chronic kidney disease who received a smartphone app called MiKidney to record their personal data (medical history, blood parameters, weight, current medication list, and physical activity) experienced activity increases after 12 months of using the app for functional capacity measured by the 6MWT (Pre-intervention *M* distance = 512 meters, *SD* = 127; post-intervention *M* distance = 542 meters, *SD* = 140, $p = .02$) (Doyle et al., 2019). Additionally, participants who were diagnosed with uncontrolled hypertension that used an app called Engaging and Motivating Patients Online With Enhanced Resources-Hypertension (EMPOWER-H) and were given a pedometer to track daily step counts demonstrated improved activity levels with a mean increase of 25.7 minutes of physical activity per week (*SD* = 133.1, $p = .03$) after 6 months of using the app (Lv et al., 2017). Adults at high risk for chronic disease who received a custom-built smartphone app that provided continuous user feedback experienced a significant increase in moderate-to-vigorous intensity physical activity (MVPA) by 24.7 minutes per day (95% CI [20, 29.5], $p < .001$, $M$ difference from control = 12.1 minutes per day, 95% CI [5.4-18.9]) and a significant decrease in sedentary leisure by 170.5 minutes per day (95% CI [ –183.5, –157.5], $p < .001$, $M$ difference from control = -137.7 minutes per day, 95% CI [–155.9 to –119.5]), when compared to the control group which received the app but no user feedback (Spring et al., 2018).

**Weight**

Three of the reviewed studies found changes in waist circumstance, weight loss, and body weight (Doyle et al., 2019, Lv et al., 2017, Spring et al., 2017). Participants using the MiKidney app demonstrated a significant decrease in waist circumstance ($M$ = 97.1 cm, $SD$ = 14.95, $R$ = 68.8-132.7, $p$ = .00) measurements after three months (Doyle et al., 2019). In another study, obese adults in the intervention group who used an app called E-Networks Guiding Adherence to Goals in Exercise and Diet (ENGAGED) to self-monitor dietary intake and body weight through social networking features and a wireless accelerometer showed greater weight loss at six months when compared to the control group, which used paper and pencil diaries (intervention $M$ = 5.7 kg, 95% CI [−7.2, −4.1]; control $M$ = 2.7 kg, 95% CI [−5.1, −0.3], $p < .05$). However, at one year, no significant difference was found between the groups (Spring et al., 2017). In another study, participants diagnosed with uncontrolled hypertension used the EMPOWER-H app and demonstrated a significant reduction in body weight ($M$ = 1.2 kg, $SD$ = 4.5, $p$ = .002) after six months of using the app (Lv et al., 2017).

**Blood Pressure**

Evaluation of participant blood pressure was measured as a health outcome in only one study. Participants who used the EMPOWER-H app to manage and record their home blood pressure twice a day demonstrated improved systolic blood pressure ($M$ = -15.2 mm Hg, $SD$ = 15.3, $p$ < .001) and diastolic blood pressure ($M$ = -6.4 mm Hg, $SD$ = 7.5, $p$ < .001) after six months of using the app (Lv et al., 2017).

**Cholesterol**

Evaluation of participant cholesterol was measured as a health outcome in only one study, in which a significant reduction was reported. Participants using the MiKidney app to track physical activity, self-manage their diet, and maintain a healthy body weight demonstrated improvements in cholesterol ($p$ = .023) and LDL cholesterol ($p$ = .005) after three months (Doyle et al., 2019).

**Calorie Intake**

One study found a change in the percentage intake of carbohydrates, fats, and saturated fats. Participants at high risk for multiple chronic diseases using the EVIDENT II app and consuming a Mediterranean diet reported a higher percent intake of carbohydrates ($M$ = 1.1%, 95% CI [0.1, 2.0], $p$ = .023) and lower percent intake of fats ($M$ = −1.0%, 95% CI [ −1.9, −0.1], $p$ = .022) and saturated fats ($M$ = −0.4%, 95% CI [−0.8, −0.1] $p$ = .007) compared to the control group at one year (Recio-Rodriguez et al., 2018). Both groups decreased their energy intake (Kcal) overall ((intervention $M$ = −114, 95% CI [ −191, −36] $p$ < .01) (control $M$ = −108, 95% CI [ −184, −31] $p$ < .01)) (Recio-Rodriguez et al., 2018).

**Fruit or Vegetable Intake**

Three studies found a change in fruit or vegetable intake (Lv et al., 2017, Mummah et al., 2017, Spring et al., 2018). Adults that were obese and used an app called Vegethon for 2 months to self-monitor vegetable consumption demonstrated increased daily vegetable consumption ($M$ = 2 servings, 95% CI [0.1, 3.8], $p$ = .04) compared to the control group who received an eight-week delay for receiving the intervention (Mummah et al., 2017). Lv and colleagues (2017) also found that participants using the EMPOWER-H app to manage their blood pressure demonstrated a significant increase in frequency of consumption (times/week) of fruits and vegetables from baseline ($M$ = 25.5, $SD$ = 10.5) to six months ($M$ = 27.9, $SD$ = 11.3, $p$ = .01). Study participants at high risk for chronic disease were assigned to two active intervention groups (simultaneously or sequentially). The participants in these two intervention groups used a smartphone app and accelerometer to track targeted behaviors and received personalized remote coaching from trained paraprofessionals, while the control group received the app but no user feedback. Both simultaneous and sequential interventions increased their fruit and vegetable intake by 6.5 servings per day (95% CI [6.1, 6.8], $p$ < .001; $M$ difference from control = 6.2 servings per day, 95% CI [5.5-6.9]) and decreased saturated fat intake by 3.6% (95% CI [ – 4.1, – 3.1], $p$ < .001; $M$ difference from control = – 3.3%, 95% CI [ – 4.3 to – 2.2]) exceeding control by the end of the nine-month intervention (Spring et al., 2018).

**Overview of Bias**

Three of the included studies used pre/post-test designs that lacked a control group (Doyle et al., 2019, Lv et al., 2017, Sittig et al., 2020). Small sample size also contributed to bias, limiting adequate representation of adults living with chronic disease or high risk for developing chronic disease (Doyle et al., 2019, Sittig et al., 2020). Short duration of study (Doyle et al., 2019, Mummah et al., 2017, Sittig et al., 2020) and reliance on participant self-report (Alonso-Dominguez et al., 2019, Mummah et al., 2017, Recio-Rodriguez et al., 2018, Spring et al., 2018) were also considered to add to study bias. Several factors regarding characteristics of study participants including high educational level (Spring et al., 2018), 100% participant employment (Sittig et al., 2020), highly motivated to participate in study (Spring et al., 2017), and ability to use a smart phone prior to study enrollment (Doyle et al., 2019) limited generalizability therefore furthering the effects of bias. Three studies experienced a high attrition rate that also contributed to overall bias (Recio-Rodriguez et al., 2018, Sittig et al., 2020, Spring et al., 2017). Lack of blinding of participants (Alonso-Dominguez et al., 2019, Recio-Rodriguez et al., 2018), affordability (Doyle et al., 2019), and underestimation of treatment effects on both the intervention and control groups (Spring et al., 2017) were a few additional factors leading to bias.

## Discussion

Overall, this systematic review provided supporting evidence for the effectiveness of multifactorial interventions involving goal setting, educational counseling, and a mobile app for delivering education, tracking features, alerts, and motivational messaging compared to stand alone apps or standard of care. Our findings are similar to Schoeppe and colleagues (2016), in that multicomponent, app-based interventions to improve diet and physical activity across the life span appear to be more effective than a stand-alone app. However, it is still unclear the ideal number of app features and participant contact time needed to maximize improvement in health outcomes.

Significant health outcome improvements were found in the reviewed studies (Alonso-Dominguez et al., 2019, Lv et al., 2017, Recio-Rodriguez et al., 2018, Sittig et al., 2020, Spring et al., 2018, 2017) that used an app that included both diet and physical activity features. Studies that used apps focusing solely on diet (Mummah et al., 2017) or physical activity (Doyle et al., 2019) noted noticeably less improvement in health outcomes compared to studies that used both diet and physical activity features. Interestingly, the health outcome that was most influenced by the combination of diet and physical activity features in an app was the improvement in activity level. This finding is important because according to the American Cancer Society, inactivity increases a person's risk for premature death (Simon, 2018).

Overall, the literature from our review supports the feasibility of using mHealth apps to prevent and manage chronic disease. However, a downside is that all the reviewed studies used a custom-built app that is not offered to the general public, which limits the generalizability of the findings only to select chronic disease populations. Therefore, future mHealth research should consider testing multifactorial interventions involving consumer-based mHealth apps that use both diet and physical activity features comparing the number of app features, participant contact time, and health outcomes.

The studies in this review are not without their limitations. A common limitation, as mentioned above, was duration of study. The identified studies revealed the short-term health outcomes of tracking diet and physical activity through mHealth apps but failed to provide evidence suggesting that mHealth apps contribute to long-term management of chronic disease. Therefore, future research needs to consider the implementation of a long-term intervention to determine the sustainability of mHealth interventions for dietary and physical health management. Small sample size limited the generalizability of the results of this review. Additional studies with large sample sizes will diversify and strengthen the literature base. Studies with a pre/post-test design resulted in limited efficacy, as their mHealth interventions are not compared to the current standard of care for improving health outcomes. Finally, seven of the eight included studies neglected to research the health outcome of blood glucose, while a single study reported blood glucose but produced no significant results. Blood glucose is a necessary health outcome to consider for mHealth research, as diabetes is a prominent chronic disease that requires long-term management.

Our review provides a novel perspective in that a promising source for achieving an increase in activity time and decrease in sedentary time can be best achieved by using a mHealth app that incorporates both diet and physical activity features. It is clear that the future of health promotion and prevention involves mHealth technology focusing on diet and physical activity. Diet and physical activity are two important areas that must change when it comes to health promotion and prevention of chronic disease. Mobile health apps involving these two components allow individuals to assess their pattern of diet and physical activity, ultimately improving their overall heath and well-being.

## Conclusion

The data suggest that people living with chronic disease may benefit from using apps that combine physical activity and dietary features. The combination of physical activity and dietary features demonstrate promise for improving activity levels in adults living with chronic disease. However, more research is needed to determine the optimal type of mHealth app that combines these features needed to maintain long-term engagement.

**Figure 1**

*Study Selection Process*

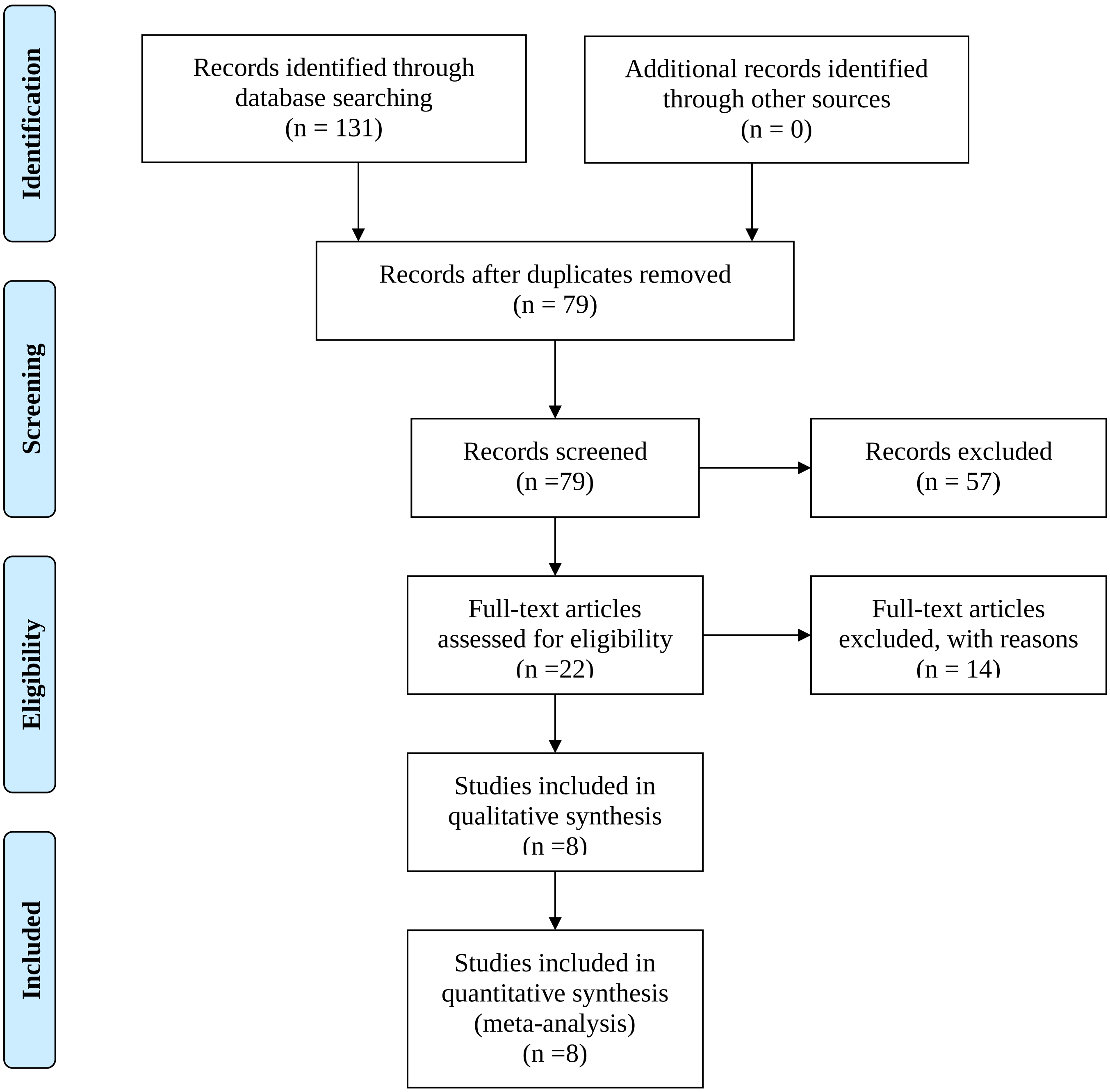

**Table 1**

*Characteristics of Selected Studies*

| First Author, Year, Country, Chronic Disease | Design and Sample Size | Mean Age | Intervention | Control | Duration | Major Finding/ Implication for Practice |
|---|---|---|---|---|---|---|
| Alonso-Dominguez et al., 2019<br><br>**Country:** Spain<br><br>**Chronic Disease:** Type 2 diabetes | **RCT**<br><br>N=204<br><br>n= 102 Intervention<br><br>n= 102 Control | Intervention = 60.4<br><br>Control = 60.8 | 1. Standardized counselling on physical activity (recommendation of 10,000 steps per day) and a healthy diet (MyPlate method).<br><br>2. Engaged in heart-healthy walks (30 minutes) one time per week for five weeks.<br><br>3. Received a smartphone app for lifestyle and vascular aging called EVIDENT II to record diet and physical activity. | 1. Standardized counselling on physical activity (recommendation of 10,000 steps per day) and a healthy diet (MyPlate method). | 12 months | **Major Finding:** After 12 months of using the multifactorial intervention (use of EVIDENT II app, diet/physical activity counseling, and heart healthy walks) the intervention group increased daily steps, aerobic steps, and distance walked compared to the control group.<br><br>**Implications for Practice**: The results support the clinical relevance of a multifactorial intervention as compared the standard management in patients with type 2 diabetes. Interventions that include mobile apps hold promise for modifying physical activity levels and reducing sedentary time. |
| Mummah et al., 2017<br><br>**Country**: USA<br><br>**Chronic Disease:** Obesity | **RCT**<br><br>N=135<br><br>n = 68 Intervention<br><br>n= 67 Control | Intervention = 40.3<br><br>Control = 39.4 | 1.Completed a short online tutorial that described the use of the mobile app Vegethon.<br><br>2. Vegethon is a stand-alone mobile app that enables goal setting and self-monitoring of vegetable consumption. | 1. Experienced an eight-week delay in receiving the intervention condition. | 2 months | **Major Finding:** Daily vegetable consumption was significantly greater in the intervention versus control condition.<br><br>**Implications for Practice**: The Vegethon app has potential to be low-cost, scalable, and an effective intervention to support dietary behavior changes among obese adults trying to achieve weight loss.<br>. |
| Doyle et al., 2019<br><br>**Country**: Ireland<br><br>**Chronic Disease:** Chronic kidney disease | **Pre/Post-Test**<br><br>N=20 | 50.1 | 1. Participants received an app called MiKidney. The MiKidney app records medical history, weight, current medication list, information pertaining to chronic kidney disease, renal diet, renal replacement treatment options, and symptom management. The app includes an exercise tracker, reminder alerts, and a note section to record any questions to be discussed with the healthcare team. The app also provides feedback to users including motivational messages<br><br>2. Renal nurses assisted participants with inputting personal data. | N/A | 3 months | **Major Finding:** The participants found the app easy to navigate**.** Significant improvements were found in the six-minute walking test, total cholesterol, LDL cholesterol, waist circumstance, and body fat.<br><br>**Implications for Practice**: The MiKidney app has the potential to empower and motivate patients to understand and self-manage their condition by providing them with the necessary information on renal diet and symptom management. |
| Spring et al., 2017<br><br>**Country**: USA<br><br>**Chronic Disease:** Obesity | **RCT**<br><br>N=96<br><br>1.Self-guided (SELF) n=32<br><br>2. Standard (STND) n=32<br><br>3. Technology-supported (TECH) n=32 | 39.3 | **TECH Group:**<br>1. Participants received a smartphone application for six months called, ENGAGED. The ENGAGED app has social networking features to self-monitor dietary intake and body weight.<br><br>2. Participants wore a wireless accelerometer, received eight in-person group treatment sessions, coaching calls, text messages, and social networking for six months. | **SELF Group:**<br>1. Participants received a calorie counting book and paper dairies for six months. | 6-month intervention and 12-month follow up | **Major Finding:** Weight loss was greater for TECH and STND than SELF at six months. Two abbreviated interventions combining face-to-face and telephone treatment but differing on whether self-monitoring was done via smartphone versus paper yielded more weight loss than a self-guided intervention at three and six months.<br><br>**Implications for Practice**:<br>Self-monitoring can produce clinically meaningful weight loss regardless of whether self-monitoring is performed on |

| First Author, Year, Country, Chronic Disease | Design and Sample Size | Mean Age | Intervention | Control | Duration | Major Finding/ Implication for Practice |
|---|---|---|---|---|---|---|
| | | | **STND Group:**<br>1.Participants received a calorie counting book and paper dairies for six months.<br><br>2. Received eight weekly group session coaching calls, text messages, and social networking. | | | paper or smartphone. However, long-term self-monitoring remains a challenge. |
| Lv et al., 2017<br><br>**Country**: USA<br><br>**Chronic Disease:** Hypertension | **Pre/Post-Test**<br><br>N=149 | 62.2 | 1. Received a wireless blood pressure (BP) monitor that transferred BP readings to an electronic medical record.<br><br>2. Received a smartphone with two apps with a comprehensive dashboard for viewing a personalized action plan, treatment goals, and self-monitoring data.<br><br>4. Received a pedometer for monitoring steps.<br><br>5. Received a web-based messaging system for communicating between the participant and members of the care team.<br><br>6. Received consultation visits for nutrition, weight, and medication.<br><br>7. Received a text link for a library of web-based, educational handouts and feedback messages.<br><br>8. Participants were instructed to measure and upload BP readings in the morning and evening for at least three days a week over the six-month intervention period. They were also asked to wear the pedometer daily. | N/A | 6 months | **Major Finding:** At 6 months, 55.9% of participants (N=83) achieved office BP goals (<140/90 mm Hg; $p < .001$) and 86.% achieved clinically meaningful reduction in office BP (reduction in systolic BP [SBP] ≥5 mm Hg or diastolic BP [DBP] ≥3 mm Hg). After six months participants demonstrated increased intake of fruit and vegetables, minutes of aerobic exercise, and hypertension knowledge (all $p < .05$).<br><br>**Implications for Practice**:<br>The data from this study suggest that technologically enabled BP home-monitoring, with structured use of patient-generated health data and a personalized care-plan facilitating patient engagement, can support effective clinical management. |
| Sittig et al., 2020<br><br>**Country**: USA<br><br>**Chronic Disease:** Type 2 Diabetes | **Pre/Post-Test design**<br><br>N=20 | 54.7 | 1. Participants received an app called capABILITY. The capABILITY app consisted of three distinct educational modules focusing on diet, exercise, and self-management. The information in each module was presented by short videos and text files.<br><br>2. Participants also received two types of text message triggers called a spark (motivational message) or facilitator (reminder message) three days a week. | 1. Received the capABILITY app but received no text message triggers (spark or facilitator message). | 9 weeks | **Major Finding:** Pre-and post-intervention results indicated statistical significance on knowledge for general diet, exercise, and blood glucose. When only analyzing the high and midusers (n=14) for capABILITY app use, a significant difference was found in both self-efficacy and exercise.<br><br>**Implications for Practice**:<br>The data suggest that spark triggers may have the ability to cue engagement in mobile tools. |
| Recio-Rodriguez et al., 2018<br><br>**Country**: Spain | **RCT**<br><br>N=833<br><br>n= 415 Intervention | Intervention = 51.4<br><br>Control = 52.3 | 1. Received three months of counseling (Mediterranean diet and physical activity) and EVIDENT app (diet and physical activity recording). | 1. Received three months of counseling (Mediterranean diet and physical activity). | 12 months | **Major Finding:** Better results (percentage intakes of fats and saturated fats) were achieved in terms of modifying usual diet composition from counseling and the diet smartphone application compared to counseling alone. |

| First Author, Year, Country, Chronic Disease | Design and Sample Size | Mean Age | Intervention | Control | Duration | Major Finding/ Implication for Practice |
|---|---|---|---|---|---|---|
| **Chronic Disease:** High risk for chronic disease due to low fruit and vegetable consumption, high fat intake, and physical inactivity. | n= 418 Control | | | | | **Implications for Practice**: The data suggest that people living with chronic disease, such as diabetes or obesity, may benefit from strategies that combine nutritional counseling and mobile app technologies. |
| Spring et al., 2018<br><br>**Country**: USA<br><br>**Chronic Disease:** High risk for chronic disease due to low fruit and vegetable consumption, high fat intake, and physical inactivity. | **RCT**<br><br>N= 212<br><br>n = 84 Intervention (simultaneous)<br><br>n = 84 Intervention (sequential)<br><br>n = 44 Control | Intervention (simultaneous) = 40.7<br><br>Intervention (sequential) = 40.9<br><br>Control= 40.8 | **Simultaneous Intervention:** Received a custom-built smartphone app to record behaviors (dietary intake, leisure screen time, stress level, relaxation exercises, and sleep).<br><br>**Sequential Intervention:** Received a custom-built smartphone app to record behaviors (dietary intake, leisure screen time, stress level, relaxation exercises, and sleep). | 1. Received a custom-built smartphone app to record behaviors (stress reduction and sleep). | 9 months | **Major Finding:** Both simultaneous and sequential interventions produced large, sustained improvements exceeding control. At nine months, the interventions increased fruits and vegetables, decreased fat intake, and increased minutes of physical activity per day<br><br>**Implications for Practice**: The data suggest a multicomponent mHealth diet and activity intervention involving connected coaching hold potential to reduce chronic disease risk. |

**Table 2**

*Health Outcomes of Selected Studies*

| Study | Type of App | | | Health Outcomes | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Author et al., year | Dietary | Physical activity | Both | Activity level | Weight | Blood pressure | Glucose | Cholesterol | Calorie intake | Fruit or vegetable intake |
| 1.Alonso-Dominguez et al., 2019 | | | X | +(b) | 0 | | 0 | | | |
| 2.Mummah et al., 2017 | X | | | | | | | | | +(b) |
| 3.Doyle et al., 2019 | | X | | +(w) | +(w) | | | +(w) | | |
| 4.Spring et al., 2017 | | | X | | +(b) | | | | | |
| 5.Lv et al., 2017 | | | X | +(w) | +(w) | +(w) | | | | +(w) |
| 6.Sittig et al., 2020 | | | X | +(w) | | | | | | |
| 7.Recio-Rodriguez et al., 2018 | | | X | | | | | | +(w) | 0 |
| 8.Spring et al., 2018 | | | X | +(b) | | | | | | +(b) |

*Note*. + (b): between-group significant improvements in favor of app intervention group, − (b): between-group significant improvements in favor of non-app control group, + (w): within-group significant improvement, 0: no significant change

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