Use of Digital Technologies in the Nutritional Management of Catabolism-Prone Chronic Diseases: A Rapid Review

Apps for Nutritional Management of Chronic Disease

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Abstract:

Background: Diet and nutrition applications (apps) have become more readily accessible as smartphone ownership increases. These apps have the potential to improve nutritional outcomes, but it remains unclear whether they are effective in patients with catabolism-prone conditions and specialized nutritional needs. **Aims:** The primary aim of this rapid review was to determine if delivery of a nutrition intervention via an app was more effective than standard care in improving nutritional outcomes in patients with a selected set of catabolism-prone chronic diseases. Secondary aims included summarizing intervention components and reviewing adherence and acceptance. **Methods:** The research question was developed using the Population, Intervention, Comparison, Outcomes (PICO) framework. Comprehensive literature searches were conducted across three databases. Screening, study selection, extraction, and risk of bias (RoB) assessment were conducted for the included randomized clinical trials (RCTs). **Results:** 15 articles were included, including 5 RCTs; 3/5 RCTs were judged to be at high RoB. The study aims, measured outcomes, and intervention components were diverse. Adherence and acceptance to the app interventions were encouraging. **Conclusions:** Due to the heterogeneity of study design, nutrition interventions, outcomes, and reporting across studies, we were unable to aggregate data regarding the impact on nutritional outcomes. Reassuringly though, the available evidence suggests high adherence and acceptance, which needs to be interpreted in light of the associated personnel support provided within each study. The use of digital technology to deliver diet and nutrition interventions in catabolism-prone conditions is feasible, easy to adhere to, and well-accepted by participants.

Keywords: nutrition, diet, application, mhealth, ehealth, chronic diseases

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1. Introduction

With advances in technology, diet and nutrition applications (apps) have become more readily accessible. An estimated 45% of the world's population in 2020 had a smartphone, and this number will only increase as nations continue to develop [1]. Smartphone users can find and download hundreds of different apps in mobile app stores with functionalities such as food composition databases, food intake diaries, nutrition education, and recipes. These tools can assist dietitians and other health care professionals implement dietary interventions to promote changes in dietary intake.

Many chronic diseases increase risk of malnutrition due to disease related catabolic processes [2]. Chronic diseases such as cancer, renal failure, heart disease, chronic obstructive pulmonary disease and chronic liver disease are a few associated with multifactorial catabolic processes that may ultimately lead to malnutrition. Malnutrition in turn is associated with increased rates of morbidity, mortality, and extended hospital stays [2]. These catabolism-prone conditions remain amongst the most prevalent diseases across North America, and in Canada, at least one in three Canadians lives with at least one major chronic disease [3]. Fortunately, specific nutrition recommendations exist for each chronic disease aimed to reduce the risk of malnutrition and other poor outcomes. With an increasing number of the population owning a smartphone, having access to the internet, and using digital technology [1], the use of apps holds promise as an innovative approach for accessible tailored nutritional interventions.

Although validated assessment frameworks, such as the Mobile App Rating Scale (uMARS) are available to reliably assess apps [4], unfortunately a comprehensive evaluation of all available apps is challenging, as new apps are being developed and added to digital marketplaces faster than they can be assessed [5]. As such, many commercially available apps are

already in use in health care settings without proof of their quality [6]. This poses a particular challenge to individuals with chronic diseases as the content may not correspond with evidence-based and disease-specific nutrition recommendations.

As summarized in several systematic reviews, [6-8] studies have been conducted to review the quality of nutrition related apps and their effectiveness in the management of chronic disease. Notably, there is a shortage of studies in populations outside of obesity, diabetes, and healthy individuals. The primary objective of this review was to determine if the use of a digital technology (app) to deliver a nutrition intervention would be more effective than standard care in improving nutritional outcomes in patients with a selected set of catabolism-prone chronic diseases, including cancer, kidney, heart, respiratory, and liver diseases. Our secondary objectives were focused on summarizing intervention components, including the: (i) description of the app and its functionality, (ii) nutrition recommendations driving the intervention, (iii) additional co-interventions including behavioral frameworks and the personnel who delivered the intervention, (iv) intervention adherence, and (v) intervention acceptability.

2. Methods

This rapid review utilized the unpublished rapid review protocol written by SKJ and MK [9]. A detailed overview of the methods and approaches used in this rapid review can be found in Appendix 1.

Search Strategy

Comprehensive search strategies were developed and executed with assistance from a University of Alberta Health Sciences Librarian. The three databases searched in this rapid review included MEDLINE (1946-March 4th, 2021), EMBASE, and the Cochrane Library (reviews and trials). In addition to the initial search strategies, the author performed basic manual

searches by reviewing reference lists from included articles for additional relevant trials. Detailed documentation on search strategy terminologies can be found in Appendix 2.

Eligibility Criteria

Studies conducted with patients with cancer, kidney, heart, respiratory, or liver diseases were included. Inclusion and exclusion criteria was defined using the Patient/Population, Intervention, Comparison, Outcomes framework (PICO) outlined in Table 1 [(10)].

Study Selection and Data Extraction

Consistent with rapid review requirements, study selection and data extraction were conducted by a single reviewer. A senior researcher checked study selection and extraction for a randomly selected 10% of the included studies to verify accuracy of eligibility and extraction. Extraction was completed using a pre-defined data extraction form. Reference lists of included trials and applicable systematic reviews were reviewed during the extraction and additional articles meeting the inclusion criteria were added to the review.

Quality Assessment

The quality of included randomized controlled trials (RCTs) was assessed by a single reviewer using a pre-defined extraction form based on the revised Risk of Bias (RoB) tool for assessing risk of bias in randomized trials [(11)]. The quality assessment included evaluation of RoB due to the randomization process, deviations from the intended interventions, missing outcome data, measurement of outcome, and selection of the reported result. A random 10% of the quality assessments were reviewed by a senior researcher to verify accuracy.

4. Results

The initial database searches, hand-searches, and reference list examinations yielded 1041 articles. After removal of duplicates, abstract screening, and full text review, 15 articles

met the inclusion criteria and were extracted. The most common reason an article did not pass the full text review was due to an ineligible patient population (n = 23). Results are summarized in Tables 2-5.

Description of included studies

A summary of the included studies can be found in Table 2. Five articles (33%) were RCTs, while the remainder were primarily non-randomized experimental studies (n = 9; 60%) with one case study (7%). Except for one, included articles were published after 2010, with the majority (n = 10; 67%) published within the past 5 years. The mean study duration was ~9 weeks, the shortest study only two weeks and the longest up to 6 months. Most of the studies were conducted in the United States (n = 8; 53%); other countries included New Zealand (n = 2), Taiwan (n = 2) Canada (n = 1) United Arab Emirates (n = 1), and Germany (n = 1). Most articles included in the review focused on patients with cancer or chronic kidney disease (CKD) (n = 6, 40% each respectively) with the remainder of the studies focused on patients with cardiovascular disease (CVD) (n = 3, 20%). None of the included articles focused on a population with chronic lung or liver disease. Three articles focused specifically on minority and/or African American participants. The number of participants ranged from one (i.e. in the case study) up to 66. Across articles that reported the age of participants, the mean age and standard deviation was 53.3 ± 9.6 years. No obvious differences in sex were noted, however three studies included only females due to the nature of the population studied (breast cancer) [12-14].

Primary objective – Summarizing the effect on nutritional outcomes

A summary of each study's aims is found in Table 2 and of measured nutrition outcomes in Table 3. Not surprisingly, the aims and measured outcomes varied, but were similar within the specific patient populations studied. For example, in studies including patients with CVD (n = 3)

the aims and interventions primarily revolved around the heart healthy diet [15] including reducing sodium, following other cardioprotective dietary patterns, and weight loss [15-17]. In studies on CKD (n = 6) adherence to the kidney or dialysis diet, and sodium, fluid, and electrolyte reduction were the focus [18-22]. Additionally, one study on CKD assessed an app that looked at phosphate counting and phosphate binders [23]. In studies on patients with cancer (n = 6), the most common aim and intervention theme was on weight management [12-14, 24]. One cancer app included assessment of changes in macronutrient intake [25], and another aimed to prevent malnutrition in patients undergoing gastrectomy [26].

A summary of the impact on nutritional outcomes can be found in Table 3. Due to the heterogeneity across apps, study aims, designs and interventions, the effect of app use on nutrition-related outcomes could not be pooled. Notably, most researchers reported positive outcomes and there were no adverse events related to app use. Further, one study reported that their non-app control group had a trend for worse nutrition outcomes [25] in comparison to their app groups. There were noteworthy significant positive results from app intervention groups in many of the studies (n = 12) including significant decreases in sodium intake, increases in energy and protein intakes and aspects of diet related self-efficacy or control, as well as improvements in anthropometric measures.

Secondary objectives

(i) Description of the app and its functionality

A variety of apps were used in the included studies with a summary of apps presented in Table 3. In most studies, the name of the app was mentioned, and a description of its functionality provided within or by use of an external reference (n=12). Seven studies provided screenshots of the app within the article [13, 15, 19, 20, 23, 25, 26]. Several apps were made in

collaboration with clinical health care or research teams [13, 15, 18-23, 25]. Only three studies included a specific section outlining the app development process [19, 25, 26]. In one of the pilot studies, a comprehensive nutrition record review of their study population was conducted and detailed to develop the novel app used in the intervention [25]. Another study mentioned the use of the Integrate, Design, Assess, and Share framework to develop their app [19] [27]. Other researchers opted to use popular commercially available apps [14, 17, 24].

(ii) Nutrition recommendations on which the interventions were based

All studies provided a broad description of the nutrition recommendations, for example, reducing sodium or calories or following a disease specific diet or receiving tailored dietary goals. However, only five studies commented on the reference which formed the nutrition recommendations and content in the apps [19-22, 25]. Only three articles included in depth elaboration on the specific nutrient recommendations or dietary prescription that were used in the intervention and app [18, 19, 24].

(iii) Description of the study co-interventions including behavioral frameworks, the personnel which delivered the intervention

Only two studies focused on the use of the nutrition app as the sole intervention [15, 23]. The remaining studies incorporated a variety of additional co-interventions. The most common adjunct to the apps included a form of nutrition or behavioral counselling, observed in most studies (n = 10) [12, 16-21, 24-26]. Further, the frequency of nutritional or behavioral counselling also varied from a single session [12] to as needed, based on app input, weight changes [26], or scheduled weekly meetings [19]. Physical activity and tracking were another component included in several studies [13, 14, 24].

With respect to overall behavioral frameworks, most researchers (n=9) highlighted the importance of behavior change theories or frameworks and incorporated aspects into their intervention in some way [12, 14, 16-19, 21, 22, 24]. The mentioned theories or frameworks included Social Cognitive Theory, the Naturalistic Decision-Making Theory, the Situated Learning Theoretical Perspective, Carver and Scheier's Control Systems, Motivational Interviewing, Theory of Planned Behavior, the Transtheoretical Model, the Reasoned Action Approach, and Self-Regulation theory. Notably, one study outlined their use of the mHealth development and evaluation framework to develop their intervention in a systematic process [16].

The personnel involved in delivery of the nutrition intervention also varied. Not surprisingly, for the articles that mentioned personnel, either registered dietitians or nutritionists were reported as the primary interventionists [12, 13, 18, 19, 21, 26]. In addition to a dietitian, a few studies mentioned involvement of a multidisciplinary team [16, 24, 25]. Other notable intervention personnel involved research assistants trained by a dietitian [20], nurses [17] and public health and computer science students [22].

Lastly, in addition to the primary app intervention, many studies used several technologies or even other apps in their intervention. For example, one study provided intervention participants with two separate apps [20], another had a supporting mobile nutrition website [16], and a few included the use of wearable devices or other tracking devices [12, 20].

(iv) Intervention adherence

A summary of the adherence measures and results can be found in Supplementary Table 1. Most studies assessed and reported the degree of adherence to at least one aspect of the intervention, whether it be to the app or other intervention components. The definitions of adherence and tools used varied between studies. Most research teams measured adherence via

self-reported questionnaires, attendance to study visits, or in-app analytics such as number of meals or days logged. Overall, adherence to the app interventions was encouraging across studies. Studies that considered adherence as attendance to counselling sessions or clinic appointments noted excellent adherence. For example, one study reported 97.1% adherence to their in person visit [12] and another reported 98.5% adherence to their intervention overall [17], but did not go in depth about what the definition of adherence was. Although of short duration, one study reported that all participants (n = 23) attended every weekly session with the dietitian over the two-week study [19].

Fortunately, studies that had in-app analytics had valuable commentary on the adherence to app usage. For example, in the case study, a patient logged ≥ 3 meals/day each day for a total of 342 meals over 14 weeks [18]. Other studies, based on varying definitions of adherence and measurement methods noted promising adherence rates ranging from 60% – 90.6%. Notably, in one of the studies using an in-app analytics, adherence to app usage was significantly correlated with improvements in one of their measured nutrition outcomes [14]. One study noted that app adherence decreased over time, particularly for logging in food [14], while another reported that adherence was consistent throughout the study [21].

Several strategies were used to increase adherence (Supplementary Table 1) including establishing an adherence goal for logging[13, 14, 24], regular reminders such as weekly texts or emails[14, 25] and in-app functionalities. One app informed researchers of non-adherence to the intervention based on user input, informing the research team to initiate a nutrition intervention [23], and another had an acoustic signal that would go off to remind the participant to use the app [25]. Motivational statements and programs were also used. For example, the commercially available app used in one study provided participants with access to motivational feedback and

automatically generated push notifications based on user input and app usage [24]. Another study provided intervention participants with a second app that provided inspirational messages [20]. Lastly, a handful of studies incorporated a monetary incentive for participation in the study and attendance [12, 14, 15, 21].

(v) Intervention acceptability

A summary of the tools to measure acceptability can be found in Supplementary Table 1. In line with the high adherence to the apps in the included studies, apps acceptance and interventions were also predominantly positive. These were typically assessed via post-intervention surveys or questionnaires and review of informal comments made by participants. [19]. In several studies (n=12), researchers were able to state that most participants found the apps easy to use or were satisfied with the corresponding interventions based on their method of assessment [12-17, 19-23, 25]. Notably, in one study, all participants (n = 23) selected "strongly agree" for all questions on a post-intervention acceptance survey of study app [19]. Further, in a studies that asked, most participants (n = 24/29) reported that they would continue to use the respective app even after study completion [23], although they did not assess if this occurred. In another study, all intervention group participants (n = 24) stated they would recommend the app and intervention to others [12]. Of note, participants in one study reported that they preferred the study app over other commercially available mHealth apps [13]. Negative feedback was also received. For example, apps were switched in a study due to negative feedback towards the first app used; not surprisingly, mixed feedback was received for app satisfaction [21]. Another study reported that participants did not comment or did not use the provided supplementary nutrition website/app as they found it time consuming [16]. In a study that utilized a wearable smart wristband, 25% of participants felt that wearing the smart wristband was inconvenient [20].

Notably, only one study mentioned future plans to validate their utilized app using the uMARS [19].

Quality assessment of RCTs

A summary of the quality assessment for the RCT's can be found in Table 4. Based on the author's quality assessment of the five RCTs, three of the RCTs were judged to have a high RoB [12, 14, 22].

5. Discussion

This rapid review included studies that used an app to improve nutrition related outcomes in participants with a selected set of chronic diseases prone to catabolism. The chosen chronic diseases were selected because of the specialized nutritional needs of these patients, which would not necessarily be addressed by non-specialized apps. For instance, a recent review of 12 commercially available cancer apps found that six apps contained potentially harmful nutrition related content that did not align with evidence-based recommendations [28].

Unique from existing reviews in this area, we excluded studies in healthy populations or studies focused on glycemic control management or weight loss in individuals without the mentioned set of chronic diseases. Perhaps not surprisingly, the search did not yield many studies (n=10) and even fewer RCTs (n=5). Further, our search did not yield any studies focusing on patients with lung or liver diseases, demonstrating knowledge gaps. Most were published within the past five years, aligning with the rapid increase of smartphone and technology and its integration into clinical care. In addition, most studies were pilot and feasibility trials, indicating that comprehensive randomized trials are needed to solidify the evidence in this area. Despite these limitations, several relevant themes arose among the results.

Although we were unable to aggregate the efficacy data due to the heterogeneity of study designs, nutrition interventions and outcomes, all studies (n=15) reported either positive trends or significant improvements in one or more nutrition-related outcomes and the absence of adverse events. As most studies used multifaceted approaches in addition to app use, such as a physical activity component (n=3), or nutritional counselling (n=10), it is difficult to differentiate which component of the intervention was responsible for the changes in outcomes. Nutritional counselling itself has been recognized as the first line approach to optimal nutritional management of chronic disease, and has been well documented as effective in improving nutrition related outcomes [29]. Therefore, in studies that implemented nutritional counselling as a co-intervention with the app (n=10), the positive effect on nutrition-related outcomes may be largely due to the addition or increased frequency of nutrition counselling, as has been demonstrated in other work [29].

Study findings may not be easily generalized outside of the research context, unless the same supports are provided to participants in the "real-world" setting as were provided in the study setting. In the study context for example, researchers and clinicians can actively monitor the health status of participants and communicate specific nutrient requirements verbally; or, if the functionality is available within the app, they can customize each user's targets. In the real-world setting, individuals with catabolism-prone conditions can find and easily download hundreds of different apps in mobile app stores, a minority of which are targeted for their specific condition. In the context of commercially available apps, concerns have been raised about the accuracy of the health information, as they are not scrutinized by regulatory bodies [4]. By the same token, even well-developed commercial apps used in the "real-world" setting

without monitoring by trained health-care professional or guidance from a nutrition expert may lead to misinterpretation and potential harm [30].

A small proportion of the included studies were RCTs and of them, more than half were deemed at high risk of bias. The bias is predominantly related to deviations from the intended intervention and measurement of outcome domains. This is not unexpected with an app-based intervention, as blinding of participants, personnel, and outcome assessors is challenging. Within the realm of what is modifiable, future studies assessing apps should consider any opportunities to reduce bias, including utilizing additional staff to collect outcome data and implement methods so that interventionists are blinded to produce reliable unbiased results.

Surprisingly, although all studies included the use of an app as the primary intervention, detail on the app's development, functionalities and content were not reported in a consistent fashion to allow for comprehensive comparisons. In general, apps that were developed specifically for the study population tended to include more app-specific information [13, 15, 18-23, 25] in comparison to studies using commercially available apps [14, 17, 24]. Seven studies went as far to provide screenshots of the app within their papers [13, 15, 19, 20, 23, 25, 26]. This provides readers with valuable visual context of the app. Limited information was provided regarding the app development process and only one group shared the specific framework used for their app development [19]. Only a handful of studies provided commentary on the nutrition guideline or reference (n=5), and except for a few (n=3), most studies did not provide a detailed outline of the specific numerical nutrient recommendations or dietary prescription used in the intervention and app. Inclusion of this information is important in assessing the efficacy and generalizability of app interventions as it provides context on what nutrition goals are being communicated to participants. Knowledge of the specific recommendations also allows for generalizability to

future trials, especially since patients with catabolism-prone chronic disease have specialized nutritional needs, such as heightened protein and caloric requirements [31].

It is known that interventions that are informed by a behavioral change framework are associated with greater adherence, assist with understanding and measuring effectiveness [32] and provide standardization for effective replicable interventions [33]. Accordingly, comprehensively developed interventions that forgo behavioral change frameworks can fail to change outcomes due to lack of adherence [34]. In the studies which referenced behavior change strategies (n=9), a total of 9 different strategies or frameworks were identified. Adherence was evaluated in most studies (n=12). In most cases, it was defined based on either app usage or adherence to other aspects of the intervention such as attendance to nutritional counselling or research visits. Although the data was compelling, the definition of adherence varied between studies, and thus, limited our ability to synthesize the results. While informative, defining adherence as attendance to in-person visits does not provide insight on user experience, and future studies should ideally consider incorporating a blend of adherence definitions and measurements to capture this in relation to both the intervention and the app itself. Notably, each research team implemented strategies to increase adherence in some form, ranging from goals, reminders from staff, and in-app functionalities. Monetary incentives were incorporated into a few trials [12, 14, 15, 21], which likely positively impacted adherence but would be less likely to be sustainable in real world settings. Other strategies would more easily be translated into use in the real world, especially the in-app adherence functionalities.

Despite a few cases of negative feedback, most individuals who were enrolled in the studies were accepting to using the apps. Although not assessed, it is promising that many participants in one study reported that they would continue to use the app after the study

completion [23]. However, it should be noted that for many studies, important inclusion criteria were that eligible participants own a smartphone or open to using a smartphone. As such, this likely affected overall acceptance of the interventions, as those enrolled were likely already familiar with using apps. User acceptability is an important factor to measure as it can help researchers to understand adherence rates and consequently impact on outcomes.

To our knowledge it was noted that only one study [19] mentioned plans to utilize the uMARS [35]. The uMARS includes assessment of a variety of aspects of mHealth apps, including functionality, aesthetics, information, and subjective quality [4]. In this rapid review, the limited data provided on the apps used in each study suggests that reporting on many of these aspects needs optimization. With respect to novel apps developed for research, the uMARS tool can allow researchers to critically evaluate the quality of their app during the development and testing process, which may result in overall improvements in app quality [35]. Further, the uMARs tool can also be conducted on commercially available apps, to determine if the app is a high quality and suitable for their patient population. For example, one study [21] chose to use the commercially available app MyFitnessPal™ from dietitians' anecdotal experiences and field testing. Use of the uMARS or other app assessment tools in app intervention studies may result in improved app quality, and with down-stream improvements in adherence, acceptance and most importantly, nutritional outcomes.

Our initial research question was to determine the efficacy of these apps on nutritional outcomes; however, our broad range of findings shifted our focus to our secondary objectives around intervention components. To help facilitate the future synthesis of trials that use digital technology to deliver a nutrition intervention, we recommend a minimal set of suggested items that all studies could report, seen in Figure 2.

Strengths and Limitations

This rapid review search was comprehensive, developed in conjunction with an experienced health science librarian, and included three large databases. As with all reviews, there is a possibility that relevant trials were missed. We did not perform a quality assessment of non-RCT studies. Due to the study heterogeneity, we were unable to pool results or identify clear differences among the different chronic pathologies that were evaluated.

6. Conclusion

Although apps for the nutritional management of selected catabolism-prone chronic diseases remain in their infancy, it is evident that interventions using diet and nutrition apps are promising, feasible, easy to adhere to, and well-accepted by participants. As the prevalence of these conditions continues to increase, so does the need for more accessible virtual interventions. Subsequent research will no doubt see an increasing number of studies that evaluate app-based nutrition interventions. To promote a deeper understanding of the intervention, encourage generalizability and allow for aggregation of results across studies, future studies should ideally aim to include more detailed information on the app, nutrition recommendations, co-intervention components, adherence, and acceptance.

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Statement of Authorship

All authors are responsible for the reported research and have participated in the concept and design; analysis and interpretation of data; drafting or revising of the manuscript and have approved the manuscript as submitted.

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Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Diagram for the article screening, selection, and extraction process for Use of Digital Technologies in the Nutritional Management of Catabolism-Prone Chronic Diseases: A Rapid Review

Figure 2. Important items to report in future trials using digital technologies to deliver a nutrition intervention

App = application, uMARS = Mobile App Rating Scale

Table 1. Population, Intervention, Comparison, Outcomes framework for the research question

	Inclusion Criteria	Exclusion Criteria
Population	Adults with one of the following catabolism-prone chronic diseases • Cancer • Kidney disease and/or renal failure • Heart disease • Respiratory disease • Liver disease	Healthy subjects Adults with diabetes or obesity only
Intervention	Nutrition intervention with use of a digital technology (diet or nutrition app) on any platform	No nutrition intervention Exercise only
Comparison / Control	Any comparison No comparison	
Outcomes	Nutrition outcomes • Food-/nutrition-related outcomes • Anthropometric measurements • Pertinent clinical/biochemical data outcomes • Nutrition-focused physical findings	
Other	English Intervention / Clinical trial studies	App development only Abstracts only Reviews Letter to editor papers Opinion papers Foreign language

Table 2. General description of studies

Publication year, first author, country of origin	Article title	Study design, duration of study	Aim of Study	Population	Total Number of Participants included in analysis	Age and Sex of Participants	Control Group	Intervention Group
2017, Helen Eyles, New Zealand	A salt-reduction smartphone app supports lower-salt food purchases for people with cardiovascular disease: Findings from the SaltSwitch™ randomized controlled trial	RCT: 6 weeks (4-week intervention)	Primary: Determine the short-term effectiveness of the Saltswitch™ smartphone app in supporting people with cardiovascular disease to make lower salt choices. Secondary: Determine the effectiveness of SaltSwitch™ in reducing the saturated fat content, energy content, and expenditure of house-hold food purchases, systolic blood pressure, urinary sodium, and use/acceptability of the Saltswitch™ app	Persons with CVD or the household shopper of the persons with CVD	66	64 (±7), 83% male, 17% female	Shop as normal and accessed usual cardiac rehab services	Use of Saltswitch™ App
2017, Rameez Imtiaz, Canada	A Pilot Study of Okkidney™, A Phosphate Counting Application in Patients on Peritoneal Dialysis	Non-randomized experimental study: 30 days	Evaluate the beta version of OkKidney, a phosphate counting app that matches meal phosphate content with binder dose. Examine patient utilization, experience with the application, and its impact on serum calcium, serum phosphate, and calcium intake as a phosphate binder	Patients with ESKD treated with PD	10	55 (± 17.5), 50% male, 50% female	N/A	Use of OkKidney™ iOS app
2008, Mary Ann Sevick, United States	A PDA-based dietary self-monitoring intervention to reduce sodium intake in an in-center hemodialysis patient	Case control study: 14 weeks	Determine the efficacy of a dietary intervention to reduce dietary sodium intake in patients receiving in-center hemodialysis with a PDA-based dietary self-monitoring paired with behavioral counseling.	African American Male on in-center HD	1	57: 100% male	N/A	Use of BalanceLog™ Software on a PDA
2014, Leila Pfaeffli Dale, New Zealand	Cardiovascular Disease Self-Management: Pilot Testing of an mHealth Healthy Eating Program	Non-randomized experimental study: 4 weeks	1. Determining the degree to which people with CVD engage with mobile technology and their interest in this type of intervention. 2. Evaluating the acceptability of an mHealth healthy eating CR program Secondary aim was to explore trends towards changes in self-efficacy to eat a heart healthy diet	Adults with CVD	20	52 (±15.5), 50% male, 50% female	N/A	Received daily texts and use of mobile technology and supporting nutrition website

2017, Carmina G. Valle, United States	Preventing weight gain in African American breast cancer survivors using smart scales and activity trackers: A randomized controlled pilot study	RCT: 6 months	Evaluate the feasibility and preliminary efficacy of two 6-month, remotely delivered, self-regulation interventions that focused on daily self-weighing and used objective monitoring and tailored feedback on weight only, or weight plus activity, to promote weight gain prevention among African American breast cancer survivors	African American breast cancer survivors	33	53 (±9.1), 100% female	Provided with wireless scale and maintain current weighing behaviors	1. INT (self-regulation intervention) – provided with wireless scale, face-to-face individual session, use of companion mobile app, email-delivered behavioral lessons, and 24 weekly emails with tailored feedback. 2. INT+ (INT + activity monitoring)
2018, Renee Stubbin, United States	A Behavior-Modification, Clinical-Grade Mobile Application to Improve Breast Cancer Survivors' Accountability and Health Outcomes	Non-randomized experimental study: 4 weeks	Test the feasibility, participant adherence, and usability of Methodist Hospital Cancer Health Application (MOCHA™). The exploratory objective was to determine weight loss and dietitian-participant interaction	Breast cancer survivors	25	57(±9), 100% female	N/A	Use of MOCHA™ app
2020, Cosette Fakih El Khoury, United Arab Emirates	A Dietary Mobile App for Patients Undergoing Hemodialysis: Prospective Pilot Study to Improve Dietary Intakes	Non-randomized experimental study: 2 weeks	Estimating the potential efficacy of a dietary intervention using a theory-based, person-centered smartphone app.	Patients on HD	23	48.5 (±13.7), 61% male, 39% female	N/A	Use of KELA.AE™ (Kidney Education for Lifestyle Application) app
2015, Michele L. McCarroll, United States	Feasibility of a lifestyle intervention for overweight/obese endometrial and breast cancer survivors using an interactive mobile application	Non-randomized experimental study: 1 month	Assess the feasibility of delivering a life-style intervention focusing on weight-loss using a multi-disciplinary team via popular mHealth app (LoseIt!™). Secondary objective was to assess characteristics of EC and BC survivors in regard to nutrient intake, physical activity (PA), self-efficacy, QOL, and correlation to patient-provider contact points.	Cancer survivors with BMI ≥ 25kg/m2	35	58.4 (±10.3 years), 100% female	N/A	Use of "Beta" healthcare version of LoseIt!™ App
2020, Wen-Yi Li, Taiwan	Mobile Health App with social media to Support Self-Management for Patients With Chronic Kidney Disease: Prospective Randomized Controlled Study	RCT: 90 days	Evaluate the effectiveness of wearable devices, a health management platform, and social media at improving the self-management of CKD, with the goal of establishing a new self-management intervention model	People with CKD at stages 1-4	49	51.22 years (±10.98), 73.5% male, 26.5% female	Routine care and use of food diary smartphone app and wearable device	Control + additional app (LINE™) with extra functionalities

2020, Jeanne M.Ferrante, United States	Feasibility and potential efficacy of commercial mHealth/eHealth tools for weight loss in African American breast cancer survivors: pilot randomized controlled trial.	RCT: 6 months	Examine the feasibility and potential efficacy of SparkPeople™ plus an activity tracker for weight loss in AA BC survivors in New Jersey	African American Breast Cancer Survivors	35	61.54 (±8.83), 100% female	Wrist-worn physical activity tracker (FitBit™)	Control + Use of SparkPeople™ app
2020, Alex R Chang, United States	Remote Dietary Counseling Using Smartphone Apps in Patients with Stages 1-3a Chronic Kidney Disease: a Mixed Methods Feasibility Study	Non-randomized experimental study: 8 weeks	Test feasibility and acceptability of a 2-month remote dietary counseling program (weekly phone calls with RDN) and daily dietary entry. Examine changes in dietary sodium intake, dietary quality, weight, 24-hour ambulatory BP and albuminuria	Patients with CKD	16	65.7 years (range 48-86), 69% male, 31% female	N/A	Use of Vibrent™ (7 participants) or Use of MyFitnessPal™ (9 participants)
2020, Seongkum Heo, United States	A Tailored Dietary Sodium Intervention Using Technology and Psychosocial Support: A Pilot Study.	Non-randomized experimental study: 3 months	Examine the feasibility of a tailored dietary intervention with a practical tool (MyFitnessPal™) and to obtain preliminary data about the effects on sodium intake, factors affecting sodium intake (knowledge, skills, experiences, confidence, perceived benefits and barriers, and depressive symptoms), HF symptoms, and HRQOL.	Patients with HF	11	52.6 years (±13.6), 18% male, 82%, female	N/A	Use of MyFitnessPal™
2018, Till Orlemann, Germany	A Novel Mobile Phone App (OncoFood™) to Record and Optimize the Dietary Behavior of Oncologic Patients: Pilot Study.	Non-experimental study: 4 weeks	Investigating the feasibility and applicability of a novel mobile phone app to assess and evaluate dietary behaviors in oncologic patients.	Patients with cancer	24	NR	Nutritional counseling, nutritional therapy without app	Nutritional counseling, nutritional therapy with app (Oncofood™)
2015, Jin-Ming Wu, Taiwan	Tablet PC-enabled application intervention for patients with gastric cancer undergoing gastrectomy	Non-randomized experimental study: 6 months	Develop and test a tablet personal computer (PC) – assisted intervention to hasten the recovery of post gastrectomy cancer patients with respect to nutritional status	Patients with gastric cancer undergoing gastrectomy	40	61.6 (±12.1), 60% male, 40% female	Retrospectively collected 20 matched cases as a control group	Perioperitive care via app
2013, Janet L. Welch, United States	Using a Mobile Application to Self-Monitor Diet and Fluid Intake Among Adults Receiving Hemodialysis	RCT: 6 weeks	Pilot test an electronic self-monitoring intervention based on social cognitive theory. Explore (a) changes in interdialytic weight gain (IWG) and (b) changes in self-efficacy, perceived benefits, and perceived control in DIMA™ users compared to a control group. Patterns of dietary and fluid intake and acceptability of DIMA™ after 6 weeks of daily usage also were explored.	Patients with ESKD receiving dialysis	33	50.3 (±13.8) 57% male, 43% female	Use of Daily Activity Monitor Application (DAMA™)	Use of Dietary Intake Monitoring Application (DIMA™)

RCT = randomized controlled trial, CVD = cardiovascular disease, ESKD = ends stage kidney disease, PD = peritoneal dialysis, HD = hemodialysis, RDN = Registered dietitian nutritionist, HF = heart failure, NAFLD = non-alcoholic fatty liver disease, BP = blood pressure, HRQOL = health related quality of life

Table 3. App description, measured nutrition related outcomes, nutrition intervention and co-intervention components, results, and overall conclusions

Publication year, first author, country of origin	Article title	Control Group	Intervention Group	App description and nutrition recommendations	Additional key nutrition intervention and co-intervention components	Nutrition related outcomes measured	Results	Author's Conclusion
2017, Helen Eyles, New Zealand	A salt-reduction smartphone app supports lower-salt food purchases for people with cardiovascular disease: Findings from the SaltSwitch™ randomized controlled trial	Shop as normal and accessed usual cardiac rehab services	Use of Saltswitch™ App	App has barcode scanner functionality and traffic light nutrition label with lower salt alternatives to switch to. Developed by the George Institute of commercial health. Specific nutrient recommendations were not reported	1) Behavioral support: None described in detail 2) Theory: None described in detail 3) Personnel: Not described in detail 4) Other co-interventions: N/A	Primary: Salt content of household food purchases. Secondary: Saturated fat content, energy content and expenditure, systolic BP, urinary sodium	Intervention group app purchased significantly less salt (~0.7 grams/day) compared to the control group (p=0.03). No significant differences between groups for nutrient outcomes or BP	"The app has potential to help people with CVD make lower salt food purchases."
2017, Rameez Imtiaz, Canada	A Pilot Study of Okkidney™, A Phosphate Counting Application in Patients on Peritoneal Dialysis	N/A	Use of OkKidney™ iOS app	App provides suggestion on meal phosphate binder dose based on documented food intake on app and a patient-specific binder to meal phosphate content multiplier. Users logged the number of phosphate binders taken. Created with assistance from the Ottawa Hospital mHealth research team. Specific nutrient recommendations were not reported	1) Behavioral support: None described in detail 2) Theory: None described in detail 3) Personnel: Not described in detail 4) Other co-interventions: N/A	Pre-/post-serum calcium, and phosphate Calcium carbonate binder intake Nutrition knowledge	No significant changes in pre-/post- serum calcium, and phosphate 7/10 participants reported improved understanding of food phosphate content and better awareness of how to control phosphate intake	"Patients reported a positive experience with OkKidney™. More patient-specific adjustments of binder dose to meal phosphorus content may be required to see clinical effect. A larger trial is warranted."

2008, Mary Ann Sevick, United States	A PDA-based dietary self-monitoring intervention to reduce sodium intake in an in-center hemodialysis patient	N/A	Use of BalanceLog™ Software on a PDA	App allows participant to evaluate content of foods, track dietary intake, evaluate the percent to dietary targets achieved by meal and by day. Specific nutrient requirements were reported	1) Behavioral support: Personalized nutritional counselling by dietitian based on reports generated by the app. 2) Theory: Counselling guided by social cognitive theory. 3) Personnel: Dietitian 4) Other co-interventions: N/A	Sodium intake Serum phosphorus Serum potassium Interdialytic weight gains	Sodium intake reduced at a rate of 192 mg a week. Reductions in serum phosphorus and potassium, and reduction in interdialytic weight gains No statistical analysis conducted	"BalanceLog™ allowed the dietitian to target problematic foods and provide counseling that appeared to be effective in reducing sodium intake, reducing interdialytic weight gain, and alleviating hyperphosphatemia and hyperkalemia."
2014, Leila Pfaeffli Dale, New Zealand	Cardiovascular Disease Self-Management: Pilot Testing of an mHealth Healthy Eating Program	N/A	Received daily texts and use of mobile technology and supporting nutrition website	Supporting nutrition app/website had role model vignettes, educational internets support, goal setting and review, healthy recipes, meal ideas, tips, and other recipes. Healthy eating advice consisted of a cardioprotective dietary pattern, but no specific nutrient recommendations were not reported	1) Behavioral support: Daily texts with behavioral support 2) Theory: Use of social cognitive theory. 3) Personnel: RDs and other health professionals involved in cooking demonstrations and vignettes 4) Other co-interventions: N/A	Self-efficacy towards healthy eating	Environmental and total self-efficacy increased significantly ($p<0.05$) Trend for increased self-efficacy toward heart healthy eating but not statistically significant	"Text messaging was seen as a simple and acceptable way to deliver nutrition information and behavior change strategies; however, future research is needed to determine the effectiveness of such programs."
2017, Carmina G. Valle, United States	Preventing weight gain in African American breast cancer survivors using smart scales and activity trackers: A randomized controlled pilot study	Provided with wireless scale and maintain current weighing behaviors	1. INT (self-regulation intervention) – provided with wireless scale, face-to-face individual session, use of companion mobile app, email-delivered behavioral lessons, and 24 weekly emails with tailored feedback.	App had goals programmed by interventionist. Included education on weight gain, energy balance, and weighing. Specific nutrient recommendations were not reported.	1) Behavioral support: Single face-to-face session. Tailored email lessons and feedback. 2) Theory: Intervention based on self-regulation theory 3) Personnel: Interventionist had PhD training in nutrition intervention 4) Other co-interventions: N/A	Anthropometric measures (weight, height, WC) Clinical data (BP, Hemoglobin a1c, blood lipids) Dietary intake	Significant weight loss from baseline to 3 months among INT ($p=0.023$), INT+ ($p=0.008$) but not in control. Significant reduction in BMI ($p=0.046$), WC ($p=0.021$), and SBP ($p=0.047$) from baseline to 6 months in INT+ group. No differences between groups in dietary intake	"An intervention focused on daily self-weighing as a self-monitoring strategy shows promise for preventing weight gain in breast cancer survivors."

			2. INT+ (INT + activity monitoring)					
2018, Renee Stubbin, United States	A Behavior-Modification, Clinical-Grade Mobile Application to Improve Breast Cancer Survivors' Accountability and Health Outcomes	N/A	Use of MOCHA™ app	App had a food diary with bar scanning, search system and customized food creation, goal monitoring, Fitbit™ synchronization, social rankings with other participants, and message portal to RD and health care team. A RD designed personal goals for nutrient intake and PA in app. MOCHA is a clinical-grade mobile application designed by a clinical care team and clinically tested/validated. Specific nutrient recommendations were not reported	1) Behavioral support: Motivational interactions with RD. 2) Theory: Not described in detail 3) Personnel: RDs 4) Other co-interventions: N/A	Weight loss RD-participant interaction	Mean weight loss of 2 lbs (Range: +4 lbs to -10.6 lbs). 56% lost an average of 3.5 lbs. Not significant (p=0.39) Average of 28 interactions with RD over study (approx. one interaction per day). 1/3 of interactions came from the participant and 2/3 came from the RD	"This study emphasizes the importance of technology use to improve goal adherence for patients by providing real-time feedback and accountability with the health care team."
2020, Cosette Fakih El Khoury, United Arab Emirates	A Dietary Mobile App for Patients Undergoing Hemodialysis: Prospective Pilot Study to Improve Dietary Intakes	N/A	Use of KELA.AE™ (Kidney Education for Lifestyle Application) app	App is an Arabic, culturally specific, education and self-monitoring app. All information included were in line with the clinical practice guidelines from the Kidney Disease Improving Global Outcomes (KDIGO). Specific nutrient recommendations were reported	1) Behavioral support: Weekly in-person dietitian meetings (2 total) 2) Theory: Intervention followed transtheoretical model and reasoned action approach 3) Personnel: RDs 4) Other co-interventions: N/A	Weight Dietary intake (energy, macronutrients) Biochemical parameters Adherence to dietary guidelines for HD	No change in weight Significant changes in dietary intakes (Increase in energy (p=0.003), protein (p<001), HBV protein (p<0.001), and fat intake (p=0.02). Decrease in sodium intake (p=0.03). Significant improvements in adherence to dietary guidelines in HD (energy p = 0.004, dietary protein = p <0.001), HBV proteins (<0.001), dietary sodium (p = 0.03)	"It is feasible to integrate a dietary app into dietetic practice, allowing it to be a tool in addition to regular meetings with dietitians. A more extended intervention using a randomized controlled trial is required to estimate parameters concerning app efficacy accurately."

2015, Michele L. McCarroll, United States	Feasibility of a lifestyle intervention for overweight/obese endometrial and breast cancer survivors using an interactive mobile application	N/A	Use of "Beta" healthcare version of LoseIt!™ App	Commercially available calorie counting app aimed at weight loss. FitNow, Inc.™ provided the healthcare provider interface of the Lose It! App for the study Specific nutrient recommendations were reported	1) Behavioral support: Two visits with exercise and nutrition counselling. Motivational patient-provider feedback in response to individual input into the app. 2) Theory: Intervention was based on Social Cognitive Theory and Theory of Planned Behavior 3) Personnel: Multidisciplinary team delivered intervention. 4) Other co-interventions: Physical Activity component	Weight change, quality of life, self efficacy, compliance with daily logging of nutrition and exercise information, number of motivational patient-provider feedback notifications to the participant in relation to weight-loss, self-efficacy towards weight-loss, minutes spent in physical activity, and nutritional content.	Significant reductions in weight, BMI, and WC ($p<0006$). Significant improvements in self-efficacy ($p=0.043$). No changes in quality of life. No significant changes in macronutrient intake. Significant increase in PA ($p=0.001$). Positive correlation between interactions and success in weight loss	"These results indicate that a lifestyle intervention delivered via a web- and mobile-based weight-loss app is a feasible option by which to elicit short-term reductions in weight."
2020, Wen-Yi Li, Taiwan	Mobile Health App with social media to Support Self-Management for Patients with Chronic Kidney Disease: Prospective Randomized Controlled Study	Routine care and use of food diary smartphone app and wearable device	Control + additional app (LINE™) with extra functionalities	LINE™ app for intervention group delivered medical knowledge of diet and exercise, included a social media group, and allowed participants in the intervention group to ask questions about CKD management resulting in teleconsultations. Diet messages were guided by a diet manual for kidney disease, reference was mentioned but no specific nutrient recommendations were reported	1) Behavioral support: Intervention group had an additional app and received teleconsultations with care team. 2) Theory: None mentioned in detail 3) Personnel: Researchers trained by a dietitian 4) Other co-interventions: Physical activity component	Anthropometrics (weight, body fat %, BMI) self-efficacy and self-management Quality of life Laboratory data (hemogram, serum biochemistry, electrolyte profile, renal function assay)	Both groups had modest weight gain, no differences between groups. No significant differences in physiological indicators. Total self-efficacy ($p=0.001$), Diet self-efficacy ($p=0.02$) and self-management ($p=0.004$) significantly increased in intervention group. Kidney disease QOL scores significantly higher in intervention group ($p=0.02$).	"A self-management intervention that combines wearable devices, a health management platform, and social media could strengthen self-efficacy and self-management, and lead to improvements in quality of life for people with CKD stages 1-4."

							88% reported improvements in dietary and exercise habits	
2020, Jeanne M.Ferrante, United States	Feasibility and potential efficacy of commercial mHealth/eHealth tools for weight loss in African American breast cancer survivors: pilot randomized controlled trial.	Wrist-worn physical activity tracker (FitBit™)	Control + Use of SparkPeople™ app	SparkPeople™ is a commercially available diet and fitness tracker that includes educational and inspirational articles, recipes, videos, incentives, and social groups, nutritional report, ability to scan food labels Intervention group was provided a caloric intake goal, but no specific nutrient recommendations were reported.	1) Behavioral support: Provided with handout with goals for weight loss. Use of tracker and Sparkpeople™ app (intervention only). 2) Theory: Intervention/app guided by social cognitive theory 3) Personnel: No comment on personnel 4) Other co-interventions: Physical activity component with tracker	Anthropometric measures (weight, BMI, WC) BP Caloric intake Social cognitive theory variables	Anthropometrics -Weight and BMI decreased significantly with no significant differences between groups -1.71 (SD 2.33) p=0.006 (intervention) -2.54 (SD 4.00) p=0.002 (control) -Only Intervention group had significant decreases in weight circumference -3.56 cm (SD 4.7 cm) (p=0.005) Diet and PA -Neither group had significant within-group changes in caloric intake or PA -Control group increased total active minutes per week while intervention group decreased activity (p=0.044) Social cognitive theory variables -both groups had significant improvement in planning and tracking nutrition and PA -Intervention group had significant improvements in strategies to increase fruits/vegetables/grains (p=0.025), strategies to decrease fat and calories (p<0.001),	"Publicly available eHealth/mHealth programs and wrist-worn activity trackers may be convenient, efficacious, and easily disseminated interventions for AA BC survivors in need of weight management."

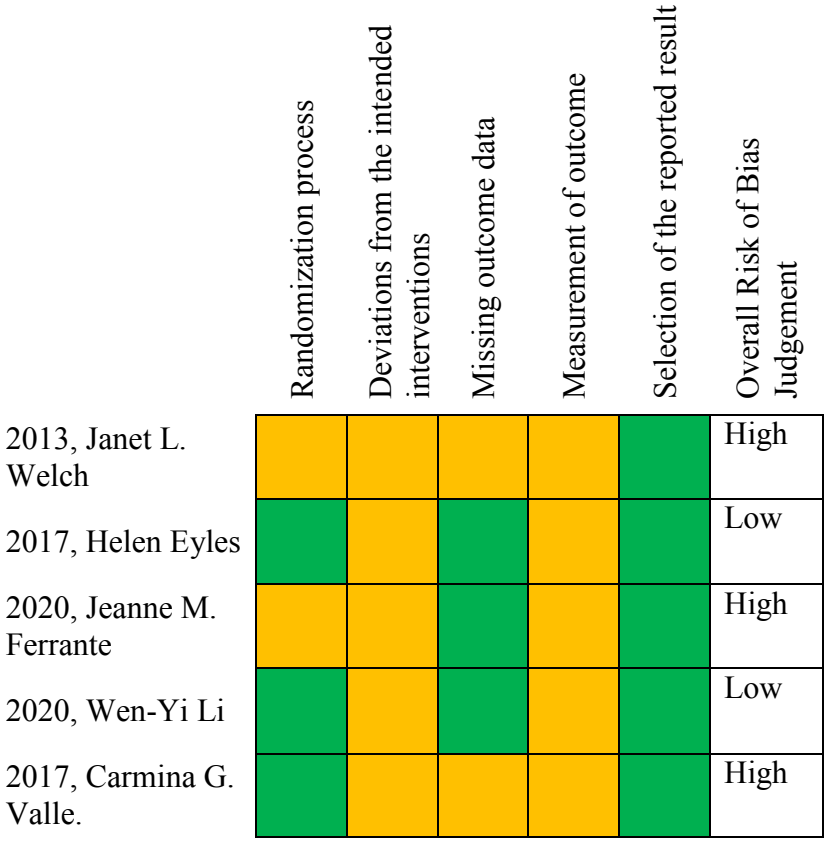
							-Increase in self-efficacy to eat healthy foods in intervention group with decrease in control group (significant p=0.015) Sparkpeople™ adherence significantly correlated with WC change (p=0.030 at 6 months and p=0.038 at 6 months)	
2020, Alex R Chang, United States	Remote Dietary Counseling Using Smartphone Apps in Patients with Stages 1-3a Chronic Kidney Disease: a Mixed Methods Feasibility Study	N/A	Use of Vibrent™ (7 participants) or Use of MyFitnessPal™ (9 participants)	Vibrent™ Health App was a customized app developed by a technology company that included a food diary that tracked sodium and vegetable and fruit servings, included healthy lifestyle tips and weekly nutrition targets, and had a patient-provider portal that enabled dietary data sharing. MyFitnessPal™ is a commercially available calorie counter and diet tracker Reference made regarding nutrition recommendations, but no specific nutrient recommendations reported.	1) Behavioral support: Additional educational website. 15–20-minute telephone motivational interviewing counselling sessions with RDN. Daily educational messages, and weekly messages to reinforce nutrition goals. 2) Theory: Intervention based on Situated Learning Theoretical Perspective and Carver and Scheier's Control Systems 3) Personnel: RDNs 4) Other co-interventions: N/A	Sodium intake Fruit and vegetable intake Processed meat intake Weight changes BP changes	Significant decrease in sodium intake (-604 mg, 22% average decrease: p=0.02). Significant Improvements in fruit/vegetable/dairy intake (p=0.03 and p=0.04 and p=0.01). Significant decrease in weight (-3.4 lbs: p=0.04). No other significant changes. No difference between apps.	"Use of smartphone apps in conjunction with remote RDN telephone counseling was feasible and well-accepted."
2020, Seongkum Heo, United States	A Tailored Dietary Sodium Intervention Using Technology and Psychosocial Support: A Pilot Study.	N/A	Use of MyFitnessPal™	Commercially available calorie counter and diet tracker Sessions involved tailored dietary education and counseling,	1) Behavioral support: 3 face-to-face sessions with nurse (60 minutes), and 3 phone sessions with nurse (10-30 minutes). 2) Theory: Intervention based on components of	Sodium intake Feasibility, Acceptability Knowledge, skills, experience,	Sodium intake significantly decreased from 3.9 (1.5) to 2.6 (1.1) g/day (p=0.034) Significant improvements in factors affecting dietary sodium intake	"A comprehensive, theoretical framework-based, symptom-driven, tailored dietary intervention was feasible and

				monitoring, and managing of sodium intake using MyFitnessPal™ and psychosocial support, but no specific nutrient recommendations reported.	Naturalistic decision-making theory 3) Personnel: Nurse 4) Other co-interventions: N/A	confidence, perceived benefits and barriers, depressive symptoms, HF symptoms, QOL	except knowledge ($p<0.05$) Significant improvements in symptoms of HF and HRQOL ($p=0.001$)	acceptable in patients with heart failure."
2018, Till Orlemann, Germany	A Novel Mobile Phone App (OncoFood™) to Record and Optimize the Dietary Behavior of Oncologic Patients: Pilot Study.	Nutritional counseling, nutritional therapy without app	Nutritional counseling, nutritional therapy with app (Oncofood™)	App included daily tracking, keyboard, and voice input, tracking memory, goal progress, and traffic light colors and symbol diagrams. Goals were defined based on current national and international guideline recommendations on cancer nutrition. App was developed by the study team after a comprehensive nutritional record review of oncologic patients. Nutritional goals configured individually for each patient by physician and nutritionist. But no specific nutrient recommendations were reported	1) Behavioral support: Nutritional counselling. 2) Theory: None described in detail 3) Personnel: Physician and nutritionist 4) Other co-interventions: N/A	Body composition (BIA) Clinical parameters Diet changes	Control had no differences in protein and fat pre and post intervention. Trend for worsening fibre and carbohydrate intake (not significant) Intervention group achieved more than 100% of nutritional goals including protein, fat, energy, and carbohydrate intake (not significant). Significant increase in skeletal muscle mass ($p=0.009$) and fat-free mass and higher weight gain ($p=0.045$).	"Our study indicates that patients who track their daily dietary habits using a mobile phone app are more likely to reach their nutritional goals than the control patients."
2015, Jin-Ming Wu, Taiwan	Tablet PC-enabled application intervention for patients with gastric cancer undergoing gastrectomy	Retrospectively collected 20 matched cases as a control group	Perioperitive care via app	App included regular weight logging and would notify patient and medical professionals in the event >5% body weight loss occurred at 3 months. App was developed by study team (including medical staff members and dietitian) to actively ensure	1) Behavioral support: RD consultation would occur if >5% body weight loss occurred at 3 months to overcome their malnourished status. 2) Theory: None described in detail 3) Personnel: RDs 4) Other co-interventions: N/A	Change in % body weight loss	App group had significantly lower body weight loss percentage compared to the control group ($p<0.01$) and had more outpatient clinic visits than those in the control group ($p<0.01$)	"This study supported the feasibility of a tablet PC-based application for the perioperative care of gastric cancer subjects to promote a lower body weight loss and the collection of comprehensive

				information provided to patients via this app was accurate and necessary. The app was not regulated by medical authorities in Taiwan No specific nutrient recommendations were reported.				surgical records."
2013, Janet L. Welch, United States	Using a Mobile Application to Self-Monitor Diet and Fluid Intake Among Adults Receiving Hemodialysis	Use of Daily Activity Monitor Application (DAMA™)	Use of Dietary Intake Monitoring Application (DIMA™)	DAMA™ allowed control participants to track various activities to ensure the same amount of time was spent as the intervention group. DIMA™ is an electronic dietary self-monitoring application for use on a PDA that provides real time feedback for recognizing personal intake performance and providing info for future goal setting. DIMA was developed by the research team Intervention group participants were given dietary prescriptions based on HD diet recommendations by interventionists at HD. No specific nutrient recommendations were reported.	1) Behavioral support: Not described in detail 2) Theory: Intervention guided by social cognitive theory. 3) Personnel: Research assistants who were graduate and undergraduate students in public health or computer science 4) Other co-interventions: N/A	Pre/post dialysis weights Dietary and fluid intake (sodium, potassium, phosphorus, protein, calories, and fluid) Self-efficacy, perceived benefits and control Acceptability	Active users had marginal effect on some aspects of dietary and fluid intake, including decrease in sodium intake, calories (significant p=0.04) and protein	"Results from this pilot study suggest the intervention is feasible and acceptable, although few significant effects on outcomes were found in this small sample."

BP = blood pressure, CVD = cardiovascular disease, PD = peritoneal dialysis, RCT = randomized controlled trial, WC = waist circumference, BMI = body mass index, SBP = systolic blood pressure, RD = Registered Dietitian, CKD = chronic kidney disease, RDN = Registered Dietitian Nutritionists, HRQOL = health related quality of life, BIA = bio-electrical impedance analysis, PA = physical activity

Table 4. Risk of bias assessment of randomized controlled trials included in the rapid review of digital technologies in the nutritional management of catabolism-prone chronic diseases



Green = low risk of bias, Orange = some concerns with bias, Red = high risk of bias

Appendix 1. Rapid review methods for Use of Digital Technologies in the Nutritional Management of Catabolism-Prone Chronic Diseases: A Rapid Review

How to write a rapid review (RR)

Protocol written by SKJ and MK, Sept 2016; updated Jan 2018. Adapted after Hartling et al 2015; Featherstone et al. 2015; Tricco et al. 2017

Rapid review – definition and aims

Rapid reviews (RRs) are NOT systematic reviews but are aimed at summarizing the existing evidence. A formal definition of rapid reviews and standardized set of methods for conducting RRs do not exist (King et al. 2017). According to Khangura et al. 2012 rapid reviews are a form of knowledge synthesis in which components of the systematic review process are simplified or omitted to produce information in a timely manner. The majority of RRs will be conducted in 1-6 month (Featherstone et al 2015).

Review step	Employed methods
Needs assessment, topic selection	Health Sciences librarian conducted pre-searches to identify pediatric topics with published evidence. If the search shows more than three published pediatric controlled trials we will consider writing a rapid review. A list of topics has been sent to the editor and 6 rapid reviews have been approved by the editor.
Protocol development	A protocol will be prepared with a pre-defined research question (PICO format).
Literature search	Comprehensive and systematic literature searches performed in at least 3 databases (Medline, Embase, Cochrane Central Register of Controlled Trials).
Screening and study selection	Previously published systematic reviews on the topic will be summarized in the background section and their reference list will be checked for relevant citation. Pre-defined inclusion and exclusion criteria for study selection. Study selection and data extraction will be performed by one person (no dual study selection and data extraction process). However, a senior researcher will check study selection and data extraction for a randomly selected 10% of the included studies. This will help to guide new students who have no previous experience in rapid review writing. A PRISMA flow-diagram will be included in the manuscript.

Data extraction	Pre-defined data extraction form. Extraction will be done by a single reviewer
Risk of bias assessment	Cochrane Risk of Bias tool for RCTs will be used for assessing the quality of included RCTs. Other designs will not be assessed for quality
Adverse events reporting	Reporting of adverse events due to intervention will be extracted and reported. List of reported adverse events of intervention will be presented (Note: Since the review did not have AE as primary outcome and the study selection may not be the best to address AEs, we would highlight that the RR is not designed to investigate about safety of the intervention)
Knowledge Synthesis and recommendations for readers	No meta-analysis will be performed for this RR except if deemed necessary. This RR is not designed for clinical recommendations, however, for better understanding of the level of evidence supporting the intervention of interest, GRADE analysis will be used to generate GRADE scores for the most common outcomes.
Manuscript length	2500 words

Table 1: Overview of methods and approaches used in our rapid reviews (for more details see Methods section below)

METHODS

Searching: Systematic searches will be developed in conjunction with a health research librarian.

- A list of search terms (keywords and subject headings) will be created and a search strategy developed
- Searches are all performed in Medline, Embase, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Google Scholar, (AcuTrials for acupuncture related topics), and CINAHL.
- Each Medline search strategy and the search terms for each topic will be documented and saved.
- In addition, each author needs to perform their own basic searches for general background information.
- Authors need to screen reference lists of relevant published clinical trials to make sure no trials are missed.
- If systematic reviews are available authors need to screen reference lists for potentially relevant clinical trials.

Screening
Record all the numbers required for the PRISMA flow-diagram and include the diagram in your manuscript (http://prisma-statement.org/prismastatement/flowdiagram.aspx).

A screening process will be conducted to identify relevant studies. Each author is responsible for screening the articles retrieved through the database searches. The retrieved studies will be collected and organized in a RefWorks account. The title and abstract screening will be performed in Excel (an example Excel screening sheet is available if needed). After the author identified potentially relevant articles he/she needs to retrieve the full-text articles.

Data extraction
Leading authors need to prepare an excel data extraction spreadsheet (detailed excel example file is available). Data that extraction will be done by a single reviewer. If needed 5-10% of the data extracted will be checked by a second reviewer to assure accuracy.

The excel spreadsheet should at least include the items listed in Table 2 but should be extended if needed. All the information from the included studies need to be extracted and entered into the excel sheets. The extracted data will later be used to create tables necessary for the manuscript.

The headings shown in Table 2 are examples for the main data entries. Please note that additional columns will need to be added for more detail information.

RefWorks ID	Journal name	First author	Publication year	Study design	Population	Setting	Mean and standard deviation	Age and sex distribution	Actual sample size	Intervention	Control	Outcome	Adverse events	Notes

Table 2: Outline of excel data extraction table.

STRUCTURE YOUR RAPID REVIEW AS FOLLOWS:
This structure will vary depending on which journal you submit to.

- **Abstract**: Submissions must include a 150-words or less abstract, (eg, objectives, methods, results and conclusions). An abstract should be substantive (eg, provide actual data where applicable) rather than purely descriptive. Only standards units of measurements should be abbreviated; no acronyms please.

- **Introduction/ Background**

- **Objectives:** explain the main objectives of this RR and discuss the research question using PICO, model, population, intervention, control and outcomes.

- **Methods section**: explain the search strategy, inclusion/exclusion criteria, data extraction, and data analysis.
  - Include a PRISMA flow-diagram http://prisma-statement.org/prismastatement/flowdiagram.aspx

  - Risk of Bias tool will be used to evaluate the quality of included RCTs and to generate RoB diagram

- **Results:** Summarize the general information starting with number of studies at entry, level one, and level two of screening, finish it by final deletion or addition of references and final numbers included. Next step is to compile all evidence in a descriptive way. Study characteristics including first author, publication year, country, settings, design, sample size, age, gender, length of study, primary and secondary outcome, unit of analysis (e.g., time, pain scale, etc.), effect estimates (mean difference, standard mean difference, risk ratio, risk difference, odd ratio, hazard ratio, number needed to treat) and their variabilities (Standard Deviations or 95% Confidence Interval), and p-values can be added to the or another table. Details of reported adverse events, safety concern for the interventions can be explained in the following paragraphs.

- **Implication:** recall the important findings of this RR. What this review can add to the literature and what is the difference between your findings and other SRs, meta-analysis, and RRs. How would you compare your review results to others. Finally mention limitations of this RR considering its scope.

- **Conclusion**: include a paragraph with the main conclusions for this RR.

- **Bibliography, tables and graphs:** We will use a bibliographic software such as RefWorks or Endnote to generate the reference list in Vancouver output style. Follow the style of the National Library of Medicine. Each reference should be numbered consecutively in the order that it is cited in the text, using Arabic numerals in parentheses on the line. DO NOT superscript.
  Tables are also numbered sequentially by ordered have been indexed in the text. Presenting data by Graph(s) will be based on availability of detailed data from the included studies.

Appendix 2. Search Strategies for Use of Digital Technologies in the Nutritional Management of High Needs Chronic Diseases and Cancer: A Rapid Review

Ovid MEDLINE(R) ALL <1946 to March 02, 2021>		
Line	Search	Results
1	mobile applications/ or web browser/	8262
2	((mobile or "smart phone" or smartphone or "cell* phone" or ipad or iphone or itunes or apple or android or digital or e-health or mhealth or m-health or ehealth or samsung or google or tablet* or online or digital or web* or "web-based" or internet) adj3 (app or apps or application*)).mp.	24491
3	((online or digital or web* or web-based or internet) adj2 platform?).mp.	4501
4	1 or 2 or 3	29722
5	((nutrition* or diet* or calorie* or caloric or protein or food*) adj3 (track* or monitor* or logging or log? or register* or diary or diaries or journal* or count*)).mp.	24329
6	4 and 5	317
7	(myfitnesspal or mynetdiary or myplate or lifesum or mymacros* or yazio or melarossa or fatsecret or "Lose it!" or cronometer or sparkpeople).mp.	457
8	nutrition app*.mp.	391
9	diet app*.mp.	1058
10	6 or 7 or 8 or 9	2160
11	renal insufficiency, chronic/ or kidney failure, chronic/	118399
12	exp renal replacement therapy/	214648
13	("chronic kidney disease*" or "kidney failure" or "renal failure" or "end-stage kidney disease*" or "end-stage renal failure" or "end-stage renal disease" or "chronic renal disease*").mp.	225517
14	exp pulmonary disease, chronic obstructive/	57577
15	("chronic respiratory disease*" or COPD or "chronic obstructive pulmonary disease" or "chronic asthma" or "chronic bronchitis").mp.	80498
16	exp liver cirrhosis/	91112
17	("end-stage liver disease" or "chronic liver disease" or cirrhosis).mp.	149009
18	exp heart failure/	125636
19	("congestive heart failure" or "chronic heart disease").mp.	41519
20	end-stage heart disease.mp.	355
21	neoplasms/ or exp neoplasms by site/ or exp abdominal neoplasms/ or exp bone neoplasms/ or exp skull neoplasms/ or exp breast neoplasms/ or exp digestive system neoplasms/ or exp biliary tract neoplasms/ or exp gastrointestinal neoplasms/ or exp liver neoplasms/ or exp pancreatic neoplasms/ or exp endocrine gland neoplasms/ or exp adrenal gland neoplasms/ or exp multiple endocrine neoplasia/ or exp ovarian neoplasms/ or exp pituitary neoplasms/ or exp testicular neoplasms/ or exp thyroid neoplasms/ or exp eye neoplasms/ or exp retinal neoplasms/ or exp uveal neoplasms/ or exp "head and neck neoplasms"/ or exp esophageal neoplasms/ or exp facial neoplasms/ or exp mouth neoplasms/ or exp otorhinolaryngologic neoplasms/ or exp hematologic neoplasms/ or exp bone marrow neoplasms/ or exp mammary neoplasms, animal/ or exp nervous system neoplasms/ or exp central nervous system neoplasms/ or	2738169

	exp brain neoplasms/ or exp central nervous system cysts/ or exp meningeal neoplasms/ or exp spinal cord neoplasms/ or exp cranial nerve neoplasms/ or exp optic nerve neoplasms/ or exp paraneoplastic syndromes, nervous system/ or exp peripheral nervous system neoplasms/ or exp pelvic neoplasms/ or exp skin neoplasms/ or exp sebaceous gland neoplasms/ or exp soft tissue neoplasms/ or exp thoracic neoplasms/ or exp heart neoplasms/ or exp respiratory tract neoplasms/ or exp thymus neoplasms/ or exp urogenital neoplasms/ or exp genital neoplasms, female/ or exp genital neoplasms, male/ or exp urologic neoplasms/	
22	(cancer? or neoplas* or carcinoma* or malignan* or tumor* lymphoma).ti,ab,kw,kf.	2789570
23	exp Chronic Disease/	267035
24	chronic disease*.mp.	320053
25	chronic illness*.mp.	16968
26	or/11-25	4589518
27	10 and 26	300

Appendix 2. Search Strategies for Use of Digital Technologies in the Nutritional Management of High Needs Chronic Diseases and Cancer: A Rapid Review

Embase <1974 to 2021 March 02>		
Line	Search	Results
1	mobile application/	13466
2	web browser/	6652
3	((mobile or "smart phone" or smartphone or "cell* phone" or ipad or iphone or itunes or apple or android or digital or e-health or mhealth or m-health or ehealth or samsung or google or tablet* or online or digital or web* or "web-based" or internet) adj3 (app or apps or application*)).mp.	34564
4	((online or digital or web* or web-based or internet) adj2 platform?).mp.	7049
5	1 or 2 or 3 or 4	46910
6	((nutrition* or diet* or calorie* or caloric or protein or food*) adj3 (track* or monitor* or logging or log? or register* or diary or diaries or journal* or count*)).mp.	35665
7	5 and 6	453
8	(myfitnesspal or mynetdiary or myplate or lifesum or mymacros* or yazio or melarossa or fatsecret or "Lose it!" or cronometer or sparkpeople).mp.	608
9	nutrition app*.mp.	535
10	diet app*.mp.	1302
11	7 or 8 or 9 or 10	2839
12	chronic kidney failure/ or kidney failure/	241637
13	renal replacement therapy/	48191
14	("chronic kidney disease*" or "kidney failure" or "renal failure" or "end-stage kidney disease*" or "end-stage renal failure" or "end-stage renal disease" or "chronic renal disease*").mp.	449880
15	exp chronic obstructive lung disease/	142251
16	("chronic respiratory disease*" or COPD or "chronic obstructive pulmonary disease" or "chronic asthma" or "chronic bronchitis").mp.	140655
17	exp liver cirrhosis/	164848
18	("end-stage liver disease" or "chronic liver disease" or cirrhosis).mp.	225718
19	exp heart failure/	526573
20	("congestive heart failure" or "chronic heart disease").mp.	96331
21	end-stage heart disease.mp.	493
22	neoplasm/ or exp neoplasms subdivided by anatomical site/	4307823
23	exp abdominal tumor/ or exp breast tumor/ or exp cardiovascular system tumor/ or exp digestive system tumor/ or exp endocrine tumor/ or exp germ cell tumor/ or exp "head and neck tumor"/ or exp hematopoietic system tumor/ or exp locomotor system tumor/ or exp lymphatic system tumor/ or exp malignant neoplasms subdivided by anatomical site/ or exp "neoplasms of the thorax and thoracic cavity"/ or exp nervous system tumor/ or exp pelvis tumor/ or exp respiratory tract	4113908

	tumor/ or exp reticuloendothelial neoplasm/ or exp skin tumor/ or exp soft tissue tumor/ or exp urogenital tract tumor/	
24	(cancer? or neoplas* or carcinoma* or malignan* or tumor* lymphoma).ti,ab,kw.	3754817
25	exp chronic disease/	186397
26	or/12-25	6496026
27	11 and 26	392

Appendix 2. Search Strategies for Use of Digital Technologies in the Nutritional Management of High Needs Chronic Diseases and Cancer: A Rapid Review

Cochrane Library 04/03/2021 06:32:55		
Line	Search	Results
1	[mh "mobile applications"] or [mh "web browser"]	725
2	((mobile or "smart phone" or smartphone or "cell* phone" or ipad or iphone or itunes or apple or android or digital or e-health or mhealth or m-health or ehealth or samsung or google or tablet* or online or digital or web* or "web-based" or internet) NEAR/3 (app or apps or application*)):ti,ab	5413
3	((online or digital or web* or web-based or internet) NEAR/3 platform?):ti,ab	1039
4	#1 or #2 or #3	6541
5	((nutrition* or diet* or calorie* or caloric or protein or food*) NEAR/3 (track* or monitor* or logging or log? or register* or diary or diaries or journal* or count*)):ti,ab	3986
6	#4 and #5	180
7	(myfitnesspal or mynetdiary or myplate or lifesum or mymacros* or yazio or melarossa or fatsecret or "Lose it!" or cronometer or sparkpeople):ti,ab	2426
8	nutrition app*:ti,ab	3
9	diet app*:ti,ab	9
10	#6 or #7 or #8 or #9	2595
11	[mh ^"renal insufficiency, chronic"] or [mh ^"kidney failure, chronic"]	6848
12	[mh "renal replacement therapy"]	9136
13	("chronic kidney disease*" or "kidney failure" or "renal failure" or "end-stage kidney disease*" or "end-stage renal failure" or "end-stage renal disease" or "chronic renal disease*"):ti,ab	17679
14	[mh "pulmonary disease, chronic obstructive"]	5838
15	("chronic respiratory disease*" or COPD or "chronic obstructive pulmonary disease" or "chronic asthma" or "chronic bronchitis"):ti,ab	21556
16	[mh "liver cirrhosis"]	2953
17	("end-stage liver disease" or "chronic liver disease" or cirrhosis):ti,ab	9371
18	[mh "heart failure"]	9594
19	("congestive heart failure" or "chronic heart disease"):ti,ab	5188
20	end-stage heart disease:ti,ab	6
21	[mh ^"neoplasms"] or [mh "neoplasms by site"] or [mh "abdominal neoplasms"] or [mh "bone neoplasms"] or [mh "skull neoplasms"] or [mh "breast neoplasms"] or [mh "digestive system neoplasms"] or [mh "biliary tract neoplasms"] or [mh "gastrointestinal neoplasms"] or [mh "liver neoplasms"] or [mh "pancreatic neoplasms"] or [mh "endocrine gland neoplasms"] or [mh "adrenal gland neoplasms"] or [mh "multiple endocrine neoplasia"] or [mh "ovarian neoplasms"] or [mh "pituitary neoplasms"] or [mh "testicular neoplasms"] or [mh "thyroid neoplasms"] or [mh "eye neoplasms"] or [mh "retinal neoplasms"] or [mh "uveal	65739

	neoplasms"] or [mh "head and neck neoplasms"] or [mh "esophageal neoplasms"] or [mh "facial neoplasms"] or [mh "mouth neoplasms"] or [mh "otorhinolaryngologic neoplasms"] or [mh "hematologic neoplasms"] or [mh "bone marrow neoplasms"] or [mh "mammary neoplasms, animal"] or [mh "nervous system neoplasms"] or [mh "central nervous system neoplasms"] or [mh "brain neoplasms"] or [mh "central nervous system cysts"] or [mh "meningeal neoplasms"] or [mh "spinal cord neoplasms"] or [mh "cranial nerve neoplasms"] or [mh "optic nerve neoplasms"] or [mh "paraneoplastic syndromes, nervous system"] or [mh "peripheral nervous system neoplasms"] or [mh "pelvic neoplasms"] or [mh "skin neoplasms"] or [mh "sebaceous gland neoplasms"] or [mh "soft tissue neoplasms"] or [mh "thoracic neoplasms"] or [mh "heart neoplasms"] or [mh "respiratory tract neoplasms"] or [mh "thymus neoplasms"] or [mh "urogenital neoplasms"] or [mh "genital neoplasms, female"] or [mh "genital neoplasms, male"] or [mh "urologic neoplasms"]	
22	(cancer? or neoplas* or carcinoma* or malignan* or tumor* lymphoma):ti,ab,kw	203255
23	[mh "Chronic disease"]	13334
24	chronic disease*:ti,ab	3914
25	chronic illness*:ti,ab	1732
26	#11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25	283459
27	#10 and #26	331

Supplementary Table 1. Description on adherence, strategies to increase adherence, and acceptance

Publication year, first author, country of origin	Article title	Control Group	Intervention Group	Adherence definition and tool used to measure adherence	Adherence and strategies to increase adherence	Tool used to measure acceptance	Acceptance
2017, Helen Eyles, New Zealand	A salt-reduction smartphone app supports lower-salt food purchases for people with cardiovascular disease: Findings from the SaltSwitch™ randomized controlled trial	Shop as normal and accessed usual cardiac rehab services	Use of Saltswitch™ App	Using the app when grocery shopping via questionnaire (4-point scale)	Most used the app all or most times they shopped (60 - 75% of the time). Participants had a monetary incentive for participating	Questionnaire (5-point scale)	"75% reported the app to be very easy to use." "All shoppers found that the app was a good way to make lower salt food purchases"
2017, Rameez Imtiaz, Canada	A Pilot Study of Okkidney™, A Phosphate Counting Application in Patients on Peritoneal Dialysis	N/A	Use of OkKidney™ iOS app	Number of days app was used and compliance to app phosphate binder recommendations via in-app analytics	3 participants used the app >30 days. 1 participant only used the app for 17 days. The app sent a message to the participants if there were discrepancies between recommended and taken and participants were called if meal or binder entries appeared to be missing	Post intervention survey	"Majority of patients had a favourable impression of the OkKidney™ app." 8/10 stated app was easy to use and would continue to use app after study completion
2008, Mary Ann Sevick, United States	A PDA-based dietary self-monitoring intervention to reduce sodium intake in an in-center hemodialysis patient	N/A	Use of BalanceLog™ Software on a PDA	Number of meals logged via in-app analytics	Participant logged ≥3 meals per day (342 meals). Participant was highly motivated to reduce dialysis treatments from 4 to 3 days a week.	Subjective commentary by authors	"App did not appear to be burdensome to participant as they had a high rate of self-monitoring"
2014, Leila Pfaeffli Dale, New Zealand	Cardiovascular Disease Self-Management: Pilot Testing of an mHealth Healthy Eating Program	N/A	Received daily texts and use of mobile technology and supporting nutrition website	Adherence questions via 32-item feedback questionnaire	10/20 participants reported reading most of the messages, 10/10 participants reported reading all the messages	32-item feedback questionnaire	"Program was well received" 19/20 thought mobile technology was a good way to deliver a healthy eating CR program. Majority of participants did not comment or did not use the website ("as it was time consuming")

2017, Carmina G. Valle, United States	Preventing weight gain in African American breast cancer survivors using smart scales and activity trackers: A randomized controlled pilot study	Provided with wireless scale and maintain current weighing behaviours	1. INT (self-regulation intervention) – provided with wireless scale, face-to-face individual session, use of companion mobile app, email-delivered behavioural lessons, and 24 weekly emails with tailored feedback. 2. INT+ (INT + activity monitoring)	Adherence to visits via attendance Self-monitoring via in-app analytics and questionnaires	97.1% adherence at 6 months for in person visit and 94.3% adherence for online measurements. INT and INT+ groups had significantly higher self-monitoring compared to control ($p < 0.0005$). INT+ participants reported significantly more frequent tracking intake using an app or website compared to INT participants. Participants had a monetary incentive for completing questionnaires and clinic assessments	Questionnaire	"Intervention participants feedback was overall positive and were satisfied with the program." 100% of both intervention groups reported they would recommend the program to other breast cancer survivors
2018, Renee Stubbin, United States	A Behavior-Modification, Clinical-Grade Mobile Application to Improve Breast Cancer Survivors' Accountability and Health Outcomes	N/A	Use of MOCHA™ app	App usage. Adherence was defined as use of app once a week during weeks 2-3 via usability scale questionnaire and post-MOCHA™ questionnaire	80% adherence to app usage. Average number of daily uses was 3.5 times. Participants were encouraged to use the app 5 days a week	Usability scale questionnaire and post-MOCHA™ questionnaire	"Most participants found the app easy to use and navigate." 90% found app easy to use. 72% stated app accurately tracked nutrition. 84% were motivated to use MOCHA and preferred it compared to other mHealth apps
2020, Cosette Fakih El Khoury, United Arab Emirates	A Dietary Mobile App for Patients Undergoing Hemodialysis: Prospective Pilot Study to Improve Dietary Intakes	N/A	Use of KELA.AE™ (Kidney Education for Lifestyle Application) app	Adherence to weekly sessions via attendance	All participants attended weekly sessions with dietitians. No data on usage frequency could be retrieved due to a lack of in-app analytics	App acceptability tool	"All participants selected strongly agree for all questions on the user acceptability tool, so analysis was not considered useful."
2015, Michele L. McCarroll, United States	Feasibility of a lifestyle intervention for overweight/obese endometrial and breast cancer survivors using an interactive mobile application	N/A	Use of "Beta" healthcare version of LoseIt!™ App	Adherence defined as 75% adherence to program. Adherence measured by attendance at baseline and exit sessions.	70% of participants adhered to program (36 completing the logging and follow up visit requirements). 30% dropout	NR	NR

				Participant app adherence needed to be >75% to be included in results	Encouraged to log nutrition and exercise once daily. Participants received motivational patient-provider feedback and automatically generated push notifications by LoseIt!™ Frequency of notifications increased with declining adherence.		
2020, Wen-Yi Li, Taiwan	Mobile Health App with Social Media to Support Self-Management for Patients With Chronic Kidney Disease: Prospective Randomized Controlled Study	Routine care and use of food diary smartphone app and wearable device	Control + additional app (LINE™) with extra functionalities	NR	NR LINE™ app was to inspire participants	Questionnaire	Most participants (76%) gave positive feedback. 25% of participants felt that wearing a smart wristband was inconvenient.
2020, Jeanne M.Ferrante, United States	Feasibility and potential efficacy of commercial mHealth/eHealth tools for weight loss in African American breast cancer survivors: pilot randomized controlled trial.	Wrist-worn physical activity tracker (FitBit™)	Control + Use of SparkPeople™ app	App usage via SparkPeople™ in-app analytics	Participants logged in more than once weekly Activity in logging in food decreased over time Adherence was significantly correlated with waist circumference change ($p = 0.03$ at 3 months, $p = 0.038$ at 6 months) Participants were instructed to self-monitor diet weekly. Participants received weekly text message reminders for first 3 months to log onto the app and had monetary incentive to complete in-person visits.	Structured and open-ended questions at each visit (4-point likert scale)	Intervention participants rated SparkPeople™ easy to use and somewhat to very useful. 10-12 month mean (SD) for intervention participants. Ease of use: 3.41/4 (0.62) Usefulness: 3.94/4 (0.24)
2020, Alex R Chang, United States	Remote Dietary Counseling Using Smartphone Apps in Patients with Stages 1-3a Chronic Kidney Disease: a Mixed	N/A	Use of Vibrent™ (7 participants) or Use of MyFitnessPal™ (9 participants)	Frequency of dietary entry via in-app analytics	14 (88%) entered dietary data at least 75% of total days and entry was consistent throughout duration	Acceptance and satisfaction measured via semi-structured interview and satisfaction surveys	Study app was switched from Vibrent™ to MyFitnessPal™ due to negative feedback from participants.

	Methods Feasibility Study				Vibrent™ users logged 75% of the total days. 5 participants entered >98% MFP users: 7 participants logged 75% of the total days, 1 logged 50%, 1 logged 32% Participants had weekly monetary incentive to adhere to logging (virtual lottery tickets)		Higher satisfaction with MyFitnessPal™ but mixed responses for app satisfaction High satisfaction with study overall.
2020, Seongkum Heo, United States	A Tailored Dietary Sodium Intervention Using Technology and Psychosocial Support: A Pilot Study.	N/A	Use of MyFitnessPal™	Adherence to intervention sessions via attendance App usage via in-app analytics	98.5% adherence to intervention sessions, 90.6% used MyFitnessPal™	Acceptability Questionnaire scored using a 10-point visual analog scale	"Participants very satisfied with intervention." Acceptability score for each session ranged from 98% to 100%
2018, Till Orlemann, Germany	A Novel Mobile Phone App (OncoFood™) to Record and Optimize the Dietary Behavior of Oncologic Patients: Pilot Study.	Nutritional counseling, nutritional therapy without app	Nutritional counseling, nutritional therapy with app (Oncofood™)	NR	Adherence rates NR App had an acoustic signal that occurred three times daily and would go off every 3 minutes in the case of a missed meal entry. Weekly reminders to enter weight and appetite parameters. Traffic light colors and symbol diagrams to help patients interpret their achievements to motivate patients to adhere to their nutritional plan	Patients were asked to provide suggestions for improvement and positive and negative feedback	"The app was rated predominantly positively by the patients in terms of user satisfaction and patients were able to adapt easily to the phones and the app."
2015, Jin-Ming Wu, Taiwan	Tablet PC-enabled application intervention for patients with gastric cancer undergoing gastrectomy	Retrospectively collected 20 matched cases as a control group	Perioperitive care via app	NR	NR	NR	NR
2013, Janet L. Welch, United States	Using a Mobile Application to Self-Monitor Diet and Fluid Intake Among Adults Receiving Hemodialysis	Use of Daily Activity Monitor Application (DAMA™)	Use of Dietary Intake Monitoring Application (DIMA™)	App usage via in-app analytics Active users were participants who used the app ≥50% of the time.	75% of participants were active users 25% attrition rate	25 item questionnaire	Mean acceptability score 3.93/5

NR = Not reported