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Wafa Khamis Al-Majarfi *

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Research Article

Re-Print: Strategies that Make Mobile Apps Effective in Increasing Physical Activity: A Scoping Review

Wafa Khamis Al-Majarfi *

Ibri Regional Hospital, Al-Dhahira Region, Oman.

***Corresponding Author**: Wafa Khamis Al-Majarfi, Ibri Regional Hospital, Al-Dhahira Region, Oman.

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Abstract

Objective: The objective of this study is to analyse the researchers' studies on the effectiveness of mobile Apps to encourage people to undertake physical activity (PA), to determine what strategy makes utilising the mobile Apps an effective experience in increasing PA in healthy people, and to identify the gaps in their research studies.

Study design: The researcher utilised a scoping review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Scoping Review extension protocol.

Methods: This scoping review was conducted to identify under what conditions the mobile Apps could lead to the increased PA of the participants through analysing the research studies on mobile App features and participants' characteristics. Studies included those with high internal validity (randomised controlled trials) that dealt mainly with PA. The articles were selected according to specific criteria including 1) quantitative studies in English language, 2) participants from 18-70 years of age, 3) healthy participants who were recruited from community/primary healthcare centres and at high risk of cardiovascular diseases, and 4) the studies' outcomes on the apps' effectiveness and efficiency in increasing PA. The articles were critiqued using the Specialist Unit for Review Evidence.

Results: Eight articles were finally selected and analysed. Four intervention strategies were identified from the studies – social aspect (3/8 studies), texting (3/8 studies), health sessions (3/8 studies), and feedback (5/8 studies). Results showed that some of the motivational strategies had a significant influence in improving PA.

Conclusions: The long-term effect was not tested on all studies. Therefore, long-term studies need to be conducted to test the consistency of the PA. Additionally, subgroup analysis should be performed to gauge the influence of individual characteristics on increasing PA.

Keywords: mobile apps, physical activity, healthy participants, motivational interventions

Introduction

Scoping reviews are an ideal tool for defining the scope or coverage of the empirical literature regarding a specific topic to give a clear indication and focused overview of all the available literature and studies.[1,2] Well-written scoping re- views are more effective than a literature review.[1,3,4] Thus, the researcher starts with a clear question in writing the lit-erature review that is focused on narrow criteria, while in a scoping review the question starts with less depth but a wider conceptual scope.[1] Moreover, a scoping review is more flexible than a systematic review because it can include various studies with different methods, which is not feasible in a systematic review.[1,5] Davis et al.[6] suggested that a well-prepared scoping review has a depth of interpretation and analysis of evidence that leads to definition and concept clarification.

The current trend is towards the use of technology to monitor peoples' health conditions. Mobile apps have been shown to be beneficial for promoting physical activity. This technol- ogy may allow the public to easily self-monitor to promote healthy lifestyles by walking. The user can monitor their own achievements directly through their mobile phone without the need to pay any additional cost to buy smartwatches or another accelerometer. There is increased worldwide effort to improve people's PA level.

In the past 10 years, many scoping reviews have been con- ducted on the ability of technology to increase physical activ- ity (PA), but there are four scoping reviews that dealt mainly and exclusion criteria were specified clearly. The researchers specified the way in which the studies were selected in de- tail and measured the degree of agreement between the se- lected studies, which indicated rigour when selecting the review studies.[12] The researchers did not identify any study of low- or middle-income countries. Moreover, the results demonstrated the effective use of technology for ensuring activities that promote physical health. The reviewers also identified a gap in the existing body of knowledge

regarding holistic healthy behaviours that can help to prevent non-communicable diseases. The authors also recommended conducting studies in low- and middle-income countries.

Whereas the reviews of Aromatario et al.[7] and Joseph- Shehu et al.[9] were undertaken to determine how effective the app and technology were at increasing PA, the reviews with PA as the primary outcome.[7–10] However, these scoping reviews answered different questions. of Monteiro-Guerra et al. [10] and Ghanvatkar et al. [8] were Aromatario et al.[7] undertook a scoping review to analyse how researchers conduct their studies assessing the effective- ness of mobile Apps. The scoping review included studies that dealt with PA and/or dietary behaviours. To avoid study selection bias, two authors appraised the studies independently.[11] The inclusion and exclusion criteria were speci- fied clearly, which will help to design an appropriate sample of studies, increase representativeness, and reduce bias.[12] Aromatario et al.[7] analysed twenty-two studies met the criteria and were analysed using Preferred Reporting Items for Systematic Reviews and Meta-Analyses Scoping Review (PRISMA-ScR). The results show that the researchers did not focus on the effectiveness of mobile Apps and the apps' characteristics. Detailed information about each study was provided in tables, which supports the transparency of report- ing the study details.[13] From Aromatario et al.[7] scoping review, it is clearly understood that information about mo- bile Apps' characteristics should be provided for the users to achieve their personal goals. Because the efficacy mechanisms were not reported in most intervention studies, there is a need for effective motivational mechanisms for PA in- terventions.[7] The strength of this review is that it included studies whose authors tested different theories of behaviour changes, different interventions, and different app compo- nents because it is known that a scoping review can deal with more general questions.[14]

In another scoping review, Joseph-Shehu et al.[9] reviewed studies to map evidence of the effect of utilising communi- cation and information technology to enhance healthy be- haviours. The authors followed the five stages of conduct- ing a scoping review that were formulated by Arksey and O'Malley.[1] The review included 24 studies (13 research articles and 11 systematic review articles). The inclusion conducted to explore what makes apps more effective in increasing the level of PA.

Monteiro-Guerra et al.[10] and Ghanvatkar et al.[8] conducted a scoping review on personalisation in PA using mobile Apps. Ghanvatkar et al.[8] discussed six personalisation categories in 49 study papers including activity recommendation, goal setting, educational content, fitness partner recommendation, intervention timing, and motivational content. Meanwhile, Monteiro-Guerra et al.[10] reviewed 28 research articles that described seven personalisation concepts including feedback, goal setting, user targeting, interaction, self-learning, context awareness, and adaptation. The objectives of the studies in both reviews were to explore different types of personalisa- tion in PA apps and identify gaps in the literature. Both of the reviews included studies that target different topics including patient rehabilitation, weight loss management, and healthy lifestyle maintenance.

The results of Monteiro-Guerra et al.'s[10] review show that all apps used the feedback concept, whereas only two apps used the adaptation concept. Both reviews showed that per- sonalisation is effective at improving customer adherence to PA. Ghanvatkar et al.[8] added that automated intervention systems need to be customised according to the users' needs. They ended their review by recommending further research into improving the efficacy of personalisation in apps.

Ghanvatkar et al. [8] and Monteiro-Guerra et al.'s[10] study selection was undertaken by one researcher initially and then verified by two researchers independently, which could help to prevent selection bias.[12]

All four scoping reviews followed the five stages adapted by Arksey and O'Malley (2005).[1] According to Arksey and O'Malley, the five stages are:

- Stage 1. Identifying the research question
- Stage 2. Identifying relevant studies
- Stage 3. Study selection
- Stage 4. Charting the data
- Stage 5. Collecting, summarising, and reporting the results

The reviewers followed the PRISMA protocol, which is con- sidered the ideal way to enhance transparency and maintain rigour in scoping review processes.[7] They followed a well- designed question to arrive at answers.[15] Despite the large body of evidence that results from the reviews, many au- thors conclude with reference to the issue of validity and generalisability because it is still unknown.[2] The scoping review is a transparent and rigorous method for mapping evidence of research.[1] The aforementioned scoping reviews are easy for the reader to follow because the included studies are arranged in tables. As a result, the data are presented transparently. When a scoping review is conducted to investigate a certain concept in the literature, it offers a rigorous alternative methodology to analysis, which makes the results more useful and helps to inform practice.[2]

The previous scoping reviews on mobile Apps were not fo- cused solely on PA but dealt with two or more factors such as PA and diet or included other factors like weight loss or smoking. The present scoping review will be more focused and deal with research into PA and randomised controlled trials (RCTs) only.

2. Methods

2.1 Aim and objectives

2.1.1 Aim

To critically evaluate the available studies to find effective strategies and techniques that could make using the app for PA promotion a successful experience.

2.1.2 Objectives

- Analyse how researchers conducted their studies into mobile App effectiveness and assess the effectiveness of various intervention strategies at increasing level of PA
- Assess the participants' commitment to maintaining a consistent level of PA
- Identify gaps in the previous research
- Evaluate using social aspects
- Utilise the findings to develop effective strategies for planning the intervention in future research

2.2 Setting

The review will include all RCTs undertaken in the previous years.

2.3 The review question

To formulate a scoping review question, Participants, Con- cept, and Context is utilised to guide and describe studies that are considered relevant.[16,17]

2.3.1 Participants

The reviewer will consider all research focusing on healthy people aged 18 years and over who are able to give consent.

2.3.2 Concept

By using health apps to monitor PA, the expected outcome is increased when using mobile Apps.

2.3.3 Context

The setting is community and primary healthcare centres. The reviewer will consider studies utilising a quantitative design and healthy participants.

2.4 Scoping review question

What factors and techniques can make using smartphone apps a successful experience?

2.4.1 Inclusion criteria

- RCTs
- English language
- PA is the primary outcome
- Full text
- Aged 18-70 years of age
- Healthy people or those at risk of cardiovascular dis- eases (CVDs) (the studies with subjects with diseases were excluded because the disease might be a moti- vator to the subject to do the exercise to relieve the disease symptoms, which might lead to confounding factors bias)
- Using mobile Apps
- Recruited from the community or primary healthcare centres.

2.5 Search strategy

The aim of the review is to critically appraise the available articles regarding the effect of using apps to increase the rate of PA. Relevant sources of evidence were identified by investigating a comprehensive set of websites and databases. The search was performed using the following keywords: "physical activity OR exercise OR walking OR activities of daily living" AND "mobile applications OR mobile Apps OR smartphone applications OR smartphone apps OR dig- ital technology OR e-health OR m-health." The keywords were chosen after multiple repeated searches to generate arti- cles that satisfy the inclusion criteria for this scoping review. Searching was undertaken using online databases including PubMed and CINAHL (see Tables 1 and 2).

Next, all of the articles were screened to ensure they satisfied the inclusion criteria: RCTs only, English language, articles from January 2010 to September 2020, dealing with PA as the primary outcome, full text freely available, participants 18-70 years of age, healthy people, and people at risk of CVDs. All articles were screened for their relevance and quality. Articles were excluded if the apps were related to sports or treatment. The research intended to deal with PA as a secondary outcome was excluded. Then the articles were interpreted and critically evaluated.

2.5.1 Study selection

The selection procedure was performed independently. The selection process involved three stages: screening the articles' titles, abstract, and full research paper. After identifying the relevant research papers, data extraction was performed. The screening of the articles was developed based on the pop- ulation, interventions, and outcomes.[18] Included articles were screened based on the previously stated inclusion and exclusion criteria. The study selection process is shown in a flow diagram (see Figure 1).

Concept	Search Number	Term	Result CINAHL/PUBMED	
	1	Physical activity	4,389	14,139
	2	Exercise	3,528	12,548
Physical activity	3	Walking	1,624	2,771
	4	Activities of daily living	2,162	2,997
	5	1 OR 2 OR 3 OR 4	10,768	17,052
	6	Mobile applications	1,293	518
	7	Mobile Apps	688	533
	8	Smartphone applications	44	348
	9	Smartphone apps	20	72
Mobile Apps	10	Digital technology	160	242
	11	e-health	149	168
	12	m-health	20	64
	13	6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12	1,685	1,039
		5 AND 13	52	302

Table 1: Online searches sion. The studies were appraised using the Specialist Unit for

Name of Database	References Found	Eligible
CINAHL via EBSCO	52	8 articles
Medline	302	

Table 2: Online search results

2.5.2 Data extraction

A self-designed form for data extraction was developed. Stud- ies were selected independently. PA was the primary out- come measured. There were no restrictions on how the out- come was measured, such as whether it was a self-report or a physiological report. However, many studies were

excluded for different reasons. Studies that dealt with an increase in PA as a secondary outcome were excluded. Any studies that targeted specific diseases to increase PA were excluded. Sim- ilarly, those that used computer games to increase PA were excluded. To answer the review question, the data extracted from each study were as follows: the study bibliography, study location, study aim, study design, population, setting, sample size, study tool, study period, findings, and conclu- sion. The studies were appraised using the Specialist Unit for Review Evidence (SURE) checklist for RCT studies, which can help to indicate error and bias in quantitative studies.[19]

The scoping review is not used for a critical appraisal of the evidence or to assess the risk of bias.[20] A quality appraisal could be suggested for some methodologists;[4] however, the PRIMSA-ScR protocol is suggested by Tricco et al.[21] for quality appraisal for the scoping review. Most reviews presented data in the PRISMA format for the critical documentation of the review process.[22,23]

2.5.3 Study characteristics

All studies included in this scoping review whose authors used apps to promote PA were conducted in the context of disease prevention/enhancing health. All studies selected for this review were randomised, which is considered to be a high internal validity method.[12] There are many differ- ences in the demographic data included in each study (see Table 3 and Supplementary). One study targeted males,[24] and one study included only female subjects.[25] Moreover, the female gender was dominant in three studies;[25–27] and the male gender was the dominant gender in the other three studies.[28–30] However, the female gender was more promi- nent in the three studies with the highest percentage (see Supplementary). Five studies stated the participants' level of education.[25–28,30] Three studies stated their employment status.[25,29,30] Four study groups used short-term interven- tions,[24,27,29,31] while the other four used various study periods, as described in Supplementary.

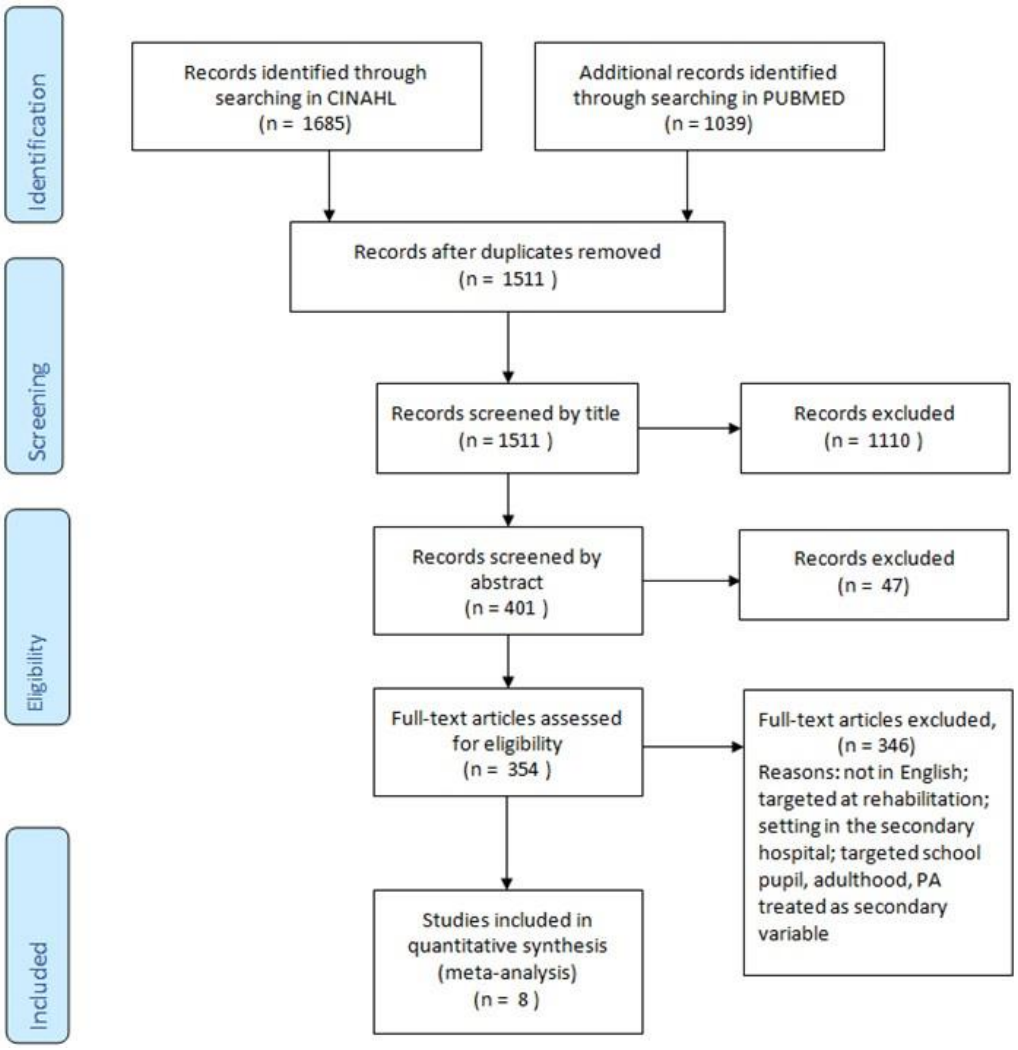

Figure 1: Flow diagram for selection process

Four study groups tested the efficiency of using text messages or messages within the app. [25,27,29] In these studies, mes- sages were used for different purposes including to remind participants to exercise, to encourage participants, positive reinforcement, and motivation. One group used a diary as an app feature so that users could monitor their exercise.[25] Three of the teams tested the social effect of encouraging users to increase PA. [24,26,27] Only two groups mentioned if the users had a car. [24,25] Two teams used samples at a high risk of CVDs and chronic diseases. [30,31] None of the re- searchers targeted obesity specifically. Participants reported their activity through emails in two

studies, [24,31] while ac- tivity data were transmitted automatically to the study server in the rest of the research. [25–30]

PA trackers were used for different purposes including so- cial support, [24,26,27] self-monitoring, [24–27,29,30] or sharing tips. [24, 25, 29]

2.6 Risk of bias in studies

Research papers should be rigorously conducted, well- designed, and analysed appropriately.[32] To assess a study for its quality is to focus on assessments of the risk of bias,[33] that is, the extent to which the results can be trusted.

The research papers are assessed for external validity, the usefulness of the study outcomes, and the transferability of the research findings to a

wider population.[34] Studies were assessed for error and bias using the SURE tool. Using a standardised assessment tool for all studies helps to ensure inter- and intra-rater reliability.[35]

Many of the included studies used small sample sizes, [27,29,31] only adult participants, [24,29] only female sub- jects,[25] or only male subjects,[24] which will affect the gen- eralisability and transferability of the results. Additionally, Glynn et al.,[31] King et al.,[27] and Edney et al. [26] included a higher percentage of females than males, as shown in Table 3. Moreover, a small sample size led the secondary outcome to be underpowered and resulted in the detection of significant differences.

Bias is any stimulus, intended or unintended, that might alter the result of the study.[36] Fukuoka et al. [25] recruited only females by advertising, which may limit the generalisability because motivated women would be disproportionately likely to participate in the study. Unfortunately, this may cause se- lection bias because the participants were influenced and had been motivated by the advertisement.[36] Another point is that Fukuoka et al. [25] used two interventions (in-person sessions and apps), which affected the accurate measurement of the independent effect of app use. Unfortunately, this may introduce detection bias, which occurs when the outcomes are influenced by another factor but not verified.[36]

Author and Year	Gender Ratio	Feedback	Body Mass Index (BMI)	Employment	Education	Car Owner
Kramer et al. (2019)[28]	47.83% females	X	X	X	University degree: 43.58%	X
Glynn et al. (2014)[31]	64% females	Not by users, only automatic feedback (app feature)	Average: 28.2	X	X	X
Edney et al. (2019) [26]	73.8% females, 222/301	X	Overweight 35.8% (107/301), obese 43.1% (129/301).	X	University education: 53.2% (159/301)	X
King et al. (2016) [27]	75.3% (67 females)	Customised feedback and information in the apps	Average: 28.8	X	University education: 97.7%	X
Fukuoka et al. (2019)[25]	Females only	Feedback on self-achievement: Diary note	Average: 29.9	74.3%	College education: 75.3% (158 of 210)	84% drive a car more than once a week
Martin et al. (2015)[29]	Men: 26 (54%); Women: 22 (46%)	X	54% (26 subjects)	88%	X	X
Harries et al. (2016)[24]	Male only	Testing feedback effect	X	X	X	Car or no car, 63%
Peacock et al. (2020) [30]	64% males	Feedback for motivation . . . feedback on behaviour, self-monitoring PA goal and behaviour	Average: 29.1	42%	Undergraduate/higher degree: 40%	X

Table 3: Demographic data

Peacock et al.[30] and Kramer et al.'s[28] studies are at a high risk of selection bias because they selected the studies' sub- jects from certain areas that have different characteristics from the general population. Peacock et al.'s[30] findings might not be generalisable because the sample came from the same area in the United Kingdom where people tend to be well-educated and there is limited socioeconomic and ethnic diversity. The same point arose in Kramer et al.'s[28] study because the sample was recruited from a single insurer and, therefore, the programme might not fit other populations or insurers.Because registration was voluntary in some studies, it might cause selection bias and make the studies susceptible to vol- unteer bias.[26,28] In Edney et al.'s[26] study,

the participants were recruited through Facebook groups, which put the study at a high risk of self-selection bias with high percentages of female and well-educated participants. Additionally, the study included only subjects who had experience using mo- bile Apps, which could lead to bias of confounding factors. Subgroup analysis to establish whether the subjects' charac- teristics had any influence on the outcome was not performed for most of the studies, which puts these studies at a high risk of bias of confounding factors.

Most researchers did not explain the reason for subjects drop- ping out before the end of the study despite a high percentage of subjects dropping out, exposing the studies to a high risk of attrition bias. Fukouka et al.[25] lacked transparency when describing the subjects' retention rate because 210 subjects were randomised into three groups and the same number was mentioned in the analysis, and they did not exclude any subjects despite multiple missed visits by certain subjects. Moreover, the study by Kramer et al.[28] is at a high risk of reporting bias because the participants' retention rate was not described. Furthermore, Glynn et al.'s[31] study had the lowest retention rate of 86%, followed by Peacock et al.[30] with 91%, and Harries et al.[24] with 92%

3. Results

The Supplementary provides a summary of each study. All studies are RCTs, which are considered the second level of evidence in the hierarchy and provide an appropriate qual- ity.[37] All studies are quantitative and based on experiments. In the context of this scoping review, the variable was the intervention (mobile Apps). The effect measured was the in- crease in steps. The researchers mainly compared the effect of the apps (the dependent variable) and their influence over PA (the independent variable).

All of the included studies have a similar aim but different evaluating measures. Some groups evaluated the increase in PA through self-report PA,[25–27] total activity time,[26,29] and physiological measures including BMI and systolic and diastolic blood pressure,[30,31] and all teams counted steps for the purpose of evaluation except King et al.,[27] who utilised an accelerometer to measure the amount of active time.

A precise description of the inclusion and exclusion criteria can increase the outcomes' generalisability.[38] However, the majority of the research teams did not give a precise descrip- tion of inclusion and exclusion criteria, although Fukuoka et al.[25] and Harries et al.[24] provided more details of the inclusion and exclusion criteria.

The main drawback with most of the included studies is that the data analysed were based on small sample sizes or con- venience samples, which affects the generalisability of the results to the wider population.

3.1 Synthesis of the results

The results varied in some studies on the basis of the de- mographic data. Participant subgroup analysis was not un- dertaken in all of the studies because of the small sample size. Subgroup analysis is important to evaluate the effect on the outcomes. Participants' characteristics are important to perform subgroup analysis and evaluate the treatment effect of the outcomes.[39] Only one study group performed sub- group analysis.[26] King et al.[27] provided a rationale for not conducting a subgroup analysis, which was that the sample size was small. Result synthesis is described as follows by providing the participants' characteristics and an overview of the intervention.

3.2 Participants' characteristics

Many characteristics of the participants could influence the successful utilisation of apps to increase the level of PA, in- cluding their age, gender, education, BMI, car ownership, and employment (see Table 3). There was considerable vari- ation in achieving the goal according to the subjects' gender. Subgroup analysis showed that there was a significant in- crease ($p = .06$) in the step-count for females responding to texts when compared with males.[29] A similar result was noted ($p = .05$) for time interaction in the text message group among females (35 mit/day) relative to males (10 mit/day). The effect of age on the intervention was discussed in one study. There was a significant increase in PA among those of an older age (> 40 years) ($p = .01$) compared with the younger (< 40) users.[26] Education level was specified in the participants' characteristics, but subgroup analysis was not undertaken nor was it established whether it affected the out- come.[25,26,28] BMI was mentioned by five teams,[25–27,29,31] but two of them analysed the effect[25,26] and one of them indicated a higher step count in the healthy BMI range ($p = .001$) relative to obese users.[26] Car ownership was specified by two groups,[24,25] one of whom indicated in the analysis that those who did not own a car had a higher step count than those who had a car.[24]

Employment status was determined in some stud- ies.[24,25,29,30] Employed users had a significantly higher step count.[24] However, none of the study groups mentioned the nature of work that the participants did, which might affect the findings. For example, a nurse naturally walks more during their working day, whereas a clerk is less likely to walk at work.

Thus, it is important to specify and analyse the subjects' char- acteristics to explore the extent to which they can affect the study result. Additionally, subgroup analysis is important to establish the factors that can affect the intervention and the personal factors that can enhance the intervention.

3.3 Overview of motivational interventions

All of the included studies involved different motivational strategies (see Table 1). Kramer et al.[28] used financial incen- tives to motivate app users to increase their step count. The incentives-intervention-group was divided into two groups. Both groups could earn rewards with the exception of charity financial subjects, who could donate their rewards to charity organisations. The effect of the incentives intervention did not seem to be effective in the long term for increasing the rate of PA.

Glynn et al.[31] used a simple intervention that consisted of two methods: providing subjects in the intervention group with a smartphone app and instructions. The results show a significant increase in step count ($p = .009$) for the interven- tion group. The effect of the intervention in increasing PA was maintained over 8 weeks.

Two groups tested the effect of different mobile app features for improving PA and increasing user engagement.[26,27] Both studies supported the social interaction feature within the app to increase PA. Edney et al.[26] tried to test the ef- fect of two different apps on engaging subjects to increase PA: a gamified app characterised by game-like elements that allowed for social interaction and challenges to achieve PA goals and a basic app that allowed subjects to monitor their own step count and contained no social or gamified features. The results show a significant increase in gamified app use ($p < .001$), which led to the gamified app working as a mo- tivating factor to increase PA. Meanwhile, King et al.[27] evaluated three apps that were customised to induce PA be- haviour. The three apps were a social app (for interaction between group members), an affected app (showing the par- ticipants' inactivity or activity through a bird character on the phone screen), and an analytic app (so the users could monitor their activity on a chart). The social app showed a significant increase in PA ($p = .005$).

Harries et al.[24] tested the effect of a social support inter- vention in a different way by adding a feedback intervention. The study included three groups: a no feedback group (con- trol group) and two intervention groups (group feedback, individual feedback). With social group feedback, the user could compare their achievement with others, while the in- dividual group feedback focused on their own achievement. All subjects were provided with smartphone devices that in- cluded a step count app and instructions. The result showed a significant increase ($p < .05$) in

individual group step count over the control group, and the social group over the con- trol group ($p < .05$). Researchers used another intervention, which was sending automatic text messages reminding and encouraging all users to accomplish their goals. However, the texting intervention was not evaluated and used as a strategy to prevent participant dropout. Similarly, the texting effect was tested by Martin et al.[29]

Martin et al.[29] examined the effect of texting and tracking interventions. They allocated 48 subjects to three groups:

1) blinded to PA tracking, 2) unblinded to PA tracking, and 3) unblinded to tracking data plus automatic reinforcement texts. There was a significant increase in the step count among subjects who received texts relative to the blinded group ($p < .001$) and over those who did not receive texts ($p< .001$). Blinding the subjects to the intervention is important because a lack of blinding can exaggerate the intervention's effect.[40]

Fukuoka et al.[25] and Peacock et al.[30] started their studies by conducting in-person sessions for their subjects in the intervention groups. Fukuoka et al.[25] conducted a study to examine the use of apps and in-person counselling for increasing and maintaining PA. The study consisted of three elements: intervention group (plus/regular group), and con- trol group. The control group participants only used the accelerometer, whereas the intervention groups were the reg- ular group (completed 3 months intervention plus 6 months accelerometer) and plus group (3 months PA plus 6 months phone diary plus accelerometer). Both of the intervention groups received the same interventions: a mobile app (for daily messages plus video clips) and in-person counselling sessions. In the sessions, each subject in the group was provided with an individual plan according to their activity baseline, information about the benefits of PA, the value of social support and relapse prevention, information about PA barriers, and PA safety. After 3 months, the results showed a significant increase in total steps and PA level ($p < .001$) for those in the intervention groups (plus and regular groups). Moreover, in the maintenance period, after 6 months the aver- age PA level remained higher in the intervention groups than the control group ($p < .001$), while the step count remained the same for the intervention groups. In summary, using the app and counselling intervention brought about a signif- icant increase in PA when compared to the control group (accelerometer alone) for the first 3 months. However, the PA level could not be maintained in the following 6 months when using the app compared with using the accelerometer alone. Thus, counselling over the long term is costly because more staff are needed.

Peacock et al.[30] conducted a study to test the effectiveness of app use when combined with trainer support to increase PA. The health trainers discussed the action plan and the health consequences of PA and how to perform PA and build self-belief. The in-person sessions were approximately 20-30 minutes in duration and five sessions were provided in total. Those in the control group were provided with stan- dardised information for 20 minutes in a meeting, whereas the intervention group was provided with five in-person ses- sions (trainers) and an app for feedback and assisted with self-monitoring, setting the goal, and visualising the achieve- ment. Eighty-five percent of the intervention group subjects attended all sessions. The result shows an equivalent statistical result of PA in both groups. The confidence interval of PA for both groups after 12 months was -17.9–15.7. The study groups used different techniques and interventions to test whether using apps would increase PA. In the following, four strategies are discussed: social aspect, texting, health sessions, and feedback.

3.3.1 Social aspect

Three study teams explored the social aspect to increase which will affect confidentiality.

3.3.2 Texting

Fukuoka et al.[25] provided the users with daily messages or video clips to motivate them to achieve their goal. The daily messages or videos offered an overview of the PA program, the health benefits of PA, the barriers to increasing PA and strategies to overcome them, PA safety, and brisk walking duration and intensity. It is important to support the PA app with weekly messages sent to subjects as encouragement for them to walk more.[24]

Additionally, text messages were utilised to remind the users to report their step counts and PA duration in the app.[24,25] The adherence rate for reporting PA through messages was 68.4%.[25] The idea of using a diary or reporting the activ- ity goal and achievement is to help the subjects with self- engagement, [26] motivate use of the apps,[27] and as encour- monitoring.[25] agement.[24] All three groups reported benefits and a positive impact of social factors as a motivation and challenge to the use of apps for PA. Social features in the health app are designed to increase engagement because users are notified when another user interacts with the group subjects, which leads the user to return to using the app.[26]

Social features in the app influence behaviour change through comparison, competition, and collaboration among the group members.[27] King et al.[27] used an app containing a discus- sion board feature to facilitate the users' interaction. Approx- imately 91.3% of social group subjects used the message board of the social app.[27] Seventy-nine percent of the mes- sages discussed the barriers to PA, which give an indication about the users' awareness of the importance of PA. Forty-eight percent of the messages were about supporting the members. The qualitative measures to explore the users' satisfaction with using the apps showed that approximately 71% of users were reminded by the app to exercise, and the app motivated approximately 69% of users to increase their PA.[27] King et al.[27] concluded that the social app was most effective at increasing PA.

Adding the feature of comparing data between users and pro- viding feedback has been shown to be effective for increasing step count and sustaining progress because 73% of subjects reported that they would continue using the app after the study.[24] Ten months after the trial, a qualitative interview was conducted with the participants, which showed that some participants were still using the app and their PA level had increased.[41]

Based on the finding of these studies, we can conclude that the social feature is an important aspect when using apps for PA. However, participants may share exposed personal data, Martin et al.[29] used two types of text messages: positive re- inforcement messages (for those who had accomplished their goal) and booster messages (for those making weak progress to motivate them to achieve the goal). Subjects received text messages three times a day, which were personalised according to their characteristics.

3.3.3 Health sessions

Researchers studying health apps started with in-person sessions and provided the participants with information about the benefits of PA to motivate subjects to achieve the goal.[25,30,31] Health sessions are important to raise partic- ipants' awareness. Counselling sessions were found to be effective for short-term interventions.[25,31]

Fukuoka et al.[25] provided in-person counselling sessions for intervention group subjects. The sessions included an outline of the PA programme, education about PA duration and types, the health benefits of PA, the value of social sup- port, and relapse prevention. The sessions and participants' questions were recorded for analysis and even though the result was not mentioned in the research paper, the intervention group demonstrated increased PA after 3 months.

Glynn et al.[31] provided all study subjects with the same session about PA at the beginning of the study, whereas Pea- cock et al.[30] trained health trainers to follow the subjects throughout the study period. The trainers' roles were to pro- vide information and encouragement, improve performance and motivation, and support the subjects to increase mainte-

nance. However, Peacock et al.'s[30] strategy increased the level of PA but was equivalent to the usual care when the par- ticipants received only an initial 20-minute session. Because the trainer role did not make a difference between the study groups,[30] it would be enough to reinforce the subjects with PA information for the initial session.

3.3.4 Feedback

Regarding feedback, more work is still needed to design the optimal technique so that information can be communicated to users considering the various communication characteris- tics (intention, timing, content, and representation).

Peacock et al.[30] used an app that provided the users with feedback on their PA duration and energy expended at each PA type (moderate, vigorous, or light PA), as well as the time they spent inactive. Peacock et al.[30] performed a qualitative investigation (interviews) to refine the PA data, and the over- all results indicated that people prefer simple messages rather than complex messages. Moreover, feedback is a supportive strategy because it was found to be motivating, understand- able, and informative.[42] Receiving positive feedback can reinforce a person's appropriateness of certain behaviour.[43]

Fukuoka et al.[25] designed a daily diary for the participants' use, so the participants were providing feedback on their own achievements, which helps to reinforce self-monitoring. Har- ries et al.[24] compared individual feedback (the participants can view their own steps) and group feedback (users can view their own steps and compare them with other group users). Participants received positive messages encouraging them to walk more. Glynn et al.[31] used an app with a feedback feature to provide the participants with details about their step count and history of goal achievement.[27]

The technique of using feedback had a positive impact in terms of increasing PA through the app.[24,25,27,31]

4. Discussion

4.1 Summary of evidence

Arksey and O'Malley[1] adapted five stages for a scoping re- view framework (research question, relevant study selection, charting data, summarising, and reporting the findings). The review was guided by PRISMA-ScR. In this scoping review, eight studies were identified describing different interven- tions and strategies on using mobile Apps to increase PA. A comprehensive approach was taken following PRISMA-ScR, collecting information about different intervention protocols, app features, and motivating strategies.

It is difficult to test sustainability for short-term interven- tion studies,[24,27,29,31] so it is recommended, along with the aforementioned intervention strategies, to conduct studies over a longer duration. Moreover, participants' character- istics may motivate them to achieve their goals including adulthood, obesity, and chronic disease. These variables should be monitored and addressed in future research. A human coach was utilised in two studies.[25,27] A human coach might enable the participants, through motivational in- terviews, to achieve more. However, some researchers used texting for encouragement.[24,25,29]

The scoping review presented various motivational interven- tions such as text messages, in-person sessions, and apps with various features to promote PA. There was a dearth of data regarding the effect of subjects' characteristics and their effect on outcomes; only one study team analysed and tested the effect of the characteristics.[26]

Moreover, this review showed that using motivating strate- gies with a mobile App can improve PA behaviour. When designing an intervention based on mobile apps to promote PA, motivating factors, social aspects, and reminders are essential. The review showed that there is still not a com- prehensive protocol available to effectively utilise mobile apps to raise the PA level. However, the review provides an overview of different strategies that can be utilised to design new research.

4.2 Limitations

This review has strengths and limitations at the study level and review level. Including only RCTs is considered as a strength of this review. Another strength is that this review has provided various techniques in interventions, which will help to formulate a good intervention plan for future research.

The limitation at the study level is that it was difficult to explore the effect of subjects' characteristics on the interven- tion because no study groups conducted precise subgroup analysis. Another limitation of the included studies in this review is that the consistency and sustainability could not be measured because most studies were only undertaken for a short period of time.

The limitations at the review level include that the time issue is challenging when completing the scoping review. Pham et al.[5] found that the accomplishment time of scoping reviews varied from 2 weeks to 20 months. Scoping reviews do not usually require a critical analysis; however, this scoping re- view required more time because the critical analysis was utilised. One strength at the review level was that utilising the critical appraisal of the included studies reinforced the review transparency and rigour.

5. Conclusion

The findings of this review showed that using various strate- gies and mobile Apps with social aspect features can increase PA, which, as a result, promotes physical health. More pri- mary studies need to be carried out to promote PA through apps as a means of preventing CVDs. Participants' charac- teristics might mitigate the intervention, so they should be comprehensively addressed in future research. Moreover, a long-term study should be conducted to test the effectiveness of the intervention. It is also recommended to use qualitative mixed-methods studies in future research because these ap-proaches are often successful in identifying motivations for behaviours.

Conflicts of Interest Disclosure

The author declares no conflicts of interest.

References

1. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology. 2005; 8(1): 19-32. https://doi.org/10.1080/136455703200 0119616
2. Munn Z, Peters MD, Stern C, et al. Systematic review or scop- ing review? Guidance for authors when choosing between a sys- tematic or scoping review approach. BioMed Central Medical Re- search Methodology Journal. 2018; 18. PMid:30453902. https: //doi.org/10.1186/s12874-018-0611-x
3. Gough D, Thomas J, Oliver S. Clarifying differences between review designs and methods. Systematic Reviews Journal. 2012; 28(1): 1-9. PMid:22681772. https://doi.org/10.1186/2046-4053-1-2 8
4. Levac D, Colquhoun H, O'Brien KK. Scoping studies: Advanc- ing the methodology. Implementation Science. 2010; 69(5): 1- 9. PMid:20854677. https://doi.org/10.1186/1748-5908-5-6 9
5. Pham MT, Rajic A, Greig JD, et al. A scoping review of scop- ing reviews: Advancing the approach and enhancing the consis- tency. Research Synthesis Methods Journal. 2014; 5(4): 371- 385. PMid:26052958. https://doi.org/10.1002/jrsm.1123
6. Davis K, Drey N, Gould D. What are scoping studies? A review of the nursing literature. International Journal of Nursing Studies. 2009; 46(10): 1386-1400. PMid:19328488.

https://doi.org/10.101 6/j.ijnurstu.2009.02.010
7. Aromatario O, Van Hoye A, Vuillemin A, et al. How do mobile health applications support behaviour changes? A scoping review of mobile health applications relating to physical activity and eating be- haviours. Journal of Public Health. 2019; 175: 8-18. PMid:31374453. https://doi.org/10.1016/j.puhe.2019.06.011
8. Ghanvatkar S, Kankanhalli A, Rajan V. User models for person- alized physical activity interventions: Scoping review. Journal of Medical Internet Research. 2019; 7(1): e11098. PMid:30664474. https://doi.org/10.2196/11098
9. Joseph-Shehu EM, Ncama BP, Mooi N, et al. The use of informa- tion and communication technologies to promote healthy lifestyle behaviour: A systematic scoping review. British Medical Journal Open. 2019; 9(10): e029872. PMid:31662364. https://doi.org/ 10.1136/bmjopen-2019-029872
10. Monteiro-Guerra F, Rivera-Romero O, Fernandez-Luque L, et al. Personalization in real-time physical activity coaching using mobile applications: A scoping review. Journal of Biomedical and Health Informatics. 2020; 24(6): 1738-1751. PMid:31751254. https://doi.org/10.1109/JBHI.2019.2947243
11. Holland K, Rees C. Nursing: Evidence-based practice skills. Oxford University Press. 2010.
12. Rees C. Introduction to research for midwives. Elsevier. 2011.
13. Fain J. Reading, understanding and applying nursing research. F. A. Davis Company. 2009.
14. Moher D, Stewart L, Shekelle P. All in the family: Systematic re- views, rapid reviews, scoping reviews, realist reviews, and more. Systematic Reviews Journal. 2015; 4(1): 183-194. PMid:26693720. https://doi.org/10.1186/s13643-015-0163-7
15. Peterson NE, Sirard JR, Kulbok PA, et al. Sedentary behavior and physical activity of young adult university students. Journal of Re- search in Nursing and Health. 2018; 41(1): 30-38. PMid:29315656. https://doi.org/10.1002/nur.21845
16. Lockwood C, Santos KB, Pap R. Practical guidance for knowledge synthesis: Scoping review methods. Asian Nursing Research Journal. 2019; 13(5): 287-294. PMid:31756513. https://doi.org/10.1 016/j.anr.2019.11.002
17. Peters MD. In no uncertain terms: The importance of a defined ob- jective in scoping reviews. JBI Database of Systematic Review and Implementation Reports Journal. 2016; 14(2): 1-4. PMid:27536788. https://doi.org/10.11124/jbisrir-2016-2838
18. Joseph-Shehu EM, Ncama BP. Evidence on health-promoting lifestyle practices and information and communication technologies: Scoping review protocol. British Medical Journal Open. 2017; 7(3): e014358. PMid:28360246. https://doi.org/10.1136/bmjope n-2016-014358
19. Specialist Unit for Review Evidence (SURE). Questions to assist with the critical appraisal of randomised controlled trials and other experimental studies. Retrieved February 21, 2021, Available from: https://www.unisa.edu.au/contentassets/72bf75606a2 b4abcaf7f17404af374ad/sure_rcts-and-other-experim ental-studies_checklist_2016.pdf
20. Peters MD. Guidance for conducting systematic scoping reviews. International Journal of Evidence-Based Healthcare. 2015; 13(3): 141-146. PMid:26134548. https://doi.org/10.1097/XEB.00 00000000000050
21. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Annals of In- ternal Medicine Journal. 2018; 169(7): 467-473. PMid:30178033. https://doi.org/10.7326/M18-0850
22. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. Jour- nal of Clinical Epidemiology. 2009; 62(10): e1-34. PMid:19631507. https://doi.org/10.1016/j.jclinepi.2009.06.006
23. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA state- ment. Journal of Clinical Epidemiology. 2009; 62(10): 1006-1012. PMid:19631508. https://doi.org/10.1016/j.jclinepi.200 9.06.005
24. Harries T, Eslambolchilar P, Rettie R, et al. Effectiveness of a smart- phone app in increasing physical activity amongst male adults: A randomised controlled trial. PubMed Central Journal of Public Health. 2016; 16: 925. PMid:27590255. https://doi.org/10.1186/s1 2889-016-3593-3599
25. Fukuoka Y, Haskell W, Lin F, et al. Short- and long-term effects of a mobile phone app in conjunction with brief in- person coun- selling on physical activity among physically inactive women. The Journal of the American Medical Association. 2019; 2(5): e194281. PMid:31125101. https://doi.org/10.1001/jamanetworkope n.2019.4281
26. Edney S, Ryan JC, Olds T, et al. User engagement and attrition in an app-based physical activity intervention: Secondary analysis of a randomized controlled trial. Journal of Medical Internet Research. 2019; 21(11): e14645. PMid:31774402. https://doi.org/10.2 196/14645
27. King AC, Hekler EB, Grieco LA, et al. Effects of three motivationally targeted mobile device applications on initial physical activity and sedentary behavior change in midlife and older adults: A random- ized trial. The Public Library of Science. 2016; 11(6): e0156370. PMid:27352250. https://doi.org/10.1371/journal.pone.0 156370
28. Kramer N, Tinschert P, Scholz U, et al. A cluster-randomized trial on small incentives to promote physical activity. American Jour- nal of Preventive Medicine. 2019; 56(2): e45-e54. PMid:30553693. https://doi.org/10.1016/j.amepre.2018.09.018
29. Martin SS, Feldman DI, Blumenthal RS, et al. mActive: A random- ized clinical trial of an automated health intervention for physical activity promotion. Journal of American Heart Association. 2015; 4: e002239. PMid:26553211. https://doi.org/10.1161/JAHA.1 15.002239
30. Peacock OJ, Western MJ, Batterham AM, et al. Effect of novel technology-enabled multidimensional physical activity feedback in primary care patients at risk of chronic disease-the MIPACT study: A randomised controlled trial. International Journal of Behavioral Nutrition and Physical Activity. 2020; 17: 99. PMid:32771018. https://doi.org/10.1186/s12966-020-00998-5
31. Glynn LG, Hayes PS, Casey M, et al. Effectiveness of a smart-phone application to promote physical activity in primary care: The SMART MOVE randomised controlled trial. British Journal of General Practice. 2014; 64: 384-391. PMid:24982490. https: //doi.org/10.3399/bjgp14X680461
32. Samuel GO, Hoffmann S, Wright RA, et al. Guidance on assessing the methodological and reporting quality of toxicologically relevant studies: A scoping review. Environmental International Journal. 2016; 93: 630-646. PMid:27039952. https://doi.org/10.1016/j.en vint.2016.03.010
33. Higgins JP, Green S. Cochrane handbook for systematic re- views of interventions: Cochrane Book Series. 2011. Available from: https://onlinelibrary.wiley.com/doi/book/10.10 02/9780470712184
34. Steckler A, McLeroy K. The importance of external validity. Amer- ican Journal of Public Health. 2008; 98(1): 9-10. PMid:18048772. https://doi.org/10.2105/AJPH.2007.126847
35. Bettany-Saltikov J, McSherry R. How to do a systematic literature review in nursing: A step-by-step guide (2nd ed.).

Open University Press. 2012.
36. Polit DF, Beck CT. Essentials of nursing research: Appraising evi- dence for nursing practice (8th ed.). Wolters Kluwer Health. 2014.
37. National Institute for Health and Care Excellence. The Guidelines Manual. 2022. Available from: https: //www.nice.org.uk/process/pmg6/resources/the-g uidelines-manual-pdf-2007970804933
38. Britton A, McKee M, Black N, et al. Threats to applicability of randomised trials: Exclusions and selective participation. Journal of Health Services Research and Policy. 1999; 4(2): 112-121. PMid:10387403. https://doi.org/10.1177/13558196990040 0210
39. Wang R, Lagakos SW, Ware JH, et al. Statistics in medicine - Reporting of subgroup analyses in clinical trials. The New England Journal of Medicine. 2007; 357: 2189-2194. PMid:18032770. https://doi.org/10.1056/NEJMsr077003
40. Pildal J, Hobjartsson A, Jorgensen KJ, et al. Impact of allocation con- cealment on conclusions drawn from meta-analyses of randomized trials. International Journal of Epidemiology. 2007; 36(4): 847-857. PMid:17517809. https://doi.org/10.1093/ije/dym087
41. Harries T, Eslambolchilar P, Stride C, et al. Walking in the wild Using an always-on smartphone application to increase physical activity. In Kotze, P. et al., Human-computer interaction (pp. 19- 36). Springer Berlin. 2013. Available from: https://doi.org/: 10.1007/978-3-642-40498-6_2
42. Western MJ, Peacock OJ, Stathi A, et al. The understanding and interpretation of innovative technology-enabled multidimensional physical activity feedback in patients at risk of future chronic dis- ease. The Public Library of Science Journal. 2015; 10(5): e0126156. PMid:25938455. https://doi.org/10.1371/journal.pone.0 126156
43. Western MJ, Thompson D, Peacock OJ, et al. The impact of multi- dimensional physical activity feedback on healthcare practitioners and patients. Royal College of General Practice Journal. 2019; 3(1). PMid:31049409. https://doi.org/10.3399/bjgpopen18X101 628

DOI:10.31579/2637-8892/230