Clinical Interventions in Aging

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REVIEW

Telephone and Smartphone-Based Interventions for Cognitive and Cardio-Metabolic Health in Middle-Aged and Older Adults: A Systematic Review

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Purpose: Dementia and cardio-metabolic diseases share many risk factors. Management of these risk factors could contribute to successful aging, including the prevention of cardio-metabolic disease and dementia. The increasing use of smartphones offers an opportunity for remote preventive interventions. We provided a systematic review of telephone and smartphone-based interventions targeting the prevention of cognitive decline, dementia cardio-metabolic diseases or their risk factors among adults aged over 50 years.

Patients and Methods: We searched Pubmed and the International Clinical Trials Registry Platform for experimental studies. We used the Cochrane risk-of-bias tool (Version 2) for randomized trials or TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) checklists to assess study quality for completed studies.

Results: We analyzed 21 completed (3 for cognition, 18 for cardio-metabolic outcomes) and 50 ongoing studies (23 for cognition, 27 for cardio-metabolic outcomes). Smartphone interventions were used in 26 studies (3 completed, 23 ongoing). Other interventions involved telephone vocal support and text messaging. Few studies were at low risk of bias. There were heterogeneous cognitive and cardio-metabolic outcomes. The highest quality studies found no significant effects on cognition, and inconsistent results for HbA1c, blood pressure or physical activity. The lower quality-studies found effects on global cognition, working memory, memory and language and inconsistent results for clinical, biological or behavioral cardio-metabolic outcomes.

Conclusion and Implications: Despite the large number of commercially available mobile health applications, the magnitude of the scientific evidence base remains very limited. Based on published studies, the added value of telephone and smartphone tools for the prevention of cardio-metabolic diseases, cognitive decline or dementia is currently uncertain, but, there are several ongoing studies expected to be completed in the coming years.

Keywords: aging, telephone, smartphone, cognition, dementia, cardio, vascular outcomes

Introduction

Promoting successful aging through the prevention of non-communicable diseases, such as dementia, cardio-metabolic diseases (cardiovascular (eg stroke, angina) or metabolic (eg dyslipidemia, obesity) diseases or mental health problems among older adults has become one of the main World Health Organization (WHO) priorities.[1] Indeed, non-communicable diseases represent 71% of all deaths worldwide with a higher burden among middle-aged and older adults.[2] Most

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cardio-vascular diseases could be prevented by modifying their risk factors; for example such as improving physical activity, stopping smoking, having a healthy diet, controlling weight or blood pressure, or decreasing cholesterol, lipids or blood sugar could also have an effect on cardio-vascular disease incidence.[3] Moreover, these risk factors are also known to be associated with dementia incidence.[4,5] Therefore, managing these risk factors could contribute to both cognitive and cardio-metabolic disease prevention. Even though some studies suggest that many older adults have only basic health literacy,[6] others suggest that middle-aged and older adults may be attentive to these factors, know the notion of risk for them[7] and could be prone to initiate healthy behavior changes with the help of promotional interventions.

Information and communication technologies could help to promote healthier behaviors, particularly through the use of mobile technology tools such as smartphones. Mobile and smartphone accessibility has rapidly increased worldwide, first, in high income countries and now also in low or middle-income countries.[8] The number of mobile phone was reached 7 billion in 2021 worldwide, of whom 6.3 billion were smartphone users.[9] The number of mobile applications is also increasing worldwide, with, for example, 47,478 iOS applications classified as "health care" applications available in the first quarter of 2020.[10] Adults over 65 years are increasingly using smartphones, but there are evident disparities, with the oldest individuals, those with lowest household income and lowest levels of education less often owning a smartphone[11] and more often using simple message and weather applications rather than more interactive ones, compared to younger individuals.[12,13] These disparities are also evident in the telemedicine field, although some studies have shown that telemedicine is feasible among older populations.[14–18]

Telephone and smartphone interventions may be interesting tools for prevention in middle-aged and older adults given their common usage, inexpensive cost, and accessibility. Moreover, mobile-phones are portable, and well-integrated in daily life. Finally, mobile phones are a potentially powerful tool for monitoring and communicating with patients (and thus providing interventions) in a continuous way. In a clinical trial setting, they may improve recruitment rates by reducing participant burden, for example by reducing/removing travel to study visits.[19] They could therefore be a powerful method for encouraging behavior changes and consequently having an impact on long-term disease prevention. Mobile phones also enable "big data" approaches through the collection of medical (and other) data in a non-decontextualized (ecological) environment via text messages,[20] mobile applications and smartphone sensors (accelerometer, location, etc.). Telephones could also facilitate cognitive assessment[21] and improve early detection of cognitive and functional decline[22] or other health issues. However, clinical trials using such tools in older populations could be particularly affected by selection bias, given the disparities in use in older populations.

Despite the many promising advantages, it is necessary to evaluate the evidence concerning the effectiveness of such strategies.

Thus, the main aim of this review was to assess the effectiveness of telephone and smartphone-based interventions to prevent cognitive decline, dementia or cardiometabolic diseases, which share many risk factors, in older adults.

When data were available, we described strategies measuring intervention adherence, factors associated with adherence and the implementation of such strategies.

Materials and Methods

Searches were run in PubMed (including MEDLINE) and the WHO International Clinical Trials Registry Platform (ICTRP), which includes various registries from around the world (eg International Standard Randomised Controlled Trials Number (ISRCTN), Clinicaltrials.gov, Australian New-Zealand Clinical Trials Registry (ANZCTR), Brazilian Clinical Trials Registry), until 17 January 2022, using the search equations outlined in the Appendix.

Eligibility Criteria (See Appendix Box A)

Studies that met the following criteria were included:

(a) Inclusion of individuals aged 50 and over living independently at home
(b) Randomized clinical trial (RCT), quasi-experimental or pilot study

(c) Assessment of efficacy (as a primary or secondary outcome) of mobile-phone or other telephone interventions targeting the prevention of cognitive decline, dementia or cardio-metabolic diseases or their risk factors (overweight, physical activity, sedentarity, sugar or lipid profile, diet food and nutrition)
(d) Articles written in English

We excluded studies focusing on other interfaces, such as tablet, computer or personal digital assistants, because we wanted to exclusively focus on telephone-interventions since they are more portable and more integrated into everyday routine. We included all kinds of telephone interventions, ie telephone calls, short messages system (SMS), applications or telephone-accessible platforms. For cognitive outcomes, as we focused on studies concerning the prevention of dementia or cognitive impairment, we excluded studies involving participants with serious diseases likely to affect cognitive function (dementia, depression, schizophrenia, Parkinson's disease), but we did not exclude studies of participants with mild cognitive impairment or subjective cognitive decline. For cardio-metabolic outcomes, we excluded participants with congenital cardio-vascular disease. We also excluded studies of advanced disease (cancer, palliative care, malnutrition).

Data Extraction

Each study's eligibility was assessed by two authors (LA and CG). Study selection was firstly based on title and abstract, and the full-text was read where necessary. Publications which possibly met inclusion criteria were then assessed by both investigators independently. In cases of discordances regarding the eligibility of an article, there was discussion between the two investigators until consensus was reached.

The reference lists of the eligible articles were also checked in order to identify other studies of potential interest that were not identified in the literature search, as well as the reference lists of selected reports and papers in our own files.

Data were extracted by one author from each study regarding setting, participant characteristics, intervention description and outcomes.

Quality Assessment

We assessed the quality of completed studies using the items of the RoB2 (Version 2 of the Cochrane risk-of-bias tool for randomized trials).[23] Quality is defined into 3 levels: low risk of bias, some concerns and high risk of bias. Due to a lack of existing scales, we used the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) statement items to evaluate the quality of non-randomized controlled studies.[24] We divided scores into 3 groups. Poor quality was defined by a score of ≤9 criteria, good quality by a score of >18 criteria, and fair quality by a score between 10 to 18.

Results

Telephone and Smartphone Interventions for the Prevention of Cognitive Decline or Dementia

The Pubmed searches yielded 989 papers, of which 10 were eligible for our review (Figure 1). Of the 10 included articles, 3 described completed studies, 7 detailed protocols of ongoing studies.

In the ICTRP, 16 ongoing studies were included of the 856 identified (Figure 1).

In total, we included 3 completed (Table 1) and 23 ongoing studies (Appendix Table A).

Quality Assessment

Based on the RoB2 and TREND Checklist scoring systems, only one study was at low risk of bias.[27] The other two studies had higher risks of bias. For example, Oh et al[26] did not detail the allocation sequence generation and did not describe who was blinded. For the remaining study,[25] details concerning location, date of inclusion and setting details of the intervention as well as side effects were missing.

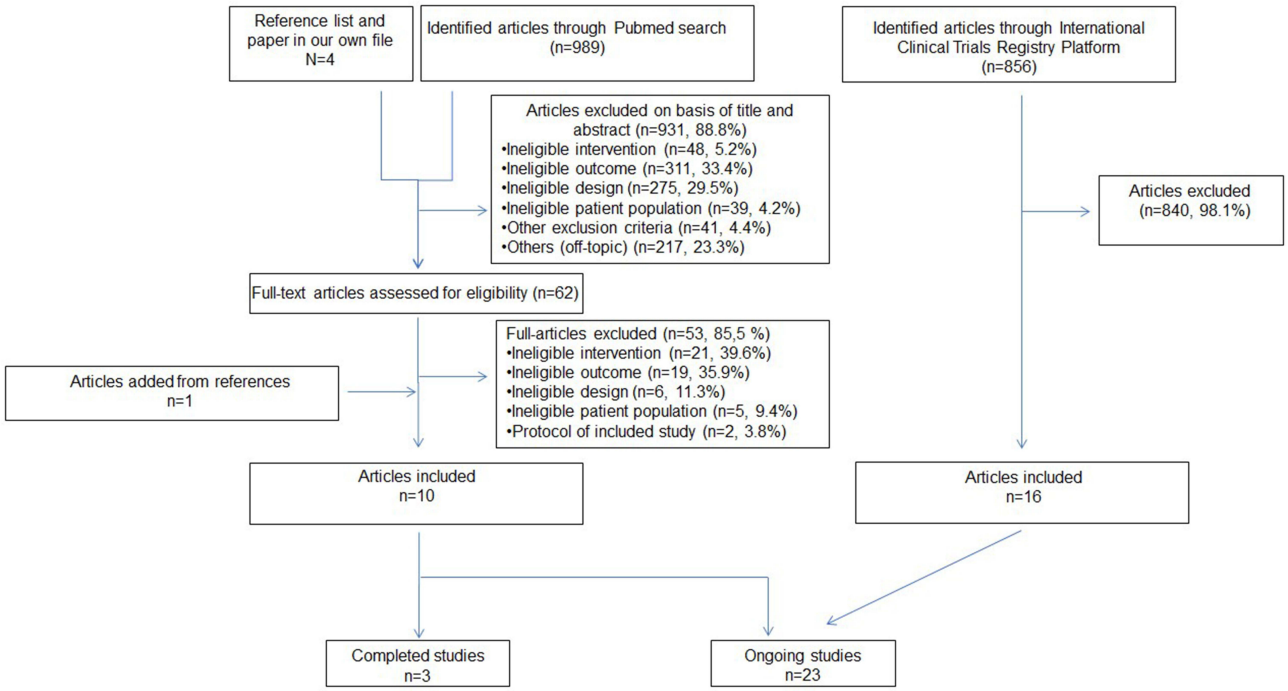

Figure 1 Study selection flow-chart for the cognitive outcome articles.

Description of Completed Studies (Table 1)

Sakakibara et al[27] evaluated in a low-risk of bias randomized clinical trial, the effect of telephone lifestyle coaching sessions (aiming to improve control of cardio-metabolic risk factors) among 126 Canadian stroke survivors adults aged 50 years and over without cognitive impairment. Participants received stroke risk factors manual, a kit to monitor risk factors and 7 coaching telephone sessions of 30–45 minutes to coach, motivate and help them to change lifestyle and 5 additional follow-up calls over 6 months. Control group received a memory training, an agenda to make reminder notes and 7 memory coaching telephone sessions of 30–45 minutes and 5 additional follow-up calls over 6 months. At 12 months, there was no change in MoCA (Montreal Cognitive Assessment), studied as tertiary outcome in intervention group compared with a memory training control group.

Oh and al[26] evaluated, in an 8-week randomized trial, the effect of a smartphone-based brain training application (Smartphone-based brain Anti-aging and memory Reinforcement Training (SMART)) among 53 South-Korean adults with subjective memory complaints and a Mini Mental State Examination (MMSE) score greater or equal to 24 (mean baseline scores: 28.06 (2.04) in the SMART group, 28.68 (1.06) in the fit Brain group and 28.25 (1.57) in the wait list group). This application, which targeted attention and working memory, was compared with another commercialized cognitive training application and a control group (no intervention). Participants used applications 5 times a week for 15 to 20 minutes. Weekly telephone calls and text messaging assessed progress and conscientious participation. The study found significant improvement between pre and post intervention on working memory for SMART group only, but not for the other tests. It should be noted that this was a poor-quality study, with several limitations, including.

The last study,[25] evaluated in an uncontrolled single arm study, a computer-based multidomain lifestyle intervention with telephone and email or text health support for a single group of 82 American aged 60–75 year-old with subjective cognitive decline. Participants received personalized coaching sessions, focusing on nutrition, physical activity, cognitive training and social engagement. The authors found significant improvement at 52 weeks compared to baseline scores for the primary outcomes on the total Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) scores (mean improvement=5.8, $p<0.001$), memory (immediate recall mean improvement=7.8, $p<0.001$, delayed recall mean improvement=5.4, $p<0.001$), language (mean improvement=5.7, $p<0.001$). Immediate recall significantly decreased at 24 weeks, but no other significant differences were found.

Table 1 Characteristics of Completed Studies Evaluating the Effect of Telephone and Smartphone Interventions on Cognitive Outcomes

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cognitive Outcomes	Phone Intervention	Population		Results
							Age	Cognitive Criteria	
Kumar et al[25] 2018 USA	Fair	Single arm pre-post pilot study	82	24 weeks 52 weeks	Primary: outcome: change in RBANS total score and sub-dimensions	Multidomain lifestyle intervention (main intervention) on computer supported by health telephone and email/text support: physical, nutritional, cognitive training and social engagement (difficulties, lifestyle behavior)	60–75	• At risk: subjective cognitive decline and worries about it • Free of dementia, mental illness and neurologic conditions	Compared to pre-intervention scores, there were significant differences at 24 weeks for immediate memory ($p<0.001$), and at 52 weeks for total RBANS scores ($p<0.001$), language ($p<0.001$), delayed memory ($p<0.001$) and immediate memory Compared to 24 week scores, there were significant effects at 52 weeks for total RBANS scores ($p<0.001$), immediate memory ($p<0.001$), language ($p<0.001$), attention ($p<0.01$) and delayed memory ($p<0.01$) There were no differences for visuo-spatial and attention scores.
Oh et al[26] 2018 South-Korea	High risk of bias	RCT	53	8 weeks	Primary outcome: K-MMSE, Korean, K-WAIS-IV, Memory Diagnostic System, Korean language version of the SCWT	Weekly call phone or text messages (progress and participation) • Intervention: SMART application brain training • Active control: Fit Brain training application • Control: no intervention	50–69	•At risk: subjective memory complaints • K-MMSE ≥ 24 • No cognitive impairment	Working memory on the Memory Diagnostic Memory ($p < 0.001$) and auditory-verbal working memory ($p < 0.001$) increased significantly between pre and post intervention in the SMART group. There was an interaction with time on auditory-verbal working memory test There were no other effects on outcomes in other groups

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Table 1 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cognitive Outcomes	Phone Intervention	Population		Results
							Age	Cognitive Criteria	
Sakakibara et al[27] 2021 Canada	Low risk of bias	Single-blinded RCT	126	6 months 12months	Tertiary outcome[a]: MoCA	Intervention: telehealth self-management: telephone lifestyle coaching sessions to improve controlling of cardiovascular risk factors with phone call. Self-monitoring kit and self-management manual •Telephone memory training program: memory coaching, memory training manual	≥50	• Vascular stroke survivors (modified Rankin Scale between 1 to 4) • Free of cognitive impairment • MoCA ≥23 • No clinically important neurological conditions • No severe aphasia or dysarthria	Stroke coach intervention did not change MOCA score at 12 months compared to memory training group (p=0.430) Adherence: •Intervention: 98% completed all coaching sessions and 96% all check-in sessions. Mean of 188.7 days (sd=30.2) •Control: 96% completed all sessions and 85% completed all check-in sessions. Mean of 188.0 days (sd= 52.5 days)

Notes: [a]Primary outcome not relevant to our work.

Abbreviations: RCT, randomized clinical trial; ≥, superior or equal to; <, inferior to; =, equal to; %, percentage; sd, standard deviation; p, p value; K-MMSE, Korean-Mini Mental State Examination; SMART, Smartphone-based brain Anti-aging and memory Reinforcement Training; WAIS-IV, Wechsler Adult Intelligence Scale-IV; SCWT, Stroop Color and Word Test; RBANS, Repeatable Battery for the Assessment of Neuropsychological Status; N, number of subjects; MoCA, Montreal Cognitive Assessment.

Description of Ongoing Studies

Australia is the country most frequently enrolling participants in the ongoing studies (7 studies). Six studies are being conducted in Asia, 4 in European countries, and 3 in North/South America (Canada, Brazil and USA). The remaining three are enrolling participants in multiple locations (Australia, Europe, Asia for one study, China and United Kingdom for the second, and Germany, the Netherlands and Norway in the third). (Appendix Table A and Figure 1)

The interventions are due to last between 4 weeks and 36 months, with a median of 12 months of follow-up. Moreover, the number of participants varies highly, from 9 for the smallest study to 3498 in the largest.

Ten of the studies are enrolling participants considered to be at risk of cognitive decline, due to the presence of memory complaints, mild cognitive impairment or stroke comorbidity (without cognitive impairment), and the others are including participants with no specific risk factors.

The interventions tested in the ongoing trials can be divided into 2 categories:

The first, and most frequent, is mobile-phone applications or mobile health interventions, which are being used by 14 studies[28–31] (CTRI/2018/01/011090, NCT03058146, DRKS00010595, NCT04692974, NCT04184037, ACTRN12619001634167, DRKS00020943, JPRN-UMIN000041926, ACTRN12620001037998, JPRN-UMIN000042123). Two of these studies (CTRI/2018/01/011090, JPRN-UMIN000042123) are using mobile phone-based cognitive training, one a physical exercise program (ACTRN12620001037998), another a meditation application (NCT04184037) while the others are using mobile phone interventions for training, monitoring, tracking, supporting and/or promoting healthy behaviors[28–31] (NCT03058146, DRKS00010595, NCT04692974, ACTRN12619001634167, DRKS00020943, JPRN-UMIN000041926).

The second type of intervention is telephone support and coaching which is being evaluated in 7 studies[32–34] (ACTRN12617000082303, NCT01012947, ACTRN12621000977875, ACTRN12620000978965). In these studies, telephone calls or messages are used to provide advice or encouragement, improve risk factor control, or increase adherence, or are used as reminders to carry out the intervention. For instance, Cox et al[32] are evaluating the effect of mentor telephone counselling. Another study (ACTRN12618000513213) is evaluating the effect of standardized reminder or reinforcement messages.

The effects of telephone interventions on cognitive function are being evaluated as a primary outcome in 12 studies, as a secondary outcome in 9 studies, using neuropsychological scores or changes on a single test (n=6) or on a battery of neuropsychological tests (n=16).

Finally, two study are evaluating the impact of a smartphone intervention on a dementia incidence, as a primary or secondary outcome (Eggink et al,[31] JPRN-UMIN000041926) and 2 trials on dementia risk score (Eggink et al,[31] ACTRN12621000977875)).

Implementation results

Few studies reported implementation results. In a 3-month pilot phase, the portability, usability and acceptability of a physical, cognitive, psychological and social mobile platform intervention were evaluated in a limited sample of 20 participants. Protocols, questionnaires and platform technical aspects were found to be good.[29] This study[29] concluded that the intervention platform was suitable (no additional details were provided), and another[31] improved functionality of application and logistic issues before beginning the main trial. Adherence, duration, frequency of use or feedback will be recorded in several trials.[28–30,32] For instance, Summer et al[29] are recording duration and frequency of mobile application use and time spent on cognitive training, and another study[30] is recording the number of logins and days using the mobile application.

Telephone and Smartphone-Based Interventions for Cardio-Metabolic Outcomes and Risk Factors

Of the 2680 articles identified in Pubmed, 30 (1.1%), published from 2007 onwards, were included (Figure 2). In the ICTRP, we identified 2207 records, and 15 studies were included. In total, 18 completed and 27 ongoing studies were analyzed.

Quality Assessment

Based on the Rob2 and TREND checklists, the 18 completed studies,[27,35–51] 4 were of good quality,[27,37,44,46] and the rest were fair or poor of quality. Among the lowest quality studies, missing information included randomization allocation,[35,39] or

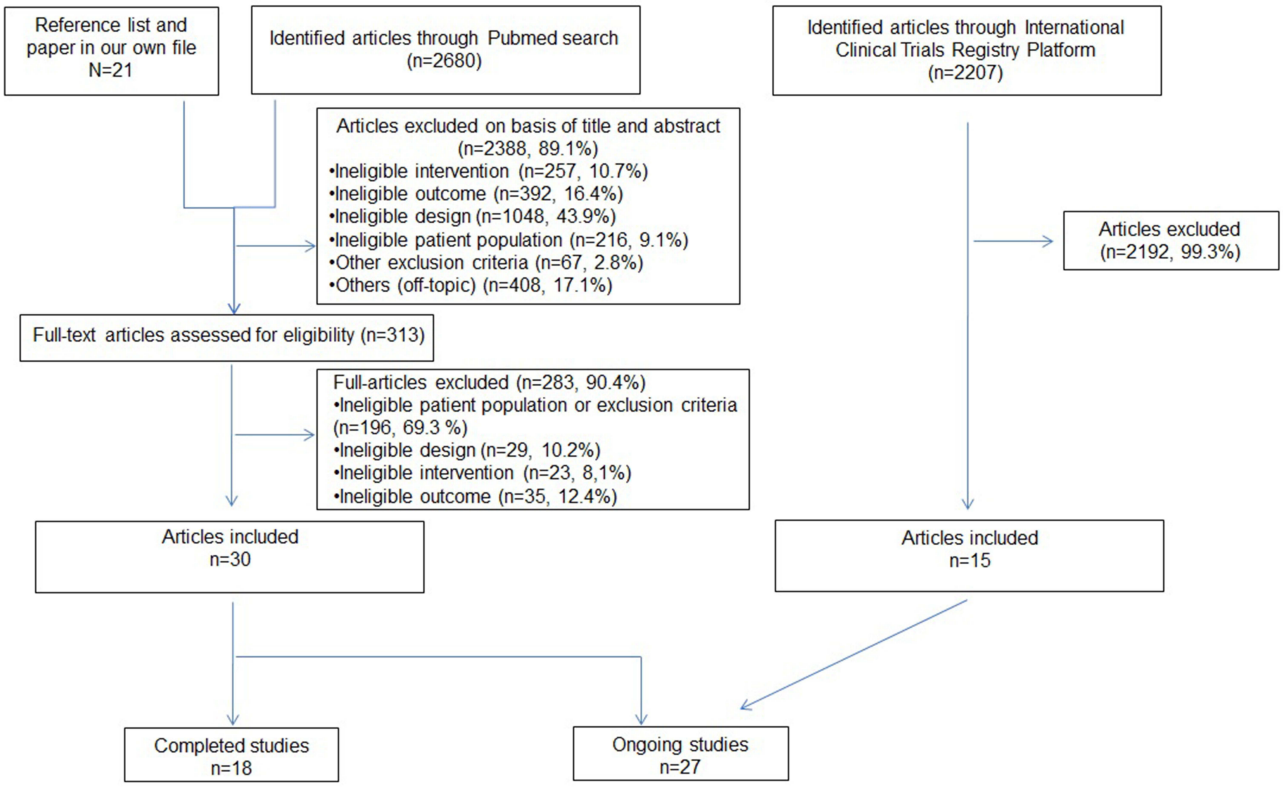

Figure 2 Study selection flow-chart for the cardio-metabolic outcome articles.

sample size calculations, for example. In one study, we did not find details concerning blinding of participants[39] or if assessor was blinded during assessment of outcomes.[40,42]

Description of Completed Studies (Tables 2–4)

Five of the studies included participants from the USA, while the others included participants from the Australia (n=4), UK (n=2), China (n=1), Belgium (n=1), Netherland (n=1), Canada (n=1), South Korea (n=1), Singapore (n=1) and New-Zealand (n=1).

Participants at risk of cardio-metabolic diseases were included in 15 studies, defined by the presence of stroke comorbidities,[27,40] type 2 diabetes,[36–38,41,42,49] obesity,[35,44,46] hypertriglyceridemia and/or high blood pressure[41,48] or sedentarism.[45,47,50] Interventions lasted between 2 weeks and 24 months.

Telephone vocal support to motivate participants to reach a goal, increase intervention adherence or resolve problems was the most frequent type of telephone intervention used, representing 9 studies' interventions.[27,35–37,40,43–45,50]

Automated motivational or reminder text messaging for adherence was used for 5 studies.[39,41,46,48,51] A wired telephone-connected glucometer associated with short message service and telephone technical support was evaluated in one study,[38] while another study[49] studied a self-monitoring dietary intake application for weight loss. The final study[42] evaluated a website with motivational sessions to increase physical activity or decrease sedentarism, associated with an optional mobile application with behavior monitoring, goal and notification reminders.

The effect of these interventions on cardio-metabolic outcomes or risk factors was evaluated as a primary outcome in eight studies using various measures, but none used hard clinical outcomes such as cardio-vascular mortality. The outcomes used include hemoglobin A1c (HbA1c),[37,38,41] body weight,[35,37,38,41,43,44,47] lipid and glycemic profile,[35–38,41,43] blood pressure,[27,35,37,41,44,48,50] waist and hip circumference,[36,37,41,44,47,48] smoking status,[40] fruit, vegetable or other consumption[27,36,40,43,47,49,51] and physical activity (eg step count) outcomes.[27,36,39,40,42–50]

Table 2 Characteristics of Completed Studies Evaluating the Effect of Smartphone Interventions on Cardio-Vascular Outcomes

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Lim and al[38] 2011 South Korea	Some concerns	RCT	154	6 months	Primary outcome: proportion of patients with HbA1c< 7% without hypoglycemia Secondary outcome: BMI change, body weight change, fasting blood samples, frequency of self-glucose monitoring, fasting and postprandial glucose, HbA1c, compliance to measure blood glucose level	•U-healthcare group: wired telephone-connected glucometer plus adapted glucose medication SMS on mobile phone •Self-monitored blood glucose: 8 times a week • Control: routine care	≥ 60	•At risk: • Type 2 diabetes • HbA1c: 6.5–10.5% • No severe diabetes complications	Primary outcome: Proportion of HbA1c without hypoglycemia was lower at 6 months among U-healthcare group (30.6%) compared to self-monitored blood glucose (23.4%) (p=0.027) and control (14.0%) groups (p=0.019) HbA1c was lower in U-healthcare group compared to self-monitored blood glucose (p<0.05) at 6 months and to control (p<0.05) at 3 and 6 months Compared to pre intervention score, intervention decreased weight, BMI, fasting glucose and LDL cholesterol and increased self-monitoring glucose concentration among U-healthcare group, Self-monitoring glucose increased in U-healthcare group compared to control (p<0.01) and increased among self-monitored blood glucose group compared to control (p<0.001) No other significant differences Study completion rate: between 92.2 to 96.1% Target frequency of glucose testing (≥8 times/week): 81.2% for u-healthcare, 68.5%, for self-monitored and 31.2% for control group

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Table 2 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Poppe et al[42] 2019 Belgium	Some concerns	RCT	63	6 weeks 6 months	Primary outcome: Change in self-reported PA (International PA Questionnaire), objective total, light and self-reported sedentary behavior via the Longitudinal Aging Study Amsterdam, physical activity Sedentary time and break via accelerometer	Phone was optional • Intervention: five motivation website sessions to increase physical (arm 1) or decrease sedentary behavior activity (arm 2) + mobile application (optional) • Control: access to the intervention after the study	≥50	• At risk: type 2 diabetes	Compared to control group, participants focusing to improve PA improve self-reported total PA No other significant effects were found Compared to control group, participants aiming to decrease sedentary did not improve cardio-metabolic outcome 5 (8%) used the optional mobile app
Zheng et al[49] 2018 USA	Poor	Pre-post test pilot study	9	8 weeks	Secondary outcome[a]: weight, steps and calorie intake change	• Intervention: biweekly self-regulation theory-based weight loss intervention and self-monitoring (1) iPhone Plus, (2) the Lose It! app for self-monitoring of dietary intake, (3) Fitbit for self-monitoring of physical activity, (4) Bluetooth-enabled scale for daily weight, and (5) Bluetooth-enabled blood glucose monitor for testing blood glucose levels	≥65	• BMI between 27–40 • Diagnosed type 2 diabetes • Prescribed insulin or oral medications • No severe complications of diabetes or current use of weight loss medication • No participation in diabetes education in the previous 12 months • Able to walk 2 blocks •No severe hypertension	Compared to pre intervention, following the intervention, there was a significant percentage of weight loss (p=0.0004), decreased calorie intake and increased steps (p=0.02) Percentage of days of using intervention components: Lose It!=92.7, Fitbit= 93.7, glucometer 76.4

Notes: [a]Primary outcome not relevant to our review.

Abbreviations: N, number of subjects; RCT, randomized-controlled trial; HbA1c, glycosylated haemoglobin; ≥, superior or equal to; <, inferior to; =, equal to; %, percentage; kg, kilogram; BMI, Body Mass Index; p, p value; SMS, Short Message System; PA, Physical Activity.

Table 3 Characteristics of Completed Studies Evaluating the Effect of Telephone Call Interventions on Cardio-Vascular Outcomes

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Chapman et al[37] 2018 China	Low risk of bias	RCT	753	18 months	Primary outcome: HbA1c Secondary outcome: weight, BMI, systolic and diastolic BP, waist and hip circumference, fasting blood samples, diabetes self-care activities, diabetes management self-efficacy	• Intervention: face-to-face and telephone health coaching + usual care • Control: usual care	≥50	• At risk: type 2 diabetes	No effect of the intervention on change from baseline to 18 months on HbA1c (mean change=−0.07, p=0.769) or on secondary outcomes, compared to the control group The participant attrition: 13.4% for intervention and 21.5% for control
Gillham et al[40] 2010 UK	Some concerns	RCT	52	3 months	Secondary outcome[a]: change in self-reported •smoking status •exercise behavior •fruit and vegetable consumption	• Intervention: risk factor information and healthy behavior + telephone support and follow-up discuss progress • Control: usual care	Mean age= 68.3	• At risk: first minor stroke or transient ischemic attack	Compared to control group • exercise frequency score between pre and post intervention increased in the intervention group (p=0.007) • change in fruit and vegetable consumption score between pre and post intervention increased in the intervention group (p=0.033) • There was no change concerning smoking status

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Table 3 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Hartman et al[50] 2021 Netherland	Fair	Pre-post intervention	15	16 weeks	PA and sedentary behavior (accelerometer), fasting glucose levels, insulin, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, BP	Information to promote physical activity and wearing an activity monitor + weekly telephone/online coaching	≥55	At risk: • >40 hours /week of self-reported sedentary behavior • One or more cardiovascular risk factors: BMI >28, high BP	Compared to pre intervention scores, participants significantly decreased sedentary time ($p< 0.01$) and increased standing time ($p=0.03$), walking time ($p<0.01$) and step count ($p<0.01$). There were no significant differences for other outcomes
Aunger et al[43] 2020 UK	Some concerns	RC feasability study	35	<18 weeks	Secondary outcome[a]: SPPB, sitting time, standing time, sit-to-stand transitions, quantity of sedentary bouts >30 minutes, older Adults' Sedentary Time, International PA Questionnaire Short Form, body weight, BMI, Short Form Mini Nutritional Assessment, LDL, HDL, triglyceride	• Intervention: Sedentary behavior reduction program + bi-weekly supportive phone calls • Control: usual care	≥60	–	No formal statistical analysis was performed in this feasibility study which was not powered to detect differences Participant uptake rate was 14.2%, and retention rate 85.7% For the entries: overall mean average weekly self-reported goal adherence =3.9 /5 Overall mean self-reported adherence= 4.2/5

Kolt et al[45] 2007 New-Zealand	Some concern	RCT	186	3 months 12 months	Primary outcome PA: Auckland Heart Study Physical	• Intervention: combination of telephone-based motivational interviewing and cognitive-behavioral techniques • Control: no intervention	≥65	• Sedentary adults (< 30 minutes of physical activity on five or more days per week) • No walking contraindication	At 12 months, moderate or vigorous leisure physical activity per week increased in intervention compared with control (significant interaction with time) No other significant effects were found at 12 months
Perri et al[35] 2008 USA	Some concerns	RT	234	12 last months 18 months	Primary outcome: change in body weight, BMI Secondary outcome: changes in BP, lipid profile, glycemic control, number of self- monitoring records, attrition, attendance and telephone calls completion	•Intervention Arm 1: 26 biweekly face-to-face group counseling sessions Arm 2: 26 biweekly telephone counseling sessions •Control: 26 biweekly newsletters mail with weight management advice	50–75	• At risk: • Women with BMI > 30 and a body weight<159.1 kg • Free of uncontrolled hypertension and diabetes • No manifestation of cardio-vascular disease. • No weight loss medication taken in the last 6 months • No weight loss >4,5 kg taken in the last 6 months	Primary outcome: compared to control group, telephone counseling group regained less weight (1.2 ±0.7kg vs 3.7±0.7kg, p=0.02) and had smaller increase in BMI (0.45± 0.27 vs 1.42± 0.26, p=0.03) There were no effects for telephone counseling on secondary outcomes compared to control group Completed face to face sessions: 13.8 (±8.6) Completed telephone sessions: 21.1 (±5.7) Adherence higher in the telephone (p=0.006) and face-to-face (p=0.003) arms compared with control group

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Table 3 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Sakakibara et al[27] 2021 Canada	Low risk of bias	RCT	126	6 months 12 months	Secondary outcomes[a]: •HBP, cholesterol, glucose •Diet (fiber and fat intake) • BMI •Daily walking physical activity •Protocol adherence	• Stroke Coach: telehealth self-management: telephone lifestyle coaching sessions to improve controlling of cardiovascular risk factors with phone call. Self-monitoring kit and self-management manual • Memory training program: memory coaching, memory training manual	≥50	• At risk: vascular stroke survivors (modified Rankin Scale between 1–4) • Free of cognitive impairment • MoCA ≥23 • No clinically important neurological conditions • No severe aphasia or dysarthria	Stroke coach intervention improved HbA1c control (p=0.034) compared to Memory training group. There were no interactions between group or time. No-other significant results were found for secondary outcomes for Stroke coach intervention compared to control Adherence: •Intervention: 98% completed all coaching sessions and 96% all check-in sessions. Mean of 188.7 days (sd=30.2) •Control: 96% completed all sessions and 85% completed all check-in sessions. Mean of completed program: 188.0 days (sd= 52.5 days)

Vita et al[36] 2015 Australia	Fair	Uni-center quasi experimental study	1238	12 months	Change goal: ≥ 210 minutes of MVPA per week, body weight, BMI, waist circumference, progressive resistance training, PA, saturated food, total fat, fibers, total energy, fasting blood samples	One behavioral individual, 3 face to face group sessions and 3 follow-up calls with coaching call (professional)	50–65	•At risk of diabetes (AUSDRISK tool ≥ 15) • No undiagnosed diabetes, use of blood glucose lowering or weight loss medications	Between pre- and post-intervention, there was a significantl decrease in weight ($p<0.02$), BMI ($p<0.01$), waist circumference ($p<0.0001$), total cholesterol ($p<0.000$), LDL cholesterol ($p<0.01$), triglycerides ($p<0.01$), saturated fat ($p<0.0001$), total fat ($p<0.0001$), total energy ($p<0.00001$), ≤30% of total energy ($p<0.001$), ≤ 10% of total energy intake from saturated fat ($p<0.001$), ≥15 g/1000 kcal of fibre ($p<0.001$) and a significant increase in physical activity ($p<0.05$), resistance training ($p<0.0001$) grams of fibre ($p<0.0001$), Non-significant improvement was found for other outcomes Adherence: 75 to 77% of participants were present at each telephone follow-up. 62% completed all the 3 sessions.

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Table 3 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if Different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Venditti et al[44] 2021 USA	Low risk of bias	RCT	322	12 months 24 months	Primary outcome: change in body weight Secondary outcome: change in waist circumference, fasting lipid profile, fasting glucose, systolic and diastolic BP, nutrition, physical function performance, PA (minutes/ per week), achieved ≥3 days of moderate intensity PA per week	• Intervention: comprehensive evidence-based lifestyle intervention + 8 conference calls for social support and problem • Control: comprehensive evidence-based lifestyle intervention + 4 additional newsletters	65–80	• BMI ≥ 27 and at least one cardio-metabolic risk factors 1) large waist circumference 2) HBP or hypertension drug 3) elevated lipids or medication for lipids or triglycerides 4) pre-diabetes or a score of 15 on the American Diabetes Association risk test • No diabetes	Compared to the control group, the intervention significantly improved weight and weight percentage loss (p=0.01) and BMI (p=0.02) at 12, but not 24, months, and improved HDL at 24 (p=0.01), but not 12, months. No significant results for other outcomes Attendance at the 8 phone group sessions> 85%

Notes: [a]Primary outcome was not relevant for our review.

Abbreviations: UK, United Kingdom; USA, United State of America; RCT, randomized-controlled trial; HbA1c, glycosylated haemoglobin; RT, randomized trial; kg, kilogram; MVPA, moderate to vigorous physical activity; ±, plus or minus; ≥, superior or equal to; ≤, inferior or equal; =, equal to; >, superior to; <, inferior to; +, plus; %, percentage; sd, standard deviation; BMI, Body Mass Index; p, p value; PA, Physical activity; HDL, High Density lipoprotein; LDL, Low Density lipoprotein; SPPB, Short Physical Performance Battery; BP, Blood Pressure; HBP, high Blood Pressure; MoCA, Montreal Cognitive Assessment; AUSDRISK, Australian Type 2 Diabetes Risk; vs, versus; N, number of subjects.

Table 4 Characteristics of Completed Studies Evaluating the Effect of Text Messaging or Text Messaging with Telephone Calls Interventions on Cardio-Vascular Outcomes

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Bennell et al[46] 2020 Australia	Low risk of bias	RCT	110	24 weeks	Primary outcome: adherence to home exercise: Self-reported number of exercise sessions, Exercise Adherence Rating Scale Section B and number of days home exercises completed in the past week Secondary outcome: PA scale for the elderly, adherence to home exercise program three times per week	Both groups had completed a previous RCT of two different exercise programs • Intervention: SMS aiming to support and facilitate adherence to the home exercise program and identify and address the barriers (< 3 sessions in the previous week) • Control: no SMS support	≥50	• Obesity (BMI≥30)	Significant differences between intervention and control groups for: • Adherence to home exercise (mean difference 3.1, p=0.01) • Number of days home exercises completed in the past week (mean difference 0.6, p=0.01) No other significant effects on secondary outcomes Completed outcomes at week 24 86% SMS group, 94% for control

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Table 4 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Jones et al[41] 2016 USA	Fair	Pre/post pilot study	40	12 weeks	Secondary outcome[a]: change in • BP • Lipid profile • HbA1c • BMI • Waist circumference •Adherence to cardio-vascular disease risk reducing behaviors	Intervention: received more than 250 informational + motivational messages designed to reduce cardio-vascular disease risk and cancer risk factors. Reply was possible.	≥50	At risk for cancer or cardio-vascular disease (≥2 criteria) • diagnosis of HBP or taking medications or found to be hypertensive by the research team • diagnosis of hyperlipidemia or taking medication, or any lipid abnormality found on screening • diagnosis of type II diabetes or HbA1c >7%• overweight or obese • waist circumference > 40 inches in men and >35 inches in women • sedentary lifestyle	There were significant improvements from pre to post intervention scores on total cholesterol (p<0.001), LDL cholesterol (p=0.015), waist circumference (p=0.002), systolic BP (p=0.009), diastolic BP (p=0.02), adherence behaviors (p<0.001) There were no effects on HDL cholesterol, triglycerides, HbA1c and BMI increased (p=0.03)
Kim et al[39] 2013 USA	High risk of bias	RCT	36	6 weeks	Change in • Step count • Leisure Time Exercise Questionnaire	• Intervention: pedometers and walking manual and simple + motivational text messages • Control: pedometers and walking manual	60–85	No medical problems that restricted them from walking	There was an improvement in the number of steps per day and on the Leisure Time Exercise Questionnaire score from pre to post intervention in the text messages group (p=0.001) There was no improvement for control

Wallis et al[48] 2017 Australia	Some concerns	RCT	46	12 weeks	Secondary outcome[a]: PA: daily number of steps, daily minutes spent walking, weekly minutes spent walking at moderate intensity cadence, weekly minutes spent walking at moderate intensity cadence and at least 10 min of continuous bouts, daily hours spent sitting or lying, systolic and diastolic BP, BMI, waist circumference, fasting lipid profile, fasting glucose level 40 meters fast paced walk test, 30-second chair stand	• Intervention: walking sessions and progress monitor with phone call or send weekly SMS reminders • Control: usual care	≥50	• Cardiovascular risk profile (at least 2 total risk factors)	ITT analysis: intervention improved the 40-meters walking test and the proportion of participants with systolic BP<140mmHg compared to control PP analysis: intervention improved the 40-meters walking test, and in systolic blood pressure, steps per days, time walking and decreased waist circumference, and BP compared to control. No other associations 70% of the intervention group completed 9 out the 12 sessions of weekly dose (70 minutes ± 10 minutes)
Wong et al[47] 2021 Singapore	Some concern	RCT	580	6 months	Primary outcome: lipid profile, blood glucose, levels of physical activity behavior: self-reported PA Secondary outcome: weight, BMI, percentage of body fat, dietary behaviors, waist and hip circumference, Waist-Hip Ratio, diastolic and systolic BP	• Intervention: multi-component intervention with nutritionist and program ambassadors telephone calls and healthy text messages • Control: fall prevention booklet	≥50	• < 150 minutes of moderate intensity physical activity per week • No medical condition that prohibit involvement in physical activity	Compared to control, intervention improved moderate PA (p<0.001), vigorous PA (p<0.001), total physical activity (p=0.004), intake of fruit (p=0.001), sugar beverages (p=0.019), vegetable (p=0.019), salt and salty sauce (p=0.042), and decreased systolic BP (p=0.020), diastolic BP (p=0.001), % of body fat (p<0.001) No other significant effects were found. Attrition rate 16% for intervention 14% for control

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Table 4 (Continued).

First Author Year Country	Quality Assessment	Design	N	Length of Intervention Follow-Up (if different)	Cardio-Metabolic Outcomes and Risk Factors	Phone Intervention	Population		Results
							Age	Cardio-Metabolic Outcomes and Risk Factors Criteria	
Zacharia et al[51] 2020 Australia	Poor	Pilot study	17	2 weeks	Change in the 14-point Mediterranean Diet Score	The AusMed diet program: 1 education materials, AusMed diet program and individual goal setting + twice weekly supported text messages	≥55	–	Compared to pre intervention score, mean Mediterranean Diet score increased at 2 weeks ($p < 0.001$), Extra Virgin Olive Oil eating vegetable, legume, fish ($p = 0.009$) and sofrito also significantly increased. Eating pastries or red meat significantly decreased. No significant associations were found for other intakes. Text messages were found of be appropriate and were beneficial in achieving their goals.

Note: [a]Primary outcome was not relevant for our review.

Abbreviations: RCT, randomized Control Trial; USA, United State of America; PA, Physical Activity; SMS, Short Message System; HbA1c, glycosylated haemoglobin; BP, Blood Pressure; HBP, High Blood Pressure; LDL, Low Density Lipoprotein; HDL, High Density Lipoprotein; ITT, Intention To Treat; PP, Per Protocol; <, inferior to; =, equal to; ≥, superior or equal to; >, superior to; +, plus; ±, plus or minus; %, percentage; mmHg, millimeters of mercury; BMI, Body Mass Index; p, p value; N, number of subjects.

The effect of telephone-support or text messaging on these outcomes was discordant. For example, high blood pressure improved in a 12 week single arm study including 40 adults aged 50 years and over at risk of cardiometabolic diseases or cancer with informational and motivational text messaging in one study[41] but no effect was found in a 18 months trial evaluating the effect of bi-weekly telephone counselling sessions in obese women aged 50 to 75 years.[35] Moreover, interventions involving telephone support seemed to be associated with self-reported dietary changes with improvement in fruit and vegetable consumption after 3 months of risk factor information and healthy behavior with telephone support among 52 stroke or transient ischemic attack adults.[40] Vita et al[36] found also healthier diet with more fiber intake and lower saturated fat intake, but a high quality study[27] find no effect of coaching sessions on fiber and fat intake change after 12 months of follow-up. Intervention effects on HbA1c were discordant in the highest quality studies: an 18-month telephone health coaching intervention[37] was not associated with improvement in mean HbA1c compared to the control group, contrary to an 12-month telephone lifestyle counselling intervention which improved HbA1c control compared to a memory training program group.[27] Results were also discordant among the highest quality studies of the effect of telephone and smartphone interventions on blood pressure[27,37,44] or physical activity,[25,44,46] although there were various differences in study population, type of telephone intervention and duration.

Description of Ongoing Studies

Eight studies are being conducted in Australia, four in the US, two in Thailand, one each in Spain, Malaysia, Slovenia, Poland, China, Iran, India, Finland, Singapore and Japan, and three in several locations (one in European countries, one in UK and China and the last one in Europe, Asia and Australia).

Participants are at risk of cardio-metabolic diseases in the majority of studies, defined by stroke comorbidities, type 2 diabetes, overweight or obesity, insufficient physical activity or smoking status (Appendix Table B).

Interventions are lasting between 6 weeks to 48 months and studies are including 30 to 2400 participants.

Mobile-phone applications are being used in 13 studies[28–31,52,53] (NCT01307137, NCT04819256, TCTR20211021006, ACTRN12621001136897, ACTRN12621000236897, TCTR20190902004, ISRCTN31471852). For instance, participants with diabetes are using smartphones to record meals and self-monitor weight (NCT04819256). Another application is using an interactive coach supported mobile application[31] among participants at risk of dementia.

Telephone vocal support is the second method used in the ongoing cardio-metabolic studies (n=12).

Finally, 2 studies are using both telephone vocal coaching and health or reminder text message interventions (ACTRN12617001022358, JPRN-UMIN000024416).

18 studies are evaluating cardio-metabolic outcomes as primary outcomes using various cardio-metabolic outcomes and risk factors, with physical activity and HbA1c being the most commonly used. Smoking status, lipid or glycemic profile, dietary outcomes or waist and hip circumference, blood pressure, BMI are also being used, but, as in the completed studies, no hard clinical outcomes.

Implementation Results

For all completed studies, adherence was high with more than 70% of participants completing the studies. Measures of adherence, including the number of sessions completed[27,36,43,44,46,48,49] or the number of participants who completed the study visit,[38] were described in eleven studies.[27,35–38,43,44,46–49] Vital et al[36] found that 71% of the initial population attended the last follow-up visit with 75 to 77% of participants receiving all follow-up telephone calls. Lim et al[38] reported higher adherence (ie 92.2 to 96.1%). Text messaging frequency (twice weekly) was also found to be appropriate.[51] Moreover a second study[46] evaluated the effect of text messages to support engagement with a home exercises program and found 86% of participants completed the study (94% for control group). Another study[49] found that a dietary intake monitoring application was used for 92.7% of the 8-week follow-up period.

When reported, the main reasons for participants withdrawing from studies were being too busy or family/personal issues.[38] In the study by Perri et al,[35] participants completed a mean of 21.1±5.7 out of 26 telephone sessions. The participants who dropped-out seemed to have higher BMI, lower income, were younger and less often had private insurance, compared to those who did not drop out.

Discussion

We found few high-quality completed studies evaluating the effectiveness of telephone or smartphone-based interventions on cognitive or cardio-metabolic outcomes among middle-age and older adults. Indeed, 21 completed studies were identified, of which only four had a good quality rating, and some of them included both cognitive and cardio-metabolic outcomes. A further 50 other studies are still ongoing. Based on these studies, no conclusions about the efficacy of telephone or smartphone-based interventions on cognition can be made because of a lack of high quality-data, and cardio-metabolic results varied depending on outcomes, interventions or the study population.

There were fewer completed trials evaluating the effects of telephone and notably smartphone-based interventions on cognitive or cardio-metabolic outcomes than we expected, given the large number of smartphone applications currently available. Indeed, many health applications have been developed without any scientific evaluation of their impact. Finally, the use of new technology tools differs in different age groups, and implementation data are still needed for older age groups.

There may be several reasons for the low number of studies identified. First, the mobile phone market is relatively recent, compared to other interfaces (ie computers). Second, mobile phone use initially grew mostly among young adults, although 62% of adults aged 70 and over owned smartphones in 2019[54] compared to 18% of adults aged 65 years and over in 2013[11] in the US. However, older adults are still the less likely to be smartphone users compared to younger adults.[55] Furthermore, mobile and smartphones were designed for younger populations, and may not always be practical for older adults. Ergonomics should be adapted for age-related features, such as larger buttons or telephone contrast.[56] This could help to increase participation and reduce attrition for smartphone interventions in older age groups. Moreover, smartphone applications should also be specifically designed for older populations. For instance, the frequency of daily smartphone access depends on age, and older individuals tend to favor weather and personal information manager applications over communication applications, such as instant messaging, compared to younger individuals.[13]

Concerning the interventions we reviewed, some used telephone support, but we do not know if they concerned landline and/or mobile phones. Furthermore, many of the studies included in the review were multicomponent interventions and the results relate to the efficacy of the intervention as a whole, and not just the telephone component.

Older adults are usually less often included in clinical trials,[57,58] and more particularly in clinical trials using new technologies.[59] Furthermore, the individuals included in the study populations might be higher-educated and healthier than the general population, since they firstly accepted to take part in a clinical trial,[60] and also because telephone and smartphone ownership depends on socio-economic status.[11] This selection of the population may have limited the effects of the interventions. Furthermore, the studies included in our review might be too small to detect intervention effects, since only 3 studies[31,36] (JPRN-UMIN000041926) include more than 1000 participants.

High quality study results concerning short and long-term effect on cognition, cardio-metabolic diseases and their common risk factors in middle aged and older adults are therefore still needed. Given the relatively wide-scale availability of commercial applications, we expected that cognitive healthcare applications would have been well-evaluated in clinical trials. With only three completed studies,[25–27] we could not draw any conclusions about the effectiveness of telephone-based interventions on cognition. Telephone call support was the main type of telephone intervention identified and none of the completed studies evaluated the effects of telephone or smartphone-based interventions on dementia incidence. Only 2 ongoing trials are evaluating dementia incidence.[31] (JPRN-UMIN000041926) However, a meta-analysis[61] found a small to moderate effect on cognition for web-based lifestyle intervention compared to control. Additionally, study-follow-up (maximum 24 months) might be too short to expect significant changes in this outcome.

We found discordant results for cardio-metabolic effects of telephone or smartphone-based interventions between studies, and the highest-quality studies[27,37,44,46] found discrepant effects on HbA1c, physical activity and blood pressure. Previous literature reviews have also found discordant results. Indeed, Widmer et al[62] reviewed the effect of any digital health intervention on cardio-metabolic outcomes and found that results depended on whether the interventions were used for primary or secondary prevention. For example, beneficial effects of digital interventions were found on systolic blood pressure for participants having cardio-metabolic risk factors (primary prevention) but not for those who had

cardio-metabolic diseases (secondary prevention). However, high blood pressure decreased with telephone support after a myocardial infarction in a meta-analysis.[63] We did not find different effects of telephone and smartphone interventions based on primary or secondary prevention in older adults. Moreover, mobile technology (smartphone and wearable sensor) seemed to be associated with better management of cardio-metabolic diseases or risk factors among community-dwelling adults[64] and a systematic review and meta-analysis based on web-based prevention of cardio-vascular outcomes found 57 studies with significant effects on blood pressure, HbA1c and weight.[59] Nevertheless, these reviews covered any kind of digital health intervention, and these studies evaluated young as well as older adults.

Our review shows that telephone and smartphone-based interventions suitable for older adults are still in the development phase, since there are relatively few eligible completed studies. However, they could be promising in older age groups since studies have showed that their use is feasible and a major application promoting health aging is currently being implemented in clinical practice.[65]

Our review has some limitations. First, our search equation included the term "prevention" which may have limited the number of relevant articles identified but we considered that this was in important term, since our aim was to evaluate telephone and smartphone for the prevention of cognitive and cardio-metabolic disease and their risk factors. However, we also scrutinized reference lists from the studies we identified, but this only led to the identification of one further study, which suggests that our original search was exhaustive. Secondly, the majority of included articles had poor or fair quality scores, and few results have so far been published in older populations, thus limiting the evidence base on which to draw conclusions. Moreover, for some studies (notably the ongoing studies identified in clinical trial registries), data were not always very detailed which limited the exhaustiveness of our descriptions of interventions or outcomes.

Research on telephone and smartphone interventions in older populations is in its early stages. However, some recommendations can be made to improve future randomized trials in this field. Digital tools (eg emails, social media advertisements) are effective for recruiting older participants[66] even those with mild cognitive impairment.[67] However, it is indispensable to take into account limitations, barriers and needs of the target population to better adapt devices and interventions.[68,69] One of the main barriers to older people using mobile technology and devices should be as simple as possible and if applicable, easy to wear.[68] Motivational behavior change techniques should be used to improve engagement with interventions[69] and therefore efficacy. Moreover, to improve engagement and digital literacy, a session to explain how to use study device with trained-staff is recommended. Reminders (by telephone calls or text messaging) could also improve engagement as well as using supervised interventions.[70] Implementation evaluation is also indispensable, in order to provide better recommendations. Finally, it is important to evaluate multiple outcomes associated with similar risk factors as was done in some of studies we identified,[27,29–34] since interventions could have simultaneous benefits on multiple age-related disease outcomes by improving these factors.

Conclusions

Few studies on telephone and smartphone for the prevention of dementia and cardio-metabolic diseases have been specifically performed in middle-aged and older adults, and few are at low of risk of bias. Most completed studies reported no statistically significant effects of their interventions. Many studies are ongoing and can be classified as pilot or Phase 2 studies. Overall, in spite of the wealth of mobile health applications available and given a lack of research data and evaluation at the current time, we cannot demonstrate the supplementary value of such technologies compared to usual intervention strategies. Nonetheless, this is a growing area of research which will help to develop patient-centered approaches to prevention, and several new studies are underway, meaning that efficacy and implementation results for middle-aged or older adults should be available in the near future.

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