# Effectiveness of mobile phone-based self-management interventions for medication adherence and change in blood pressure in patients with coronary heart disease: A systematic review and meta-analysis

**Authors: Yun Shan Sua[1], Ying Jiang[1], David R. Thompson[2], Wenru Wang[1]***

[1]Yun Shan Sua, BSc(Hons), RN
Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
Email: e0007362@u.nus.edu

[1]Ying Jiang, BA, RN, RMN
Research Associate, PhD Candidate
Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
Email: nurjiy@nus.edu.sg

[2]David R. Thompson, PhD, RN, FRCN, FAAN, FESC
Professor of Nursing
School of Nursing and Midwifery, Queen's University Belfast, Belfast, United Kingdom
Email: David.Thompson@qub.ac.uk

[1]Wenru Wang, PhD, RN
Associate Professor
Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
Email: nurww@nus.edu.sg

Correspondence:
Associate Professor Wang Wenru, Alice Centre for Nursing Studies, Yong Loo Lin School of Medicine, Level 2, Clinical Research Centre, Block MD 11, 10 Medical Drive, Singapore
E-mail: nurww@nus.edu.sg; Tel: (65) 6601 1761

**Effectiveness of mobile phone-based self-management interventions for medication adherence and change in blood pressure in patients with coronary heart disease: A systematic review and meta-analysis**


## Abstract

**Aims:** To synthesize and evaluate the effectiveness of mobile phone-based self-management interventions for medication adherence and change in blood pressure (BP) in patients with coronary heart disease (CHD).

**Methods:** Relevant randomized controlled trials evaluating mobile phone-based self-management interventions for medication adherence and/or change in BP in CHD patients were identified by searching six electronic databases (PubMed, Cochrane, CINAHL, ProQuest, Scopus and EMBASE) from January 2008 to January 2019. The trials were screened, data were extracted and quality was assessed by two independent reviewers. Meta-analyses were performed for different outcomes while narrative syntheses were conducted for studies that could not be pooled or when there was presence of high heterogeneity.

**Results:** Fifteen trials were included in this review, of which 11 of these trials were meta-analysed. Mobile phone-based self-management interventions were associated with a statistically significant reduction in diastolic BP (combined mean difference of -1.99 [95% CI -3.20 to -0.78, p=0.0001]). However, the combined effect on medication adherence (medium size effect of $d$ = 0.72 [95% CI -0.32 to 1.75, p=0.17]) and change in systolic BP (combined mean difference of -1.08 [95% CI -5.51 to 3.35; p=0.63]) were not statistically significant. There was significant heterogeneity among the trials reviewed.

**Conclusion:** Mobile phone-based self-management interventions have the potential to improve self-management and adherence in patients with CHD but better designed, conducted and reported trials are needed to demonstrate this.

**Keywords**

Coronary heart disease, self-management, mobile phone, medication adherence, blood pressure systematic review

## Introduction

Coronary heart disease (CHD) is a major cause of death and morbidity as well as impaired quality of life.[1] The main risk factors for CHD - obesity and sedentary lifestyle coupled with high blood pressure, smoking and high blood cholesterol - are amenable to behavioural change interventions through the use of mobile phone text messaging[2] and applications.[3] Medication adherence presents a particular challenge as non-adherence in CHD patients is associated with poor self-management leading to poor clinical outcomes, including rehospitalisation, subsequent myocardial infarction and increased mortality.[4,5]

High blood pressure (BP) is strongly associated with the risk of CHD events[6] and secondary prevention efforts are focused on achieving good BP control: defined as systolic BP <120 mmHg and diastolic BP <80 mmHg.[7] Maintaining optimal BP is crucial in reducing the risk of subsequent cardiovascular complications.[6]

Lately, mobile phone-based technologies have been increasingly used in promoting physical activity and lifestyle modification among patients with CHD.[8] According to the International Telecommunication Union[9], 69% of the world's adult population has mobile-broadband subscriptions. Mobile phone-based technologies such as text messaging and applications are ubiquitous, offering promising potential to improve an individual's health by helping them with self-management and healthy behaviour modifications.[10] Due to accessibility and ease of use, mobile phone technology allows real-time information to be retrieved conveniently for relevant and personalized decisions to be made for efficient behaviour change support.[3,11] For instance, patients may input their BP readings and exercise frequencies into a mobile phone-based

application, permitting healthcare providers almost instant access to these data and the ability to offer personalized advice as required. Additionally, automated medication reminders or motivational and educational messages can be sent to patients to enhance knowledge and adherence.[12] Thus, mobile phone-based technologies for CHD patients help increase access to pertinent information to enhance knowledge of their disease.[8] This is likely to help patients develop self-efficacy, encourage behavioural change and improve adherence.[13]

Of recent systematic reviews of mobile phone-based interventions for CHD patients,[14-17] only a narrative synthesis was reported regarding medication adherence. One of these reviews[15] reported a meta-analysis of mobile health interventions on the combination of pharmacological and non-pharmacological adherence. Hence, any change in adherence scores may not necessarily be due to pharmacological (medication) adherence alone. Two reviews[15,17] did not evaluate the risk of bias of each included study which is crucial in providing an indication of the quality of available evidence. Moreover, one review by Yousuf et al.[17] only conducted a systematic search in PubMed which may introduce database bias. Additionally, none of these reviews reported a meta-analysis on BP outcomes.[14-17] Therefore, the effectiveness of mobile phone-based technologies on medication adherence and change in BP remains unclear. As medication adherence and change in BP are crucial secondary prevention measures, the current review aims to synthesize and evaluate the effectiveness of mobile phone-based self-management interventions on medication adherence and change in BP in patients with CHD.

## Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was adopted as a guideline to ensure transparency, accuracy and comprehensiveness of the dissemination of data in this review.[18]

### *Search strategy*

Relevant randomized controlled trials were identified by searching PubMed, Embase, Cochrane Central Register of Controlled Trials (Cochrane), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus and ProQuest databases from January 2008 to January 2019. The search terms and strategy are provided in Appendix 1 (supplementary).

In addition, searches of grey literature such as ongoing trials with outcomes from the Clinical Trials Registry (www.clinicaltrials.gov) and New York Academy of Medicine Grey Literature Report (https://nyam.org/) were performed using keywords. A manual screening of the reference list in eligible studies and relevant systematic reviews of the topic was also done to identify additional relevant trials that were not retrieved through database searching.

### *Study selection*

Studies that met the following eligibility criteria were included: (1) designed as a randomized controlled trial (RCT) or a cluster RCT; (2) published in English in recent 10 years from January 2008 to January 2019 to include the most updated research; (3) population included adults (aged ≥18 years) who were clinically diagnosed with CHD; (4) used mobile phone-based self-management interventions with either text messaging or patient-directed applications that provided education or self-monitoring functions; (5) reported medication

adherence and/or BP (systolic or diastolic) outcomes; and (6) had a comparator that did not use a mobile health intervention, including but not limited to usual care or waitlist.

We excluded interventions that were solely based on phone calls or computer use. We also excluded articles that were abstracts only, conference papers, discussion papers or letters.

The articles retrieved from the search were imported into a reference manager, EndNote Software Version X8 (Thomson Reuters, New York, USA). Duplicates were removed using the software and manually by hand. Firstly, titles and abstracts of the studies were screened independently by two reviewers (SYS and YJ) to identify potential trials to be included in this review. Studies with titles and abstracts deemed inappropriate were removed. If there were any uncertainties, over caution was imposed and a full-text version of the article was obtained for thorough appraisal. Next, full-text review of the remaining articles that fulfilled the eligibility criteria were included if there was unanimous agreement between the two reviewers. In the case of differing opinions regarding the inclusion or exclusion of a study, the study was reassessed again and a discussion was held until consensus has been attained. A third reviewer (WW) was consulted for any unresolved disputes.

***Data extraction***

All outcome data were extracted independently by SYS and YJ using a standardized data extraction form modified accordingly from the Cochrane Handbook for Systematic Reviews of Intervention.[19] In the case of incomplete relevant data for extraction, the respective study authors were contacted for

information. The extracted data were then computed into RevMan software by SYS, while YJ ensured that the data computed were accurate.

***Quality appraisal***

Each study was evaluated for the risk of bias by SYS and YJ independently using the Risk of Bias tool in the Cochrane Handbook for Systematic Reviews of Interventions.[19] Disparities among the two reviewers were settled through discussion and consultation with WW. Five biases (i.e. selection bias, performance bias, detection bias, attrition bias, and reporting bias) were assessed and categorised as 'low risk', 'high risk' or 'unclear risk' for each study.

***Data synthesis and analysis***

RevMan 5.3 software was used to synthesize the data.[19] The outcomes of the included studies were presented as continuous data and analyzed using the inverse variance (IV) approach by combining the mean difference (MD) of individual studies. When the outcome (medication adherence) was reported using different measurement scales, the standardised mean difference (SMD) of individual studies were combined. When study had multiple intervention arms using a shared control group, the sample size, mean and standard deviations of the relevant experimental intervention arms were combined into a single intervention arm based on the method recommended by the Cochrane Handbook of Systematic Reviews of Interventions. The amplitude of the pooled treatment effect size was evaluate using Cohen's *d* whereby $d<0.2$ indicates negligible effect, $0.2\leq d<0.5$ indicates small effect, $0.5\leq d<0.8$ indicates medium effect and

$d \geq 0.8$ indicates large effect.[20] The overall effect was assessed by Z-statistic. The significant level was set at $p<0.05$.[19]

Given the differences in the behaviour change interventions, patient populations, measures and outcome assessment time points, it would be likely that true effect size varied across the studies. Therefore, a random-effects model was used for all meta-analyses to estimate the means of these effects.[21] Heterogeneity was estimated using Chi-Squared test and $I^2$ test. For heterogeneity to be statistically significant, p-value was set as <0.10 and the degree of variability was determined using $I^2$ values whereby 0% to 40% indicates unimportant heterogeneity, 30% to 60% moderate heterogeneity, 50% to 90% substantial heterogeneity and 75% to 100% considerable heterogeneity.[19] In the case of considerable and significant heterogeneity whereby $I^2$ was more than 50% and p-value was less than 0.10, a narrative and qualitative summary was performed.[22]

## Results

### *Study selection*

Figure 1 illustrates the PRISMA flow diagram in the systematic search process. A total of 2306 articles was retrieved from the six electronic databases, and no studies were identified through grey literature searching or from reference lists. 957 were duplicates and 30 were published before the year 2008, leaving 1319 articles for screening, of which 1152 were excluded based on title and abstract.

The remaining 167 articles were then assessed in full-text independently against the eligibility criteria by SYS and YJ and 152 were excluded (Figure 1), leaving 15 trials deemed eligible for review. These 15 trials were evaluated

independently for quality by both reviewers. Four had insufficient information for meta-analysis[23-26] and the study authors were contacted, but there was no response from any of them. Hence these four trials[23-26] are presented in narrative form. The remaining 11 trials[27-36] were incorporated in various meta-analyses according to their reported outcomes.

***Description of studies***

The summary of characteristics of the 15 trials can be found in Appendix 2 (supplementary): 14 (93.3%) of which were individualised RCTs[23-36] and one (6.7%) a cluster RCT.[37] From the 15 trials, 19 mobile phone-based self-management intervention arms were reported. Three trials[26,33,35] compared two smartphone-based intervention arms to a control group, though only one[35] combined the results of the two intervention arms into a single value instead of separate ones. One trial[24] included four different groups of participants and two different sets of intervention against control results: medication adherence intervention group vs medication adherence control group and exercise adherence intervention group vs exercise adherence control group.

***Description of participants***

The sample size across all 15 trials (total n=2978; males n=2326, females n=652) ranged from 28 to 710 participants. The mean age of all participants ranged from 53.7 to 75.3 years, though one trial[32] did not report these. Five trials had an age inclusion criteria of ≥18 years,[29-32,35] one of ≥21 years,[33] one of ≥65 years[37] and one of ≤75 years;[28] the remaining seven trials did not specify an age limit.[23-27,34,36]

Different definitions of CHD were used in the trials: acute coronary syndrome (n=2, 13.3%),[23,27] chronic stable angina (n=1, 6.7%),[26] post-myocardial infarction (n=3, 20%),[24,30,36] revascularization (n=8, 53.3%)[25,28,29,31,33-35,37] and one (6.7%) with no definition specified.[32] Only one trial[31] clearly indicated participants be diagnosed with CHD for at least 6 months.

All trials included participants who could speak, write and understand English or the native language(s) used locally. In addition, all participants eligible for inclusion were required to know how to use at least the text messaging function on mobile phones. Five trials did not require participants to own a mobile phone as it was provided by the researchers,[27,28,31,34,36], while the other 10 trials required participants to personally own one.[23-26,29,30,32,33,35,37]

***Description of interventions***

The description of interventions has been categorised into mode of delivery, frequency and duration of interventions and intervention components (education, reminders, self-monitoring and feedback) as summarised in Appendix 2, 3 and 4 (supplementary).

***Quality appraisal***

The summary for risk of bias is shown in Figure 2. Ten trials (66.7%) were classified as low risk of selection bias for random sequence generation.[24-26,28,29,31,32-36] Four trials (26.7%) were rated as low risk of selection bias for allocation concealment.[31,34-36] No trial mentioned blinding of participants and personnel, which may be due to the intervention nature whereby blinding of both parties was not easy to establish and maintain. Five trials (33.3%) reported

blinding of outcome assessment[27,29,31,37] and one (6.7%) attrition bias.[37] One trial (6.7%) was identified as high risk of selection bias due to its cluster RCT design whereby participants were recruited into the trial after the cluster had been randomized.[37] Four trials (26.7%) were rated as unclear risk of selection bias due to insufficient information provided about the randomization procedure.[23,25,27,30]

***Effectiveness of mobile phone-based self-management interventions on medication adherence***

A meta-analysis was performed on four trials including five arms that reported post-intervention scores of medication adherence among participants (n=612). The combined intervention effect was in favour to the intervention group, but the effect was not statistically significant (*d*=0.72; 95% CI -0.32 to 1.75; p=0.17) (Figure 3). The heterogeneity was high and significant ($I^2$=97%; p<0.00001).

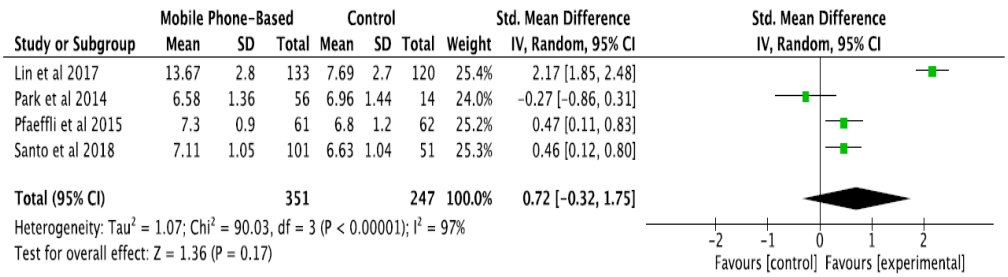



Figure 3 Forest plot: Effectiveness of mobile phone-based self-management interventions on medication adherence

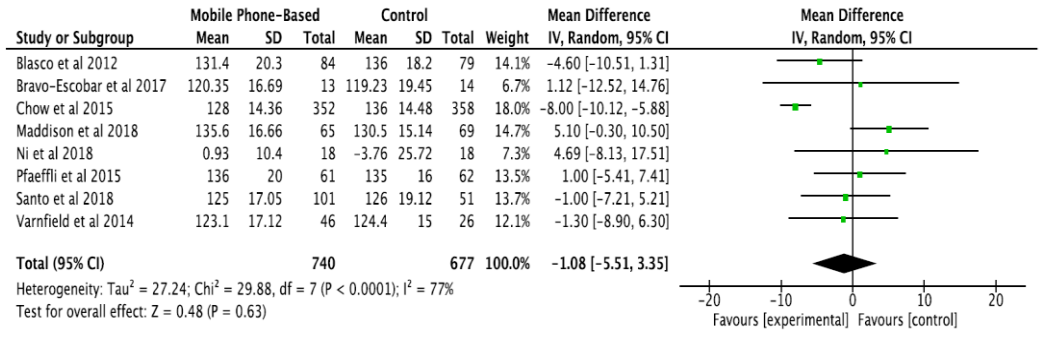
Due to the presence of considerable heterogeneity in the pooled meta-analysis, narrative synthesis was done. On a closer look, only 3 out of the 4 trials reported a standardized mean difference that favours the intervention group as indicated by the significant improvement in medication adherence among the experimental groups.[34, 35, 37] In particular, Lin et al. [37] reported a much greater mean difference than the other two studies, which may have contributed to the considerable heterogeneity in current meta-analysis. On the other hand, Park et

al.[33] reported no significant improvements in both intervention arms regarding medication adherence scores after 30 days.

Five other studies also reported the outcome of medication adherence but were not included in the meta-analysis because mean and SD values were not reported.[23-26, 32] As such, we were not able to pool the data from these studies.[23-26,32] Among the five studies, three measured medication adherence by number of events, and found significant improvements in the experimental groups.[23,24,25] One study reported insignificant but better medication adherence in experimental group.[32] Another study reported medication adherence based on various demographics, and only education level and disease history were found to have significant correlation to medication adherence.[26]

***Effectiveness of mobile phone-based self-management interventions on change in systolic BP***

A meta-analysis was performed on the eight trials that reported post-intervention levels of systolic BP among participants (n=1417). The pooled intervention effect in systolic BP was in favour to the intervention group, but the effect was not statistically significant (combined MD of -1.08 (95% CI -5.51 to 3.35; p=0.63) (Figure 4). The heterogeneity was substantial and significant ($I^2$=77%; p=<0.0001).




is,

Figure 4 Forest plot: Effectiveness of mobile phone-based self-management interventions on systolic BP

interventions (SMS: n=3, mobile phone-based applications: n=4, SMS plus smartphone applications: n=1). Among the three studies[27,29,34] using SMS interventions, two studies[27,29] reported significant improvements in the change of systolic BP post-intervention. Pfaeffli et al.[34] however reported that there were no differences in the change of systolic BP in either the control or experimental groups. All the four studies that utilized only mobile phone-based application interventions reported that the change in systolic BP were no significant differences between control and experimental group[28,31,32,35]. The only study that used SMS plus smartphone application intervention also reported no significant difference in change of systolic BP between experimental and control groups[36]. One trial was not included in the meta-analysis as systolic BP values were not reported in mean and SD.[30]

***Effectiveness of mobile phone-based self-management interventions on change in diastolic BP***

A meta-analysis was performed on the eight trials that reported post-intervention levels of change in diastolic BP among participants (n=1417). The interventions were associated with a change in diastolic BP, and the effect was statistically significant (*d*=-1.99; 95% CI -3.20 to -0.78; p=0.001) (Figure 5). The heterogeneity was low and insignificant ($I^2$=12%; p=0.34).

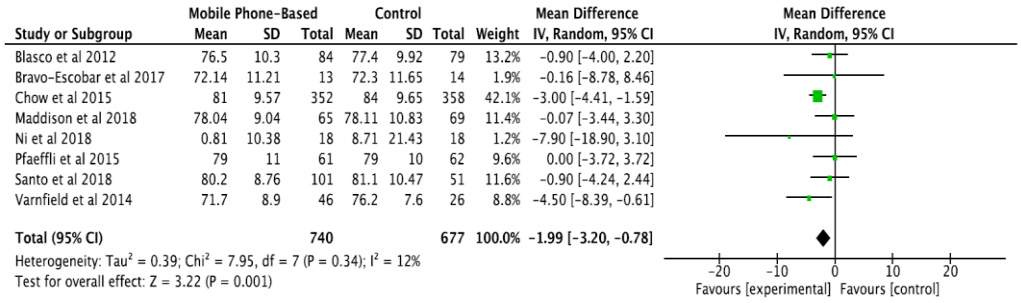



Figure 5 Forest plot: Effectiveness of mobile phone-based self-management interventions on diastolic BP

## Discussion

This review of 15 RCTs (n=2978) of mobile phone-based self-management interventions for CHD patients found they were associated, though not statically significantly, with improved medication adherence, and statistically significantly with change in diastolic, but not systolic BP. However, there was great variation among the trials with intervention mode being smartphone applications, SMS or both, duration ranging from one to 18 months, frequency varying from three times a week to four times a month and content using different combinations of self-management components, such as feedback, reminders, education and self-monitoring.

The statistically non-significant association with improvements in medication adherence[33-35,37] may be partly due to insufficient sample sizes. In addition, a high degree of heterogeneity was found among the trials, likely due to the different measurement tools, combinations of intervention components and delivery modes. This finding is consistent with another review which reported high heterogeneity in medication adherence.[17]

The finding of a medium effect size for mobile phone-based self-management interventions on medication adherence is consistent with narrative reviews.[16,17,19] The incorporation of self-management components in mobile phone-based interventions, such as medication reminders, may help boost an individual's confidence in their self-care activities.[40] A recent trial[35] found that the provision of daily medication reminders to patients helps address forgetfulness, a common unintentional reason for non-adherence.

The finding that mobile phone-based self-management interventions are statistically significant reduction in diastolic BP but not systolic BP is novel and

intriguing but the reasons are unclear, thus warranting further exploration. Other reviews evaluating the effectiveness of telehealth interventions on BP outcomes found no effect on systolic or diastolic BP.[41-43] A recent review[44] of medication adherence behaviour change interventions on BP outcomes found that they were effective in decreasing systolic and diastolic BP, but the effect size was modest. These findings reflect the difficulty in changing adherence behaviour to control BP, as well as the other health behaviours that are associated with health outcomes. As authors of the review[44] noted, while most interventions focus on knowledge and beliefs, these may not be adequate to sustain behavioural change. Their exploratory moderator analysis found that habit-focused interventions, which examine the participant's routines and link their medication administration to existing habitual behaviours, might be more effective than the other interventions.[44] Consideration of this in future mobile phone-based self-management interventions may prove fruitful.

The high levels of patient satisfaction and interest among patients using mobile phone-based technologies for the self-management of CHD[45] presents an array of opportunities to evaluate and determine the delivery mode, content, duration and frequency likely to be most effective in medication adherence and blood pressure control as well as other cardiovascular outcomes.

***Limitations***

The main limitation of this review was the presence of high heterogeneity in medication adherence and change in systolic BP outcomes due to variances in study designs, samples, and interventions. Such inherent heterogeneity is expected with behaviour change interventions, but complicate efforts to

synthesize the results of intervention studies. Additionally, most trials revealed selection and performance bias, whereby allocation concealment and blinding of participants and personnel were not carried out. Hence, the meta-analyses results may have been influenced by the low quality of included trials.[20] Furthermore, only English language articles were included, which may introduce inherent bias. A comprehensive search of multiple databases including other languages might mitigate this bias. Lastly, some relevant studies were not included due to a lack of reported data for calculating effect sizes.

## Conclusion

Mobile phone-based self-management interventions for CHD patients were associated with improved medication adherence, despite statistical insignificance. Moreover, such interventions were associated with statistically significant reduction in diastolic BP but not systolic BP. Despite a high degree of heterogeneity among trials, the findings suggest that mobile phone-based self-management interventions have the potential to improve health experiences and outcomes for CHD patients. With the rapid advancements in technologies, the growth of mobile phone usage globally and the numerous applications and functions available, choice is likely to be a major consideration.

**Funding**

The research was funded by Ministry of Health, Health Services Research Grant May 2018. Singapore. Grant No. HSRGOC18may002.

Conflicting interest: none declared.

## References


1. Le J, Dorstyn DS, Mpfou E, et al. Health-related quality of life in coronary heart disease: A systematic review and meta-analysis mapped against the international classification of functioning, disability and health. *Qual Life Res* 2018; 27: 2491-2503.
2. Cole-Lewis H and Kershaw T. Text messaging as a tool for behaviour change in disease prevention and management. *Epidemiol Rev* 2010; 32: 56-69.
3. Coorey GM, Neubeck L, Mulley J, et al. Effectiveness, acceptability and usefulness of mobile applications for cardiovascular disease self-management: Systematic review with meta-synthesis of quantitative and qualitative data. *Eur J Prev Cardiol* 2018; 25: 505-521.
4. Du L, Cheng Z, Zhang Y, et al. The impact of medication adherence on clinical outcomes of coronary artery disease: A meta-analysis. *Eur J Prev Cardiol* 2017; 24: 962-970.
5. Schwalm JD, Ivers NM, Natarajan MK, et al. Cluster randomized controlled trial of Delayed Educational Reminders for Long-term Medication Adherence in ST-Elevation Myocardial Infarction (DERLA-STEMI). *Am Heart J* 2015; 170: 903-913.
6. Tajeu GS, Booth JN, Colantonio LD, et al. Incident cardiovascular disease among adults with blood pressure <140/90 mm Hg. *Circulation* 2017; 136: 798-812.
7. Whelton PK, Carey RM, Aronow WS, et al. Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of

Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2018; 71(19):e127-248.

8. Cho MJ, Sim JL and Hwang SY. Development of smartphone educational application for patients with coronary artery disease. *Healthc Inform Res* 2014; 20: 117-124.
9. International Telecommunication Union. *Information and communications technology facts and figures 2017*. https://www.itu.int/en/ITUD/Statistics/Pages/stat/default.aspx (2018, accessed 2 December 2018)
10. Krishna S, Boren SA and Balas EA. Healthcare via cell phones: A systematic review. *Telemed J E Health* 2009; 15: 231-240.
11. Whitehead L and Seaton P. The effectiveness of self-management mobile phone and tablet apps in long-term condition management: A systematic review. *J Med Internet Res* 2016; 18(5): e97.
12. Steinkamp JM, Goldblatt N, Borodovsky JT, et al. Technological interventions for medication adherence in adult mental health and substance use disorders: A systematic review. *JMIR Ment Health* 2019; 6(3): e12493.
13. Saffari M, Ghanizadeh G and Koenig HG. Health education via mobile text messaging for glycemic control in adults with type 2 diabetes: A systematic review and meta-analysis. *Prim Care Diabetes* 2014; 8: 275-285.
14. Adler AJ, Martin N, Mariani J, et al. Mobile phone text messaging to improve medication adherence in secondary prevention of

cardiovascular disease. *Cochrane Database Syst Rev* 2017; 4: CD011851.

15. Gandhi S, Chen S, Hong L, et al. Effect of mobile health interventions on the secondary prevention of cardiovascular disease: Systematic review and meta-analysis. *Can J Cardiol* 2017; 33: 219-231.
16. Liu H, Xiao X, Lu C, et al. A systematic review of the effect of mobile health on cardiac rehabilitation among coronary heart disease patients. *Frontiers Nurs* 2018; 5: 217-226.
17. Yousuf G, Sina K, Heval MK, et al. The role of mHealth for improving medication adherence in patients with cardiovascular disease: a systematic review. *Eur Heart J Qual Care Clin Outcomes* 2016; 2: 237-244.
18. Moher D, Shamseer L, Clarke M et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015 4(1):1. doi:10.1186/2046-4053-4-1.
19. Higgins JPT and Green S. Cochrane handbook for systematic reviews of interventions version 5.1.0 [updated March 2011]. *The Cochrane Collaboration 2011*. http://handbook-5-1.cochrane.org (2011, accessed 3 February 2019)
20. Cohen J. A power primer. *Psychol Bull* 1992; 112: 155-159.
21. Borenstein M, Hedges LV, Higgins JPT, et al. Introduction to meta-analysis. 2009; John Wiley & Sons,Ltd. West Sussex, United Kingdom.
22. Valentine JC, Wilson SJ, Rindskopf D et al. Synthesizing evidence in public policy contexts: The challenge of synthesis when there are only a few studies. *Evaluation Rev* 2017; 41: 3-26.

23. Khonsari S, Subramanian P, Chinna K, et al. Effect of a reminder system using an automated short message service on medication adherence following acute coronary syndrome. *Eur J Cardiovasc Nurs* 2015; 14: 170-179

24. Pandey A, Krumme A, Patel T, et al. The impact of text messaging on medication adherence and exercise among postmyocardial infarction patients: Randomized controlled pilot trial. *JMIR Mhealth Uhealth* 2017; 5(8): e110

25. Quilici J, Fugon L, Beguin S, et al. Effect of motivational mobile phone short message service on aspirin adherence after coronary stenting for acute coronary syndrome. *Int J Cardiol* 2013; 168: 568-569.

26. Fang R and Li X. Electronic messaging support service programs improve adherence to lipid-lowering therapy among outpatients with coronary artery disease: An exploratory randomised control study. *J Clin Nurs* 2016; 25: 664-671.

27. Blasco A, Carmona M, Fernández-Lozano I, et al. Evaluation of a telemedicine service for the secondary prevention of coronary artery disease. *J Cardiopulm Rehabil Prev* 2012; 32: 25-31.

28. Bravo-Escobar R, González-Represas A, Gómez-González AM, et al. Effectiveness and safety of a home-based cardiac rehabilitation programme of mixed surveillance in patients with ischemic heart disease at moderate cardiovascular risk: A randomised, controlled clinical trial. *BMC Cardiovasc Disord* 2017; 17(1): 66.

29. Chow CK, Redfern J, Hillis GS, et al. Effect of lifestyle-focused text messaging on risk factor modification in patients with coronary heart disease: A randomized clinical trial. *JAMA* 2015; 314: 1255-1263.

30. Johnston N, Bodegard J, Jerström S, et al. Effects of interactive patient smartphone support app on drug adherence and lifestyle changes in myocardial infarction patients: A randomized study. *Am Heart J* 2016; 178: 85-94

31. Maddison R, Rawstorn JC, Stewart RA, et al. Effects and costs of real-time cardiac telerehabilitation: Randomised controlled non-inferiority trial. *Heart* 2018; 105: 122-129.

32. Ni Z, Liu C, Wu B, et al. An mHealth intervention to improve medication adherence among patients with coronary heart disease in china: Development of an intervention. *Int J Nurs Sci* 2018; 5: 322-330.

33. Park LG, Howie-Esquivel J, Chung ML, et al. A text messaging intervention to promote medication adherence for patients with coronary heart disease: A randomized controlled trial. *Patient Educ Couns* 2014; 94: 261-268.

34. Pfaeffli Dale L, Whittaker R, Jiang Y, et al. Text message and internet support for coronary heart disease self-management: Results from the Text4Heart randomized controlled trial. *J Med Internet Res* 2015; 17(10): e237.

35. Santo K, Singleton A, Rogers K, et al. Medication reminder applications to improve adherence in coronary heart disease: A randomised clinical trial. *Heart* 2018; 105: 323-329.

36. Varnfield M, Karunanithi M, Lee C, et al. Smartphone-based home care model improved use of cardiac rehabilitation in postmyocardial infarction patients: Results from a randomised controlled trial. *Heart* 2014; 100: 1770-1779.

37. Lin CY, Yaseri M, Pakpour AH, et al. Can a multifaceted intervention including motivational interviewing improve medication adherence, quality of life, and mortality rates in older patients undergoing coronary artery bypass surgery? A multicenter, randomized controlled trial with 18-month follow up. *Drugs Aging* 2017; 4: 143-156.

38. Hanlon P, Daines L, Campbell C, et al. Telehealth interventions to support self-management of long-term conditions: A systematic metareview of diabetes, heart failure, asthma, chronic obstructive pulmonary disease, and cancer. *J Med Internet Res* 2017; 19(5): e172.

39. Palacios J, Lee GA, Duaso M, et al. Internet-delivered self-management support for improving coronary heart disease and self-management-related outcomes: A systematic review. *J Cardiovasc Nurs* 2017; 32: E9-E23

40. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev* 1977; 84: 191-215.

41. Devi R, Singh SJ, Powell J, et al. Internet-based interventions for the secondary prevention of coronary heart disease. *Cochrane Database Syst Rev* 2015; (12):CD009386.

42. Rawstorn JC, Gant N, Direito A, et al. Telehealth exercise-based cardiac rehabilitation: A systematic review and meta-analysis. *Heart* 2016; 102: 1183-1192.

43. Huang K, Liu W, He D, et al. Telehealth interventions versus center-based cardiac rehabilitation of coronary artery disease: A systematic review and meta-analysis *Eur J Prev Cardiol* 2015; 22: 959-971.

44. Conn VS, Ruppar TM and Chase JD. Blood pressure outcomes of medication adherence interventions: Systematic review and meta-analysis. *J Behav Med* 2016; 39: 1065-1075.

45. Park LG, Beatty A, Stafford Z, et al. Mobile phone interventions for the secondary prevention of cardiovascular disease. *Prog Cardiovasc Dis* 2016; 58: 639-650.

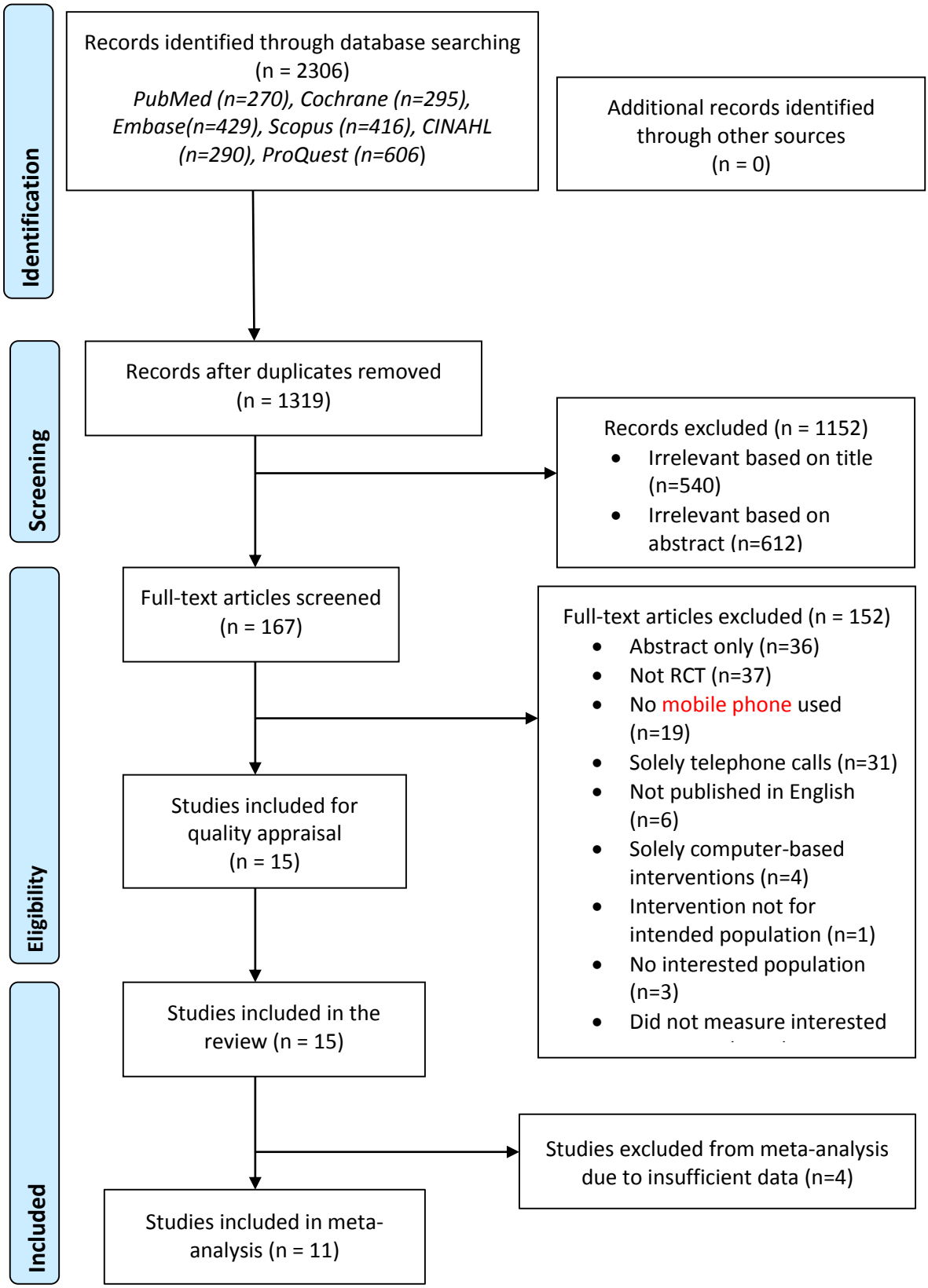



**Figure 1 PRISMA Flow Diagram**

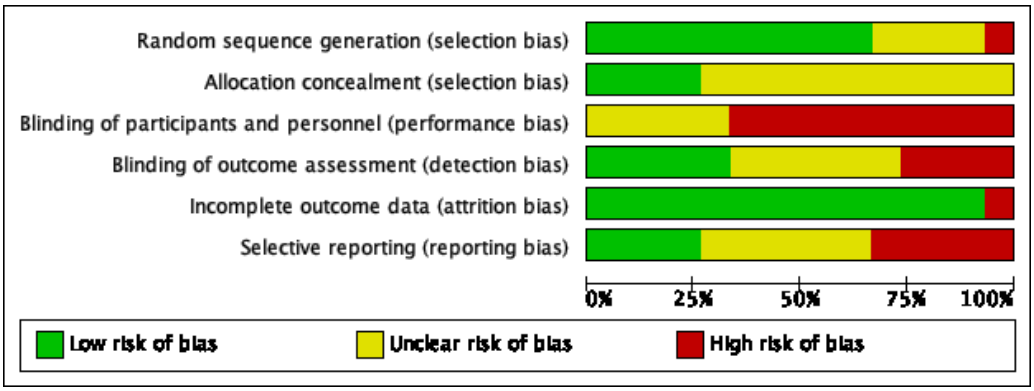



**Figure 2 Risk of bias graph**

Dear Editor,

On behalf of the authors, I thank you again for your positive response regarding our paper entitled "Effectiveness of mobile phone-based self-management interventions for medication adherence and change in blood pressure in patients with coronary heart disease: A systematic review and meta-analysis" (Ms. Ref. No. CNU-D-19-00174R1)

We have studied reviewers' comments carefully and have made revisions accordingly, which are marked in red in the manuscript. Our detailed response to the reviewers' comments is attached as a separated file.

Once again, we would like to express our appreciation to you and your reviewers for the valuable and constructive comments on our paper. Please kindly understand that this is a review paper and it is expected the paper can be published as early as possible so as to keep the updated evidence. We would really appreciate if you could help to expedite reviewing process given this is our second revision and the reviewers recommended minor revisions. Your assistance is much appreciated and we look forward to hearing from you in due course.

With kind regards,

Yours sincerely,
Wang Wenru, Ph.D.
Corresponding author:
Email: nurww@nus.edu.sg

Table

## Appendix 1: Search Strategies

### COCHRANE

| No. | Search Details | No. of Articles |
|---|---|---|
| 1 | MeSH descriptor: [Coronary Artery Disease] explode all trees | 5069 |
| 2 | MeSH descriptor: [Arteriosclerosis] explode all trees | 8720 |
| 3 | MeSH descriptor: [Myocardial Ischemia] explode all trees | 25447 |
| 4 | MeSH descriptor: [Percutaneous Coronary Intervention] explode all trees | 5006 |
| 5 | MeSH descriptor: [Angioplasty] explode all trees | 4337 |
| 6 | MeSH descriptor: [Coronary Artery Bypass] explode all trees | 5219 |
| 7 | (“coronary artery disease” OR “coronary heart disease” OR (coronary NEXT isch*mia) OR (cardiac NEXT isch*mia) OR artheroscleros?s OR arterioscleros?s OR arterioloscleros?s OR “ischemic heart disease” OR “ischaemic heart disease” OR “ischemia heart disease” OR “ischaemia heart disease” OR (myocard* NEXT isch*mia) OR angina* OR (angina NEXT pectoris) OR (angor NEXT pectoris) OR (myocard* NEXT infarct*) OR “percutaneous coronary intervention” OR PCI OR “percutaneous transluminal coronary angioplasty” OR PTCA OR angioplast* OR stent* OR “coronary artery bypass grafting” OR CABG OR “coronary artery bypass” OR “acute coronary syndrome”):ti,ab,kw | 61698 |
| 8 | #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 | 64750 |
| 9 | MeSH descriptor: [Telemedicine] explode all trees | 1966 |
| 10 | MeSH descriptor: [Cell Phone] explode all trees | 1036 |
| 11 | MeSH descriptor: [Smartphone] explode all trees | 191 |
| 12 | MeSH descriptor: [Mobile Applications] explode all trees | 330 |
| 13 | (smartphone* OR cellphone* OR (smart NEXT phone*) OR (cell* NEXT phone*) OR (mobile NEXT phone*) OR (mobile NEXT technolog*) OR (mobile NEXT app*) OR (smartphone NEXT app*) OR (smart-phone NEXT app*) OR (phone NEXT app*) OR (cellphone NEXT app*) OR (cell-phone NEXT app*) OR (text NEAR messag*) OR text-based OR texting OR “short message service” OR “short message services” OR “short messaging service” OR (instant NEXT messag*) OR m-health OR mhealth OR "mobile health" OR telemedicine OR tele-medicine OR telehealth):ti,ab,kw | 9078 |
| 14 | #9 OR #10 OR #11 OR #12 OR #13 | 9376 |
| 15 | #8 AND #14 | 307 |
| 16 | Searching in Cochrane Central Register of Controlled trial | 295 |

**PubMed**

| No. | Search Details | No. of Articles |
|---|---|---|
| 1 | "Myocardial Ischemia"[Mesh] OR "Arteriosclerosis"[Mesh] OR "Coronary Artery Disease"[Mesh] OR "Percutaneous Coronary Intervention"[Mesh] OR "Angioplasty"[Mesh] OR "Coronary Artery Bypass"[Mesh] | 553092 |
| 2 | ("coronary artery disease"[Title/Abstract] OR "coronary heart disease"[Title/Abstract] OR "coronary ischemia"[Title/Abstract] OR "coronary ischaemia"[Title/Abstract] OR "cardiac ischemia"[Title/Abstract] OR "cardiac ischaemia"[Title/Abstract] OR artherosclerosis[Title/Abstract] OR arteriosclerosis[Title/Abstract] OR arteriolosclerosis[Title/Abstract] OR "ischemic heart disease"[Title/Abstract] OR "ischaemic heart disease"[Title/Abstract] OR "ischemia heart disease"[Title/Abstract] OR "ischaemia heart disease"[Title/Abstract] OR "myocardic ischemia"[Title/Abstract] OR "myocardial ischemia"[Title/Abstract] OR "myocardial ischaemia"[Title/Abstract] OR angina*[Title/Abstract] OR "angor pectoris"[Title/Abstract] OR myocardial infarct*[Title/Abstract] OR "percutaneous coronary intervention"[Title/Abstract] OR PCI[Title/Abstract] OR "percutaneous transluminal coronary angioplasty"[Title/Abstract] OR PTCA[Title/Abstract] OR angioplast*[Title/Abstract] OR stent*[Title/Abstract] OR "coronary artery bypass grafting"[Title/Abstract] OR CABG[Title/Abstract] OR "coronary artery bypass"[Title/Abstract] OR "acute coronary syndrome"[Title/Abstract]) | 504375 |
| 3 | #1 OR #2 | 732675 |
| 4 | "Telemedicine"[Mesh] OR "Smartphone"[Mesh] OR "Cell Phone"[Mesh] OR "Mobile Applications"[Mesh] | 35609 |
| 5 | (smartphone*[Title/Abstract] OR cellphone*[Title/Abstract] OR smart phone*[Title/Abstract] OR cell phone*[Title/Abstract] OR cellular phone*[Title/Abstract] OR mobile phone*[Title/Abstract] OR mobile technolog*[Title/Abstract] OR "mobile app"[Title/Abstract] OR "mobile apps" [Title/Abstract] OR mobile application*[Title/Abstract] OR "smartphone app"[Title/Abstract] OR "smartphone apps"[Title/Abstract] OR smartphone application*[Title/Abstract] OR "smart-phone app"[Title/Abstract] OR "smart-phone apps"[Title/Abstract] OR smart-phone application*[Title/Abstract] OR "phone app"[Title/Abstract] OR "phone apps" [Title/Abstract] OR phone application*[Title/Abstract] OR cellphone application*[Title/Abstract] OR "cell-phone app"[Title/Abstract] OR cell-phone application*[Title/Abstract] OR text messag*[Title/Abstract] OR text-based[Title/Abstract] OR texting[Title/Abstract] OR m-health[Title/Abstract] OR mhealth[Title/Abstract] OR mobile health*[Title/Abstract] OR telemedicine[Title/Abstract] OR tele-medicine[Title/Abstract] OR telehealth[Title/Abstract] OR tele-health[Title/Abstract]) | 37475 |
| 6 | #4 OR #5 | 53186 |
| 7 | (randomized controlled trial[Publication Type] OR controlled clinical trial[Publication Type] OR randomized[Title/Abstract] OR placebo[Title/Abstract] OR drug therapy[Mesh Subheading] OR randomly[Title/Abstract] OR trial[Title/Abstract] OR groups[Title/Abstract] NOT (animals [Mesh] NOT humans [Mesh])) | 3824031 |
| 8 | #3 AND #6 AND #7 | 270 |

**EMBASE**

| No. | Search Details | No. of Articles |
|---|---|---|
| 1 | 'coronary artery disease'/exp OR 'ischemic heart disease'/exp OR 'arteriosclerosis'/exp OR ‘angina pectoris’/exp OR ‘heart infarction’/exp OR ‘percutaneous coronary intervention’/exp OR ‘angioplasty’/exp OR ‘coronary artery bypass graft’/exp OR 'coronary artery disease':ti,ab OR 'coronary heart disease':ti,ab OR 'coronary isch*mia':ti,ab OR 'cardiac isch*mia':ti,ab OR artheroscleros?s:ti,ab OR arterioscleros?s:ti,ab OR arterioloscleros?s:ti,ab OR 'isch*mic heart disease':ti,ab OR ‘isch*mia heart disease’ OR 'myocard* isch*mia':ti,ab OR angina*:ti,ab OR ‘angor pectoris’:ti,ab OR ‘myocard* infarct*’:ti,ab OR ‘percutaneous coronary intervention’:ti,ab OR PCI:ti,ab OR ‘percutaneous transluminal coronary angioplasty’:ti,ab OR PTCA:ti,ab OR angioplast*:ti,ab OR stent*:ti,ab OR ‘coronary artery bypass grafting’:ti,ab OR CABG:ti,ab OR ‘coronary artery bypass’:ti,ab OR ‘acute coronary syndrome’:ti,ab | 1181467 |
| 2 | 'telemedicine'/exp OR 'text messaging'/exp OR 'mobile phone'/exp OR 'mobile application'/exp OR smartphone*:ti,ab OR cellphone*:ti,ab OR 'smart phone*':ti,ab OR 'cell phone*':ti,ab OR 'cellular phone*':ti,ab OR 'mobile phone*':ti,ab OR 'mobile technolog*':ti,ab OR 'mobile app*':ti,ab OR ‘smartphone app*’:ti,ab OR ‘smart-phone app*’:ti,ab OR ‘phone app*’ OR ‘cellphone app*’ OR ‘cell-phone app*’:ti,ab OR 'text messag*':ti,ab OR text-based:ti,ab OR texting:ti,ab OR m-health:ti,ab OR mhealth:ti,ab OR 'mobile health':ti,ab OR telemedicine:ti,ab OR tele-medicine:ti,ab OR telehealth:ti,ab OR tele-health:ti,ab | 72809 |
| 3 | 'crossover procedure':de OR 'double-blind procedure':de OR 'randomized controlled trial':de OR 'single-blind procedure':de OR random*:de,ab,ti OR factorial*:de,ab,ti OR crossover*:de,ab,ti OR ((cross NEXT/1 over*):de,ab,ti) OR placebo*:de,ab,ti OR ((doubl* NEAR/1 blind*):de,ab,ti) OR ((singl* NEAR/1 blind*):de,ab,ti) OR assign*:de,ab,ti OR allocat*:de,ab,ti OR volunteer*:de,ab,ti | 2343263 |
| 4 | #1 AND #2 AND #3 | 429 |

**SCOPUS**

| No. | Search Details | No.of Articles |
|---|---|---|
| 1 | TITLE-ABS-KEY ( “coronary artery disease” OR “coronary heart disease” OR “coronary isch*mia” OR “cardiac isch*mia” OR artherosclerosis OR arterioscleros*s OR arterioloscleros*s OR “isch*mic heart disease” OR “isch*mia heart disease” OR “myocard* isch*mia” OR angina* OR “angor pectoris” OR “myocard* infarct*” OR “percutaneous coronary intervention” OR PCI OR “percutaneous transluminal coronary angioplasty” OR PTCA OR angioplast* OR stent* OR “coronary artery bypass grafting” OR CABG OR “coronary artery bypass” OR “acute coronary syndrome” ) | 879678 |
| 2 | TITLE-ABS-KEY ( smartphone* OR cellphone* OR “smart phone*” OR “cell phone*” OR “cellular phone*” OR “mobile phone*” OR “mobile technolog*” OR “mobile app*” OR “smartphone app*” OR “smart-phone app*” OR “phone app*” OR “cellphone app*” OR “cell-phone app*” OR “text messag*” OR text-based OR texting OR m-health OR mhealth OR “mobile health” OR telemedicine OR tele-medicine OR telehealth OR tele-health ) | 196029 |
| 3 | ( INDEXTERMS ( "clinical trials" OR "clinical trials as a topic" OR "randomized controlled trial" OR "Randomized Controlled Trials as Topic" OR "controlled clinical trial" OR "Controlled Clinical Trials" OR "random allocation" OR "Double-Blind Method" OR "Single-Blind Method" OR "Cross-Over Studies" OR "Placebos" OR "multicenter study" OR "double blind procedure" OR "single blind procedure" OR "crossover procedure" OR "clinical trial" OR "controlled study" OR "randomization" OR "placebo" ) ) OR ( TITLE-ABS-KEY ( ( "clinical trials" OR "clinical trials as a topic" OR "randomized controlled trial" OR "Randomized Controlled Trials as Topic" OR "controlled clinical trial" OR "Controlled Clinical Trials as Topic" OR "random allocation" OR "randomly allocated" OR "allocated randomly" OR "Double-Blind Method" OR "Single-Blind Method" OR "Cross-Over Studies" OR "Placebos" OR "cross-over trial" OR "single blind" OR "double blind" OR "factorial design" OR "factorial trial" ) ) ) OR ( TITLE-ABS ( clinical trial* OR trial* OR rct* OR random* OR blind* ) ) | 6973292 |
| 4 | #1 AND #2 AND #3 | 416 |

**CINAHL**

| No. | Search Details | No. of Articles |
|---|---|---|
| 1 | (MH "Myocardial Ischemia+") OR (MH "Arteriosclerosis+") OR (MH "Angina Pectoris+") OR (MH "Myocardial Infarction+") OR (MH "Myocardial Revascularization+") | 105696 |
| 2 | TI ("coronary artery disease" OR "coronary heart disease" OR "coronary isch#emia" OR "cardiac isch#emia" OR artheroscleros?s OR arterioscleros?s OR arteriolosclerosis OR "isch#emic heart disease" OR "isch#emia heart disease" OR "myocard* isch#emia" OR angina* OR "angor pectoris" OR "myocardial infarct*" OR "percutaneous coronary intervention" OR PCI OR "percutaneous transluminal coronary angioplasty" OR PTCA OR angioplast* OR stent* OR "coronary artery bypass grafting" OR CABG OR "coronary artery bypass" OR "acute coronary syndrome") | 59903 |
| 3 | AB ("coronary artery disease" OR "coronary heart disease" OR "coronary isch#emia" OR "cardiac isch#emia" OR artheroscleros?s OR arterioscleros?s OR arteriolosclerosis OR "isch#emic heart disease" OR "isch#emia heart disease" OR "myocard* isch#emia" OR angina* OR "angor pectoris" OR "myocardial infarct*" OR "percutaneous coronary intervention" OR PCI OR "percutaneous transluminal coronary angioplasty" OR PTCA OR angioplast* OR stent* OR "coronary artery bypass grafting" OR CABG OR "coronary artery bypass" OR "acute coronary syndrome") | 65594 |
| 4 | #1 OR #2 OR #3 | 148250 |
| 5 | (MH "Telemedicine+") OR (MH "Mobile Applications") OR (MH "Cellular Phone+") OR (MH "Smartphone+") | 18832 |
| 6 | TI (smartphone* OR cellphone* OR "smart phone" OR "smart phones" OR "cell phone" OR "cell phones" OR "cellular phone" OR "cellular phones" OR "mobile phone" OR "mobile phones" OR "mobile technology" OR "mobile technologies" OR "mobile app*" OR "smartphone app*" OR "smart-phone app*" OR "phone app*" OR "cellphone app*" OR "cell-phone app*" OR "text messag*" OR text-based OR texting OR m-health OR mhealth OR "mobile health" OR telemedicine OR tele-medicine or telehealth or tele-health) | 11733 |
| 7 | AB (smartphone* OR cellphone* OR "smart phone" OR "smart phones" OR "cell phone" OR "cell phones" OR "cellular phone" OR "cellular phones" OR "mobile phone" OR "mobile phones" OR "mobile technology" OR "mobile technologies" OR "mobile app*" OR "smartphone app*" OR "smart-phone app*" OR "phone app*" OR "cellphone app*" OR "cell-phone app*" OR "text messag*" OR text-based OR texting OR m-health OR mhealth OR "mobile health" OR telemedicine OR tele-medicine or telehealth or tele-health) | 13203 |
| 8 | #5 OR #6 OR #7 | 29575 |
| 9 | #4 AND #8 | 290 |

**PROQUEST**

| No. | Search Details | No. of Articles |
|---|---|---|
| 1 | TI (“coronary artery disease” OR “coronary heart disease” OR (coronary NEXT isch*mia) OR (cardiac NEXT isch*mia) OR artheroscleros?s OR arterioscleros?s OR arteriolosclerosis OR “ischemic heart disease” OR “ischaemic heart disease” OR “ischemia heart disease” OR “ischaemia heart disease” OR (myocard* NEXT isch*mia) OR angina* OR (angina NEXT pectoris) OR (angor NEXT pectoris) OR (myocard* NEXT infarct*) OR “percutaneous coronary intervention” OR PCI OR “percutaneous transluminal coronary angioplasty” OR PTCA OR angioplast* OR stent* OR “coronary artery bypass grafting” OR CABG OR “coronary artery bypass” OR “acute coronary syndrome”) | 284071 |
| 2 | AB ("coronary artery disease" OR "coronary heart disease" OR (coronary NEXT isch*mia) OR (cardiac NEXT isch*mia) OR artheroscleros?s OR arterioscleros?s OR arteriolosclerosis OR "ischemic heart disease" OR "ischaemic heart disease" OR "ischemia heart disease" OR "ischaemia heart disease" OR (myocard* NEXT isch*mia) OR angina* OR (angina NEXT pectoris) OR (angor NEXT pectoris) OR (myocard* NEXT infarct*) OR "percutaneous coronary intervention" OR PCI OR "percutaneous transluminal coronary angioplasty" OR PTCA OR angioplast* OR stent* OR "coronary artery bypass grafting" OR CABG OR "coronary artery bypass" OR "acute coronary syndrome") | 510475 |
| 3 | #1 OR #2 | 604820 |
| 4 | TI (smartphone* OR cellphone* OR (smart NEXT phone*) OR (cell* NEXT phone*) OR (mobile NEXT phone*) OR (mobile NEXT technolog*) OR (mobile NEXT app*) OR (smartphone NEXT app*) OR (smart-phone NEXT app*) OR (phone NEXT app*) OR (cellphone NEXT app*) OR (cell-phone NEXT app*) OR (text NEAR messag*) OR text-based OR texting OR “short message service” OR “short message services” OR “short messaging service” OR (instant NEXT messag*) OR m-health OR mhealth OR "mobile health" OR telemedicine OR tele-medicine OR telehealth) | 139315 |
| 5 | AB (smartphone* OR cellphone* OR (smart NEXT phone*) OR (cell* NEXT phone*) OR (mobile NEXT phone*) OR (mobile NEXT technolog*) OR (mobile NEXT app*) OR (smartphone NEXT app*) OR (smart-phone NEXT app*) OR (phone NEXT app*) OR (cellphone NEXT app*) OR (cell-phone NEXT app*) OR (text NEAR messag*) OR text-based OR texting OR “short message service” OR “short message services” OR “short messaging service” OR (instant NEXT messag*) OR m-health OR mhealth OR "mobile health" OR telemedicine OR tele-medicine OR telehealth) | 318604 |
| 6 | #4 OR #5 | 401516 |
| 7 | #3 AND #6 | 606 |

## Appendix 2 Description of included trials (n=15)

| Author, Year, Country | Design, Setting | Participants | Mobile phone-based self-management intervention | Theory, Intervention Duration | Comparison Group | Outcomes assessed immediately after intervention |
|---|---|---|---|---|---|---|
| Blasco et al., 2012[27] Spain | 2-arm RCT hospital | T: n=203<br>I: n=102<br>83 males, 19 females<br>Mean age: 60.6 (11.5)<br>C: n=101<br>80 males, 21 females<br>Mean age: 61 (12.1) | Automatic sphygmomanometer + glucose and lipid meter + cellular phone to measure participant's BP, heart rate and weight weekly<br><br>Individualized text messages with recommendations sent to patients based on BP, heart rate and weight results | No theory, 12 months | Usual care | 1) SBP, DBP<br>2) BMI<br>3) Smoking status<br>4) LDL-c<br>5) HbA1c |
| Bravo-Escobar et al., 2017[28] Spain | 2-arm RCT cardiac rehabilitation centre | T: 28<br>I: n=14<br>14 males<br>Mean age: 56.50 (6.01)<br>C: n=14<br>14 males<br>Mean age: 55.64 (11.35) | NUUBO® application: prescribed exercise program (≥ 2 days per week) that uses Bluetooth wireless technology and biometric vests using textile electrodes | No theory, 2 months | Usual care | 1) SBP, DBP<br>2) BMI<br>3) MET<br>4) LDL-c<br>5) HbA1c<br>6) HRQoL |
| Chow et al., 2015[29] Australia | 2-arm RCT hospital | T: 710<br>I: n=352<br>287 males, 65 females<br>Mean age: 57.9 (9.1)<br>C: n=358<br>295 males, 63 females<br>Mean age: 57.3 (9.3) | 4 semi-personalized text messages per week on either smoking, diet, physical activity and general cardiovascular health modules | No theory, 6 months | Usual care | 1) SBP, DBP<br>2) BMI<br>3) MET<br>4) Smoking status<br>5) LDL-c |
| Fang & Li 2016[26] China | 3-arm RCT outpatient clinic | T: 271<br>I (a): n=91<br>64 males, 27 females<br>Mean age: 53.73 (7.20)<br>I (b): n=90 | I(a): Text messages on medication reminders and educational materials | No theory, 6 months | Phone call | 1) Medication adherence |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 61 males, 29 females<br>Mean age: 53.69 (7.74)<br>C: 90<br>61 males, 29 females<br>Mean age: 53.50 (7.62) | I(b): Text messages on medication reminders + text-messaging application on educational materials | | | |
| Johnston et al., 2016[30]<br>Sweden | 2-arm RCT<br>outpatient clinic | T: 166<br>I: n=86<br>71 males, 15 females<br>Mean age: 56.8 (8.0)<br>C: n=80<br>63 males, 17 females<br>Mean age: 58.4 (8.6) | Application installed that consists of drug adherence e-diary and secondary prevention educational modules<br><br>SMS reminders for participants who have missed their dose registration | No theory,<br>6 months | SMS reminders + e-diary without educational materials (Placebo) | 1) SBP<br>2) BMI<br>3) Smoking status<br>4) LDL-c<br>5) HRQoL |
| Khonsari et al.,2015[23]<br>Malaysia | 2-arm RCT<br>hospital | T: 62<br>I: n=31<br>27 males, 4 females<br>Mean age: 56 (11.3)<br>C: n=31<br>26 males, 5 females<br>Mean age: 59 (13.9) | Text message medication reminders daily | No theory,<br>2 months | Usual care | 1) Medication adherence<br>2) Heart function status<br>3) Readmission rate<br>4) Death rate |
| Lin et al., 2017[37]<br>Iran | 2-arm cluster RCT<br>outpatient clinic | T: 288<br>I: n=144<br>94 males, 50 females<br>Mean age: 75.33 (7.41)<br>C: n=144<br>97 males, 47 females<br>Mean age: 74.33 (7.41) | 4 medication reminders sent monthly + 3 psycho-education sessions weekly + 5 motivational interviewing sessions weekly | Theory of planned behaviour<br>4 months | Usual care | 1) LDL-c<br>2) HRQoL<br>3) Medication adherence |
| Maddison et al., 2018[31]<br>New Zealand | 2-arm RCT<br>cardiac rehabilitation centre | T: 162<br>I: n=82<br>69 males, 13 females<br>Mean age: 61.0 (13.2)<br>C: n=80<br>70 males, 10 females<br>Mean age: 61.5 (12.2) | Chest-worn wearable sensor (heart rate, respiratory rate single lead ECG, accelerometry) that connects to application for self-monitoring.<br><br>Text-messages on behaviour change education | Social cognitive theory<br>3 months | Usual care | 1) SBP, DBP<br>2) BMI<br>3) LDL-c<br>4) HRQoL |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ni et al., 2018[32]<br>China | 2-arm RCT<br>outpatient clinic | T: 36<br>I: n=18<br>14 males, 4 females<br>Mean age: NR<br>C: n=18<br>15 males, 3 females<br>Mean age: NR | Text-messaging application to send medication reminders daily | No theory<br>1 month | Usual care | 1) SBP, DBP<br>2) Medication non-adherence<br>3) Heart rate |
| Pandey et al., 2017[24]<br>Canada | 4-arm RCT<br>cardiac rehabilitation | T: 83<br>I(a): n=17<br>6 males, 11 females<br>Mean age: 64.6 (11.5)<br>C(a): n=16<br>14males, 2 females<br>Mean age: 62.1 (11.0)<br>I(b): n=25<br>15 males, 10 females<br>Mean age: 64.3 (10.7)<br>C(b): n=25<br>11 males, 14 females<br>Mean age: 63.7 (9.6) | I(a) medication adherence trial: daily text messages on medication reminders<br><br>I(b) exercise adherence trial: 4 exercise text-messaging reminders daily | No theory<br>3 months | Usual care | 1) Medication adherence<br>2) METS |
| Park et al., 2014[33]<br>United States of America | 3-arm RCT<br>outpatient clinic | T: 90<br>I(a):n=30<br>23 males, 7 females<br>Mean age: 58.2(10.6)<br>I(b): n=30<br>20 males, 10 females<br>Mean age: 58.3 (8.5)<br>C: n=30<br>25 males, 5 females<br>Mean age: 61.1 (9.1) | I(a): 74 text messages on medication reminders and health-related education over 30 days<br><br>I(b): 14 text messages on educational materials only over 30 days | Social cognitive theory<br>1 month | Usual care | 1) Medication adherence |
| Pfaeffli et al., 2015[34]<br>New Zealand | 2-arm RCT<br>cardiac rehabilitation centre | T: 123<br>I: n=61<br>48 males, 13 females<br>Mean age: 59.0 (10.5)<br>C: n=62<br>52 males, 10 females<br>Mean age: 59.9 (11.8) | | Social Cognitive Theory<br>6 months | Usual care | 1) Smoking status<br>2) BMI<br>3) SBP & DBP<br>4) LDL-c<br>5) Medication adherence<br>6) Self-efficacy |

| | | | | | | |
|---|---|---|---|---|---|---|
| Quilici et al., 2013[25]<br>France | 2-arm RCT<br>outpatient clinic | T: 499<br>I: n=250<br>195 males, 55 females<br>Mean age: 64 (14)<br>C: n=249<br>187 males, 62 females<br>Mean age: 64 (10) | Text messaging on medication reminders | No theory<br>1 month | Usual care | 1) Medication adherence |
| Santo et al., 2018[35]<br>Australia | 3-arm RCT<br>hospital | T: 163<br>I: n=107<br>93 males, 77 females<br>Mean age: 56.8 (8.64)<br>C: n=56<br>50 males, 6 females<br>Mean age: 58.4 (9.04) | I(a): Basic smartphone application that includes non-interactive daily medication reminders<br><br>I(b): Advanced smartphone application that includes interactive daily medication reminders whereby participants can snooze or reschedule doses | No theory<br>3 months | Usual care | 1) SBP, DBP<br>2) LDL-c<br>3) Medication adherence |
| Varnfield et al., 2014[36]<br>Australia | 2-arm RCT<br>cardiac rehabilitation centre | T: 94<br>I: n=53<br>48 males, 5 females<br>Mean age: 54.9 (9.6)<br>C: n=41<br>34 males, 7 females<br>Mean age 56.2 (10.1) | Text messages on motivational and educational materials<br><br>Application with health diary, activity monitor, BP monitor and weight scale | No theory<br>6 months | Usual care | 1) Nutritional status<br>2) Functional capacity<br>3) SBP, DBP<br>4) Heart rate<br>5) LDL-c<br>6) HRQoL |

RCT: randomized controlled trial; T: Total number of participants; I: intervention group; C: control group; BP: blood pressure, SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; ECG: electrocardiogram; LDL-c: low-density lipoprotein cholesterol; HRQoL: health-related quality of life; MET: metabolic equivalent; HbA1c: glycohemoglobin; SMS: short message service; NR: not reported.

**Appendix 3. Delivery mode, supplementary tools and frequency of interventions**

| Author (Year) | Delivery mode | Supplementary tools | Frequency |
|---|---|---|---|
| Blasco et al., 2012[27] | SMS | BP machine, glucose and lipid meter, cellular phone | NR |
| Bravo-Escobar et al., 2017[28] | Smartphone app | Remote electrocardiographic monitoring device | ≥2 days per week |
| Chow et al., 2015[29] | SMS | | 4 per week |
| Fang & Li 2016 [26](a) | SMS | | NR |
| Fang & Li 2016[26](b) | SMS + Smartphone app | | NR |
| Johnston et al., 2016[30] | SMS + Smartphone app | | Daily |
| Khonsari et al.,2014[23] | SMS | | Daily |
| Lin et al., 2017[37] | SMS | | 4 per month |
| Maddison et al., 2018[31] | Smartphone app | Smartphone, chest-worn wearable sensor (HR, RR, single lead ECG, accelerometry) | 3 per week |
| Ni et al., 2018[32] | Smartphone app | | Daily |
| Pandey et al., 2017[24](c) | SMS | | NR |
| Pandey et al., 2017[24](d) | SMS | | 4 daily |
| Park et al., 2014[33](e) | SMS | | 74 over 30 days |
| Park et al., 2014[33](f) | SMS | | 14 over 30 days |
| Pfaeffli et al.,2015[34] | SMS | Website, pedometer | Weekly |
| Quilici et al., 2013[25] | SMS | | NR |
| Santo et al., 2018[35] | Smartphone app | | Daily |
| Varnfield et al., 2014[36] | SMS + Smartphone app | Smartphone with installed health diary, activity monitoring applications, BP monitor, weight scale | NR |

SMS: short message service; app: application; NR: not reported; BP: blood pressure; ECG: electrocardiogram; HR: heart rate; RR: respiratory rate; (a): intervention group A; (b) intervention group B; (c) medication adherence arm, (d) exercise adherence arm, (e) SMS on education and reminders, (f) SMS on education alone

**Appendix 4. Summary of mobile phone-based self-management components**

| Author (year) | Intervention Components | | | |
|---|---|---|---|---|
| | Education | Reminders | Self-monitoring | Feedback |
| Blasco et al., 2012[27] | | | ✓ | ✓ |
| Bravo-Escobar et al., 2017[28] | | ✓ | ✓ | |
| Chow et al., 2015[29] | ✓ | | | |
| Fang & Li 2016 [26](a) | ✓ | ✓ | | |
| Fang & Li 2016[26](b) | ✓ | ✓ | | |
| Johnston et al., 2016[30] | ✓ | ✓ | ✓ | |
| Khonsari et al.,2014[23] | | ✓ | | |
| Lin et al., 2017[37] | ✓ | ✓ | | |
| Maddison et al., 2018[31] | | | ✓ | ✓ |
| Ni et al., 2018[32] | ✓ | ✓ | | |
| Pandey et al., 2017[24](c) | | ✓ | ✓ | |
| Pandey et al., 2017[24](d) | | ✓ | ✓ | |
| Park et al., 2014[33](e) | ✓ | ✓ | | |
| Park et al., 2014[33](f) | ✓ | ✓ | | |
| Pfaeffli et al.,2015[34] | ✓ | | ✓ | |
| Quilici et al., 2013[25] | | ✓ | | |
| Santo et al., 2018[35] | | ✓ | | |
| Varnfield et al., 2014[36] | ✓ | | ✓ | ✓ |

✓ - yes; (a): intervention group A; (b) intervention group B; (c): medication adherence arm; (d) exercise adherence arm, (e): SMS on education and reminders; (f): SMS on education alone