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Review

Telehealth interventions for primary prevention of cardiovascular disease: A systematic review and meta-analysis

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ABSTRACT

Objective. To assess the effectiveness of telehealth interventions in the primary prevention of cardiovascular disease in adult patients in community settings.

Methods. Systematic literature review of randomised controlled trials comparing the effectiveness of telehealth interventions to reduce overall cardiovascular disease (CVD) risk and/or to reduce multiple CVD risk factors compared with a non-telehealth control group was conducted in June 2013. Study quality was assessed using the Cochrane Risk of Bias tool. Fixed and random effects models were combined with a narrative synthesis for meta-analysis of included studies.

Results. Three of 13 included studies measured Framingham 10-year CVD risk scores, and meta-analysis showed no clear evidence of reduction in overall risk (SMD −0.37%, 95% CI −2.08, 1.33). There was weak evidence for a reduction in systolic blood pressure (SMD −1.22 mm Hg 95% CI −2.80, 0.35) and total cholesterol (SMD −0.07 mmol/L 95% CI −0.19, 0.06). There was no change in High-Density Lipoprotein cholesterol or smoking rates.

Conclusion. There is insufficient evidence to determine the effectiveness of telehealth interventions in reducing overall CVD risk. More studies are needed that consistently measure overall CVD risk, directly compare different telehealth interventions, and determine cost effectiveness of telehealth interventions for prevention of CVD.

Contents

Introduction

Cardiovascular Diseases (CVDs[1]) are responsible for the largest burden of disease globally. The 2010 Global Burden of Disease study demonstrated that the burden of ischaemic heart disease and stroke has risen significantly since the first similar study in 1990. These conditions were ranked number one and three respectively for global Disability Adjusted Life Years (Vos et al., 2012), and remain the top two causes of mortality in the world (Lozano et al., 2012).

CVD commonly occurs as the result of a combination of risk factors; some are considered modifiable and some are non-modifiable. Modifiable CVD risk factors include hypertension, tobacco use, physical activity, excess alcohol consumption, poor diet, high serum triglycerides, low High-Density Lipoprotein (HDL) cholesterol, abdominal obesity, high serum blood glucose, and insulin resistance/diabetes (Cannon, 2007;

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[1] SMD — Standardised Mean Difference; BMI — Body Mass Index; SBP — Systolic Blood Pressure; DBP — Diastolic Blood Pressure; Chol — Cholesterol; HDL — High Density Lipoprotein; LDL — Low Density Lipoprotein; CHD — Coronary Heart Disease; CVD; Cardiovascular Disease; NICE — National Institute for Clinical Excellence.

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Mendis et al., 2011; World Heart Foundation, 2013). Non-modifiable risk factors include age, gender, and ethnicity (World Heart Foundation, 2013). Other risk factors that have been shown to have some effect on the risk of developing CVD include poverty, low education status, stress, depression, raised serum homocysteine levels, and raised C-reactive protein (Mendis et al., 2011).

It is widely accepted that a significant proportion of the burden of CVD is preventable (Mendis et al., 2011). In the United States of America (USA) alone, between 36 and 63% of myocardial infarctions and 20 and 31% of strokes could be prevented through risk factor reduction (Kahn et al., 2008). Franco (2010) has pointed out that the age-old adage that 'prevention is better than cure' has been extensively tested to determine which interventions are most effective and which are most cost effective (Capewell et al., 2000; Cobiac et al., 2012; Kabir et al., 2007; Unal et al., 2005; Young et al., 2010). Reducing the prevalence of risk factors has resulted in greater reductions in CVD-related mortality compared to pharmacological treatments for acute events and secondary prevention.

Telehealth has gained interest recently for its potential to deliver preventive care in a wide range of settings. Examples of telehealth interventions include telephone quit lines for cigarette smokers (Sood et al., 2009), telemonitoring devices for blood pressure in patients' homes (Hodgkinson et al., 2011), and interactive online food and exercise diaries or tailored mobile phone text messages for weight loss (Maon et al., 2012; Woolford et al., 2010). Researchers have also begun assessing the effect of mobile devices in disease prevention (Pellegrini et al., 2012).

There are a number of systematic reviews assessing the effect of telehealth interventions on individual CVD risk factors, particularly in the areas of hypertension (AbuDagga et al., 2010; Hodgkinson et al., 2011; Jaana et al., 2007; Pare et al., 2007), tobacco use (Chen et al., 2012; Mottillo et al., 2008; Stead et al., 2009; Whittaker et al., 2012) and obesity (Bacigalupo et al., 2012; Cohen et al., 2012; Khaylis et al., 2010; Wieland et al., 2012). However, risk factors for CVD should not be considered in isolation since it is the combination of factors that determine a person's risk of CVD (D'Agostino et al., 2008). Similarly, since many people with high CVD risk have multiple risk factors, it seems appropriate to design interventions addressing all of their modifiable risks.

Arguably, the most important outcomes are a reduction in CVD risk and lower mortality. Neubeck et al. (2009) conducted a systematic review of the effectiveness of telehealth interventions in the secondary prevention of coronary heart disease and showed some evidence of lower all-cause mortality and reduction in multiple CVD risk factors. However, there appears to be no previous reviews of the evidence for telehealth interventions to reduce overall CVD risk in disease-free individuals (primary prevention).

Methods

Selected databases (MedLine via OVID, Embase Classic via OVID, Web of Science via Thomson Reuters, CINAHL Plus via EBSCOhost, PsycINFO via OVID, SCOPUS via SciVerse, BioMed Central, PLoS, and the Cochrane Library via Wiley Online) were searched between June 11th and June 26th 2013. Key search terms were utilised for each database using Boolean operators, and combined with MeSH or subject terms specific to each database identified from initial search hits (See example in Table 1). Randomised controlled trial search filters created by the Scottish Intercollegiate Guidelines Network (SIGN) were utilised to refine searches in MedLine and Embase (http://www.sign.ac.uk/methodology/filters.html#random). Citation searching was also performed via Web of Science.

Registers of incomplete systematic reviews and clinical trials (DARE [Database of Abstracts of Reviews of Effects], PROSPERO, ClinicalTrials.gov, and Current Controlled Trials) were searched utilising the key search terms. Reference lists of included papers were scanned by title for potentially relevant studies.

All search hits were assessed by title and abstract against the eligibility criteria. Trials utilising real-time or asynchronous telehealth interventions delivered to patients in at least one arm of the study to reduce overall CVD risk and/or addressing multiple (i.e. more than one) CVD risk factors were included. Studies were limited to those focused on adults (aged 18 years and above), with no history of CVD, based in the community. Non-randomised and observational studies were excluded in order to ensure that the best available evidence was used in the analysis. Studies of hospital inpatients, interventions only delivered in a clinic setting, decision support systems for clinicians, and interventions delivered between health services (not focused on patients) were excluded from this review. Unpublished studies and grey literature were not included. Articles published in a language other than English were noted in the search but excluded from the review. No restrictions were placed on date of publication.

Change in overall CVD risk was the primary outcome of interest in this review. A number of CVD risk scores have been created and validated (Conroy et al., 2003; D'Agostino et al., 2008; Hippisley-Cox et al., 2008; Mendis et al., 2011; Woodward et al., 2006). Current guidelines for CVD prevention are not consistent in their recommendations of which CVD risk score to utilise in practice (NICE, 2010; Pearson et al., 2002; Perk et al., 2012; WHO, 2007). Therefore, a pre-specified risk score was not set for study inclusion. Similarly, specific CVD risk factor measures were not set as part of the eligibility criteria given the significant number of modifiable CVD risk factors that exist and the wide range of outcome measures used for each one.

The primary researcher (SM) and a second reviewer (VA) assessed search hits against the eligibility criteria independently. If inclusion/exclusion of a particular study was unclear or there was disagreement between reviewers, the full article was assessed and a decision was made by consensus.

The Cochrane Risk of Bias tool was selected to assess the methodological quality of the included papers. This assessment tool is designed specifically for clinical trials and is most appropriate for this review question on effectiveness of telehealth interventions. The quality assessment was performed at the individual study level only.

Data were extracted by the primary researcher (SM) and second reviewer (VA) using a standardised form that was developed based on two guides for systematic reviews (CRD, 2008; Higgins and Green, 2011). The form was trialled with a sample of selected papers to allow iterative refinement. Data were extracted from the published articles in the following areas; Study characteristics, Participants, Intervention, Primary outcome, Secondary outcome(s). Results of the independent data extraction were directly compared to ensure accuracy of data collection. Where insufficient data was reported to perform the meta-analysis, study authors were contacted to request the relevant data.

Statistical methods for meta-analysis

Data relating to changes in overall CVD risk and individual CVD risk factors in each study were converted into standard international units, allowing the standard mean difference (SMD) between intervention and control groups to be determined. Analysis of individual CVD risk factors was limited to modifiable risk factors that are consistently used in overall CVD risk scores. Fixed and random effects models were used to generate an overall estimate of the effect of the interventions on CVD risk and the individual risk factors. Study heterogeneity was assessed using the Chi^2 test and I^2 statistic, with an I^2 greater than 70% being considered a high level of heterogeneity. Random-effects modelling was used in the case of high heterogeneity, and fixed-effects modelling was used when heterogeneity was low. Continuous variables were presented as the difference in the means whilst dichotomous variables were summarised using odds ratios, both with 95% confidence intervals. The meta-analysis was conducted using Review Manager 5.2.5 (The Nordic Cochrane Centre, 2012).

Results

The search for relevant studies in bibliographic databases, trial and review registries, and through citation searching returned 2268 hits. After removing duplicates, and applying the inclusion and exclusion criteria, 13 studies were included in this review. See Fig. 1 for a full breakdown of study selection.

The 13 included studies are summarised in Table 2. They featured a diverse range of participants, with sample sizes ranging from 146 to 3382, for a total of 10,057 study subjects. 41.38% of participants were male, with a mean age of 55.51 years. Reporting of other demographic characteristics was highly variable across all included studies, and

Table 1
Medline RCT search strategy from INTERTASC with key search terms 11/06/13.

Study	Sequence generation	Allocation concealment	Blinding participants & personnel	Blinded outcome assessment	Incomplete outcome data	Selective outcome reporting	`Other issues´
Bennett et al. (2011)	?	?	–	–	–	–	–
Bove et al. (2011)	+	?	–	?	–	+	+
Broekhuizen et al. (2012)	+	+	–	?	+	+	+
Claes et al. (2013)	–	+	?	?	+	+	?
Cook et al. (2007)	?	?	–	?	+	+	+
Dekkers et al. (2011)	+	+	–	?	–	+	–
Nolan et al. (2012)	+	+	+	+	–	+	–
Nolan et al. (2011)	+	+	+	?	+	+	+
Ruffin et al. (2011)	?	?	–	?	+	+	+
Sone et al. (2010)	+	?	–	?	–	+	+
Verheijden et al. (2004)	+	+	+	+	+	?	–
Wakefield et al. (2011)	–	+	?	?	–	+	+
Wister et al. (2007)	+	+	–	+	–	+	–

completely absent from three articles. Seven studies recruited participants through GP or specialist clinics; four trials recruited through the workplace; and the remaining studies gathered subjects through Health Maintenance Organizations, Veterans Affairs departments or the community. Follow-up periods for participants ranged from 3 to 96 months, however only three trials followed the participants for more than 12 months (Sone et al., 2010; Dekkers et al., 2011; Claes et al., 2013).

The trials included in this review used a broad selection of outcome measures (see Table 2), and the various studies utilised between 2 and 14 of these measures. Four studies reported a measure of overall CVD risk (Bove et al., 2011; Claes et al., 2013; Nolan et al., 2011; Wister et al., 2007), with three of these studies using the Framingham 10-year CVD risk score (Bove et al., 2011; Nolan et al., 2011; Wister et al., 2007) and one using SCORE overall CVD mortality risk charts (Claes et al., 2013).

The methodological quality of included trials was assessed using the Cochrane Risk of Bias tool. Study quality varied markedly between studies and between different domains of the quality assessment. The majority of studies were assessed as being of moderate quality, with low risk of bias in three to five of the seven domains within the tool. However, incomplete reporting of outcome measures was a common problem and reporting on the blinding of participants and outcome assessors was particularly poor (see Table 3).

Impact on CVD risk

Four of the included studies measured overall CVD risk (Bove et al., 2011; Claes et al., 2013; Nolan et al., 2011; Wister et al., 2007). Bove et al. (2011) compared a nurse management CVD risk reduction programme augmented with telemedicine communication to nurse management alone, in medically underserved urban and rural communities. The mean baseline Framingham CVD risk was relatively high in both study groups (17.50 vs. 17.80), and after 12 months of follow-up the intervention (−2.50 95% CI −3.38, −1.61 $p < 0.05$) and control (−2.70 95% CI −3.74, −1.68 $p < 0.05$) groups had a similar reduction in overall risk.

The study by Nolan et al. (2011) assessed the effects of a telehealth protocol using motivational interviewing on CVD risk factors for patients with existing diabetes or CHD, a Framingham 10-year absolute risk for CHD >20%, or two or more modifiable CVD risk factors. Subgroup analysis of the participants without a history of CHD showed significant small reductions in Framingham 10-year CVD event risk for both the exposed (−1.12 95% CI −0.36, −1.88) and active control (−1.77 95% CI −0.89, −2.65) groups, with no statistically significant difference between the groups in adjusted analyses (0.65 95% CI −0.53, 1.83 $p = 0.28$).

Wister et al. (2007) also utilised a telehealth counselling approach to deliver a 'Heart health report card system'. This study showed a significantly greater reduction in Framingham risk score in the intervention arm when compared to the control arm (difference = −1.97, 95% CI −2.85, −1.09 $p = 0.002$).

One included trial, by Claes et al. (2013), utilised the European Society of Cardiology SCORE charts to assess 10-year risk of CVD mortality. This study evaluated the effect of a Medical + Lifestyle Programme, consisting of a CVD risk profile and personalised lifestyle follow-up via a website, email and phone, to a medical programme comprising just the CVD risk profile. Both groups had a small reduction in the mean overall risk (−0.002 and −0.004 respectively), and the difference between the groups was not statistically significant ($p = 0.33$, confidence intervals not reported).

Combining the data from the three studies that used the Framingham 10-year CVD risk score in a random effects model showed no evidence for a reduction in CVD risk (SMD −0.35, 95% CI −1.97, 1.27) in the telehealth intervention groups compared to controls. Random effects modelling was chosen given the high level of study heterogeneity (see Fig. 2).

Impact on modifiable CVD risk factors

Eight studies measured systolic blood pressure at baseline. Four studies found a significantly greater reduction in systolic blood pressure in the intervention groups when compared to the control groups (Bove et al., 2011; Dekkers et al., 2011; Nolan et al., 2011, 2012). The trial by (Dekkers et al. 2011) featured two telehealth treatment arms, one delivered via telephone and the other via the Internet. Summarising all included studies using a random effects model suggests that multi-focal telehealth interventions possibly have a small effect on reducing systolic blood pressure (SMD −1.22 mm Hg, 95% CI −2.80, 0.35) (see Fig. 3).

Six studies included in the review assessed total cholesterol. Three of the trials demonstrated a small but statistically significant

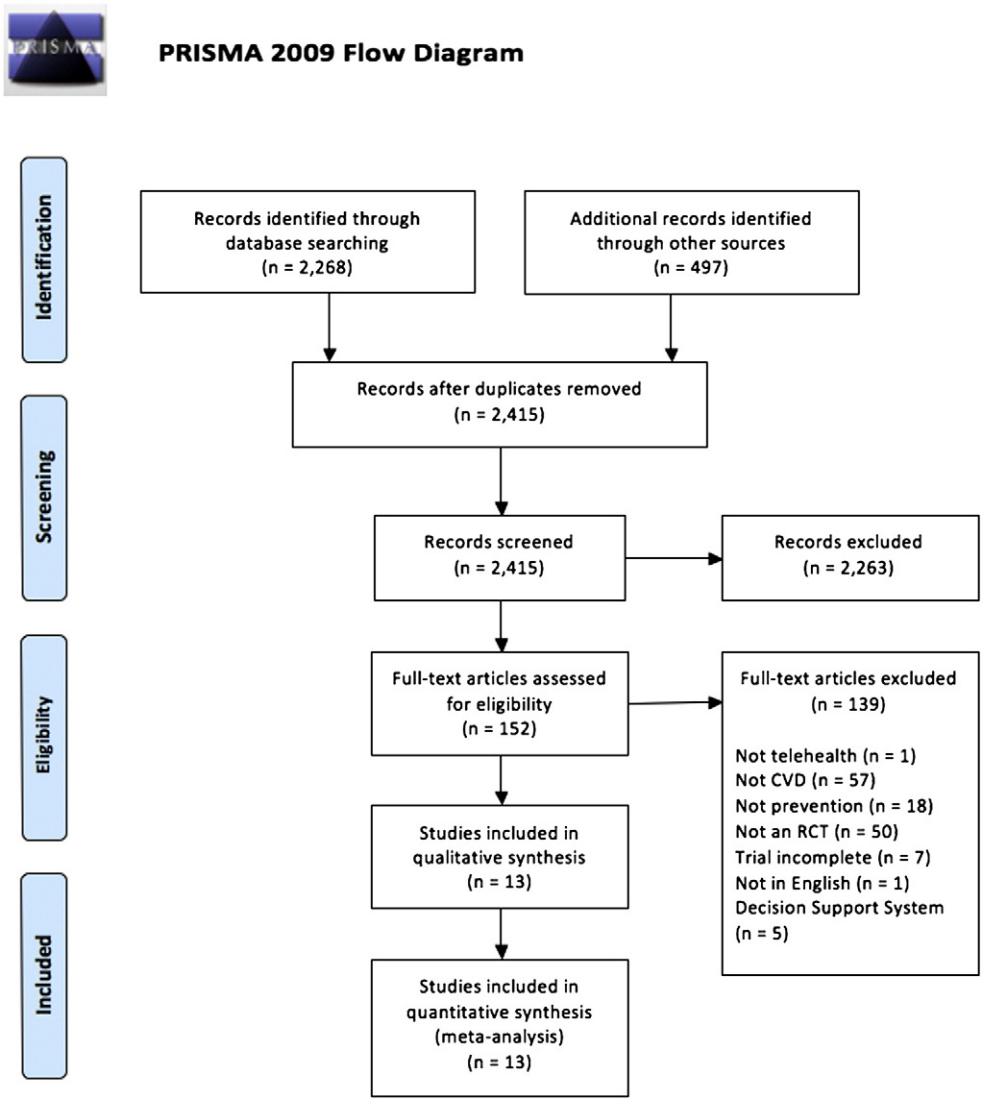

Fig. 1. PRISMA Study selection flow diagram (65).

reduction in total cholesterol when the telehealth intervention groups were compared to control groups (Dekkers et al., 2011; Nolan et al., 2012; Wister et al., 2007). Overall, random effects modelling showed that these telehealth interventions reduced total cholesterol by 0.07 mmol/L (95% CI −0.19, 0.06). See Fig. 4 for full meta-analysis results.

In this review, four studies measured HDL cholesterol. None of the individual studies demonstrated a greater increase, if any, in the participants receiving telehealth interventions compared to their controls. Consequently, random effects modelling (see Fig. 5) suggests that these interventions did not affect HDL cholesterol levels (SMD −0.01 mmol/L, 95% CI −0.03, 0.02).

Four included trials measured participants' smoking status at baseline. There was no significant reduction in the number of current smokers in any of the relevant included trials. Study heterogeneity was very low for smoking, so a fixed effects model was employed (see Fig. 6). The odds ratio for smoking after receiving a telehealth intervention compared to no intervention was 1.09 (95% CI 0.82, 1.44).

Meta-analyses and summary of other modifiable CVD risk factors measured in the included trials were not performed due to lack of consistent inclusion in overall CVD risk score calculations, or the inability to convert reported outcomes into single measures for comparison and analysis.

Discussion

This systematic review sought to evaluate the evidence for the effectiveness of telehealth interventions that address multiple CVD risk factors in the primary prevention of cardiovascular disease. To date, this appears to be the only published systematic review that addresses this research question. We identified 13 trials that measured the impact of telehealth interventions on overall CVD risk and/or multiple CVD risk factors. Meta-analyses showed that these types of interventions have no effect on reducing overall CVD risk or cigarette smoking, or increasing HDL cholesterol. There was weak evidence of a small reduction in systolic blood pressure and total cholesterol.

The findings of this study need to be considered in the context of existing evidence for telehealth interventions. Several reviews have been conducted assessing the impact of telemonitoring and telemedicine programmes on blood pressure alone. Studies by Verberk et al. (2011), AbuDagga et al. (2010), and Pare et al. (2007) concluded that telehealth interventions can reduce systolic blood pressure, however there may be some publication bias in this field (Wootton, 2012). Four systematic reviews, including two Cochrane reviews, summarised the evidence for telephone counselling (Mottillo et al., 2008; Stead et al., 2009), mobile phone messaging (Whittaker et al., 2012), computer and other electronic aids (Y.-F. Chen et al., 2012) for smoking cessation;

Table 2
Summary of included studies addressing changes in overall CVD risk and/or multiple CVD risk factors. Age presented in years as mean +/− SD or range (low–high). SMD — Standardised Mean Difference; BMI — Body Mass Index; SBP — Systolic Blood Pressure; DBP — Diastolic Blood Pressure; Chol — Cholesterol; HDL — High Density Lipoprotein; LDL — Low Density Lipoprotein; CHD — Coronary Heart Disease.

Author	Participants	Intervention	Follow-up	Comparison	Outcome measures
Bennett et al. (2011)	145 managers from eight US organisations	Internet-based training programme	6 months	Normal daily activities	Dietary attitudes & beliefs, exercise participation & beliefs, mental health symptom frequency & beliefs, weight, waist circumference, BMI, body fat%
Bove et al. (2011)	465 participants from medically underserved and rural areas (USA)	Nurse management of CVD risk factors with telemedicine communication	12 months	Nurse management of CVD risk factors	Framingham 10 year CVD event risk, waist circumference, BMI, SBP, DBP, total Chol, HDL Chol, LDL Chol, triglycerides, blood glucose, HbA_{1c}, smoking
Broekhuizen et al. (2012)	340 Dutch adults with Familial Hypercholesterolaemia	Personalised health counselling, using computer-generated tailored advice and face-to-face counselling complemented by telephone booster sessions	12 months	Usual care	LDL Chol, HDL Chol, total Chol, triglycerides, SBP, serum glucose, BMI, waist circumference
Claes et al. (2013)	314 self-employed lawyers in Belgium	Personalised online and one-to-one coaching via mail, email, telephone and face-to-face. Printed profile with individual risk factors and total CVD risk. Annual multidisciplinary screening.	3 years	Printed profile with individual risk factors and total CVD risk. Annual multidisciplinary screening.	SCORE 10 year fatal CVD risk, SBP, DBP, Total Chol, BMI, physical fitness (HR in recovery post exercise)
Cook et al. (2007)	419 US human resource company employees	Comprehensive multimedia health promotion programme	3 months	Commercially available booklets	Eating practices & attitudes, stress management, physical activity
Dekkers et al., 2011	276 healthy overweight employees of Dutch companies	Distance-counselling lifestyle intervention programme via phone or internet, called 'Leef je Fit' ('Live yourself Fit'). Also received self-help materials.	2 years	Self-help materials	Body weight, waist circumference, sum of skinfolds, SBP, DBP, total Chol
Nolan et al. (2012)	387 hypertensive patients (Canada)	e-Counselling with motivational messaging	4 months	Usual care and e-newsletter	SBP, DBP, pulse pressure, total Chol
Nolan et al. (2011)	680 participants at high risk of CVD or history of CAD (Canada)	Small group lifestyle counselling via teleconference. Written summary of CVD risk factor profiles with brief advice and educational handouts.	6 months	Written summary of CVD risk factor profiles with brief advice and educational handouts.	Framingham 10 year CVD risk, SBP, DBP, Total Chol:HDL Chol
Ruffin et al. (2011)	3382 participants in Family Healthware Impact Trial (USA)	Interactive online tool for family history of six common diseases (including CHD and stroke). Provides risk assessment and tailored preventive health messages.	6 months	Standard prevention messages for common diseases of interest	Smoking, fruit and vegetable intake, physical activity, BP measurement, Chol measurement, blood glucose measurement
Sone et al., 2010	2033 Japanese type 2 diabetes patients	Individual telephone counselling sessions every two weeks	8 years	Usual care	Incidence of macrovascular and microvascular complications, BMI, SBP, DBP, fasting plasma glucose, HbA_{1c}, total Chol, triacylglycerol, HDL Chol, lipoprotein, food energy intake, exercise, smoking
Verheijden et al. (2004)	146 general practice patients with chronic diseases (Canada)	Self-assessment tool for stage of behaviour change, providing targeted information packages.	8 months	Usual care	BMI, SBP, DBP, total Chol, HDL Chol, LDL, Chol, triglycerides
Wakefield et al. (2011)	302 US war veterans with hypertension and diabetes	Home telehealth device for BP and blood glucose data input. High-intensity group received prompts from pre-programmed branching disease management algorithm. Low-intensity group received automated responses from device.	12 months	Usual care	HbA_{1c}, SBP
Wister et al. (2007)	611 patients at high risk of CVD or history of CHD (Canada)	Health report card, with telehealth counselling follow-up sessions.	12 months	Usual care	Framingham 10 year CVD risk, Framingham global risk score, total Chol, HDL Chol, glucose, SBP, smoking, physical activity, BMI

all finding significantly higher rates of abstinence from smoking in the experimental groups. Neubeck et al. (2009) performed a review of telehealth interventions in the secondary prevention of CHD. Similar to the findings of this study, they found that telehealth interventions resulted in lower total cholesterol, however the effect was larger and statistically significant. The review also found evidence that telehealth interventions increased HDL cholesterol and lowered systolic blood pressure, smoking rates, and BMI.

There are a number of possible reasons why this review failed to find any major effect for primary prevention telehealth interventions. The reviews that focused on individual CVD risk factors may have shown positive findings because of the quality of the included trials and the use of more appropriate methods, or it could be that the effect of an intervention is diluted when addressing multiple CVD risk factors. The vast majority of studies included in this review had follow-up periods of 12 months or less, possibly affecting their ability to detect a true difference. The review by Neubeck et al. (2009) focused on the prevention of further CVD in patients who had a history of AMI or stroke, and this patient group may respond to lifestyle interventions differently when compared to individuals at-risk of CVD with no past history.

The WHO, the American Heart Association, the National Institute for Clinical Excellence (NICE) in the UK, and the European Society of Cardiology all recommend the use of different validated tools for assessing the CVD risk in individuals (NICE, 2010; Pearson et al., 2002; Perk et al., 2012; WHO, 2007). This lack of consensus is perhaps reflected in the paucity of telehealth intervention studies assessing overall CVD risk, and the fact that two different tools were used in the four studies that did measure CVD risk. The absence of clear evidence regarding the impact of telehealth interventions in the primary prevention of CVD is probably due in part to this low number of studies assessing

Table 3
Cochrane Risk of bias assessment, + = low risk of bias, − = high risk of bias, ? = unknown risk of bias.

Study	Sequence generation	Allocation concealment	Blinding participants & personnel	Blinded outcome assessment	Incomplete outcome data	Selective outcome reporting	`Other issues´
Bennett et al. (2011)	?	?	–	–	–	–	–
Bove et al. (2011)	+	?	–	?	–	+	+
Broekhuizen et al. (2012)	+	+	–	?	+	+	+
Claes et al. (2013)	–	+	?	?	+	+	?
Cook et al. (2007)	?	?	–	?	+	+	+
Dekkers et al. (2011)	+	+	–	?	–	+	–
Nolan et al. (2012)	+	+	+	+	–	+	–
Nolan et al. (2011)	+	+	+	?	+	+	+
Ruffin et al. (2011)	?	?	–	?	+	+	+
Sone et al. (2010)	+	?	–	?	–	+	+
Verheijden et al. (2004)	+	+	+	+	+	?	–
Wakefield et al. (2011)	–	+	?	?	–	+	+
Wister et al. (2007)	+	+	–	+	–	+	–

the overall CVD risk. There is also a growing range of modes of delivery for telehealth interventions as technology advances, as reflected in the different interventions tested in the included trials. In this review, a comparison of the relative effectiveness of different methods of delivery was not possible given that only the study by Dekkers et al. (2011) compared two different telehealth interventions (online vs telephone).

Study strengths and limitations

This review was conducted in a systematic manner, following strict protocols guided by the Cochrane Collaboration (Higgins and Green, 2011), the PRISMA statement (Moher et al., 2009), and the Centre for Reviews and Dissemination (2008). This review also followed the approach of the Cochrane Collaboration by only including the randomised controlled trials and clinical controlled trials in systematic reviews of interventions, in an attempt to obtain the highest level of evidence. Two reviewers independently performed the literature search and data extraction, reducing the likelihood of errors in the conduct of the review. The samples of patients selected for the included studies varied in their age, gender and socio-economic status. Whilst this may reduce the comparability of results between studies, it may also increase the external validity of the review.

This review also has some limitations. The exclusion of non-randomised trials, unpublished studies, and articles not published in English could have introduced publication bias. Methods for assessing for publication bias, such as generating funnel plots, were not employed as they are of relatively low yield in reviews with high study heterogeneity and less than ten studies contributing data to each primary outcome (CRD, 2008). All included trials were conducted in high-income

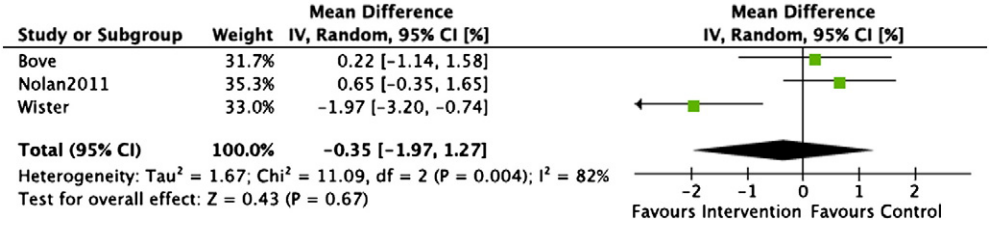

Fig. 2. Random effects modelling of differences in Framingham 10-year CVD risk between intervention and control groups, CI = confidence interval.

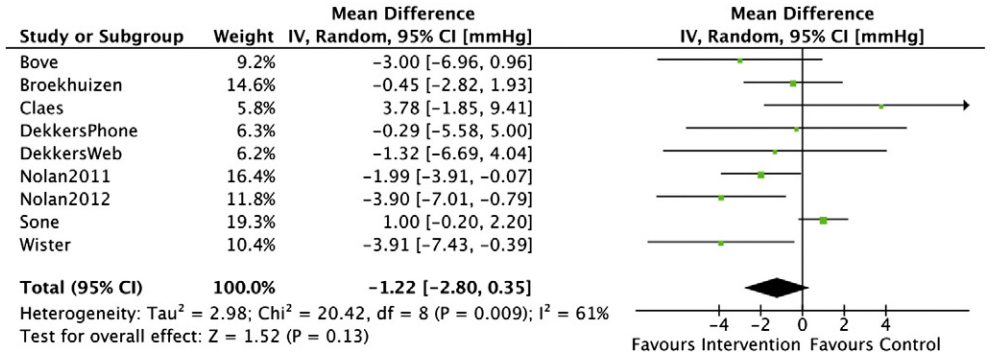

Fig. 3. Random effects modelling of differences in SBP between intervention and control groups, CI = confidence interval.

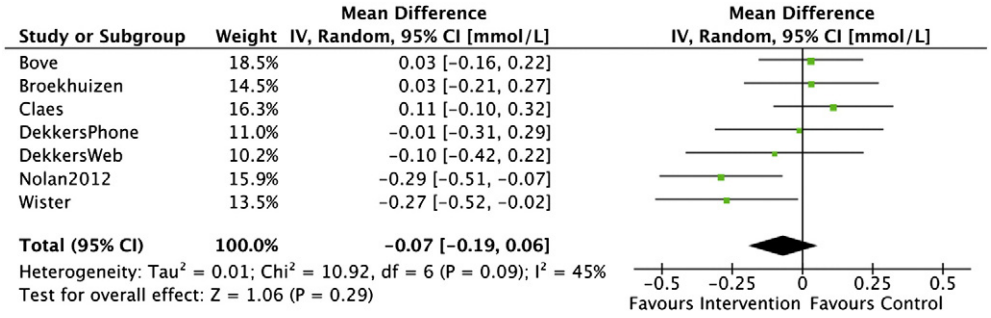

Fig. 4. Random effects modelling of differences in total cholesterol between intervention and control groups, CI = confidence interval.

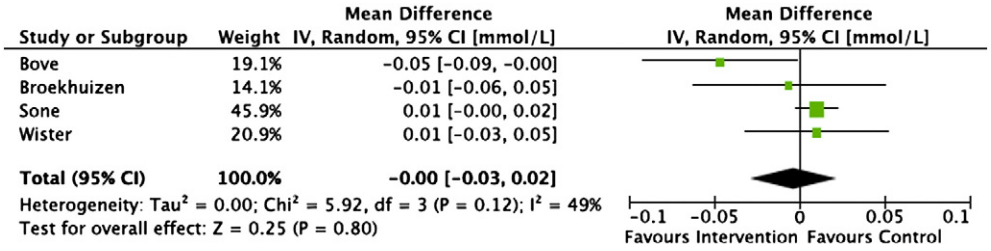

Fig. 5. Random effects modelling of differences in HDL cholesterol between intervention and control groups, CI = confidence interval.

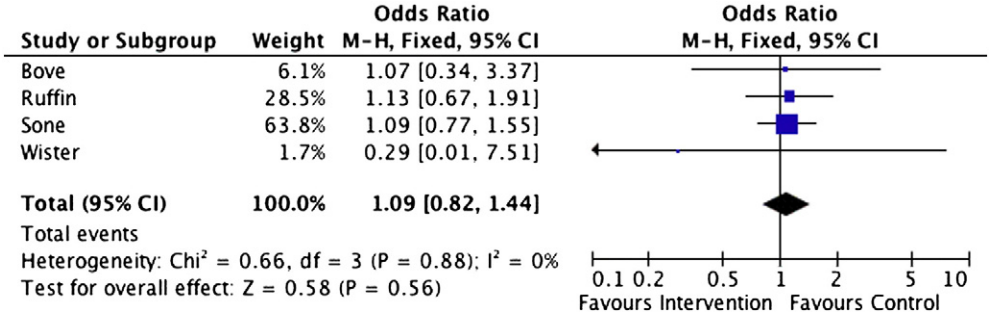

Fig. 6. Fixed effects modelling of odds of smoking in intervention and control groups, M–H = Mantel–Haenszel, CI = confidence interval.

countries: the USA, Canada, Belgium, The Netherlands or Japan. Thus, the generalisability of these findings to low- and middle-income countries is limited. There was no set minimum standard for study quality in assessing eligibility, resulting in the inclusion of some potentially low quality studies. Some of these were inadequately analysed or reported, for example, not reporting 95% confidence intervals or making between-group comparisons.

Conclusion

Telehealth is an evolving field of health research, and it may have potential as an approach to addressing the significant global challenge of combating the rising burden of non-communicable diseases. There is some evidence suggesting that telehealth interventions may be effective in reducing specific individual risk factors for CVD, however this review has not found strong evidence for the effectiveness of multifactorial intervention programmes delivered via telehealth in terms of primary prevention. An agreed, standard overall CVD risk tool is needed in future telehealth trials to measure and report the effect, if any, of these interventions on primary prevention of CVD, and more studies need to compare the effect of various forms of telehealth interventions to determine whether telehealth has a role in improving the health of populations.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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