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Long-term effects of eHealth secondary prevention on cardiovascular health: A systematic review and meta-analysis

Abstract

Aim

Despite the well-documented short to medium-term effectiveness of eHealth (electronic health) secondary prevention interventions on patients with cardiovascular disease (CVD), there is limited empirical evidence regarding long-term effectiveness. This review aims to evaluate the long-term effects of eHealth secondary prevention interventions on the health outcomes of patients with CVD.

Methods and results

This systematic review and meta-analysis followed *Cochrane Handbook for Systematic Reviews of Interventions*. EMBASE, Medline, Web of Science, and Scopus were searched from 1990 to May 2022. Randomized controlled trials investigating the effects of eHealth secondary prevention on health outcomes of CVD patients that collected end-point data at ≥ 12 months were included. RevMan 5.3 was used for risk of bias assessment and meta-analysis. Ten trials with 1,559 participants were included. Data pooling suggested that eHealth programs have significantly reduced low-density lipoprotein cholesterol (LDL-C) [n = 6; SMD= -0.26, 95%CI (-0.38, -0.14), I^2=17%, p<.001]; systolic blood pressure [n=5; SMD= -0.46, 95% CI, (-0.84, -0.08), I^2=90%, p=0.02]; and, re-hospitalization, reoccurrence, and mortality [RR= 0.36, 95% CI [0.17, 0.77], I^2 = 0%, p = .009]. Effects on behavioral modification, physiological outcomes of body weight and blood glucose, and quality of life were inconclusive.

Conclusion

eHealth secondary prevention is effective in improving long-term management of risk factors and reducing the reoccurrence of cardiac events in patients with CVD. Results are inconclusive for behavior modification and quality of life. Exploring, implementing and strengthening strategies in eHealth secondary prevention programs that focus on maintaining behavior changes and enhancing psychosocial elements should be undertaken.

Registration

PROSPERO CRD42022300551

Keywords: cardiovascular disease, eHealth, secondary prevention, long-term, meta-analysis,

1. Introduction

Cardiovascular disease is the leading cause of morbidity and mortality globally, and is related to a significant increase in healthcare costs.[1] The current incidence of CVD is approximately 470 million with about 17.9 million CVD-related deaths worldwide.[2] The incidence of CVD is related to a combination of behavioral and metabolic risk factors. A majority are preventable by modifying unhealthy behaviors such as tobacco use, physical inactivity, unhealthy diet, psychological distress, and alcohol abuse.[2] Secondary prevention is indispensable in augmenting first-line treatment by improving the underlying cause of CVD and optimizing the biopsychosocial condition of patients to restore health.[3] Secondary prevention programs comprised of behavior modification, medication adherence, disease management, and psychosocial support, which play a pivotal role in reducing modifiable CVD risk factors and improving quality of life (QoL).[4] Despite the clinical benefits, participation in and adherence to secondary prevention interventions by patients with CVD are suboptimal.[5] Only one-third of patients with CVD attend some form of secondary prevention program, and accessibility and a fragmented care system are the main issues for non-participation.[6] This underpins the need to develop alternative models for the provision of secondary prevention, such as e-Health initiatives where patients access services at their discretion.[5]

Electronic health (eHealth) evolved as a generic term referring to the use of information and communication technology for health purposes, including electronic medical and health records, telemedicine and mobile health (mHealth).[7] eHealth has grown exponentially for disease management, which allows services and information (e.g., voice, data, images) delivered or promoted through the Internet and other related technologies (e.g., mobile devices).[8,9] Electronic platforms enable service access with minimal geographical and time barriers by using technologies such as cellphones/mobile phones, the Internet, and wearable sensors (e.g., heart rate meters).[10] Such modes permit patients to access and receive educational information, learn skills, upload in-the-moment data (e.g., exercise), receive automatic feedback, and obtain ongoing social support.[11,12] These technologies also enable personalization by enabling individualized settings, progress tracking, and real-time feedback.[10,13,14]

There is growing evidence regarding the effect of eHealth interventions to improve the health outcomes of patients with CVD. Two systematic reviews on eHealth interventions described the use of an Internet-based[15] or smartphone-based platform,[16] for secondary prevention of CVD. By conducting narrative synthesis, the smartphone-based interventions showed a higher rate of participant engagement, adherence, and acceptance.[16] For the Internet-based interventions, the meta-analysis showed no significant effects on lifestyle behaviors, mortality, and physiological parameters, including blood pressure (BP), cholesterol, and body weight.[15] Another meta-analysis of randomized controlled trials (RCTs) regarding eHealth indicated a significant reduction in hospitalizations and increased physical activity at three to six months after intervention but no improvement in physiological parameters.[11] One systematic review and meta-analysis looked at the cost-effectiveness of eHealth interventions in managing CVD and supported the notion that eHealth significantly reduces healthcare costs.[17] Moreover, two systematic reviews found that information on health consequences/benefits, goal setting, self-monitoring, and social support was critical features in eHealth interventions that significantly promoted behavior change and disease management.[11,18]

However, there is a lack of systematic review examine the long-term effect (end-point data collected at $\geq$ 12 months) [19] of secondary prevention eHealth interventions for patients with CVD. Previous review included most original studies with intervention duration at six month or less. Some physiological and clinical outcomes (i.e., lipid profile, HbA1c, weight reduction) take time for significant positive change to become apparent.[11,20] Clinically, about 26.6% of patients post cardiovascular event experienced a recurrence in their condition within one year, which requires maintainable benefits for secondary prevention interventional programs.[21] This review focused on multiple CVD, heart disease and stroke, with a shared emphasis on promoting healthy lifestyle patterns, reducing risk factors for disease progression, and decreasing the impact of CVD on quality of life, morbidity, and mortality.[22] Additionally, there is limited understanding of crucial eHealth intervention components to boost/encourage self-directed use over time.[10,23,24] Therefore, this systematic review and meta-analysis of RCTs aim to investigate the long-term effect of eHealth secondary prevention interventions on the health outcomes of patients with CVD.

2. REVIEW

2.1 Design

This review was guided by the Cochrane Handbook for Systematic Reviews of Interventions (Cochrane Collaboration, Oxford, UK) and presented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[25] The systematic review protocol was registered in PROSPERO (CRD42022300551).

2.2 Eligibility criteria

The Populations, Interventions, Comparisons, Outcomes, and Study designs (PICOS) framework was used to guide eligibility criteria. The inclusion criteria were: (1) P: people with medical diagnosis of CVD, acute (unstable) to chronic (stable) phase; (2) I: intervention group received eHealth secondary prevention intervention (assessment, monitoring, health education, and disease prevention) using tele-monitoring devices, the Internet, and technologies such as a landline telephone; (3) C: usual care, waitlist, placebo, or other active control (i.e., telephone follow up), (4) O: results measured at one year or later that focused on healthy behaviors, physiological risk parameters (e.g., lipid profile), or clinical outcomes (e.g., reoccurrence, re-hospitalization, and mortality); and (5) S: RCT. Only RCT studies were included to generate the best evidence.[26] Studies that collected end-point data for 12 months or longer were eligible.

The exclusion criteria were as follows: (1) quasi-experimental, qualitative, or case studies; (2) sample size of less than 30 as a low statistical power reduces the chance of detecting a true intervention effect;[27] (3) studies that provided assistive devices to stroke patients for the lack of self-directed disease management; (4) conference abstracts; and (5) unavailable full-text even after contacting the authors.

2.3 Search methods

A comprehensive search was conducted in four databases: Embase (1910-), Medline (1946-), Web of Science (1956-), Scopus (1823-), from January, 1990 to May 2022, using the PICOS framework as eHealth secondary preventions are relatively new and it also coincided with the global introduction of the world wide web (the Internet). A hand search of bibliographical references from relevant reviews was conducted to detect additional studies. Medical Subject Headings (MeSH) terms were used, including "coronary disease*" OR "coronary heart disease*" OR "coronary artery disease*" OR "heart disease*" OR "cardiovascular disease*" OR angina OR "acute coronary syndrome" OR stroke OR "heart disease*" OR "cerebrovascular disease " OR chd OR cvd* OR "myocardial infarction" OR "myocardial ischemia" AND "cell phones" OR "mobile phones" OR "smart phones" OR "mobile devices" OR "telemedicine" OR "telehealth" OR "ehealth" OR "e-health" OR "mhealth" OR "m-health" OR "mobile application*" OR web OR computer OR "information technology" OR digital OR technology AND "secondary prevention" OR "self-management" OR rehabilitation OR "health education" OR "health promotion" OR "health teaching". The search strategy for Scopus and Embase is presented in Supplementary 1.

2.4 Study selection

Endnote software was used to remove duplicates, and two reviewers (JJS & SSW) independently reviewed and selected studies from the initial title and abstract screening to the full-text review. Any disagreement on study inclusion was resolved by discussing it with a third researcher (JL).

2.5 Study quality and risk of bias

Methodological quality was assessed independently by two researchers (JJS and DC) using the Cochrane risk of bias tool 2.0. Study quality was assessed with regard to selection bias, performance bias, attrition bias, detection bias, reporting bias, and intention to treat analysis.[28] Risk of vias was judged as unclear, low, or high when data were insufficient or uncertain. The funnel plots were not conducted due to an inadequate number of studies.

2.6 Data extraction

All study data were extracted independently by two authors (JJS &SSW) and any disagreement in interpretation of data was resolved by a third author (JL). The authors developed a table to extract data, including: (a) origin of the articles: authors, year, and country; (b) sample characteristics: sample size, setting, age, and diagnosis; (c): group design: brief description of intervention and control group, (d) assessment time point, (e) health outcomes and instruments, and (f) attrition rate. Details of the interventions were extracted in concordance with the TIDieR checklist .[29]

2.6 Data Analysis and Synthesis

Review Manager 5.3 (Nordic Cochrane Centre, Cochrane Collaboration) was used for data pooling when three or more studies were reporting the same outcome; otherwise, narrative synthesis was conducted. Physiological parameters were considered the primary outcome. Where the same study reported outcomes at different endpoints, data from the final follow-up were used to investigate the long-term effect. For each outcome of interest, an intervention effect was expressed as Cohen's d, calculating standard mean difference (SMD) with a 95% confidence interval (CI) of post-intervention results between groups. Cohen's d >0.8 describes a large effect, 0.5–0.8 a medium effect, and 0.2–0.5 a small effect.[30] Risk ratios (RR) were calculated for dichotomous outcomes with the Mantel-Haenszel method.[31] Statistical heterogeneity between studies was quantified with the I^2 statistic. The SMD was computed using a random effect model for I^2 >50%.[32] Leave-one-out sensitivity analysis was conducted when the pooled effect showed significant heterogeneity. Meta-regression and subgroup-analysis were not performed due to the limited number of included studies.

3. RESULTS

3.1 Search outcome

A total of 1,774 studies were exported from the literature search and screened for potential inclusion. Titles and abstracts were screened and 82 full text articles were further reviewed. In total, ten studies met the inclusion criteria for this review, involving 1,847 patients with CVD.[33–42] (Figure 1)

[Figure 1. PRISMA diagram of identifying studies of eHealth secondary prevention interventions]

3.2 Study characteristics

The majority (71.68%) of study participants were male, with a mean age ranging from 56.9 to 74.1 years, with the exception of one study, which focused on youths with an average age of 19.48 years..[35] The reviewed studies recruited patients with CHD (n=4),[33,35,36,42] stroke (n=3),[37–39] and CVD (n=3).[34,40,41] Three studies recruited participants at outpatient clinics[34,35] while the remaining studies recruited hospitalized patients after an acute cardiovascular event. The study endpoint ranged from 12 to 16 months with varied sample sizes (n=78-330) (Table 1). Five studies with an intervention duration of around six months were included because: 1) they collected health outcomes at one year; and 2) participants still had access to intervention components during the follow-up period (e.g., mobile app, website, text messages, and monitoring devices).

3.3 Study quality

Overall, all studies had a low or medium risk of bias. Most were judged to have an unclear risk due to an inadequate report of allocation processes. Participants and personnel were not blinded across all studies, while two were rated as low risk for assigning control group memory training[37] and phone call follow-up.[39] One study omitted a detailed description of allocation and blinding, which yielded unclear risks.[35] All studies were checked with previous published protocols or trial registrations, with one judged as having selective reporting bias[42] and one judged as unclear due to lack of a trial registration identifier.[39] One study was judged high in other bias for not reporting allocation, blinding, and assessing only subjective outcomes (Figure 2&3).[35]

[Figure 2. Risk of bias summary]

[Figure 3. Risk of bias graph]

3.4 Intervention characteristics

Details of the interventions are presented in Table 2 in concordance with the TIDieR checklist.[29] Three studies focused on physiological risk factors (e.g., BP, lipid profile) modification.[33,39,42] Seven studies focused mainly on behavioral modification, including comprehensive healthy behavior change,[34,37,40,41] and specific behaviors of physical activity.[35,36,38]

[Table 2. Description of the interventions of the reviewed studies]

The physiological risk factors modification interventions started with an individual assessment, with personal risk factors presented on an e-platform. Tele-monitoring was enabled by providing a sphygmomanometer,[33,39,42] glucose meter,[33,39] and lipid meter.[33] Tele-monitored data was retrieved by cardiologists,[33] physical therapists,[39] and physicians[42] to offer regular feedback. One study also integrated lifestyle plans and education in the intervention.[42]

Comprehensive behavior modification interventions provided educational information via websites,[34,40,41] mobile applications,[35] and phone calls,[37] covering physical activity, nutrition, smoking cessation, and medication. These studies consistently integrated extensive input from health care professionals, such as exercise specialists,[41] nurses,[40,41] dietitians,[41] a trained lifestyle coach,[37] the research team,[35] and medical, and allied health professionals.[34] For the study focusing on exercise, an exercise specialist conducted face-to-face individual assessment before hospital discharge [36] and physical therapists during home visits.[38] After which, participants were instructed to use a pedometer and upload exercise data to a specific website to tailor interventions/plans, obtain feedback, [36] and receive regular phone calls and text messages.[38]

Studies used different approaches to improve the credibility of the intervention content. Two studies followed current practice guidelines,[36,40] two studies engaged experts to validate the intervention content,[35,41] and two studies involved patients and healthcare professionals collaboratively in intervention design.[34,38]

The interventions adopted a series of behavioral change techniques to alter cognition related to health and motivate health behavior change among participants. Two studies followed Social Cognitive Theory.[36,37] Specifically, most studies used tele-monitoring/ self-monitoring and ongoing feedback.[33,34,36–41] One study followed self-regulation theory with self-monitoring and automatic feedback for self-judgment[35], and another study integrated Control Theory to sustain the changes for long-term health benefits.[37]

3.5 Intervention engagement

Few studies reported eHealth system usage data to capture participants' intervention engagement. A majority of the participants completed the expected eHealth tasks, including online tutorials (61.7%),[36] lifestyle coaching (87.5%),[37] tele-monitoring and data uploads (83%),[33] except one study reported that only 26% of patients uploaded all BP values.[41] For the website visits, one study reported a median of 56 website visits in one year.[40] Two studies reported a median of 27 times[41] and a range of one to 43 times per person[34] in six months. None of the studies reported a trajectory of intervention engagement against intervention time.

3.6 Outcome measures of eHealth intervention in long-term follow-up

eHealth interventions were evaluated regarding their effects on physiological outcomes, behavioral outcomes, and clinical outcomes at ≥12 months post-test data collection. The physiological outcomes focused on lipid profile, BP, body mass index (BMI), and blood glucose. The behavioral outcomes were summarized to include comprehensive behavior change, physical activity, smoking cessation, and medication adherence. Clinical outcomes assessed health-related quality of life and re-hospitalization, reoccurrence, and mortality.

3.6.1 Physiological risk factor parameters

Six studies reported the effects of eHealth interventions on physiological risk factors including lipid profile, BP, weight, and hemoglobin A1c (HbA1c)(Figure 4). Participants who received eHealth interventions showed significant improvement in low-density lipoprotein cholesterol (LDL-C) [n = 6; SMD=-0.26, 95%CI (-0.38, -0.14), I^2=17%, *p*<.001] and systolic blood pressure (SBP) [n=5; SMD = -0.46, 95% CI, (-0.84, -0.08), I^2=90%, *p*=0.02]. However, no significant effects were identified in other physiological parameters including high-density lipoprotein cholesterol (HDL-C) [n=4; SMD = 0.07, 95% CI, (-0.08, 0.22), I^2 = 0%, *p*=0.36], total cholesterol [n=3; SMD = -0.12, 95% CI, (-0.29, 0.04), I^2=39%, *p*=0.13], diastolic BP [n= 4; SMD=-0.04, 95% CI (-0.17, 0.08), I^2=0%, *p*=0.49], BMI [n=5; SMD=-0.50, 95% CI (-1.21, 0.21), I^2=96%, *p*=0.17], and HbA1c [n=3; SMD=-0.14, 95%CI (-0.37, 0.09), I^2=54%, *p*=0.24].

[Figure 4. The effects of eHealth interventions**]**

3.6.2 Behavioral outcomes

Healthy lifestyle behavior: Two studies measuring comprehensive healthy lifestyle behavior change reported inconsistent results. One study that provided telephone calls by a trained lifestyle coach and enabled self-monitoring, showed no significant behavioral change as measured by a health-promoting lifestyle profile,[37] while another study using mobile application self-learning, various tele-monitoring devices and professional guidance showed significant improvement in self-care behaviors.[39]

Physical activity. Physical activity was evaluated by calculating the time of engagement in physical activities or daily steps counts. Data pooling of four studies indicated no significant effect on physical activity level [SMD=0.07, 95% CI (-0.11, 0.25), I^2=0%]. Data from one study was not combined for reporting median values and showed a non-significant trend increase in this outcome.[41](Figure 5)

[Figure 5. Effect of eHealth interventions on physical activity]

Smoking cessation. Smoking cessation was measured by the number of participants who quit smoking or the level of nicotine dependence in three studies at 12 months post-intervention. One study which provided healthy lifestyle education modules and e-diaries showed a significant reduction in nicotine dependence;[34] another study that provided personal assessment, web-based goal setting, and nurse support also suggested a significant number of people quit smoking after undertaking the intervention.[40] However, one study that provided tele-monitoring for physiological risk parameters showed no between-group differences for smoking cessation.[33]

Medication adherence. Medication adherence was measured and significantly improved in two studies at 12 months.[39,42] Both studies provided participants with tele-monitoring, health education, and professional guidance. In addition, one study enabled medication reminders,[39] and another offered abnormal health data alarming and symptom notes.[42]

3.6.3 Clinical outcomes

Quality of life. The effect of eHealth interventions on QoL was evaluated by reporting the total score measured by the MacNew health-related quality of life, Short Form 36, and the EuroQol Five-dimensions. Data pooling of three studies that provided interventions for six months and measured the outcomes at 12-month follow-up, showed that eHealth interventions had no significant improvement in QoL [SMD=0.07, 95% CI (-0.26, 0.39), I^2=58%, p=0.68] (Figure 6).

[Figure 6. Effect of eHealth interventions on QoL]

Reoccurrence, re-hospitalization, and mortality. Six studies evaluated the effect of eHealth interventions on reoccurrence, re-hospitalization, and mortality. Data pooling showed a significant improvement [RR = 0.36, 95% CI [0.17, 0.77], I^2 = 0%, p = .009] (Figure 7).

[Figure 7. Effect of eHealth interventions on reoccurrence, re-hospitalization, and mortality]

3.6.4 Sensitivity analysis and subgroup analysis

The sensitivity analysis for SBP and BMI did not show significant deviation, indicating that the high heterogeneity may be due to the difference in intervention components and engagement (Supplementary 2). Subgroup analysis was not conducted for SBP and BMI outcomes because they pooled only five studies and could not be divided into two sub-groups with ⩾ three studies.

4. Discussion

The findings of this review support the effect of long-term eHealth secondary prevention interventions on improving physiological and clinical outcomes of patients with

CVD. Contrary to previous reviews with no or inconclusive effects of eHealth secondary prevention on lipid profile, BP, and cardiovascular events, this review showed a significant improvement in LDL-C, systolic blood pressure, and reoccurrence, re-hospitalization, and death. The findings suggest that improving physiological outcome variables using eHealth is possible, this difficulty being that it takes time for patients to engage in physical activities and other heart-healthy behaviors to yield long-term changes.[43] However, the impact on behavioral modification, diastolic blood pressure, BMI, and QoL appear ineffective or inconclusive. Further studies are needed to allow for ongoing motivational support and the adoption of more advanced technological methods to attract eHealth users in the long-term. Clinicians should be encouraged to use eHealth programs embedded with effective components/features (e.g., individualization, action planning, telemonitoring) to provide secondary prevention services which promote long-term benefits.

The LDL-C causes atherosclerotic disease, which has been well-documented across experimental and epidemiological studies, with the casual relationship gradient becoming steeper as the individual ages and with accumulative exposure.[44,45] One precondition for a significant improvement in LDL-C is the need for long-term observation beyond six months considering the timeframe needed for lipid-lowering interventions to have an effect.[46] Unlike conventional supervised secondary prevention interventions with a specific dosage that significantly improves lipid profile, such change can be challenging for eHealth programs.[47] Significant improvement of eHealth interventions may result from continuous professional support from nurse practitioners[40] and physicians[33,39] in continuous evaluation of physiological risk parameters and treatment prescription. Consistent with the literature's emphasis on the importance of medications in achieving LDL-C control,[46] added focus on the prescriptive drug regimen and the integration of medication reminders were deemed as crucial components in improving intervention outcomes.[39,40] Despite the significant effect, it is worth noting the small effect size that only one study[42] had in achieving the LDL-C goal of $\leqslant$ 1.8 mmol/L ($\leqslant$70 mg/dL) among people with clinically diagnosed CVD.[48] This necessitates having an inter-disciplinary team that considers comprehensive behavior modification and risk factor reduction, especially when promoting strict medication adherence.[49] For example, nurses should consider the prescription from the physicians, exercise experts, dietitians, and the patients' perspectives to assist in personalizing the overall care plan.

Another encouraging finding was that eHealth interventions significantly reduced reoccurrence, re-hospitalization, and mortality. A positive change in the LDL-C and SBP may play a critical role in such benefits. In addition, the wide integration of professional support through the online platform and/or in-person home/clinic visits allowed patients to reach healthcare professionals during the post-cardiac event period. Such increased access to professional guidance has been consistently found to promote/encourage prompt self-care action at an earlier stage and preclude avoidable severe adverse events.[11]

Long-term effect of eHealth interventions on behavioral change remains inconclusive despite the wide integration of recommended persuasive design, such as goals and action planning, monitoring and feedback, and social support.[11,18,50] The difficulty in modifying behavior in the long term is well-recognized throughout traditional in-person and eHealth models. Further studies are needed to explore how to harness advantages of eHealth to sustain behavior change achievements. It is stated that health data tracking and motivational feedback via system/professionals can assist participants in understanding their self-monitored data, enabling them to engage in analytical thinking about the health implications, thereby reinforcing lifestyle decisions to maintain health behaviors.[51] However, it was unclear how to offer feedback in an individualized approach in the long term, such as delivering new information or reinforcing the same messages.[52] It may also become resource intensive to have health professionals consistently deliver feedback for the long-term, and thus, adopting conversational artificial intelligence messages for feedback during the stable rehabilitative phase may be promising. This approach to developing healthy habits could include integrating various strategies, such as culturally and personally appropriate colloquial content and tones; personification; positively framed words; emojis that emulate emotional expressions for sending reminders; and citations of credible information sources.[53] Caution is required because it may affect the safety and accuracy of the intervention as a result of a lack of full human-level language abilities to avoid misunderstandings. [54]

The rehabilitation trajectory should be considered in improving behavior change and QoL. The early phase after a cardiac event may be difficult if there is a lack of rehabilitation services and result in serious ramifications for patients who require coordinated therapeutic care.[55,56] Evidence has indicated that initiation of secondary prevention interventions immediately after the event is associated with better adherence and a lower incidence of recurrent cardiac events.[57] However, as individual's condition becomes stable over time, they may disengage from the interventions/program if the overall purpose of participation remains acute disease management-focused.[23] One qualitative study suggested that gradually empowering intrinsic motivation is the key to long-term maintenance, such that patients can appreciate their own strengths and efforts in achieving health benefits internally.[58]

Despite the endless components and features of diverse technologies, it's crucial to remember that technology is merely a tool to resolve barriers in service provision rather than the focus in and of itself.[59] The wide range of technologies from simple phone calls and text messages,[37,38] to Internet-based apps or websites, to more advanced moment-to-moment tele-monitoring devices (i.e., sphygmomanometer)[33,35,39,41] allows a feedback loop on physical activity and physical parameters. Yet, it appears inadequate in yielding an improvement in QoL. The lack of effect on the QoL may imply that mental wellbeing should also be enhanced or not confined to knowledge acquisition only. An epidemiological study showed that the presence of a mental health issue post-acute cardiac event is associated with greater participation in preventive care.[60] Mental health improvement practices for CVD patients, such as meditation,[61] mindfulness,[62] and progressive muscle relaxation[63] may be integrated to improve QoL for future studies.

4.1 Limitations

Meta-regression was unable to be carried out due to the limited number of identified studies. The significant effect on SBP needs to be interpreted with caution as the heterogeneity could not be explained by sensitivity analysis, and subgroup analysis was inappropriate due to the inadequate number of studies. Additionally, funnel plot asymmetry was not applied in this meta-analysis since there were less than 10 studies, which is too few to distinguish chance from real asymmetry. However, the researchers assessed and reported publication bias in terms of selective reporting by checking against the trial registration and published protocol. More RCTs are needed to enable subgroup analysis and meta-regression to understand the reasons for high heterogeneity. The insufficient concealment of the included RCTs made it difficult to assess their methodological quality, as many items were unclear. To improve the quality of evidence, further studies may strengthen the methods of randomization, allocation, and blinding.

5. Conclusion

eHealth secondary prevention effectively improves LDL-C, systolic blood pressure, and reduces reoccurrence, re-hospitalization, and mortality in the long term. Hospitals and large health centers may integrate eHealth secondary prevention programs to compensate for limited conventional care services. Community health centers can also deliver eHealth secondary prevention programs for patients using a safe and maintainable approach. However, given the limitations of the studies reviewed, the effects of eHealth CR on health behaviors, psychosocial wellbeing, and other cardiac risk parameters remain ineffective. Empowering intrinsic motivation and harnessing the advantages of e-platforms may be needed to attract patients continuously. Studies with a rigorous design are needed to provide evidence to address these areas.

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Conflict of interest

None declared.

Data availability

Data will be shared upon reasonable request to the corresponding author.