ORIGINAL ARTICLE

Using mHealth tools to improve access, coverage and treatment of uninsured people with high cardiovascular disease risk in Argentina: a study protocol for a pragmatic cluster randomised trial

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ABSTRACT

Introduction Cardiovascular disease (CVD) accounts for approximately one-third of Argentina's deaths. Despite government provision of free primary care health services to the uninsured population, with a focus on non-communicable diseases, screening and management of those with high CVD risk at primary care clinics (PCCs) remain low.

Methods and analysis This pragmatic cluster randomised trial will take place in two provinces of Argentina and will recruit 740 participants. Eight PCCs will be randomised to either the intervention or current practice arm. Community health workers (CHWs) in the intervention arm will be trained to use a set of integrated mHealth tools (a validated risk screening tool mobile application; electronic scheduling system using wireless access to PCCs; and educational text messages) to screen for CVD and to schedule appointments with primary care providers for persons with high CVD risk (≥10%). The primary aims of this study are to determine if the use of mHealth tools will (1) increase attendance of first appointments scheduled by CHWs for persons determined to have high risk for CVD during screening and, (2) lead to an increase in follow-up visits at PCCs by high risk patients. Secondary outcomes include assessing the proportion of high-risk patients receiving appropriate medications and a cost-effective analysis of the intervention.

Ethics and dissemination This study has been approved by the Institutional Review Boards at Partners/Brigham and Women's Hospital (USA) and the Hospital Italiano de Buenos Aires (Argentina). The open-source software for the mHealth tools will be made publicly available at the end of the study.

Trial registration number NCT02913339.

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of death in Argentina,[1] where mortality rates have continued to rise along with the prevalence of risk factors for CVD. The government of Argentina has made the reduction of the CVD burden a priority. Specifically, the National Primary Care Network (Programa REDES)[2] is designed to address health inequities through strengthening primary care services for the 15 million uninsured Argentinians. The programme focuses on strategies to reduce the burden of non-communicable disease through providing increased training and technological infrastructure support and the free provision of essential medications. Like other low-income and middle-income countries (LMICs), Argentina's systemic challenges to improving the detection and management of CVD include low rates of awareness, shortages of trained healthcare workers to provide services, overcrowded primary care centres (PCCs) and overall lack of resources in healthcare systems.[3]

Hypertension, one of the primary, modifiable risk factors for CVD, has been shown to be controlled for only 20% of Argentinians.[4] In order to reduce the CVD burden in Argentina through programmes such as REDES, a high priority is to determine ways to increase screening in community settings along with efficient referral to PCCs for proper management of the disease, using task-shifting[5] and mHealth technologies.[6] Patients' health-seeking behaviours at PCCs are largely driven by emerging and acute healthcare needs[7] and align significantly with cultural norms (eg, traditional medicine).[8] We have demonstrated that the task of screening for CVD can be shifted effectively from formally trained health professionals to community health workers (CHWs)[9] in LMICs using a validated, low-cost non-laboratory-based screening tool.[10] A mobile phone application version of this screening tool also reduced the time required for CVD screening by CHWs and further improved the cost-effectiveness of the intervention.[11] Mobile health interventions hold promise for healthcare delivery in LMIC and in resource-constrained settings where mobile technology has high penetration rates. In many places in Argentina, people have better access to mobile phones services than to basic services, such as water and sanitation.[12]

One systematic review to address the impact of mHealth on chronic disease in LMICs published by our group showed positive but modest effects in chronic disease outcomes.[13]

What has not been shown is whether the use of mHealth tools by CHWs to screen for CVD and schedule appointments with primary care providers at PCCs in Argentina will lead to proper evaluation of CVD risk, appropriate referral to PCCs for evaluation and treatment and effective management of the condition within the primary care system. This study will address these gaps in the current evidence as well as assessing the cost-effectiveness of the intervention.

METHODS

Objectives and associated endpoints

1. To investigate if the use of a mHealth risk calculator application (the app) by CHWs in Argentina increases the rate of the number of uninsured community members at high risk for CVD who are referred to and seen at the PCCs.
   Endpoint: proportion of patients with a 10-year CVD risk ≥10% who have successfully completed the baseline (first) visit to a clinic out of all those classified as having risk >10% within the prior 6 weeks in the community.
2. To evaluate if use of the integrated mHealth electronic appointment scheduling tool increases follow-up care for people who are referred to the PCCs. We will develop an algorithm of reminders that is integrated into the central data and appointment system that creates follow-up appointments for those at high CVD risk and creates reminders and educational messages to increase follow-up care that is essential to management of long-term chronic care conditions.
   Endpoint: proportion of patients with a 10-year CVD risk ≥10% who have successful completed the follow-up visit to a clinic within 4 months of the baseline visit out of all those classified as having risk ≥10% in the community.
   Secondary endpoint: proportion of patients who are on appropriate medications for respective conditions and have a 10-year CVD risk ≥10% (ie, antihypertensives if systolic blood pressure (SBP) >140 mm Hg or statins if CVD risk ≥20%).
3. Assess the cost-effectiveness of the intervention to use the mHealth tools for screening in the community and referral to the PCCs. We will use the CVD Policy Model for R isk, Events, Detection, I nterventions, C osts, and T rends (PREDICT)model[14] to evaluate the cost-effectiveness of the interventions, linking increased awareness and treatment rates to reductions in CVD risk factors and ultimately CVD events.

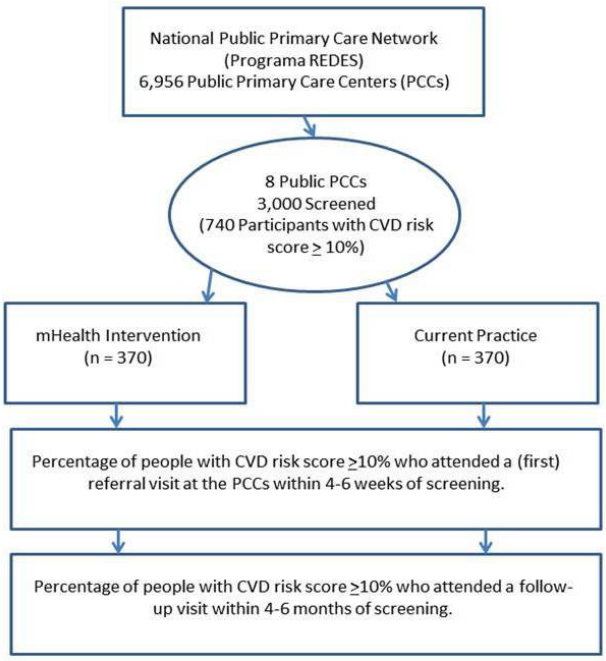

Figure 1 Study design and enrolment goals. CVD, cardiovascular disease.

Study design

This is a pragmatic cluster randomised trial in which eight individual PCCs will be randomised to either the intervention arm or the current practice arm. Overall design and enrolment goals are summarised in figure 1. In the intervention arm, CHWs will use the set of mHealth tools to screen for CVD and to schedule appointments at the PCCs. The current practice arm will calculate CVD risk using the paper-based WHO CVD classification tool,[15] and CHWs will verbally recommend that high-risk participants schedule an appointment at their local PCC. The timeline for measuring endpoints 1 (within 4–6 weeks of screening) and 2 (within 4–6 months of screening) are

Box 1 Inclusion criteria for study primary care centres (PCCs).

- Is affiliated with the REMEDIAR and REDES programmes.
- Located in poor urban areas according to the 2010 census data.[27]
- Clinical load of 800 or more outpatient visits each month (to facilitate effective recruitment).
- The minimum distance between the selected PCCs will be 10 km to minimise the risk of contamination between intervention and current practice catchment populations.
- Physician visits and essential medications are free of charge to patients under all circumstances.
- Employs community health workers.
- Has a history of good performance in the REMEDIAR and REDES programmes.
- Internet connectivity.

summarised in figure 1. Cost-effectiveness data will be collected over the course of the study period.

Clinics will be selected based on the criteria outlined in box 1, matched by district, and then randomised to either the intervention or the current practice arms of the trial using the random number generator function in Excel®. To prevent bias in clinic selection, randomisation will be performed by the study team in Boston, while the implementation of the intervention will be undertaken by the team in Argentina.

Patient population

We aim to recruit participants from 'real world' community settings with minimum eligibility criteria (table 1). Each PCC will recruit 84–100 study participants with moderate and high CVD risk. CHWs will be trained to recruit participants in their homes using the WHO screening questionnaire. Eligibility and exclusion criteria are outlined in table 1. Persons who agree to participate will be asked to sign a written informed consent form after the eligibility screening is completed.

Usual care/control

In the centres randomised to the control group, CHWs were trained during a 1-day interactive workshop that focuses on: (1) improving knowledge and skills related to CVD and risk factors; (2) blood pressure measurement; (3) using the paper-based WHO charts to calculate CVD risk[15]; and (4) scheduling an appointment at the clinic using a paper-based scheduling system. Training sessions were followed by field observation during a 2-week run-in period prior to enrolment. CHWs were certified based on their proficiency using the WHO chart to classify participants with high cardiovascular risk. Additionally, CHWs conducted home visits to identify participants with CVD risk ≥10%. Participants were encouraged to go to the clinic.

Table 1 Eligibility criteria for participants.

Inclusion criteria	Exclusion criteria
Age 40–79 years	Plans to move from the neighbourhood in the next 2 years
Have public health insurance	Pregnant at the time of screening
Access to a cell phone for personal use	Be bed-bound
Family home located within 10 km from the clinic	Persons who do not consent
A 10-year CVD risk of ≥10%	

CVD, cardiovascular disease.

The intervention

We have developed a set of mHealth tools (the app) to implement and evaluate as our intervention: (1) a mobile phone risk calculator that CHWs will use to calculate the risk of CVD (online supplementary figure S1); (2) an electronic appointment scheduling system that is integrated with the app and the scheduling system at PCCs, which CHWs will use to schedule appointments for participants as part of the screening process (online supplementary figure S2); (3) sending educational and appointment reminder text messages to participants with high CVD risk (≥10%). The intervention is described in figure 2. The app will calculate CVD risk using age, sex, SBP, reported diabetes status, current tobacco use and body mass index and will upload data through a secure file transfer protocol connection to a central web-based platform. This web platform will interact with the scheduling system to obtain participants' contact information. Then it will integrate reminders for recommendations and will generate text messaging to be sent through the free software SMS Gateway (https://play.google.com/store/apps/details?id=eu.apksoft.android.smsgateway&hl=es_419). An open-source mHealth information system, SANA (http://sana.mit.edu), was used to develop the app,[16] while the electronic scheduling system will be centralised on a Linux web server and accessed through a secure Wi-Fi protocol (WPA2-AES).

The scheduling system allows access with different levels of user permissions. For example, administrators can schedule or cancel appointments for healthcare professionals across all specialties at the PCC, while CHWs are restricted to scheduling, modifying or cancelling appointments only for primary care physicians. All activities in the system will be recorded, enabling ongoing monitoring of study activities, generating of reports and generating data for a process evaluation of the intervention.

The intervention will be rolled out in two stages: (1) preparation for implementation of the intervention and training for CHWs and administrative staff; and (2) implementation and monitoring of the intervention

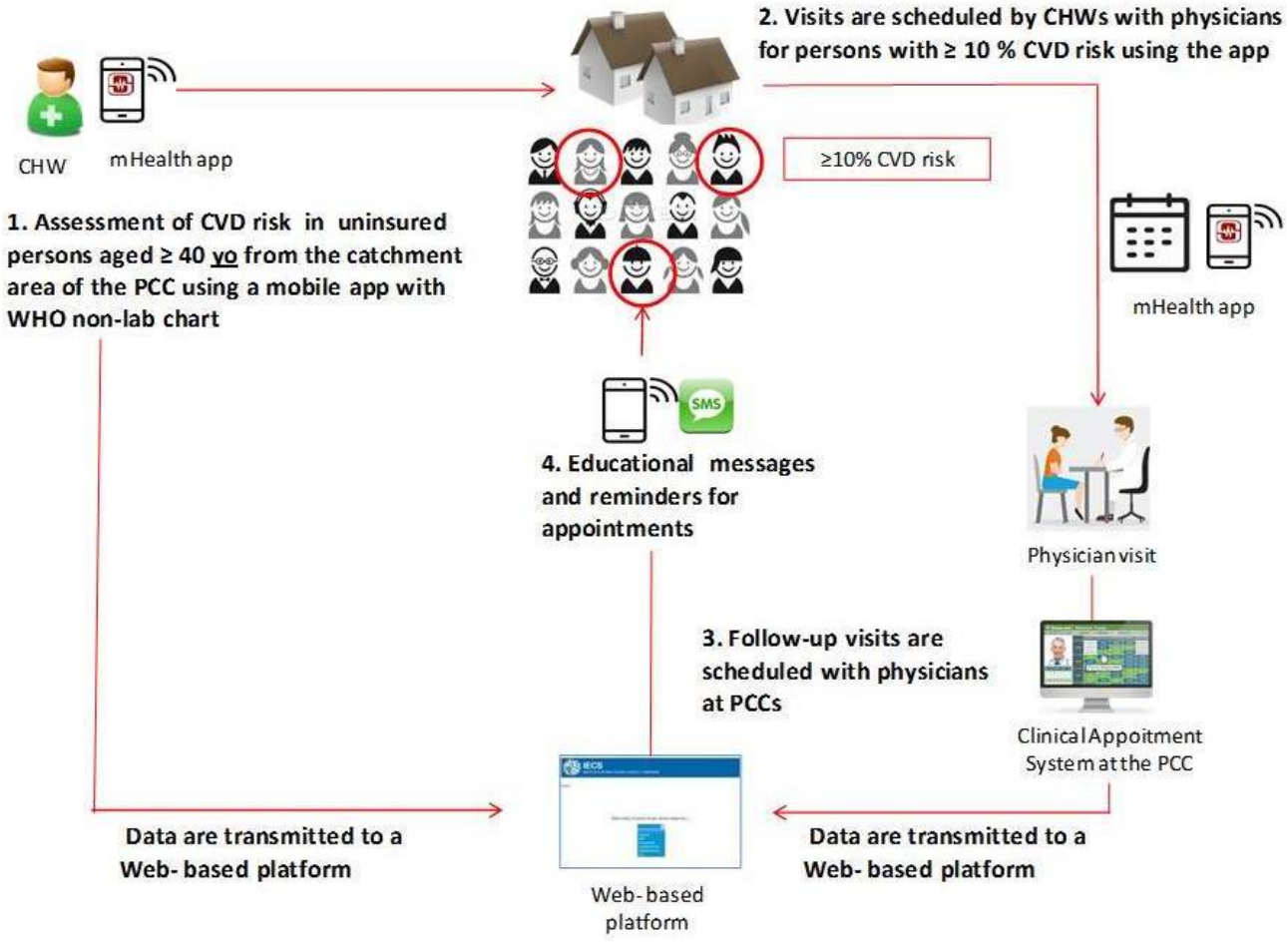

Figure 2 Summary of process flow in the intervention arm. CHWs, community health workers; CVD, cardiovascular disease; PCC, primary care centre.

Stage 1: preparation for implementation of the intervention and training

The geographic area where the intervention will be implemented was mapped for internet connectivity, and 3G mobile phones with SIM cards were purchased for each CHW. Before distributing the mobile phones to the CHWs, the app will be installed on the phones and field tested to ensure functionality of the mobile app, as well as testing Wi-Fi connectivity to the electronic clinical appointment systems. Individual user profiles for CHWs will be created on the mobile phones, and each user will be granted access to the mobile app and also to the electronic clinical appointment system of their assigned clinic. A web-based clinical appointment system will be installed on a single computer at each of the participating clinics, and appointment logs will be set up for key personnel at the clinics. The CHWs will access the clinical appointment system using a secure Wi-Fi connection and the hypertext transfer protocol protocol to select available appointments with primary care providers based on the participant's preferences. CHWs will be trained during a 1-day interactive workshop that focuses on: (1) improving the knowledge and skills of CHWs related to CVD and risk; (2) blood pressure measurement; (3) using the mobile app to calculate CVD risk; and (4) scheduling an appointment at the clinic using the web-based electronic scheduling system via Wi-Fi connection. Training sessions will be followed by field observation during a 2-week run-in period prior to enrolment, and CHWs will be certified based on their proficiency using the mobile app and scheduling system.

Training will also be provided to administrative staff, including scheduling appointments with healthcare professionals, monitoring the scheduled appointments and managing providers' schedules.

Stage 2: implementation of the intervention and monitoring the delivery of intervention

CHWs will visit the homes within the PCCs catchment area to identify participants who meet the eligibility criteria as outlined in box 1. For participants with a CVD risk ≥10%, the CHW will schedule an appointment with a primary care physician at the PCC for evaluation and treatment by accessing the electronic scheduling system at the clinic and selecting an available appointment. Next, customised short text

messages are sent to the participant reminding him or her of the scheduled visit set up during the CHWs home visit. An additional reminder will also be sent to the participant 24 hours before the scheduled appointment. Participants also will receive weekly one-way educational messages to promote follow-up and continuity of treatment. All educational messages were created using content that was previously validated in this population for cultural appropriateness.[17]

Data collection

Medical records will be reviewed at the PCCs by study staff in Argentina to capture baseline visit information using a data collection form designed to capture visit dates, type of provider seen by the participant, any CVD risk assessment performed, any CVD risk noted in the record and any relevant medication prescriptions for CVD. At the conclusion of the 6-month follow-up period following the final participant enrolment, study staff will repeat this review of medical records to capture information related to follow-up visits. These data will be used in the analysis for primary objectives 1 and 2. Cost-effectiveness data (primary objective 3) for two healthcare perspective cost categories will be obtained: (1) the costs of the development and implementation of the intervention and (2) costs of the use of health resources by participants in both the study arms and the costs of CHW training. Costs will be included as recommended in current economic evaluation guidelines.[18] Fixed costs (eg, development and maintenance of the electronic appointment scheduling and mobile app components of the integrated mHealth tool) will be derived from the budget for the research project, administrative databases for the local healthcare system, official labour market surveys and tariffs for the telephone service providers. Variable costs will be obtained from the utilisation rate of healthcare resources at the patient level and from national claims data.

Process evaluation

Uptake of the intervention will be monitored by the frequency of usage of the app by CHWs and of the clinical appointment system by the administrators at the clinics. Research assistants will monitor the intervention clinics to assess the functionality of the intervention on site, provide updates of the challenges faced by CHWs and administrative staff with using the app and the electronic clinical appointment system and to supervise data collection activities. As part of the final analyses, a formal process evaluation will be performed to identify potential moderators on the study outcomes and adherence as a measure of implementation fidelity. We will evaluate the intervention by applying a conceptual framework for assessing the fidelity and quality of implementation for complex interventions.[19] The assessment will include evaluation of adherence measures (eg, use of electronic appointment scheduling system), potential moderators (eg, impact of strategies to facilitate the implementation) and identification of the essential components.

Sample size calculation

Increased awareness leads to improved detection, treatment and, ultimately, control of CVD risk factors. Based on data provided by the REDES programme,[20] we hypothesise that an increase of 40% in the rate of first time visits and follow-up visits of those at risk for CVD is significant. Baseline rates for first time visits of those with CVD risk ≥10% is currently 35%. We hypothesise that the intervention will lead to greater than a 50% visit rate or a 15% absolute increase. For our first objective, adjusting for design and using an intraclass correlation coefficient of 0.01 and a cluster size of 8, we will need 84 subjects per cluster. Assuming up to a 10% loss to follow-up or poor data quality, we will need 370 patients in each arm to detect a significant difference with a power of 0.80 and a type I error (alpha) of 0.05 in a two-sided test. For our second objective, the proportion of patients who make follow-up visits after first visit (baseline) is 40%. We hypothesise we can increase this to 60%. Using similar assumptions of power and error as above, the sample size is 40 subjects per cluster for a total of 320 subjects, 50 subjects fewer than required for the first aim. Assuming only 25% of adults screened have a CVD risk ≥10%, based on REDES programme data, we will need to recruit at a pace of 65–70 subjects per month, over 5 months, to reach our study recruitment goal of 740 patients.

Statistical analyses

Outcomes will be analysed on an intention-to-treat basis. A logistic regression model will be used to evaluate the effect of the intervention with stratification by region as a cofactor. The model parameters will be estimated by the generalised estimating equations approach, which takes into account the clustering of patients within clinics. ORs will be presented with 95% CIs. Health outcomes and cost-effectiveness for the intervention will be conducted using the validated CVD PREDICT (**P**olicy Model for **R**isk, **E**vents, **D**etection, **I**nterventions, **C**osts, and **T**rends) model.[12] The model uses microevent simulation with inputs including demographic information and risk factors for a specific population of adults to predict future events (eg, acute myocardial infarction).[21–26] We will also conduct probabilistic sensitivity analysis by defining probability distributions of variables used in the model used to calculate the costs and effectiveness. Cost-effective analyses will be conducted using evidence-based inputs for healthcare costs.

DATA SAFETY AND MONITORING

The risks of the study to the trial participants are minimal as this is not a clinical trial where we are

testing treatments for CVD. The CHW will refer trial participants who are newly identified as being at high risk for an acute cardiovascular event through the eligibility screening and who also have measured SBP >180 mm Hg or a diastolic blood pressure >110 mm Hg to the PCC for further assessment by a physician.

Regular, ongoing random audits of enrolled participants will be conducted by the study staff in Argentina throughout the enrolment period to independently verify that participants were visited by a CHW, recruited appropriately and signed a written consent form to indicate their willingness to participate.

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Contributors TAG, AR, AB, SA-G and VI created the concept for the study and the protocol. AF, AC, LAC and EW developed the mHealth tools. AB, LG, DM, AH and AC were responsible for the design, collection and implementation of data collection. SA-G wrote the primary draft of the manuscript with input from AB and DM. TAG, AB, VI, AF, AC, LAC, EW and LG all reviewed and provided feedback on the final manuscript.

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Disclaimer The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Competing interests None declared.

Patient consent Obtained.

Ethics approval This trial has been registered with ClinicalTrials.Gov (NCT02913339). A CONSORT checklist for reporting randomised trials has been completed for this study. The protocol complies with the requirements of the Ethics Committee (IRB) of the Hospital Italiano de Buenos Aires and the IRB at the Brigham & Women's Hospital, Boston.

Provenance and peer review Not commissioned; externally peer reviewed.

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