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Cluster randomised trial to evaluate comprehensive approach to hypertension management in Nepal: a study protocol

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ABSTRACT

Introduction Despite having effective approaches for hypertension management including use of antihypertensive medication, monitoring of blood pressure and lifestyle modification many people with hypertension in Nepal remain undetected and untreated. A comprehensive intervention which provides personalised counselling on lifestyle modification, medication adherence together with support for regular monitoring of blood pressure is expected to achieve well controlled blood pressure.

Methods and analysis This is a community-based, non-blinded, parallel group, two-arm cluster randomised controlled trial, with an allocation ratio of 1:1, conducted in Budhanilkantha municipality, Nepal. Ten health facilities and their catchment area are randomly allocated to either of the two arms. 1250 individuals aged 18 years and older with an established diagnosis of hypertension will be recruited. The intervention arm receives a comprehensive hypertension management package that includes blood pressure audit by health workers, home-based patient support by community health workers to engage patient and family members in providing tailored educational counselling on behavioural and lifestyle changes in addition to routine care. The control arm includes routine hypertension care. Trained enumerators will ensure consent and collect data. Outcome data on blood pressure, weight, waist and hip circumference will be measured and self-reported data on diet, lifestyle, medication adherence and hypertension knowledge will be registered at 11 months' follow-up. The change in outcome measures will be compared by intention to treat, using a generalised linear mixed model. A formative assessment will be conducted using semistructured interviews and focus group discussions to explore factors affecting hypertension management. A mix-method approach will be applied for process evaluation to explore acceptability, adoption, fidelity, feasibility and coverage.

Ethics and dissemination Ethics approval was obtained from Nepal Health Research Council (682/2021) and Regional Committee for Medical and Health Research Ethics, Norway (399479). The findings will be disseminated in peer-reviewed journal articles and with decision makers in Nepal.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ A comprehensive intervention providing tailored home counselling and support to hypertension patients and family members along with training of the health workers is not known to have been tested in a low-resource setting.
⇒ Hypertensive patients and their family members will be engaged in identifying problems and solutions on aspects of hypertension management.
⇒ Inbuilt process evaluation promotes a pragmatic approach facilitating timely improvement to intervention delivery.
⇒ The trial measures the short-term effect of the intervention and is thus unable to assess the long-term impact.

INTRODUCTION

Hypertension is a global risk factor for cardiovascular diseases (CVDs) and attributes to 7.6 million premature deaths worldwide.[1] Approximately 80% of the hypertension burden is in low-income and middle-income countries (LMICs).[1] In Nepal, a quarter of the adult population have hypertension.[2] Also, a meta-analysis of studies between 2016 and 2020 from Nepal reported that 32% of adults were hypertensive, 50% of them were unaware of their status, only 27% were on treatment and 38% on treatment had well-controlled blood pressure (BP).[3]

Despite having several effective interventions to prevent and control hypertension,[4–6] its management has been challenging.[7 8] Randomised controlled trials (RCTs) have demonstrated that weight loss programmes,[9] physical activity[10 11] and a diet rich in fruits and vegetables and low-fat dairy[12 13] can reduce BP. Several RCTs have also shown a causal association between high dietary sodium intake and high BP.[13 14] Antihypertensive treatment has been associated with reductions in stroke incidence by about 35%–40%; myocardial infarction, 20%–25% and heart failure by more than 50%.[4 15–19]

Nepal government piloted a Package of Essential Non-Communicable Diseases (PEN), an evidence-based cost-effective intervention for prevention and control of non-communicable diseases in 2016 and gradually scaled it up to all 77 districts by

2021.[20] However, several health systems and patient-level challenges continue to hinder effective management of hypertension.[21 22] Although the primary healthcare facilities are mandated to provide hypertension services, they suffer from inadequate supplies, high workloads, and poor remuneration, poor training on treatment guidelines resulting in poor identification and follow-up of hypertension patients.[23]

Interventions addressing different aspects of hypertension care have shown encouraging reports, for instance, physician education has resulted in a median reduction in systolic BP of 3.3 mm Hg (from 11 trials) and diastolic BP of 0.6 mm Hg (from 16 trials).[24] A systematic review of studies with patient education component found 19% increase in control of systolic BP and 17% increase in control of diastolic BP.[25] Community health workers (CHWs) facilitated BP control programmes have shown significant improvement in health outcomes, especially among minority communities in poor and urban settings.[26 27] CHW-facilitated hypertension programmes have been shown to reduce cultural and educational barriers,[28] optimise healthcare resources and increase quality of care.[29] A trial testing CHW-delivered intervention among hypertensive patients in Nepal reported 4.90 mm Hg reductions in mean systolic BP.[30] BP monitoring outside the clinical setting minimises the heightened anxiety leading to 'white coat effect' and thus allows more accurate and frequent BP reading.[26]

The complexities of hypertension management suggest that a comprehensive strategy would be advantageous. Randomised trials implementing comprehensive strategies in the USA[31 32] and Argentina[33] have shown promising results. A randomised trial of physician and patient interventions reported the greatest improvement in the group that received both interventions.[34] Comprehensive intervention involving primary care providers and family to support adhering to treatment was effective in improving BP control.[35] Integration of multiple intervention strategies (even those that are ineffective in isolation) in the appropriate context results in improved outcomes.[34 36] However, whether a comprehensive intervention that includes CHW-supported home-based management of hypertension with referral linkage to primary care may be implemented in a low-resource setting such as Nepal has not been investigated. Therefore, this study aims to test whether a comprehensive intervention providing personalised home-based counselling and support for hypertension patients in urban Nepal could be acceptable, feasible and effective in controlling BP. The primary objective is to assess the impact on net change in mean systolic BP measured at follow-up of a comprehensive approach to hypertension management (CAHM) intervention which provides personalised counselling on lifestyle modification and medication adherence together with support for regular monitoring of BP at home compared with a control arm where hypertensive patients have access to routine care only. We hypothesised that CAHM would reduce mean BP levels. The secondary objectives of this study are to (1) assess the impact of CAHM by comparing proportion of hypertensive patients controlling BP and adhering to prescribed medication, (2) assess the impact of CAHM by comparing mean physical activity, body mass index (BMI), waist circumference and diet quality and knowledge of hypertension, (3) compare intervention effects by subgroups such as gender, income levels, BMI and salt intake, (4) explore the individual, community and the health system factors affecting hypertension management and (5) assess the implementation of the CAHM in the primary healthcare setting.

METHODS/DESIGN

Study design and setting

This is a non-blinded two-arm cluster RCT, with an allocation ratio of 1:1, conducted in urban Nepal. Trial arms are (1) intervention arm: CAHM that includes BP audit and feedback by health worker, and patient support to monitor BP, and home-based patient care by CHWs to encourage self-monitoring of BP followed by tailored counselling on behavioural and lifestyle change in addition to routine care; (2) control arm: routine hypertension care.

The trial is being implemented in Budhanilkantha municipality located in Kathmandu district, the capital of Nepal as shown in figure 1. The total population of the municipality is 146 828.[37] It is largely urban, consisting of a culturally and linguistically mixed population with locals and migrants settled from other parts of the country. The municipality is administratively divided into 13 wards with 11 public health facilities spread across them. Hypertension prevalence in Bagmati province to which the municipality belongs was similar to the national average (25.2% vs 24.5%).[2]

Study population

At the cluster level, out of 11 primary healthcare facilities managed by Budhanilkantha municipality, 10 were included in the trial. One municipal hospital and private health facilities were excluded. The inclusion and exclusion criteria of the individual participants are shown in table 1.

Outcomes

The trial outcome measures are shown in table 2. The primary outcome is net change in mean systolic BP measured after 11 months from enrolment. The secondary outcomes are net change in mean diastolic BP, proportion of hypertensive patients controlling BP and adhering to prescribed medication, mean physical activity, BMI, waist circumference, diet quality and knowledge of hypertension.

Sample size

Our estimated sample size is 1250 hypertension patients, 625 in each arm to be enrolled over the period of 6

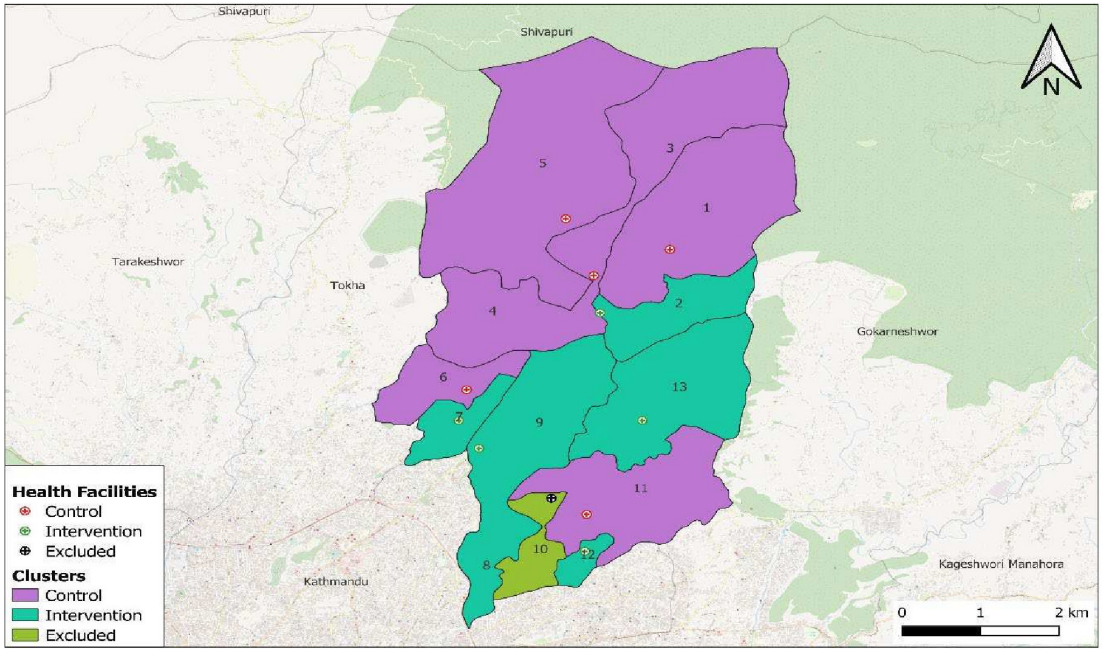

Figure 1 Map of Budhanilkantha municipality showing intervention and control health facilities and areas (wards) they cover.

months. Participants from each cluster are recruited proportionate to the total population residing in the areas served by the health facilities (clusters) as shown in figure 2.

For sample size calculation, power was set at 80% and level of significance at 5% to observe a minimum detectable mean difference of 3.5 mm Hg. There is evidence that a 5 mm Hg decrease in systolic BP at the population level reduces risk of CVD by 10%.[38] We set a variance 196 based on Dhulikhel Heart Study (unpublished). We used 80% follow-up rate and intracluster correlation coefficient 0.0146[39] to account for cluster design.

Randomisation

The health facilities were randomly allocated to either of the two trial arms (five in each arm). A statistician not directly involved in field implementation of the trial used Stata 14.1 version to generate 10 different combinations of random allocation lists of health facilities, printed and prepared sealed envelopes. A participatory randomisation event was organised with municipal stakeholders at the municipality on 25 March 2022. The orientation on trial activities followed by a discussion on strategies to enrol trial participants was conducted. One of the stakeholders was invited to pick a sealed envelope to reveal the random allocation sequence of the clusters (health facilities) to everyone present.

Enrolment process

Before enrolment, we interacted with government stakeholders at federal and local levels, meeting with the Ministry of Health and Population, Epidemiology and Disease Control Division and elected municipal representatives. We enrolled individual participants from 2 May 2022 to 11 November 2022. Enumerators sought support from health workers and female community health volunteers to list individuals with high BP in each cluster that is, the areas served by the participating health facilities. The required sample size was not achieved, therefore, the enumerators conducted community orientations asking people to participate or refer participants to the trial, they also went to health camps and community events for BP screening of attending participants. Patients identified during screening with no previous confirmation of hypertension by a physician were referred to confirm diagnosis before enrolment. Health workers and

Table 1 Trial participant inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
► Adults ≥18 years with an established hypertension diagnosis (systolic BP ≥140 mm Hg and/or diastolic BP≥90 mm Hg on at least two separate visits or using antihypertensive medication)	► Self-reported critically ill patients (dementia, prior heart condition)
► Able to give consent and respond to questions	► Pregnant
► Residents of the areas served by the participating health facilities in Budhnilakantha municipality	► Planning of relocation during the follow-up period (within 1 year)

BP, blood pressure.

Table 2 Trial outcomes measured at baseline and follow-up

Outcomes	Description	Variable type	Effect measure, summary statistic
Primary outcome			
Systolic BP (mm Hg)	Net change in mean systolic BP from baseline	Continuous	Difference in mean
Secondary outcomes			
Diastolic BP (mm Hg)	Net change in mean diastolic BP from baseline	Continuous	Difference in mean
Control BP	Participants with BP<140/90 mm Hg	Binary	Difference in proportion, OR
Waist circumference	Waist circumference measured in cm	Continuous	Mean difference
Hip circumference	Hip circumference measured in cm	Continuous	Mean difference
Body mass index	Weight measured in kilograms divided by height squared measured metres (kg/m^2) (cut-off <25 kg/m^2)	Binary	Difference in proportion, OR
Diet Diversity Score	Count of the number of food groups (out of 10) consumed in the previous 24 hours assessed using the list-based method	Count (0–10)	Difference in mean
Salt intake	Daily intake of salt as reported by participant (cut-off 5 g per day)	Binary	Difference in proportion
Oral health status	Dental health status as perceived by participant	Binary	Difference in proportion, OR
Adherence to prescribed medication	Eight Item Morisky Medication Adherence Scale (cut-off <6 low adherence)	Binary	Difference in proportion, OR
Physical activity	Metabolic equivalents of task (METs) minutes per week using global physical activity questionnaire (cut- off ≥600 MET)	Binary	Difference in proportion, OR
Hypertension Knowledge Score	21 item knowledge questions each correct answer scored as 1 and incorrect 0.	Count (0–21)	Mean difference
Perceived Social Support Scale	Multidimensional Scale of Perceived Social Support (12 statements)	Mean score	Mean difference
Confounders to adjust			
Marital status	Marital status at baseline	Binary	
Education	Years of education	Continuous	
Age	Measured in completed years at baseline	Continuous	
Exposure to intervention (for dose-response effect on outcomes)	No of home visits 0, 1, 2, 3, 4, 5, 6	Continuous	

BP, blood pressure.

volunteers continued to refer new patients to the trial. Enumerators screened for eligibility, ensured informed consent, and collected baseline data. Enumerators measuring outcome know the arm in which participant is allocated to. However, to minimise risk of bias, roles for data collection and intervention are kept separate. We will use printed barcodes (four in one set) to track participants throughout the trial. The enumerators paste identical barcodes on the trial participant card (TPC) provided to the participant at enrolment and on the CHW forms to confirm participant identity during home visits. The remaining two barcodes will be retained to confirm participant identity during follow-up and to replace if the participant loses their TPC.

Data collection and assessment

Sociodemographic data such as age (years), gender (male/female/other), marital status (married/unmarried/widow), education (years of education), occupation (government/ self-employed/private/ unemployed), income (annual household and per capita income) will be collected at enrolment. Health behaviours such as diet using diet quality questionnaire,[40] physical activity (metabolic equivalents of task minutes per week) using a global physical activity questionnaire,[41] alcohol (drinks per week) and smoking (cigarettes per day), knowledge of hypertension[42] and salt intake and adherence to prescribed medication[43] will be collected and BP and anthropometric measurements taken during enrolment and follow-up. Three BP measurements will be taken and an average of the last two measurements will be used.[30] Weight (in kg) will be measured with light clothing using an Omron digital weighing scale. A plastic measuring tape scaled in cms will be used for height by asking participant to stand barefoot beside a wall on even

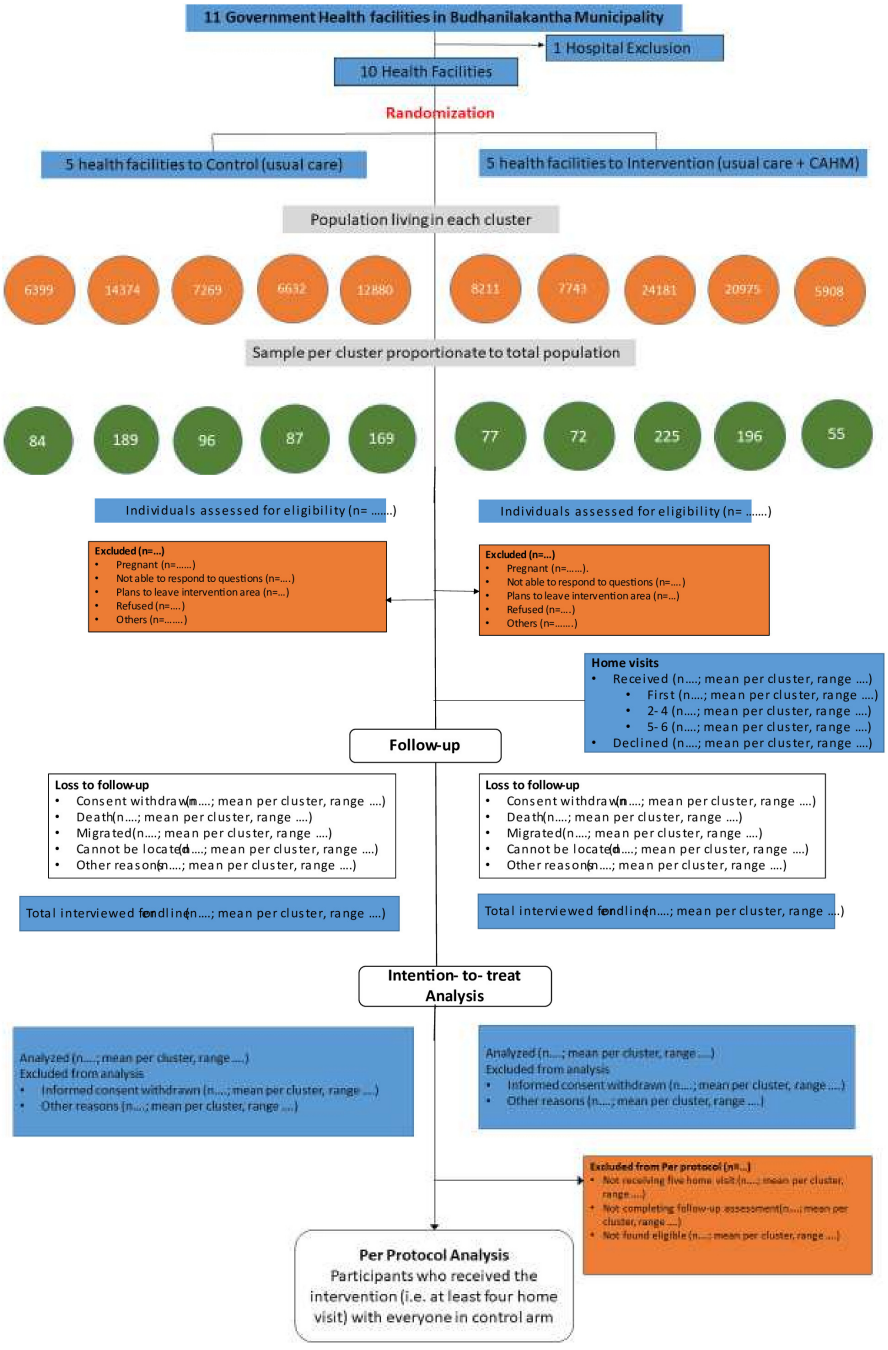

Figure 2 Consolidated Standards Of Reporting Trials (CONSORT) flow diagram.

floor, hip circumference by placing the tape parallel to the floor at widest part of buttocks and waist circumference by placing the tape horizontally passing it along the umbilicus midway between the 12th rib and the iliac crest on the mid axillary line. An 'Omron' digital instrument will be used to measure BP three times in resting position.

Android operating system tablets installed with KOBO toolbox electronic data collection platform will be used for data collection. In-built jump-sequences and value limits are preset to prevent entry of implausible data. Training of enumerators and pretesting of the tools and picture cards with examples of physical activity and commonly used utensils for drinking alcohol will be shown to ensure accurate measurements. Enumerators share problems daily and during weekly meetings with the investigator who maintains a log of the problems making corrections reversibly in the data using Stata data cleaning 'do' files as required.

Intervention: CAHM

The intervention clusters will benefit from a multicomponent intervention consisting of training of health workers from intervention health facilities, and the individual participants will be supported by CHWs to manage hypertension at their home over the period of 6 months.

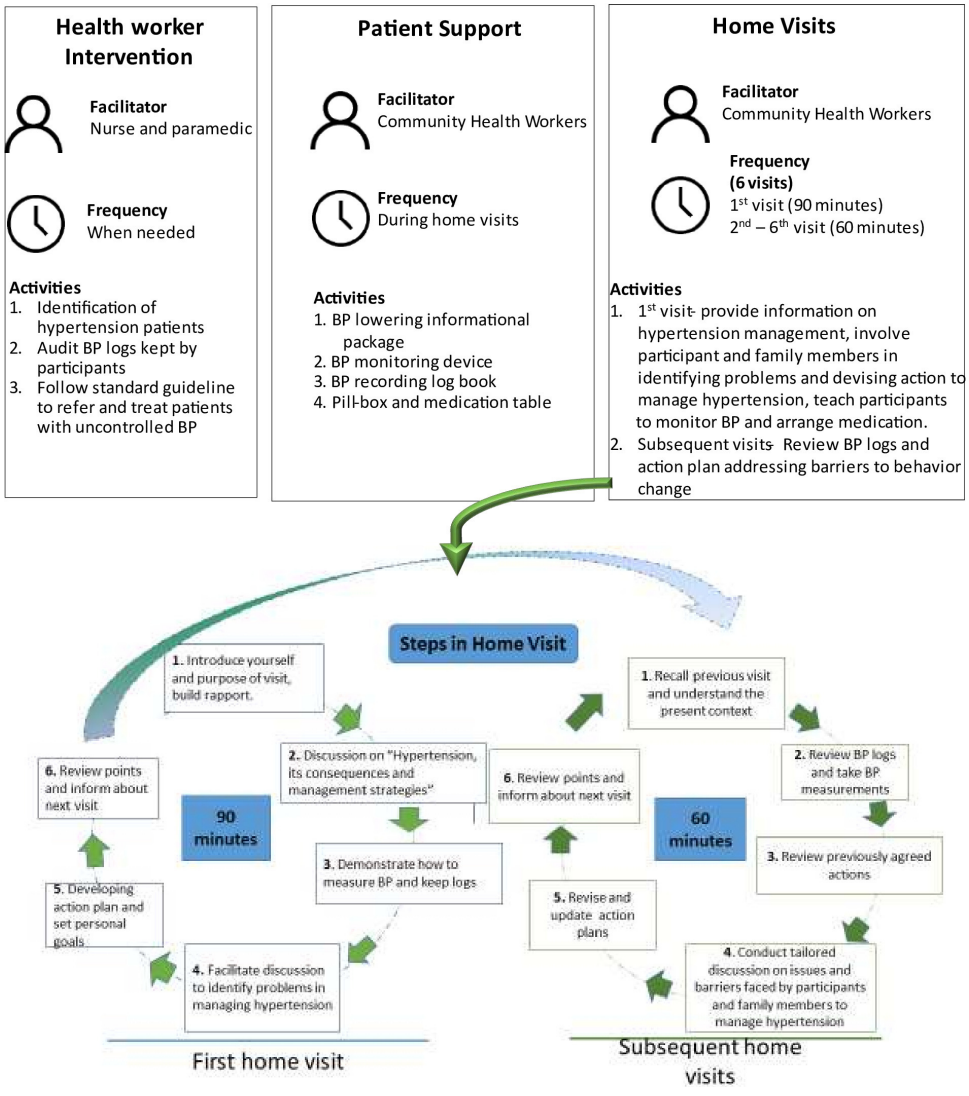

Figure 3 Different components of the intervention. BP, blood pressure.

Different components of the interventions are shown in figure 3.

Health worker intervention

Ten health workers from intervention clusters (two from each health facility) receive a 4 days' standard service provider's training on PEN.[44] The training includes protocol on screening, counselling and management of hypertension. Trial participants will be encouraged to go to the health facilities every 6 months for follow-up. The health workers will audit the BP logs kept by participants and follow standard protocol for referral and treatment.

Patient support

The participants will be provided with an informational package on hypertension management with a logbook to track BP level and physical activity as well as medication table, a BP monitoring device and a pill-box to manage medication.

Home visits

Five CHWs (nurse or paramedic) were recruited to deliver the intervention. They received standard government training on PEN[44] and 4 days training on home visit manual. A home visit manual was developed using resources from 'Your heart, your life: A CHW's manual for the Hispanic community'[45] and adding components on family engagement to identify and solve problems.

Each CHW is provided with a list of trial participants to schedule and conduct home visits. All together, each participant will receive six home visits, the first visit within 2 months of enrolment, and 5 monthly visits thereafter. During the first home visit (lasting tentatively 90 min) the CHWs will introduce themselves, explain the purpose of the home visit, discuss hypertension, its consequences and management strategies, provide the information package, BP monitor and pill box showing them how to measure and keep BP logs and arrange medication in the pill box. The CHWs will encourage the participant and family members for critical thinking to identify problems

Table 3 Data collection method, respondent type and number for formative research

Tool	Respondent type and no
Focus group discussion guide (8–12 participants per group)	Three with hypertension patients (mix of ethnic, education and gender) in the study municipality
	Four with family members of hypertensive patients (mix of ethnic, education and gender) in the study municipality
Interview guide	Ten semistructured interviews with healthcare providers (government/ private)
	Eight semistructured interviews with hypertension patients (mix of ethnic, education, age and gender) in the study municipality
	Two key informant interviews with municipal authorities

in hypertension management in their home and community. They will apply inductive questioning techniques to initiate dialogue and reflection[46] on attempts and difficulties with lifestyle modification, medicine adherence, monitoring BP and routine follow-ups. They will be encouraged to make action plans to address the issues that are relevant for them. Each participant will pick a lifestyle goal based on the guideline for the management of high BP.[47]

In the subsequent home visits (lasting approximately 60 min), the CHWs will review the BP logs and address ongoing hypertension management problems. The participant and family members will be engaged in a cycle of action and reflection, discussing problems faced in achieving their goals and implementing their action plans. The discussion will be tailored to the specific needs of the participants and a new action plan for support will be developed as required.

Control arm

Participants in the control group will continue to seek routine hypertension care from health facilities. After 8 months of enrolment, follow-up data will be collected from the same participants.

Participants safety

The intervention is not expected to have any negative effects. We take informed consent before recruitment informing participants their rights to stop participation at any time during the trial. During the trial if the CHWs and interviewers observe patients having high BP or not feeling well, they are advised to follow government protocols to refer patients to the nearest health facility.

They will also record any adverse events informing the principal investigator who will inform the trial safety and monitoring committee.

Formative assessment

Prior to trial implementation, we applied qualitative methods to collect contextual information exploring factors affecting hypertension management in the trial area. Table 3 presents the estimated sample sizes for formative assessment.

Process evaluation

We will apply a mixed-method approach to explore how the context may influence intervention effect.[48] We will describe and understand the potential mechanisms

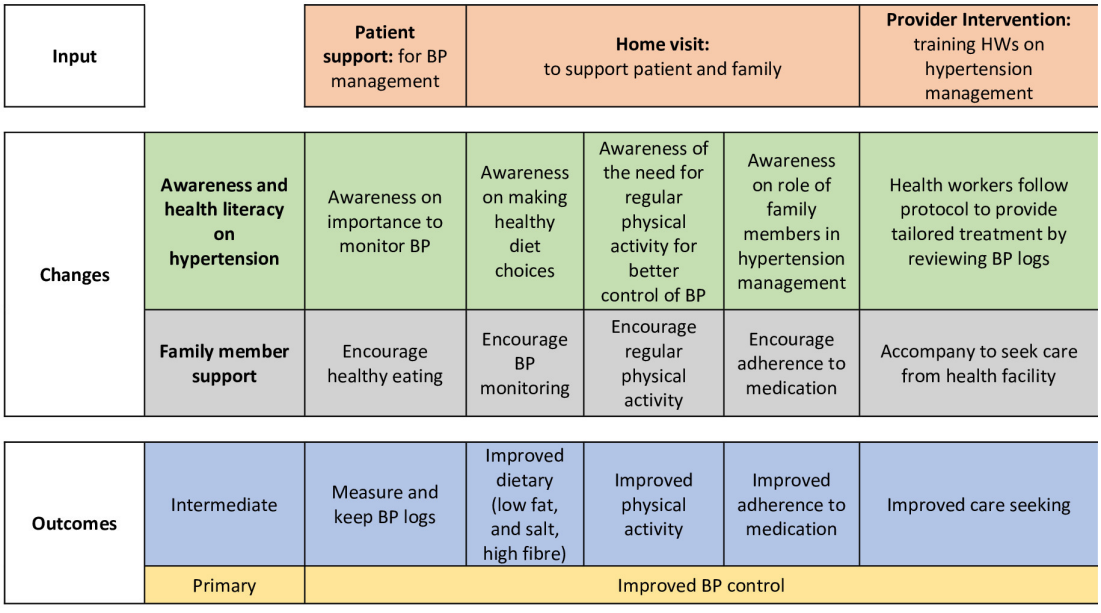

Figure 4 Theory of change. BP, blood pressure; HWs, health workers.

Table 4 Indicators to measure process outcomes

Implementation matrices	Indicator	Data source
Adoption	No of health workers and CHW completing Package of Essential Non-Communicble Disease (PEN) training	PEN training report
Acceptability	Proportion of participants: ► Consented to participate in the trial out of those eligible	Baseline
	► Whose family member/s attended the home visit sessions ► Missing follow-up visits to health facilities	Post home visit forms
	► Were satisfied with discussion during home visit sessions ► Were satisfied with service received from their health facilities ► Reported home visit as an acceptable way to receive counselling for hypertension management	Follow-up
Feasibility	Proportion of participants: ► Completing six home visit sessions ► Whose scheduled home visits were cancelled Mean no of calls/visits required for home visit	Post home visit forms
Effectiveness	Proportion of participants: ► Implemented the action plan ► Needed support to measure and keep logs of BP	Post home visit forms
	► Reported receiving satisfactory support from family members ► Felt confident in their hypertension knowledge and their ability to take actions to manage hypertension	Follow-up
Fidelity	Proportion of CHWs adhering to home visit manual	Observation of home visits
	Proportion of participants: ► Maintaining weekly BP logs	Post home visit forms
	► Adhering to prescribed medication	Follow-up
Coverage and reach	Proportion of participants: ► Enrolled from different sociodemographic groups (age, ethnic, gender, income and education)	Baseline
	► From different sociodemographic groups completing six home visits	Post home visit forms

BP, blood pressure; CHW, community health worker.

through which the intervention may affect the trial outcome using the theory of change in figure 4.

Quantitative process outcomes and the data sources are listed in table 4.

As part of process data after each home visits the CHWs document and submit participants progress, their reflection and copies of the action plan developed using a paper-based form. We will observe 50 home visit sessions (10 sessions per CHW) to describe intervention implementation, fidelity and adherence to home visit manuals. We will interview CHWs at three different points during intervention delivery to explore how context affects the intervention and analyse factors affecting the families' interaction during the home visits. We will conduct semi-structured interviews with trial participants and family members from intervention clusters to explore factors affecting their participation, acceptability and perception of the intervention. Twenty trial participants will be purposively sampled based on age, education, ethnicity and number of home visits attended. Twenty family members 15 participating and 5 not participating in the home visit will be sampled.

Three health workers from the intervention health facilities will be interviewed to discuss the feasibility and sustainability of home visits within the health system and community and three female community health volunteers involved in recruitment of participants to explore the factors affecting recruitment and enrolment of participants and their as well as the community perception of the intervention.

Statistical analysis plan

The baseline characteristics of the control and intervention group will be presented as the mean and SD for normally distributed continuous variables, median and IQR for skewed variables, and frequency and percentages for categorical variables.

Our primary analyses will follow an intention-to-treat approach comparing differences in difference in mean BP (net change in mean BP from baseline to 11 months follow-up) between the intervention and control group. Comparisons between the two groups will be performed using a generalised linear model (GLM) accounting for the clustering of the data and adjusting for baseline values of primary outcome. If a substantial baseline

imbalance between randomised groups is identified, an additional sensitivity analysis will be performed with additional adjustment for predefined variables (age, marital status, education and exposure to intervention) to assess the robustness of the primary analysis.

In the secondary 'per-protocol' analyses, the participants will be excluded if they (1) received less than five home visits, (2) did not complete assessment at follow-up or (3) were found not eligible based on the inclusion and exclusion criteria.

Secondary outcomes presented in table 2 will also be analysed using GLMM. Alongside mean differences between the outcome variables, OR and corresponding 95% CI will be estimated for all binary outcomes. In all analyses, SEs will be estimated by a clustered sandwich estimator.

We anticipate a very low proportion of missing data at baseline, but we expect some lost to follow-up or incomplete follow-up data. We will consider data as missing where the participant is unavailable, has moved away, or withdrawn consent but we do not regard data as 'missing' if the participant died or is unable to speak due to deteriorating health conditions. We are not planning imputation of the primary or any other outcome since there is little information on which to base the imputation other than baseline values of the outcomes, which will be adjusted for in our regression models.

Explanatory analyses of possible interaction will be undertaken to assess whether the observed intervention effect is modified by gender (male vs female), obesity (non-obese vs obese), salt intake (low vs high), socioeconomic status (low vs high). These subgroup analyses will be performed by adding the interaction term between randomised group and the subgroup variable into the regression model and assessed by likelihood ratio test. All statistical analyses will be performed using Stata V.16 (IBM).

Thematic analysis

All focus group discussions and interviews will be conducted in Nepali language by a native Nepali speaker and audiorecorded. Audiorecordings will be transcribed verbatim in Nepali. We will use inductive coding to allow findings to emerge from frequent, dominant and significant themes inherent in the raw data. Thematic analysis[49 50] of the data will be used to identify prominent themes. Two investigators will independently read 5% of transcripts several times to familiarise themselves with the data. They will identify meaningful units, such as phrases and quotes and condense these units and are abstracted and labelled with codes manually. We will accept an 80% intercoder agreement in coding between the two investigators. Then all coded and remaining transcripts are coded using Dedoose software. The various codes are compared based on differences and similarities and sorted into categories. The categories will be further discussed by the investigators for identification and formulation of themes and subthemes.

Ethics and dissemination

We have obtained ethical approval from Nepal Health Research Council (Protocol number: 682/2021) approved on 24 December 2021 with amendment approval on (24 January 2022 and 21 August 2022), and Regional Committee for Medical and Health Research Ethics, Norway (Reference number: 399479) approved on 22 February 2022. Approvals were sought from municipal representatives and health facility in charge. Written consent (signature or thumbprint) will be taken from eligible participants by enumerators at enrolment.

Patient and public involvement

Hypertension patients, their family members, health workers and municipal representatives were involved during the formative stage of the trial to provide feedback on the planned intervention and the information was used to guide development of the home visit manual and intervention package. However, they were not directly involved in developing research questions, study design, outcome measures and the intervention. The results of this study will be disseminated to the municipal committees and health facilities.

DISCUSSION

Hypertension, a common condition, disproportionately affects older men living in urban areas in Nepal.[3] Hypertension and its complications incur huge economic burden to individuals and the healthcare system. Low awareness, treatment and control of hypertension at the population level signify limited progress of current hypertension care approaches in Nepal.[3] Accelerated actions are essential in achieving the goal to reduce the burden of hypertension by 25% by 2025 as outlined in the multisectoral action plan for the prevention and control of non-communicable diseases (2014–2020).

Therefore, tailored interventions addressing individual-level and family-level behavioural change problems in hypertension management are needed. This cluster RCT evaluating CAHM is an innovative strategy for hypertension management in Nepal, which if found effective can have profound policy implications and has scalability potential. Its impact may not be limited to Nepal but to the rest of the LMICs with increasing burden of hypertension. In a federalised context municipalities in Nepal have authority to mobilise resources for local needs. This trial has received approval from the municipality, and they closely monitor its implementation. Their involvement and interest attest commitment to use the evidence generated from the trial. Locally generated evidence will serve as an asset to develop cost-effective programmes to curb the burden of hypertension. Being an RCT, we expect it to provide valid evidence on effectiveness of the CAHM interventions, and a well-documented process evaluation will guide future implementers to plan for any potential challenges. Choosing a cluster RCT has made the participant

recruitment process easier minimising contamination between trial arms.[51] Chances of family members and neighbours being recruited in the intervention may increase motivation to attend home visits, and adhere to healthy behaviours, lifestyle goals and agreed action plans made for hypertension management.

The trial also has some limitations, first by design a cluster RCT requires a larger sample size to account for intracluster correlation. Second, the minimum duration a participant is involved from enrolment to follow-up is 11 months, therefore, there is a possibility of lost to follow-up. Third, we only enrolled those who gave their consent to participate. This may lead to selection bias, however, reasons for not consenting and possibility of bias will be explored. Fourth, there is a chance of cross-over if participants seek hypertension care from outside their cluster (health facility). However, during formative assessment very few participants mentioned going to municipal health facilities for hypertension care, and also, those in the intervention arm will be continuously followed up by CHWs for 6 months so we expect minimal crossover.

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Contributors SB led the development of the protocol, writing of the draft manuscript and oversaw data collection and intervention delivery. ArS and AbS provided technical inputs during development of the protocol and trial implementation. SB, AbS, ArS, BOÅ, ES and BPM provided inputs and read and approved the final protocol.

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Competing interests None declared.

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REFERENCES

1 Lawes CM, Hoorn SV, Rodgers A. Global burden of blood-pressure-related disease, 2001. *The Lancet* 2008;371:1513–8.
2 Dhimal AK. 2020. Report of non communicable disease risk factors: steps survey Nepal 2019
3 Dhungana RR, Pandey AR, Shrestha N. Trends in the prevalence, awareness, treatment, and control of hypertension in Nepal between 2000 and 2025: a systematic review and meta-analysis. *Int J Hypertens* 2021;2021:6610649.
4 Paul KW. Clinical trials in heart disease. 2004.
5 Chobanian AV, Bakris GL, Black HR, *et al*. Seventh report of the joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension* 2003;42:1206–52.
6 Fagard R, Grassi G, Hall J, *et al*. International Society of hypertension low and middle income countries Committee. *J Hypertens* 2010;28:635–6.
7 Jafar TH, Stark PC, Schmid CH, *et al*. Progression of chronic kidney disease: the role of blood pressure control, proteinuria, and angiotensin-converting enzyme inhibition: a patient-level meta-analysis. *Ann Intern Med* 2003;139:244–52.
5 Institute of Medicine (US). *A population-based policy and systems change approach to prevent and control hypertension*. Washington, D.C, 13 July 2010.
9 Elliott WJ. Long-Term effects of weight-reducing interventions in hypertensive patients: systematic review and meta-analysis. *Yearbook of Cardiology* 2009;2009:88–90.
10 Kelley GA, Sharpe Kelley K. Aerobic exercise and resting blood pressure in older adults: a meta-analytic review of randomized controlled trials. *J Gerontol A Biol Sci Med Sci* 2001;56:M298–303.
11 Thompson S, Wiebe N, Padwal RS, *et al*. The effect of exercise on blood pressure in chronic kidney disease: a systematic review and meta-analysis of randomized controlled trials. *PLoS ONE* 2019;14:e0211032.
12 Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. *Journal of Cardiopulmonary Rehabilitation* 2001;21:176.
13 Svetkey LP, Simons-Morton DG, Proschan MA, *et al*. Effect of the dietary approaches to stop hypertension diet and reduced sodium intake on blood pressure control. *J Clin Hypertens (Greenwich)* 2004;6:373–81.
14 Cutler JA, Follmann D, Allender PS. Randomized trials of sodium reduction: an overview. *Am J Clin Nutr* 1997;65(2 Suppl):643S–651S.
15 Gueyffier F. Effect of antihypertensive drug treatment on cardiovascular outcomes in women and men. *Ann Intern Med* 1997;126:761.
16 Garg R, Yusuf S. Overview of randomized trials of angiotensin-converting enzyme inhibitors on mortality and morbidity in patients with heart failure. Collaborative group on ACE inhibitor trials. *JAMA* 1995;273:1450–6.
17 Flather MD, Yusuf S, Køber L, *et al*. Long-Term ACE-inhibitor therapy in patients with heart failure or left-ventricular dysfunction: a systematic overview of data from individual patients. *The Lancet* 2000;355:1575–81.
18 Psaty BM, Lumley T, Furberg CD, *et al*. Health outcomes associated with various antihypertensive therapies used as first-line agents: a network meta-analysis. *JAMA* 2003;289:2534–44.
19 Neal B, MacMahon S, Chapman N. Effects of ACE inhibitors, calcium antagonists, and other blood-pressure-lowering drugs: results of prospectively designed overviews of randomised trials. *The Lancet* 2000;356:1955–64.
20 Department of Health Services, Ministry of Health & Government of Nepal. Annual reportAvailable: https://dohs.gov.np/publications/
21 Shrestha S, Shrestha A, Koju RP, *et al*. Barriers and facilitators to treatment among patients with newly diagnosed hypertension in Nepal. *Heart Asia* 2018;10:e011047.
22 Devkota S, Dhungana RR, Pandey AR, *et al*. Barriers to treatment and control of hypertension among hypertensive participants: a community-based cross-sectional mixed method study in municipalities of Kathmandu, Nepal. *Front Cardiovasc Med* 2016;3:26.
23 Rawal LB, Kharel C, Yadav UN, *et al*. Community health workers for non-communicable disease prevention and control in Nepal: a qualitative study. *BMJ Open* 2020;10:e040350.
24 Walsh JME, Sundaram V, McDonald K, *et al*. Implementing effective hypertension quality improvement strategies: barriers and potential solutions. *J Clin Hypertension* 2008;10:311–6.
25 Walsh JME, McDonald KM, Shojania KG, *et al*. Quality improvement strategies for hypertension management: a systematic review. *Med Care* 2006;44:646–57.

26 Stergiou GS, Bliziotis IA. Home blood pressure monitoring in the diagnosis and treatment of hypertension: a systematic review. *Am J Hypertens* 2011;24:123–34.
27 Brownstein JN, Chowdhury FM, Norris SL, *et al*. Effectiveness of community health workers in the care of people with hypertension. *Am J Prev Med* 2007;32:435–47.
28 Brownstein JN, Bone LR, Dennison CR, *et al*. Community health workers as interventionists in the prevention and control of heart disease and stroke. *Am J Prev Med* 2005;29(5 Suppl 1):128–33.
29 Witmer A, Seifer SD, Finocchio L, *et al*. Community health workers: integral members of the health care work force. *Am J Public Health* 1995;85(8 Pt 1):1055–8.
30 Neupane D, McLachlan CS, Mishra SR, *et al*. Effectiveness of a lifestyle intervention led by female community health volunteers versus usual care in blood pressure reduction (cobin): an open-label, cluster-randomised trial. *Lancet Glob Health* 2018;6:e66–73.
31 Elliott WJ. Two self-management interventions to improve hypertension control: a randomized trial. *Yearbook of Cardiology* 2010;2010:88–9.
32 Bosworth HB, Olsen MK, Grubber JM, *et al*. Two self-management interventions to improve hypertension control: a randomized trial. *Ann Intern Med* 2009;151:687–95.
33 Mills KT, Rubinstein A, Irazola V, *et al*. Comprehensive approach for hypertension control in low-income populations: rationale and study design for the hypertension control program in Argentina. *Am J Med Sci* 2014;348:139–45.
34 Svetkey LP, Pollak KI, Yancy WS, *et al*. Hypertension improvement project. *Hypertension* 2009;54:1226–33.
35 Schwalm J-D, McCready T, Lopez-Jaramillo P, *et al*. A community-based comprehensive intervention to reduce cardiovascular risk in hypertension (hope 4): a cluster-randomised controlled trial. *Lancet* 2019;394:1231–42.
36 Weingarten SR, Henning JM, Badamgarav E, *et al*. Interventions used in disease management programmes for patients with chronic illness-which ones work? meta-analysis of published reports. *BMJ* 2002;325:925.
37 Budhanilakantha. बूढानलिकण्ठ नगरपालकिाको संक्षपि्त ववविरण. n.d. Available: https://budhanilkanthamun.gov.np/en/about
38 Rahimi K, Bidel Z, Nazarzadeh M, *et al*. Pharmacological blood pressure lowering for primary and secondary prevention of cardiovascular disease across different levels of blood pressure: an individual participant-level data meta-analysis. *The Lancet* 2021;397:1625–36.
39 van Breukelen GJP, Candel M. Calculating sample sizes for cluster randomized trials: we can keep it simple and efficient! *J Clin Epidemiol* 2012;65:1212–8.
40 Global Diet Quality Project - DQQ Tools & Data. *Global Diet Quality Project - DQQ Tools & Data*. Available: https://www.globaldietquality.org/dqq
41 World Health Organization. Global physical activity questionnaire global physical activity questionnaire (GPAQ). n.d. Available: www.who.int/chp/steps
42 Han H-R, Chan K, Song H, *et al*. Development and evaluation of a hypertension knowledge test for Korean hypertensive patients. *J Clin Hypertens (Greenwich)* 2011;13:750–7.
43 Morisky DE, Ang A, Krousel-Wood M, *et al*. Predictive validity of a medication adherence measure in an outpatient setting. *J Clin Hypertens (Greenwich)* 2008;10:348–54.
44 Epidemiology and Disease Control Division, Ministry of Health and Population & Government of Nepal. *Trainer's guide, Package of Essential Non Communicable Disease (PEN) Intervention at Primary Health Service Setting*.
45 Nhlbi. A community health worker's manual for the Hispanic community. In: *Your Heart, Your Life*.
46 Wallerstein N, Bernstein E. Empowerment education: freire's ideas adapted to health education. *Health Educ Q* 1988;15:379–94.
47 Farooq U, Ray SG. 2014 guideline for the management of high blood pressure (eighth joint National Committee): take-home messages. *Med Clin North Am* 2015;99:733–8.
48 Moore GF, Audrey S, Barker M, *et al*. Process evaluation of complex interventions: medical Research Council guidance. *BMJ* 2015;350:h1258.
49 Peterson BL. Thematic analysis/interpretive thematic analysis. Wiley, 2017.
50 Guest G, MacQueen K, Namey E. Applied thematic analysis. *Applied Thematic Analysis*. 2455 Teller Road, Thousand Oaks California 91320 United States : SAGE Publications, Inc, 2012.
51 Eldridge S, Kerry S, Torgerson DJ. Bias in identifying and recruiting participants in cluster randomised trials: what can be done? *BMJ* 2009;339:bmj.b4006.