Final Technical Report

for

Research Project

Effectiveness of Home Based Self-Monitoring of Blood Pressure in a Primary Care set-up of India. An Open Label Randomized Controlled Trial

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Final Technical Report

Disclaimer

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PROJECT REPORT

Effectiveness of Home-Based Self-Monitoring of Blood Pressure in a Primary Care set-up of India: An Open Label Randomized Controlled Trial

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New Delhi, India

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iii. List of Abbreviations

AIIMS	All India Institute of Medical Sciences
ASCVD	Atherosclerotic Cardiovascular Diseases
BMI	Body Mass Index
BP	Blood Pressure
CI	Confidence Interval
CONSORT	Consolidated Standards of Reporting Trials
CRF	Case Report Form
CRHSP	Comprehensive rural Health Services Project
CTRI	Clinical Trial Registry India
DBP	Diastolic Blood Pressure
HDSS	Health and Demographic Surveillance System
IEC	Institutional Ethics Committee
IHCI	India hypertension Control Initiative
IHD	Ischemic Heart Disease
ISH	International Society of Hypertension
MARS	Medication Adherence Reporting Scale
MI	Myocardial Infarction
mmHg	Millimeter Mercury
NCD	Non-Communicable Diseases
OR	Odds Ratio
PHCs	Primary Health Centers
RCTs	Randomized Controlled Trials
SBP	Systolic Blood Pressure
SD	Standard Deviation
SMBP	Self-Monitoring of Blood Pressure
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist-to-Height Ratio

1. PROJECT DETAILS

1.1 Title

Effectiveness of Home-Based Self-Monitoring of Blood Pressure in a Primary Care set-up of India: An Open Label Randomized Controlled Trial

1.2 Investigators

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Additional Professor, Center for Community Medicine
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1.3 Project Duration

The project duration was for 09 months, and a Technical Services Agreement vide WHO Reference number 2022/1304973-0 was signed between AIIMS, New Delhi and WHO.

1.4 Budget

The total budget sanctioned was INR 12,12,310.00 (released in four installments) excluding the Blood Pressure apparatus cost. Budget was revised after the first installment with the realization that the project needs travel cost for four staff (travel allowance) and additional contingency. The final budget allocated and utilized was INR 1,336,390.00.

1.5 Project Staff

Four staff were engaged in the EASE-BP project for data collection and delivery of project logistics.

Research Assistant

(a) Mr. Mohammad Nadeem

(b) Ms. Neetu

Field Worker

(a) Ms. KM Babita Jadon

(b) Ms. Jyoti Maan

1.6 Trial Registration Number

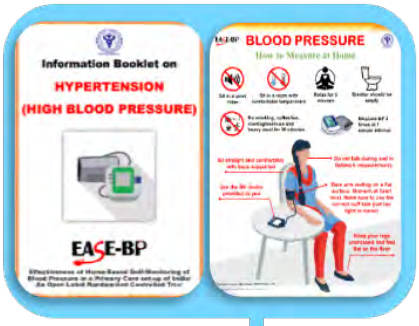
This trial was registered under Clinical Trial Registry – India with reference number CTRI/2023/02/049949 (registration date: 22/02/2023).

1.7 Ethics

Ethics approval was obtained from the Institutional Ethics Committee, All India Institute of Medical sciences, New Delhi (reference number: IEC-795/07.10.2023). Copy attached in ANNEXURE I.

2. PROJECT TIMELINE

The technical start of EASE-BP trial was on **1st March 2023** after obtaining project code from the PI institute. Prior to that, we had conducted meetings with the Primary Health Center Medical Officers and staff, developed trial educational materials, case report form (CRF), and constructed project CRF in RedCap online data capture tool.



Preparation of Information Booklet, Poster, Household BP Tracker and CRFs

Jan 2023

Received BP Device from WHO

Feb-March 2023

Training of staff and initiation of **fieldwork** on 15th April 2023

April 2023

Discussion of project and fieldwork modalities with Investigators at AIIMS-Ballabgarh site

Field site visitation and Project briefing with PHC Doctors and Sub-Center staff

Nov 2023

~ Completed Follow-Up
~ Data Entry
~ Data Cleaning

3. TRIAL OVERVIEW

3.1 Background and Rationale

Non-communicable Disease (NCD) pose the greatest public health challenge globally.[1] In India, NCD-related deaths increased from 37.9% in 1990 to 61.8% in 2016.[2] One underlying risk factor invariably attributed is hypertension.[3] Undetected/untreated hypertension and non-compliance to medication are the major culprits. Recently, the ICMR-INDIAB-17 study reported hypertension prevalence at 35.5%.[4] Conversely, a nationally representative study among hypertensive individuals reported 44.7% awareness, 13.3% on anti-hypertensive medication and only 7.9% with controlled blood pressure (BP).[5] Hence, public health initiatives are crucial for improving this gap. NCD and wellness clinics under national programs have been established to help achieve detection, treatment, and follow-up.[6,7] The India Hypertension Control Initiative (IHCI) is an excellent initiative to help achieve India's NCD goals.[8] However, challenges exist in community participation and changing attitudes. Its latest report indicated 23% of patients had uncontrolled BP and 27% did not return for follow-up.[8]

High-quality evidence on the effectiveness of different hypertension detection and control strategies is scarce.[9] Home-based self-monitoring of blood pressure (SMBP) is an effective way to detect and manage hypertension, recommended by major guidelines.[10-12] In a prospective cohort study, SMBP was effective in reducing BP, increased adherence, and attainment of target BP goals at 3-month follow-up.[13] Meta-analysis of RCTs, however, revealed SMBP in conjunction with co-interventions and not SMBP as a stand-alone intervention was associated with lower BP and better control.[14] Hence, we aimed to assess whether provision of a BP measuring device at home will lead to increased detection of hypertension, better control of BP, adherence to medication, and increased frequency of BP monitoring among those individuals compared to those without a BP apparatus while education and counseling is provided to both the groups.

3.2 Study Design and Setting

EASE-BP was an open-label randomized controlled trial in two distinct populations – self-reported non-hypertensive healthy individuals and individuals with known hypertension as previously diagnosed by a health professional. Participants from each population were randomly allocated to either the intervention group or the control group in 1:1 ratio. The study framework is shown in *Figure 1*.

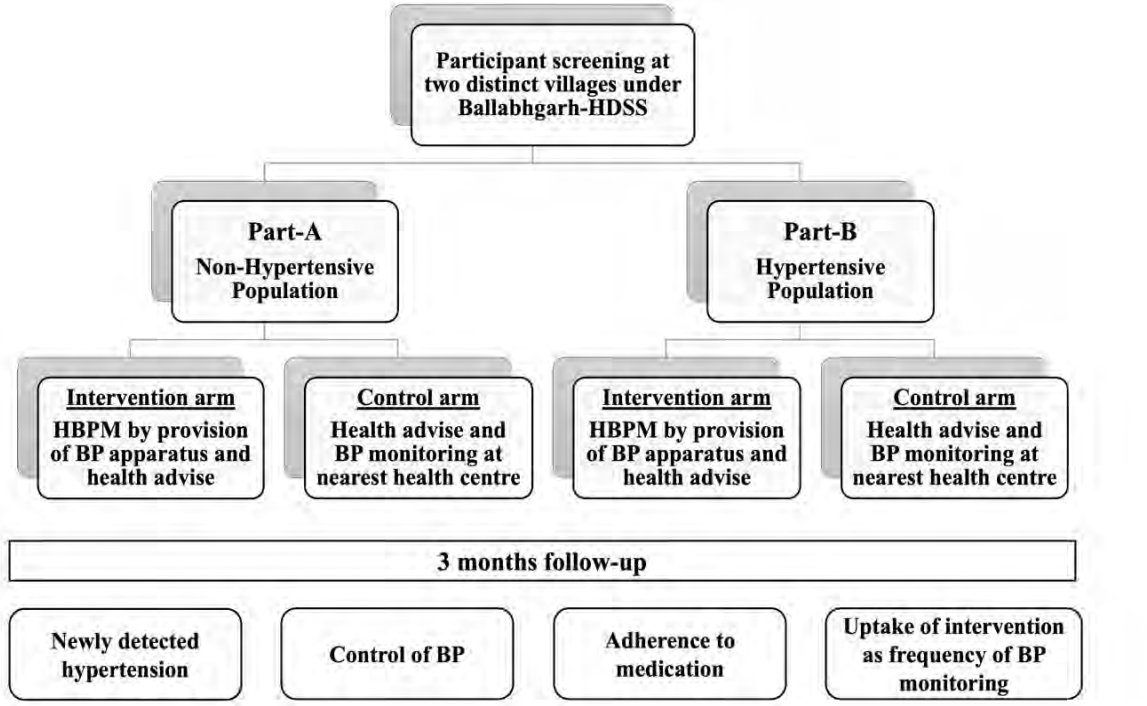


Figure 1: Study workflow of EASE-BP trial. *HDSS* health and demographic surveillance system. *HBPM* home-based blood pressure monitoring; *BP* blood pressure

The setting of the EASE-BP trial was in primary care, in the villages served by the Ballabgarh Health and Demographic Surveillance System (HDSS). The Ballabgarh HDSS, also known as Comprehensive Rural Health Services Project (CRHSP), is in North India, ~40 km to the south of New Delhi. It was established in 1965 to develop a model for rural health-care practice. The Ballabgarh HDSS has two Primary Health Centres (PHCs) and one sub-district level hospital. The two PHCs provide comprehensive primary health-care services to 28 villages, through a network of 12 sub-centres and they are under the administrative control of CRHSP, which is the rural wing of the All India Institute of Medical Sciences, New Delhi.

Two geographically isolated villages under the Ballabhgarh HDSS were randomly selected for sampling of the respective populations. A door-to-door household survey was conducted to identify eligible participants. Randomization was after ascertaining the inclusion and exclusion criteria. Only one individual per household was randomized if there are more than one eligible individual in a household *(Figure 2)*.

3.3 Inclusion and Exclusion criteria

Inclusion criteria (part-A)

1. Age ≥30 years

2. Self-reported no history of hypertension
3. Not on any antihypertensive medication currently or previously
4. Willingness to self-monitor BP at home or get BP examined at the nearby health centre
5. No cardiovascular comorbidity
6. Written informed consent

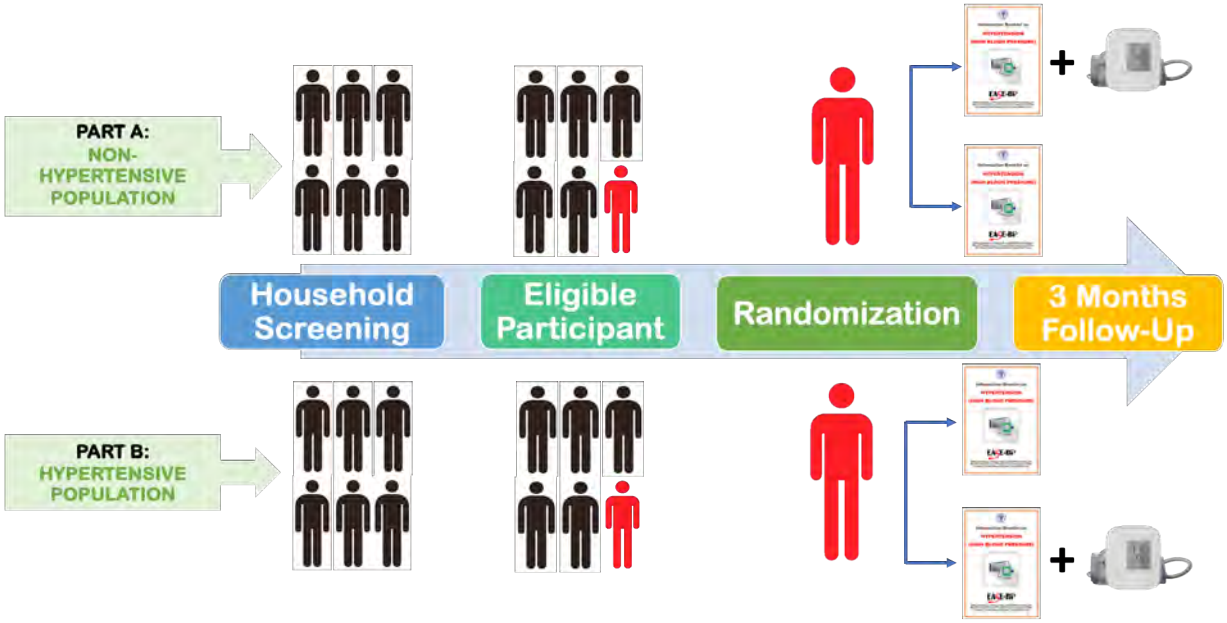


Figure 2: Sampling process

Inclusion criteria (part-B)

1. Age ≥18 years
2. Diagnosed as having hypertension previously by a physician or currently on antihypertensive medication
3. Willingness to self-monitor BP at home or get BP examined at the nearby health centre
4. Written informed consent

Exclusion criteria (both parts)

1. Pregnancy, lactating or planning pregnancy during the trial
2. Denial of consent, unwilling to self-monitor
3. Inability to undertake self-monitoring

3.4 Study objectives

The primary objective in the EASE-BP trial consists of two parts, corresponding to its two study populations.

Part-A non-hypertensive population

1. To assess the effectiveness of home-based Self-Monitoring of Blood Pressure in identifying new hypertensive cases among those with no hypertension.

Part-B hypertensive population

2. To assess the effectiveness of home-based Self-Monitoring of Blood Pressure in controlling BP among patients with hypertension.
3. To assess the effectiveness of home-based Self-Monitoring of Blood Pressure in *adherence to antihypertensive treatment.*

Secondary objectives (common to both parts)

1. Uptake of the intervention among the recruited participants.
2. Any vascular event including stroke, myocardial infarction (MI), or death.
3. Uptake of the intervention among the eligible family members of recruited participants and additional yield of new cases of hypertension.
4. To help integrate this intervention into the national NCD and IHCI programs for long-term NCD goals.

3.5 Randomization

Eligible participants were randomized in a 1:1 ratio to either the intervention group or control group. Computer-based block randomization in blocks of 4 was used to generate a random allocation sequence by an independent biostatistician. Allocation concealment was done using serially numbered opaque envelopes. The investigators and outcome assessors (biostatisticians) were blinded to the group allocation. Trial participants and research staff who assigned the participants to groups in real-time were not blinded *(Figure 3)*.

3.6 Study Intervention

Participants randomized in the intervention group were provided with a validated electronic BP device (model HEM-7156, Omron Corporation, Tokyo, Japan). They were trained by research staff for self-monitoring of BP as per the standard protocol established by the International Society of Hypertension (ISH)[12] and were advised to measure BP at least twice a

month (or more) and to maintain the BP log in a diary provided to them. Health education was given on the primary prevention of hypertension and atherosclerotic cardiovascular diseases (ASCVD) and provided educational booklets in the local language.

Figure 3: Research staff after imparting health education and training for self-measurement of blood pressure in intervention group

3.7 Control group

Participants randomized in the control group were given health education on the primary prevention of hypertension and ASCVD and provided educational booklets in the local language. They were advised to monitor their BP at least twice a month (or more) at the nearest sub-centre or PHC of the village and to maintain a BP log in a diary provided to them. Moreover, BP apparatus was provided at each village sub-centres and PHCs.

4. METHODOLOGY

The trial progressed dynamically from recruitment to follow-up. Each randomized participant was followed up for three months by the research staff. Data were collected at baseline and at each follow-up using a structured Case Report Form (CRF). The data variables and frequency of data collection is indicated in *Figure 4*.

4.1 Baseline Investigation

Post randomization the research staff measured BP (baseline BP) as per the standard protocol established by the International Society of Hypertension (ISH)[12] and recorded demographic details (age, sex, marital status, years of schooling, occupation), family medical history (history of hypertension, diabetes, IHD and stroke) and lifestyle information (smoking status, alcohol consumption, dietary pattern, physical activity). Anthropometric measurements including height, weight, waist circumference and hip circumference were measured as per standard protocol. Medication adherence in part-B hypertensive population was administered by the research staff and assessed using a validated scale.[15, 16]

Variables	Baseline	Follow-up visits		
		Month 1	Month 2	Month 3
Demographic detail	X			
Medical history	X			
Anti-hypertensive medication information†	X	X	X	X
Medication adherence†	X	X	X	X
Lifestyle information	X			X
BP measurement (by researcher)	X			X
BP measurement (from participant BP logbook)		X	X	X
Height	X			
Body weight	X			X
Waist circumference	X			X
Hip circumference	X			X

Figure 4: EASE-BP Trial data variables and data collection frequency

4.2 Follow-up Investigation

At each follow-up visit, the research staff noted the frequency of BP measurements and recorded the BP readings in CRF from participant's BP logbook. They also collected anti-

hypertensive medication information and administered medication adherence scale (in part-B hypertensive population). During the final follow-up visit (3-month), besides recording the BP measurements entered by participants in their BP logbook, the research staff repeated the CRF on lifestyle information, anthropometric measurements, and measured BP (endline BP).

4.3 Outcome Measures

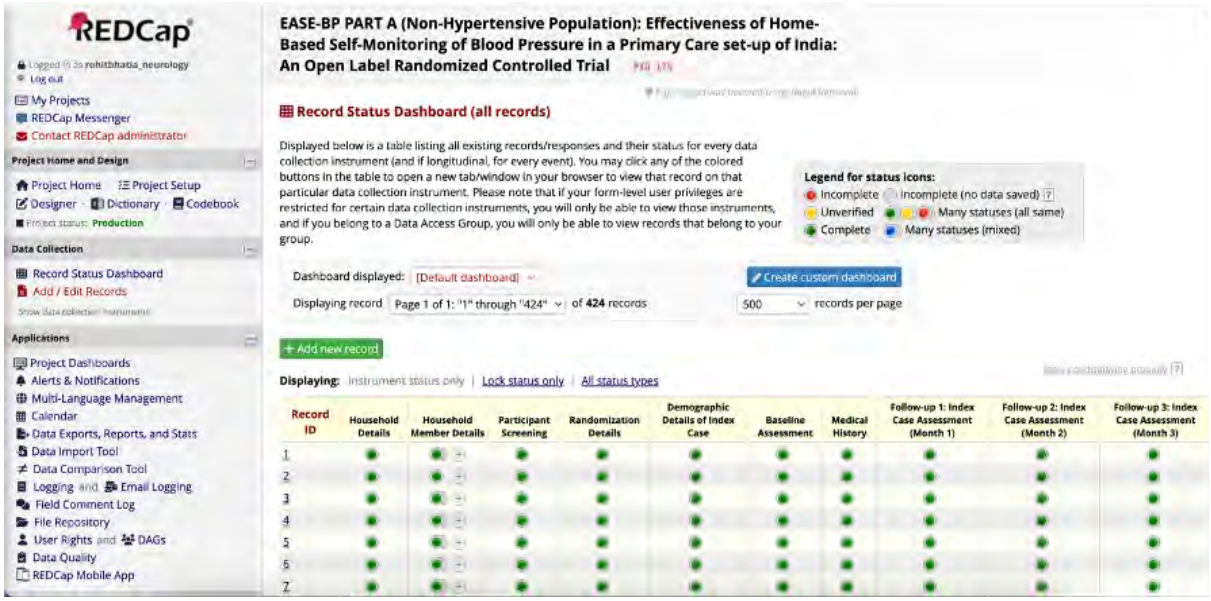
Primary outcome in part-A was measured as the incidence of new cases of hypertension that were identified during the 3-month follow-up between the intervention group and control group. The new cases were identified at each follow-up from the participant's BP logbook. The final proportion of newly detected hypertension were those individuals that were detected at least once throughout the study period (three months).

Primary outcome in part-B were measured as (1) change in SBP at 3-month follow-up, as assessed by the difference between the baseline and 3-month follow-up average SBP reading, between the intervention group and the control group. (2) Rate of medication adherence at 3-month follow-up, between the intervention group and the control group. The adherence to antihypertensive medication was measured by two methods – pill counting i.e., the proportion of days on which the participant took their anti-hypertensive medication as prescribed, divided by the total number of days that they are expected to take them (number of days in the assessed period), and a five-item Medication Adherence Report Scale (MARS-5)[25,26]

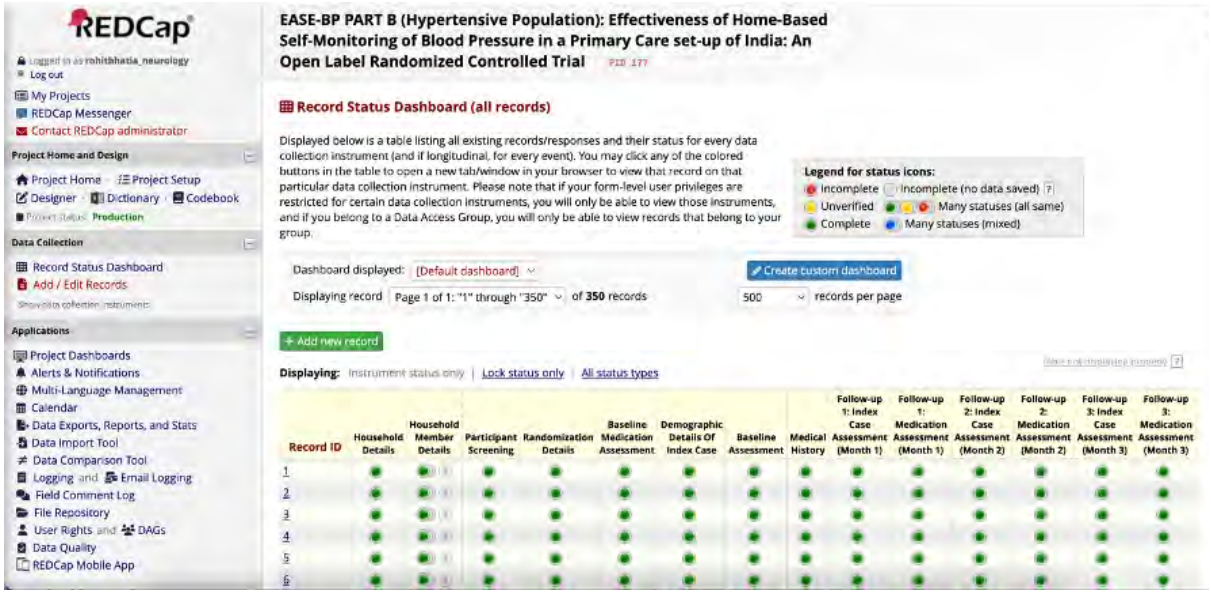
4.4 Data Management and Validation

Data were collected using a physical CRF and managed using REDCap electronic data capture tool hosted at All India Institute of Medical Sciences, New Delhi (*Figure 5*). Data were monitored and assessed for errors and missing information by an independent researcher monthly, as a quality control measure and to provide maximum data for the final analyses.

For data validation, BP measurements recorded by participants in the intervention group were validated by cross-checking the readings from their BP apparatus, matched with date and time. BP measurements recorded by participants in the control group were validated by confirming the signature of the health center staff.



(a)



(b)

Figure 5: RedCap Data capture tool. (a) Data of part-A non-hypertensive population. (b) Data of part-B hypertensive population

4.5 Statistical Analysis

Baseline characteristics were compared between the intervention group and the control group and were summarized as means with standard deviations (SD) for continuous variables, and frequencies with percentages for categorical variables. Differences were assessed using t-test for continuous variables and chi-square test for categorical variables. The primary outcome in part-A was assessed using binary logistic regression i.e., the association of getting diagnosed

as a new case of hypertension, with intervention, adjusted for covariates. The variables which are significant in univariable analysis at $p<0.25$ were included for multivariable binary logistic regression analysis. In part-B, primary outcome 1 and primary outcome 2 were assessed using simple linear regression, adjusted for covariates. The variables which were significant in univariable analysis at $p<0.25$ were included for multivariable linear regression analysis. Statistical significance for all tests were considered at $p<0.05$. Data analysis was performed using STATA statistical software (ver. 15).

5. TRIAL CONSORT

Between April and August 2023, a total of 662 households in part-A and 1380 households in part-B were screened for eligibility. The detailed trial CONSORT diagram is given in *Figure 6*. In part-A, 238 households were excluded and the reasons include: at least one hypertensive patient in the household and remaining not eligible as per study criteria (81 households), availability of BP apparatus at home (66 households), presence of cardiovascular comorbidity or lactating women or unavailable at home during home visits (39 households), and members from 52 households denied consent or were unwilling to self-monitor BP. In part-B, 1015 households were excluded due to no hypertensive patients in the family (1015 households) and availability of BP apparatus at home (15 households).

In part-A, 424 eligible individuals were randomly assigned to either the intervention group (n= 212) or the control group (n= 212). In part-A, 350 eligible individuals were randomly assigned to either the intervention group (n= 175) or control group (n= 175). All participants were followed up at month-1, -2, and -3. Four participants in part-A control group were unable to complete follow-up 1 and one each in follow-up 2 and 3. One participant each at follow-up 1 and 3 in part-B control group were unable to complete the trial assessment.

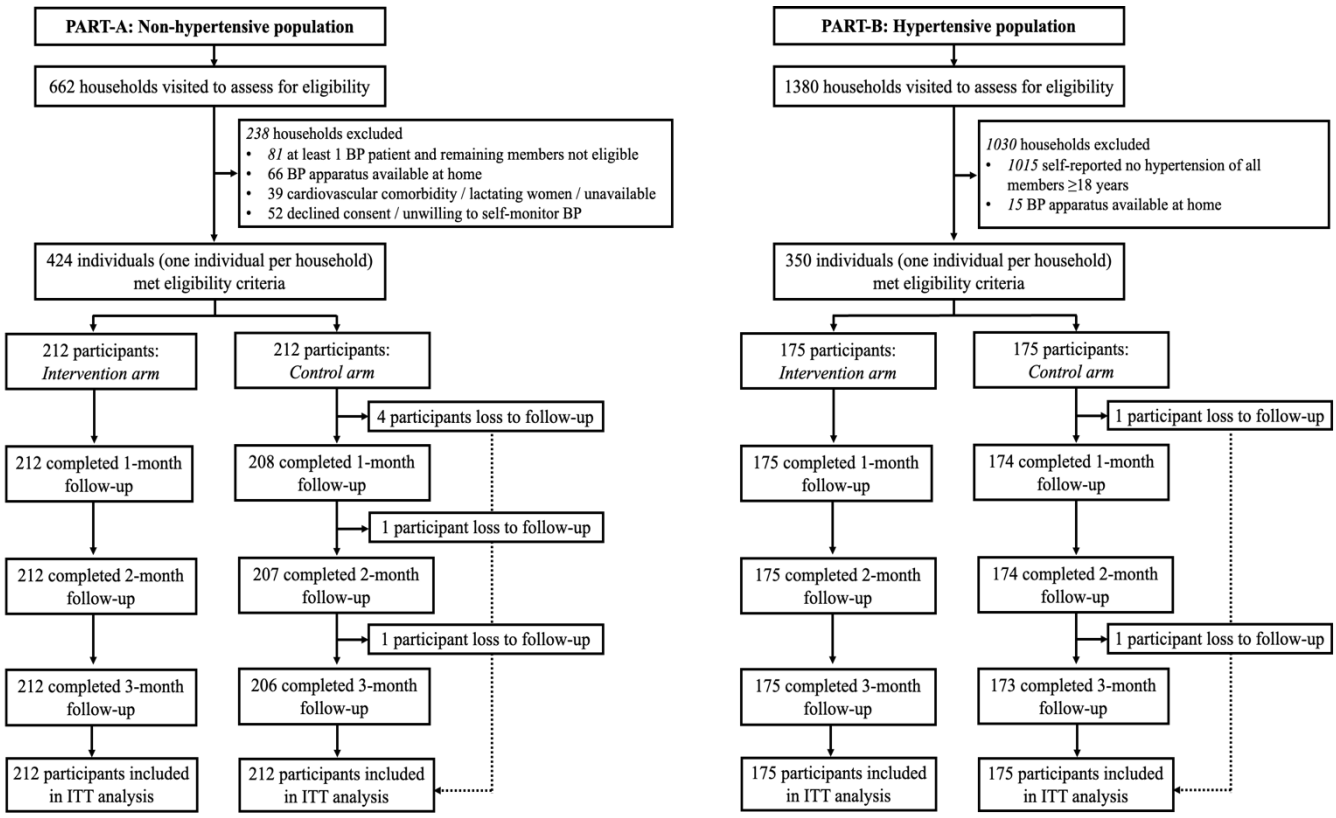


Figure 6: EASE-BP Trial CONSORT diagram

6. PART-A NON-HYPERTENSIVE POPULATION

6.1 Baseline Characteristics

Distribution of baseline demographic characteristics and lifestyle-behavioural characteristics were similar between the two groups (*Tables 1* and *2*). Mean age of the study population was 44 (SD±10.84) in the intervention group and 46 (SD±10.15) in the control group, while females were slightly more in each group. Family history of hypertension and diabetes was >40% and >20%, respectively in each group. Mean BMI was >25m/kg^2 in each group, suggesting a high burden of obesity among the study population.

Table 1: Part-A non-hypertensive population baseline demographic characteristics

Variable		**Intervention group (N= 212)**	**Control group (N= 212)**
Age (Mean ± SD)		44.37 ± 10.84	45.58 ± 10.15
Sex, N (%)	Male	96 (45.28)	98 (46.23)
	Female	116 (54.72)	114 (54.72)
Number of years of schooling (Mean ± SD)		6.05 ± 5.12	6.35 ± 5.51
Currently married, N (%)		212 (100.00)	212 (100.00)
Occupational status, N (%)	Primarily agriculture	37 (17.45)	43 (20.28)
	Homemaker/housewife	110 (51.89)	109 (51.42)
	Teacher	5 (2.36)	7 (3.30)
	Business/shopkeeper	13 (6.13)	18 (8.49)
	Professionals	30 (14.15)	24 (11.32)
	Others	17 (8.02)	11 (5.19)
Family medical history	Hypertension	89 (41.98)	87 (41.04)
	Diabetes	48 (22.64)	46 (21.70)
	Stroke	32 (15.09)	31 (14.62)
	IHD	40 (18.87)	48 (22.64)
Height (Mean ± SD)		162.52 ± 10.18	162.40 ± 10.18
Weight (Mean ± SD)		66.79 ± 13.19	67.90 ± 16.17
BMI (Mean ± SD)		25.22 ± 4.09	25.66 ± 5.27
Waist circumference (Mean ± SD)		94.12 ± 10.30	95.64 ± 13.78
Hip circumference (Mean ± SD)		100.48 ± 9.60	100.44 ± 10.11

N number, *SD* standard deviation, *BMI* body mass index, *IHD* ischemic heart disease

Table 2: Part-A non-hypertensive population baseline behavioural and lifestyle characteristics

Variables		Intervention group (N= 212)	Control group (N= 212)
Tobacco-smoking		37 (17.45)	31 (14.62)
Tobacco-chewing		12 (5.66)	11 (5.19)
Hookah smoking		11 (5.19)	7 (3.30)
Alcohol intake		31 (14.62)	27 (12.74)
Dietary habit	Vegetarian	148 (69.81)	144 (67.92)
	Non-vegetarian	64 (30.19)	68 (32.08)
Physical activity	Active	211 (99.53)	210 (99.06)
	Non-active	1 (0.47)	2 (0.94)
BMI	Normal	68 (32.08)	64 (30.19)
	Overweight	39 (18.40)	39 (18.40)
	Obese	105 (49.53)	109 (51.42)
WC	Optimal	34 (16.04)	42 (19.81)
	High	178 (83.96)	170 (80.19)
WHR	Optimal	15 (7.08)	7 (3.30)
	High	197 (92.92)	205 (96.70)

Data presented as number (percentage). *BMI* body mass index, *WC* waist circumference, *WHR* waist-to-hip ratio

6.2 Result of Primary Objective

"To assess the effectiveness of home-based Self-Monitoring of Blood Pressure in identifying new hypertensive cases among those with no hypertension"

- The outcome of primary objective in part-A non-hypertensive population were analyzed as per the intention-to-treat analysis plan.
- Participants who did not self-monitored their BP (in intervention group) or who did not visit health-center for BP monitoring (in control group) were assumed to be undetected.
- The outcome assessment i.e., new cases of hypertension detection was based on **any measurement** among participants with logbook recorded BP measurements.

New cases of hypertension were defined using three criteria: (1) SBP ≥140 mmHg and/or DBP ≥90 mmHg[17] in both intervention group and control group. (2) SBP ≥135 mmHg and/or DBP ≥85 mmHg in intervention group based on ISH hypertension definition guideline for home-

based self-monitoring[12] and SBP ≥140 mmHg and/or DBP ≥90 mmHg in control group. (3) SBP ≥135 mmHg and/or DBP ≥85 mmHg in both intervention group and control group (modified ISH guideline).

Individuals meeting the three defining criteria for once or more (corresponding to their number of BP measurements) were considered as newly detected hypertension. The final proportion of newly detected hypertension were those individuals that were detected at least once throughout the study period (three months).

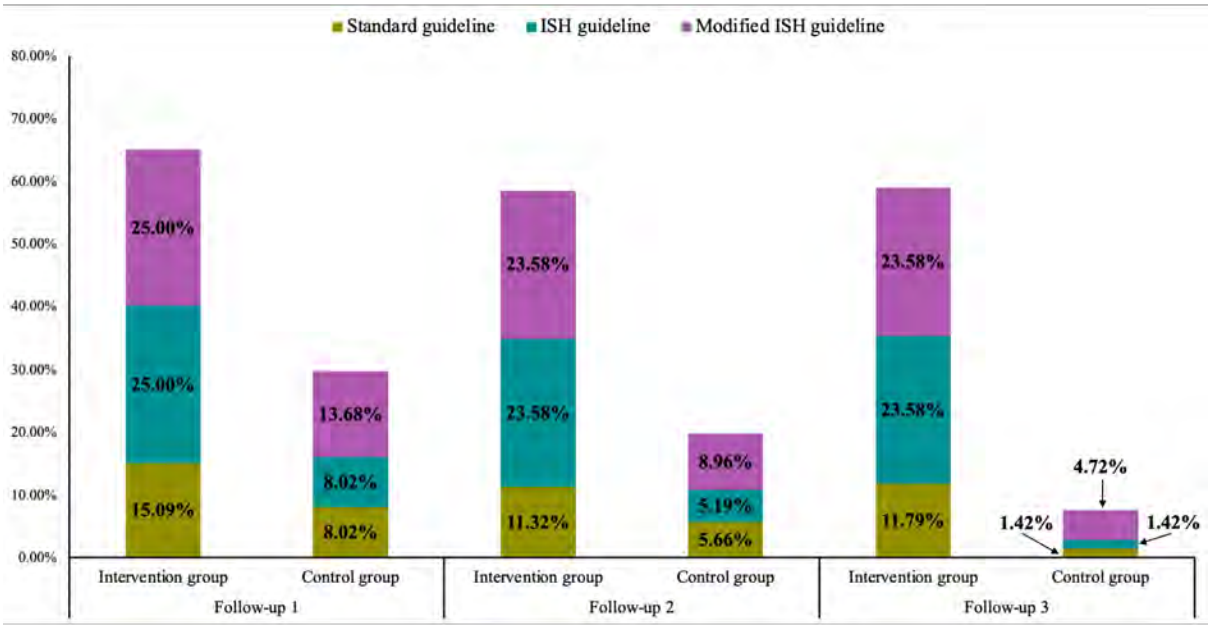


Figure 7: Part-A non-hypertensive population primary outcome at each monthly follow-up based on the hypertension definition

Figure 7 shows the rate of hypertension detection at each monthly follow-up based on the different hypertension definition between the intervention group and the control group. The rate of hypertension detection was significantly higher in the intervention group compared to the control group at each follow-up, irrespective of the definition used ($p<0.001$). In 1-month follow-up, the proportion of newly detected hypertension was 15.09% in the intervention group vs 8.02% in the control group based on the standard guideline. Similarly, it was 25% in the intervention group vs 8.02% in the control group and 25% in the intervention group vs 13.68% in the control group based on ISH guideline and modified ISH guideline, respectively. The same trend is observed at 2-month follow-up and 3-month follow-up (*Figure 7*).

Table 3 presents the proportion of newly detected hypertension during the study period as per the three guidelines. The total number of newly detected hypertension was 77 (18.16%) based

on the standard guideline, 116 (27.36%) as per the ISH guideline, and 136 (32.08%) as per the modified ISH guideline. The newly detected hypertension was significantly higher in the intervention group as compared to those in the control group based on all the three guidelines [*standard guideline*: intervention group (53, 25.00%) vs control group (24, 11.32%); p<0.001], [*ISH guideline*: intervention group (92, 43.40%) vs control group (24, 11.32%); p<0.001), [*modified ISH guideline*: intervention group (92, 43.40%) vs control group (44, 20.75%); p<0.001].

Table 3: Part-A non-hypertensive population primary outcome during the 3-month follow-up

Hypertension detection		**Total**	**Intervention group**	**Control group**	***p*-value**
Standard guideline	Not detected	347 (81.84)	159 (75.00)	188 (88.68)	<0.001
	New case of hypertension	77 (18.16)	53 (25.00)	24 (11.32)	
ISH guideline	Not detected	308 (72.64)	120 (56.60)	188 (88.68)	<0.001
	New case of hypertension	116 (27.36)	92 (43.40)	24 (11.32)	
Modified ISH guideline	Not detected	288 (67.92)	120 (56.60)	168 (79.25)	<0.001
	New case of hypertension	136 (32.08)	92 (43.40)	44 (20.75)	

Data are presented as number (percentage)

Logistic regression analysis was performed to investigate the likelihood of hypertension detection due to our study intervention (*Figure 8*). In the unadjusted model, intervention was significantly associated with higher odds of hypertension detection [standard guideline: OR= 2.61 (95% CI 1.54-4.42) p<0.001; ISH guideline: OR= 6.01 (95% CI 3.63-9.94) p<0.001; modified ISH guideline: OR= 2.93 (95% CI 1.91-4.49) p<0.001]. When adjusted for covariates (age, sex, BMI, waist circumference, hip circumference, baseline SBP, baseline SBP, tobacco-smokeless, smoking, alcohol consumption, family history of diabetes, and family history of stroke), intervention was associated with significantly higher likelihood of hypertension detection [standard guideline: OR= 3.59 (95% CI 1.93-6.66) p<0.001; ISH guideline: OR= 9.94 (95% CI 5.38-18.38) p<0.001; modified ISH guideline: OR= 3.77 (95% CI 2.31-6.15) p<0.001].

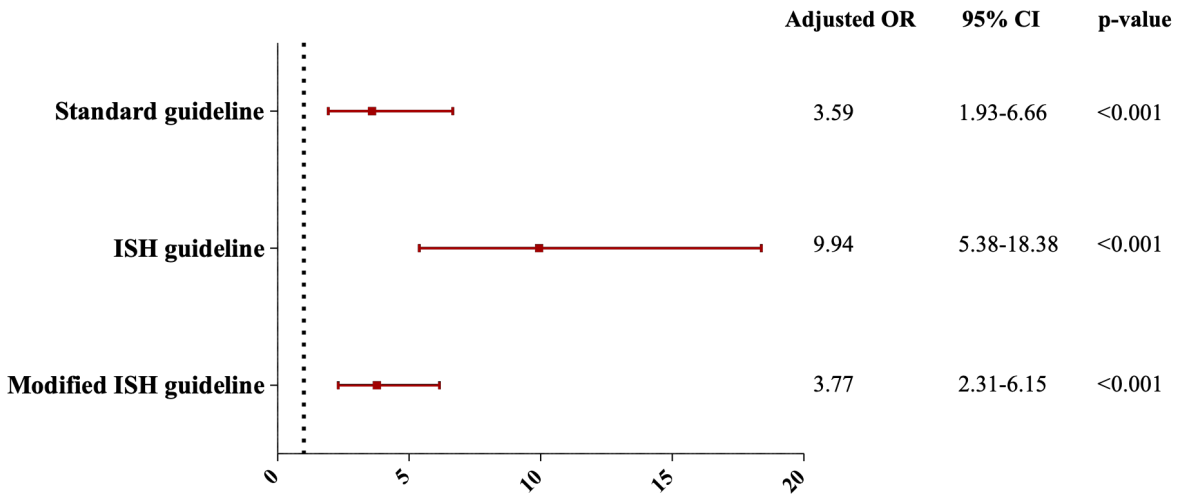


Figure 8: Part-A non-hypertensive population – Forest plot showing the association of study intervention with primary outcome. Adjusted for age, sex, BMI, waist circumference, hip circumference, baseline SBP, baseline SBP, tobacco-smokeless, smoking, alcohol consumption, family history of diabetes, and family history of stroke

6.3 Result of Part-A Secondary Objective 1

"Uptake of the intervention as assessed by frequency of BP monitoring among index participants and family members"

Secondary objective 1 assessed the frequency of BP measurements in the intervention group (number of BP measurements based on self-monitoring) and the control group (number of BP measurements based on monitoring from health-center) among both the index participants and their family members. For index participants, the frequency of BP measurements was identified from the participant BP logbook and for family members, the frequency of BP measurements was identified from the family BP logbook.

The total number of index participants who measured their BP at least 2 times each month was 189/424 at month-1, 169/424 at month-2, and 147/424 at month-3 *(Figure 9)*. Among them, the frequency of BP measurement was significantly higher in the intervention group as compared to the control group at each follow-up month i.e., at month-1: 156 (73.58%) in intervention group vs. 33 (15.57%) in control group; at month-2: 137 (64.62%) in intervention group vs. 33 (15.09%) in control group; at month-3: 132 (62.26%) in intervention group vs. 15 (7.08%) in control group. The **uptake of intervention (SMBP)** by the study population was 73.58% at month-1, 64.62% at month-2 and 62.26% at month-3.

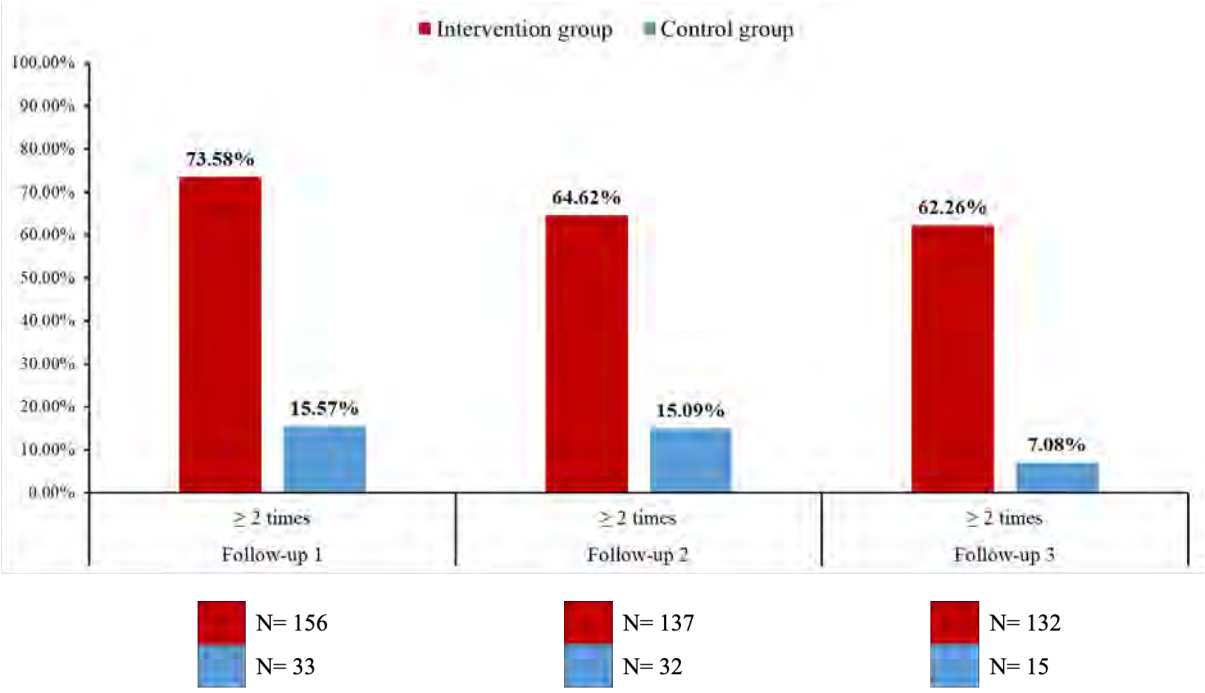


Figure 9: Part-A non-hypertensive population – Frequency of BP measurements among index participants during the study period between intervention group and control group

The mean number of family members who were 18 years and above in part-A non-hypertensive population was 3 (range: 0-9). In both the intervention group and control group, the mean number of family members was 3. There were a total of 1280 family members who were 18 years and above, out of which 663 were in the intervention group and 617 were in the control group.

Figure 10 shows the frequency of BP measurements among family members of index participants. The total number of family members who measured their BP at least 2 times each month was 270/1280 at month-1, 281/1280 at month-2, and 248/1280 at month-3. Among them, the frequency of BP measurement was significantly higher in the intervention group as compared to the control group at each follow-up month i.e., at month-1: 259 (39.06%) in intervention group vs. 11 (1.78%) in control group; at month-2: 257 (38.76%) in intervention group vs. 24 (3.89%) in control group; at month-3: 233 (35.14%) in intervention group vs. 15 (2.43%) in control group. The **uptake of intervention (SMBP)** by the study population was 39.06% at month-1, 38.76% at month-2 and 35.14% at month-3.

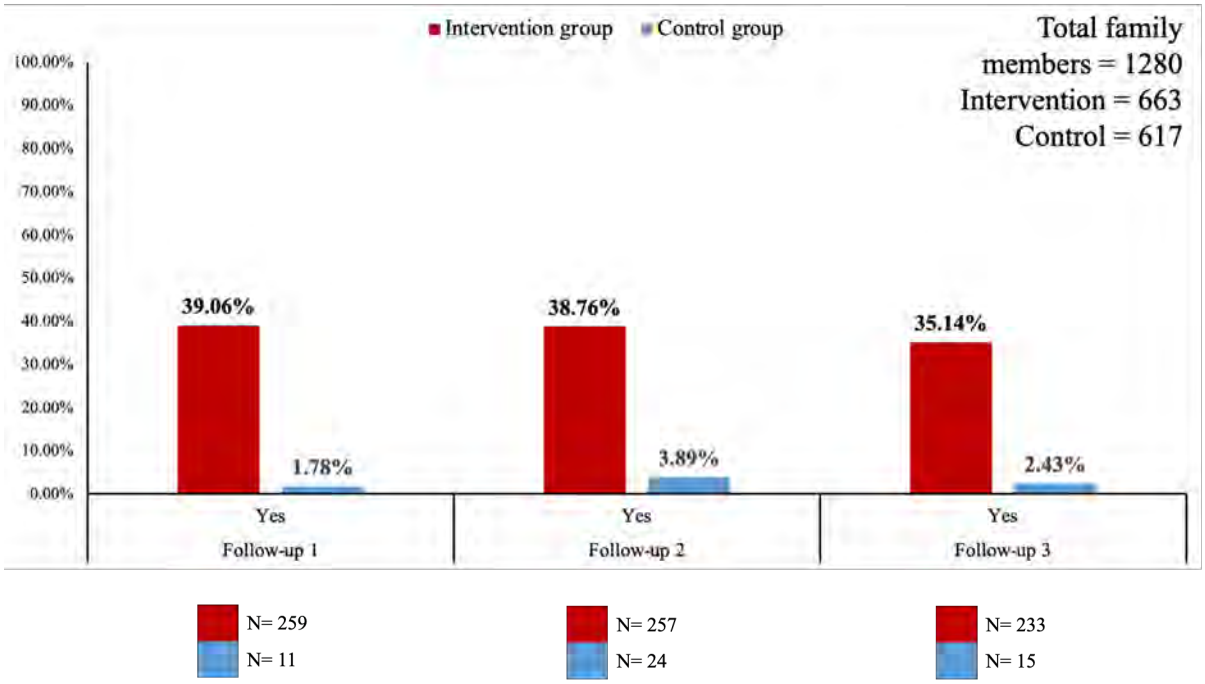


Figure 10: Part-A non-hypertensive population – Frequency of BP measurements (at least 2 times) among family members during the study period between intervention group and control group

6.4 Results of Part-B Secondary Objective 2

"Any vascular event including stroke, myocardial infarction (MI), or death"

In part-A non-hypertensive population, no vascular events or mortality due to vascular origins were recorded during the study period (*Table 4*).

Table 4: Vascular events and/or death between the intervention group and control group in part-A non-hypertensive population

Events	Follow-up 1		Follow-up 2		Follow-up 3	
	Intervention group	**Control group**	**Intervention group**	**Control group**	**Intervention group**	**Control group**
Stroke	0/212	0/212	0/212	0/212	0/212	0/212
MI	0/212	0/212	0/212	0/212	0/212	0/212
Death	0/212	0/212	0/212	**1/212**	**1/212**	0/212
Reason for death	NA	NA	NA	Suicide	Suicide	NA

MI myocardial infarction

6.5 Result of Part-A Secondary Objective 3

"To measure additional yield of new cases among all the family members, where the denominator will be the total number of household members in each group"

Additional yields of new cases of hypertension among family members of recruited participants were identified based on **any measurement** of logbook recorded BP measurements among family members at each follow-up. The new cases of hypertension were defined according to the three criteria: standard guideline, ISH guideline, and modified ISH guideline. The final proportion of newly detected hypertension were those individuals that were detected at least once throughout the study period (three months). Family members with no BP recordings (SMBP or BP from health center) were considered as not detected. From the total of 1280 family members in part-A non-hypertensive population who were 18 years and above, 224 (17.5%) had a previous history of hypertension or were on antihypertensive medication (self-reported) – 110 were in the intervention group and 117 were in the control group. Therefore, the additional yield of new cases of hypertension was estimated from the self-reported non-hypertensive family members. There were 1056 family members with no history of hypertension – 553 were in the intervention group and 503 were in the control group.

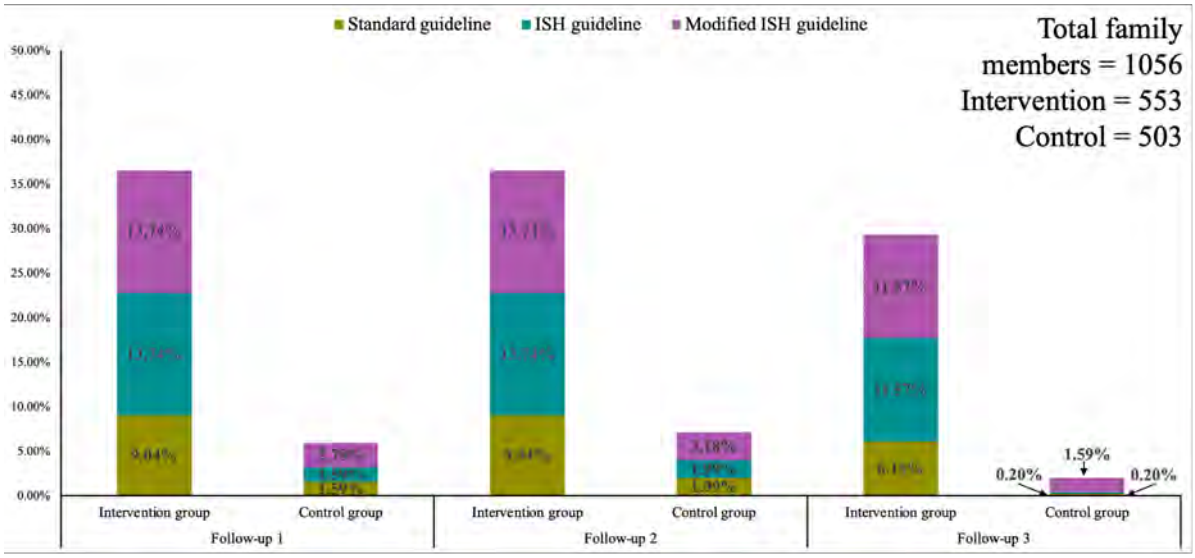


Figure 11: Part-A non-hypertensive population – Additional yield of new cases of hypertension among the family members of index participant during the study period between intervention group and control group

Figure 11 shows the rate of hypertension detection among family members at each monthly follow-up based on the different hypertension definition between the intervention group and

the control group. The rate of hypertension detection was significantly higher in the intervention group compared to the control group at each follow-up (p<0.001). In 1-month follow-up, the proportion of newly detected hypertension was 9.04% in the intervention group vs 1.59% in the control group based on standard guideline definition. Similarly, it was 13.74% in the intervention group vs 1.59% in in the control group, and 13.74% in the intervention group vs 2.78% in the control group based on ISH guideline and modified ISH guideline, respectively. The same trend is observed at 2-month follow-up and 3-month follow-up (*Figure 11*).

Table 5: New cases of detected hypertension among family members in part-A non-hypertensive population

Hypertension detection		**Total**	**Intervention group**	**Control group**	***p*-value**
Standard guideline	Not detected	950 (89.96)	459 (83.00)	491 (97.61)	<0.001
	New case of hypertension	106 (10.04)	94 (17.00)	12 (2.39)	
ISH guideline	Not detected	895 (84.75)	404 (73.06)	491 (97.61)	<0.001
	New case of hypertension	161 (15.25)	149 (26.94)	12 (2.39)	
Modified ISH guideline	Not detected	881 (83.43)	404 (73.06)	477 (94.83)	<0.001
	New case of hypertension	175 (16.57)	149 (26.94)	26 (5.17)	

Data are presented as number (percentage). *ISH* International Society of Hypertension

Table 5 presents the proportion of newly detected hypertension among family members during the study period. Out of the 1056 family members, the total number of newly detected hypertension was 106 (10.04%) as per the standard guideline, 161 (15.25%) as per the ISH guideline, and 175 (16.57%) as per the modified ISH guideline. The newly detected hypertension among family members was significantly higher in the intervention group as compared to those in the control group based on all the three guidelines [*standard guideline*: intervention group (94, 17.00%) vs control group (12, 2.39%); p<0.001], [*ISH guideline*: intervention group (149, 26.94%) vs control group (12, 2.39%); p<0.001), [*modified ISH guideline*: intervention group (149, 26.94%) vs control group (26, 5.17%); p<0.001].

Table 6: Logistic regression showing the association of study intervention with hypertension detection among family members in part-A

Hypertension guidelines	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Standard	8.38	4.53-15.49	<0.001	8.69	4.67-16.17	<0.001
ISH	15.09	8.26-27.58	<0.001	15.89	8.65-29.21	<0.001
Modified ISH	6.77	4.37-10.47	<0.001	7.04	4.52-10.97	<0.001

Adjusted for age and sex

Logistic regression analysis was performed to investigate the likelihood of hypertension detection due to our study intervention among family members (Table 6). After adjusting for age and sex, intervention was associated with significantly higher likelihood of hypertension detection [standard guideline: OR= 8.69 (95% CI 4.67-16.17) p<0.001; ISH guideline: OR= 15.09 (95% CI 8.65-29.21) p<0.001; modified ISH guideline: OR= 7.04 (95% CI 4.52-10.97) p<0.001].

7. PART-B HYPERTENSIVE POPULATION

7.1 Baseline Characteristics

Distribution of baseline demographic characteristics, medical history, and lifestyle-behavioural characteristics were similar between the two groups (*Tables 7, 8 and 9*). Mean age of the study population was 54 (SD±12.01) in the intervention group and 53 (SD±13.52) in the control group, while females were more in each group. Mean BMI was >25m/kg^2 in each group, suggesting a high burden of obesity among the study population.

Table 7: Part-B hypertensive population baseline demographic characteristics

Variable		**Intervention group (N= 175)**	**Control group (N= 175)**
Age (Mean ± SD)		53.59 ± 12.01	52.59 ± 13.52
Sex, N (%)	Male	50 (28.57)	59 (33.71)
	Female	125 (71.43)	116 (66.29)
No. of years of schooling (Mean ± SD)		6.05 ± 5.12	6.35 ± 5.51
Marital status, N (%)	Married	175 (100.00)	174 (99.43)
	Unmarried	0 (0.00)	1 (0.57)
Occupational status, N (%)	Primarily agriculture	13 (7.43)	14 (8.00)
	Homemaker/housewife	83 (47.43)	76 (43.43)
	Business/shopkeeper	9 (5.14)	7 (4.00)
	Professionals	13 (7.43)	18 (10.29)
	Others	57 (32.57)	60 (34.29)
Height (Mean ± SD)		158.19 ± 9.49	158.50 ± 10.36
Weight (Mean ± SD)		65.92 ± 12.22	64.57 ± 14.41
BMI (Mean ± SD)		26.33 ± 4.24	25.66 ± 4.92
Waist circumference (Mean ± SD)		91.89 ± 10.77	89.27 ± 13.60
Hip circumference (Mean ± SD)		99.86 ± 10.40	97.16 ± 12.21

SD standard deviation

Although no differences were observed between groups, family history of hypertension and diabetes was >50% and >25%, respectively in each group (*Table 9*). There were high instances of self-reported diabetes co-morbidity in each group among the study participants (21.14% in the intervention group, 22.29% in the control group).

Table 8: Part-B hypertensive population baseline medical history

Medical history		**Intervention group (N= 175)**	**Control group (N= 175)**
Family medical history	Hypertension	90 (51.43)	90 (51.43)
	Diabetes	48 (27.43)	53 (30.29)
	Stroke	30 (17.14)	27 (15.43)
	IHD	35 (20.00)	30 (17.14)
Self-medical history	Diabetes	37 (21.14)	39 (22.29)
	Stroke	11 (6.29)	11 (6.29)
	IHD	20 (11.43)	20 (11.43)

IHD ischemic heart disease. Data presented as number (percentage)

Table 9: Part-B hypertensive population baseline behavioural and lifestyle characteristics

Variables		**Intervention group (N= 175)**	**Control group (N= 175)**
Tobacco-smoking		4 (2.29)	6 (3.43)
Tobacco-chewing		27 (15.43)	37 (21.14)
Hookah smoking		14 (8.00)	15 (8.57)
Alcohol intake		9 (5.14)	18 (10.29)
Dietary habit	Vegetarian	142 (81.14)	142 (81.14)
	Non-vegetarian	33 (18.86)	33 (18.86)
Physical activity	Active	174 (99.43)	172 (98.29)
	Non-active	1 (0.57)	3 (1.71)
BMI	Overweight	31 (17.71)	27 (15.43)
	Obese	106 (60.57)	89 (50.86)
WC	Optimal	32 (18.29)	56 (32.00)
	High	143 (81.71)	119 (68.00)
WHR	Optimal	13 (7.43)	16 (9.14)
	High	162 (92.57)	159 (90.86)

BMI body mass index, *WC* waist circumference, *WHR* waist-to-hip ratio. Data presented as number (percentage)

7.2 Result of Primary Objective 1

"To assess the effectiveness of self-monitoring of blood pressure in controlling blood pressure among patients with hypertension in a community set-up of North India"

To assess the control of BP in hypertensive population, the outcome of objective 1 was measured as the difference in SBP and hypertension control status at 3-month follow-up between the intervention group and control group. The BP control was assessed through two methods based on the source of data obtained at the end of study – (a) BP measurements at 3-month follow-up measured by the research staff, and (b) BP measurements obtained from participant's BP logbook at 3-month follow-up.

7.2.1 BP Measurements by Research Staff at 3-month Follow-up

To observe any difference in SBP at 3-month follow-up between intervention group and control group, a delta change was constructed between SBP at baseline and at 3-months based on BP measurements by the research staff (*Figure 12*). The trial observed reduction in SBP in both the intervention group (–6.57 mmHg) and the control group (–6.24 mmHg) at 3-month follow-up, with no statistical difference between the two groups. Similarly, DBP in the intervention group decreased by –3.16 mmHg in the intervention group and by –5.16 mmHg in the control group at 3-month follow-up, with no statistical difference between the two groups.

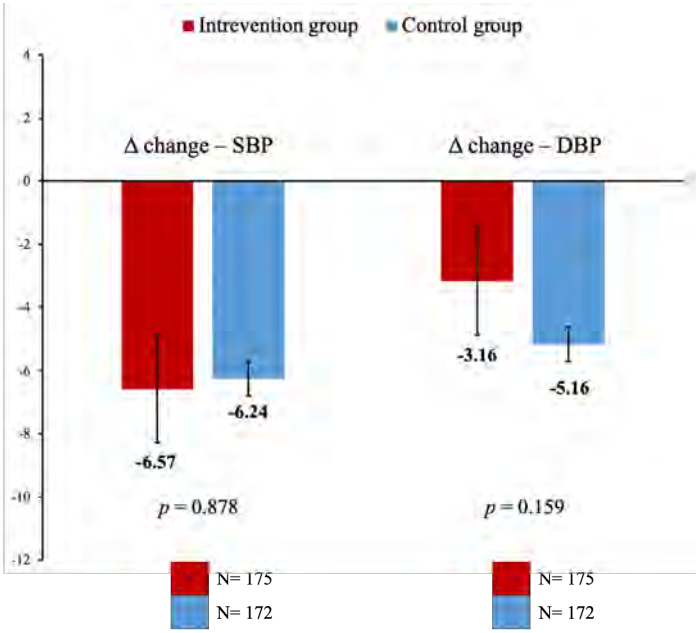


Figure 12: Difference in SBP and DBP at 3-month follow-up between the intervention group and control group (BP as measured by research staff)

Further, linear regression was performed to assess the association of the difference in SBP between baseline and at 3-months based on BP measurements by the research staff, with intervention (*Table 10*). The analysis revealed that our trial intervention was not associated with the observed difference in SBP and DBP between baseline and at 3-month follow-up, adjusted for multiple covariates.

Table 10: Multivariate linear regression assessing the association of the difference in BP between baseline and at 3 months, with intervention (BP as measured by research staff)

	β	**SE**	***p*-value**
SBP	1.749	1.919	0.363
DBP	1.300	1.230	0.292

SBP systolic blood pressure, *DBP* diastolic blood pressure, *SE* standard error. SBP adjusted for age, sex, smoking, alcohol, baseline SBP and baseline DBP. DBP adjusted for age, sex, education, waist circumference, hip circumference, smoking, alcohol, baseline SBP and baseline DBP

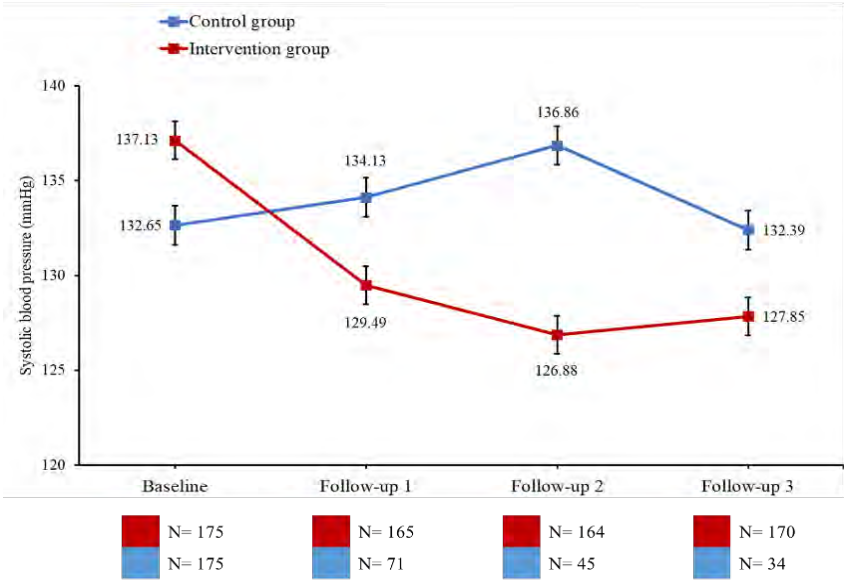
7.2.2 BP Measurements from Participant's BP Logbook at 3-month Follow-up

Originally in the proposal, we aimed to analyze the data as per intention-to-treat analysis method. However, we observed that many of the patients in the control group did NOT monitor their BP at health centers. By imputing the missing data, the outcome measure would not be pragmatic. Therefore, we are presenting our data as per protocol analysis i.e., using the data as obtained from patients that recorded BP readings in their BP logbook.

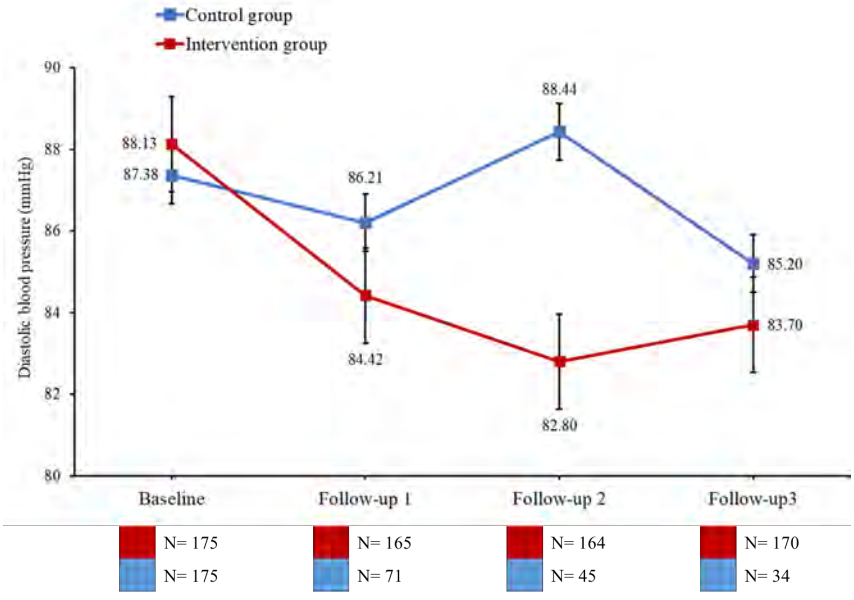
In the intervention group, BP recordings in the logbook were obtained from 165 (94.29%) participants at follow-up 1, 164 (93.71%) participants at follow-up 2, and 170 (97.14%) participants at follow-up 3. Conversely, in the control group, BP recordings in the logbook were obtained from 71 (40.57%) participants at follow-up 1, 45 (25.71%) participants at follow-up 2, and 34 (19.43%) participants at follow-up 3. The following results are presented based on these collected data.

We first compiled all the BP recordings per month as a single average value for each participant and plotted the mean BP value. *Figure 13* depicts the changing trend in SBP (a) and DBP (b) from baseline to 3-month follow-up between intervention and control group. In the intervention group, the mean±SD SBP at baseline was 137.13±21.02 mmHg, at 1-month follow-up was 129.49±17.07 mmHg, at 2-month follow-up was 126.88±17.11 mmHg, and at 3-month follow-up was 127.85±18.04 mmHg. There was a significant reduction in mean SBP from baseline to

3-month follow-up (baseline: 137 mmHg vs. 3-month follow-up: 128 mmHg, p<0.001) in the intervention group. In the control group, the mean±SD SBP at baseline was 132.65±20.70 mmHg, at 1-month follow-up was 134.13±18.03 mmHg, at 2-month follow-up was 136.86±17.40 mmHg, and at 3-month follow-up was 132.39±16.35 mmHg. There was no significant reduction in mean SBP from baseline to 3-month follow-up 3 (baseline: 133 mmHg vs. 3-month follow-up: 132 mmHg, p= 0.587) in the control group.



(a)



(b)

Figure 13: Trends in blood pressure from baseline to follow-up month-3 between intervention group and control group (BP measurements from participant's BP logbook). (a) systolic blood pressure (b) diastolic blood pressure

Similarly, the mean±SD DBP in the intervention group at baseline was 88.13±11.47 mmHg, at follow-up 1 was 84.42±10.32 mmHg, at follow-up 2 was 82.80±10.60 mmHg, and at follow-up 3 was 83.70±11.77 mmHg. There was a significant reduction in mean DBP from baseline to follow-up 3 (baseline: 88 mmHg vs. follow-up 3: 83 mmHg, p<0.001) in the intervention group. In the control group, the mean±SD DBP at baseline was 87.38± 12.90 mmHg, at follow-up 1 was 86.21±10.80 mmHg, at follow-up 2 was 88.44± 10.57 mmHg, and at follow-up 3 was 85.20± 10.04 mmHg. There was no significant reduction in mean DBP from baseline to follow-up 3 (baseline: 87 mmHg vs. follow-up 3: 85 mmHg, p= 0.360) in the control group.

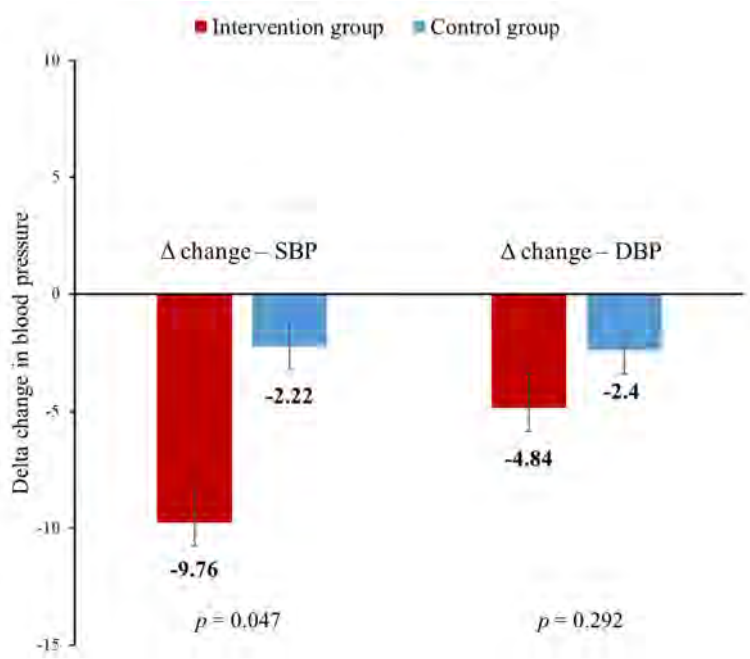


Figure 14: Difference in SBP and DBP at 3-month follow-up between the intervention group and control group (BP measurements from participant's BP logbook)

To observe any difference in SBP at 3-month follow-up between intervention group and control group, a delta change was constructed between SBP at baseline and at 3-months based on BP measurements from participant's BP logbook (*Figure 14*). The study observed a reduction in SBP (–9.76 mmHg) in the intervention group as compared to the control group (–2.22 mmHg) at 3-month follow-up (towards statistical significance at p= 0.047). Similarly, DBP in the intervention group decreased by –4.84 mmHg in the intervention group as compared to –2.40 mmHg in the control group, albeit with no statistical significance, at 3-month follow-up.

Table 11: Multivariate linear regression assessing the association of the difference in BP between baseline and at 3 months, with intervention (BP measurements from participant's BP logbook)

	β	SE	*p*-value
SBP	-5.833	2.849	0.042
DBP	-2.561	1.96	0.193

SBP systolic blood pressure, *DBP* diastolic blood pressure, *SE* standard error. SBP adjusted for age, sex, family history of hypertension, baseline SBP. DBP adjusted for age, sex, waist circumference, baseline DBP

Further, linear regression was performed to assess the association of the value of difference in SBP between baseline and at 3-month follow-up based on BP measurements from participant's BP logbook, with intervention (*Table 11*). The analysis revealed that our trial intervention was significantly associated with the observed difference in SBP between baseline and at 3-month follow-up (β= –5.833, p= 0.042), adjusted for age, sex, family history of hypertension, and baseline SBP. On the other hand, our trial intervention was not associated with the observed difference in DBP between baseline and at 3-month follow-up (β= –2.561, p= 0.193), adjusted for age, sex, waist circumference, baseline DBP.

7.3 Result of Primary Objective 2

"To assess the effectiveness of self-monitoring of blood pressure in adherence to the antihypertensive treatment in a community set-up of North India"

The primary objective 2 in part-B hypertensive population was to assess the effectiveness of EASE-BP intervention in anti-hypertensive medication adherence. Presently, medication adherence was assessed based on two methods as previously mentioned – pill counting method i.e., the proportion of days on which the participant took their anti-hypertensive medication as prescribed, divided by the total number of days that they are expected to take them (number of days in the assessed period), and a five-item Medication Adherence Report Scale (MARS-5).

Figure 15 describes the current use of anti-hypertensive medication among the trial participants. At baseline and at each subsequent monthly follow-up, higher proportion of participants in the intervention group were currently on anti-hypertensive medication compared to participants in the control group.

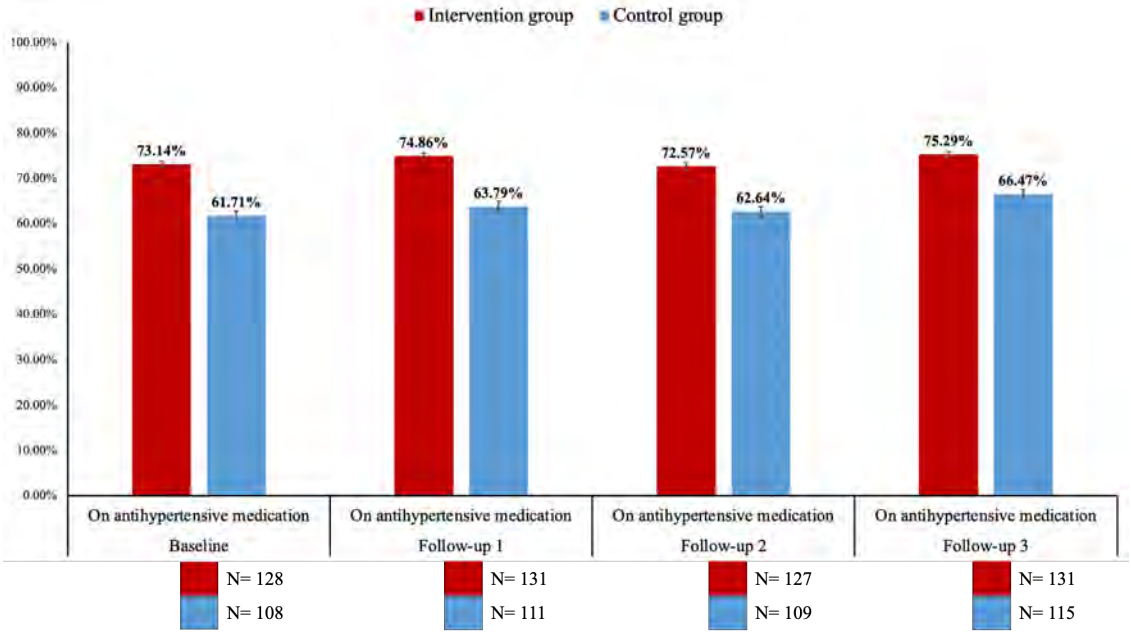


Figure 15: Trends in current use of anti-hypertensive medication

Table 12: Type of anti-hypertensive medications used

Medications	Baseline	Follow-up 1	Follow-up 2	Follow-up 3
Calcium channel blockers	184 (76.99)	195 (80.25)	188 (79.32)	201 (81.71)
Beta blockers	21 (8.79)	16 (6.58)	17 (7.17)	16 (6.50)
Angiotensin receptor blockers	31 (12.97)	30 (12.35)	29 (12.24)	26 (10.57)
Angiotensin-converting enzyme inhibitors	3 (1.26)	2 (0.82)	3 (1.27)	3 (1.22)
Diuretics	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

Data presented as number (percentage)

Overall, the number of anti-hypertensive medications used was one-type at baseline and at all monthly follow-ups. The most common type of anti-hypertensive medication used was calcium channel blockers, followed by angiotensin receptor blockers, beta blockers, and angiotensin-converting enzyme inhibitors (*Table 12*). None of the participants were on diuretics.

7.3.1 Pill-counting Method

At 3-month follow-up, adherence to anti-hypertensive medication estimated through the pill count method (*Figure 16*), and defined as participants taking medication days per month, was

significantly higher in the intervention group (0.54 days per month) compared to the control group (0.39 days per month) (p<0.001).

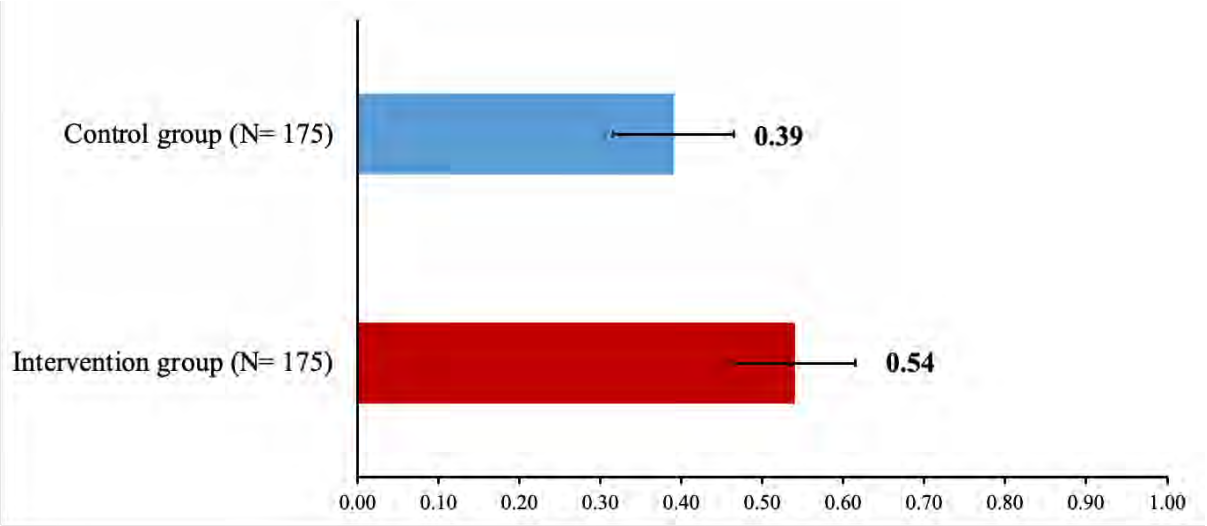


Figure 16: Medication adherence at 3-month follow-up (pill count method)

Further, multivariate linear regression analysis showed that at 3-month follow-up EASE-BP trial intervention was significantly associated with increasing the medication adherence (β= 0.110, p= 0.006), after adjusting for age, sex, educational level, waist circumference, hip circumference, smoking, family history of IHD, baseline SBP and baseline SBP (*Table 13*).

Table 13: Multivariate linear regression assessing the association of the antihypertensive medication adherence with intervention (pill count method at month-3)

Pill count method	**β**	**SE**	***p*-value**
Medication adherence	0.110	0.039	0.006

Adjusted for age, sex, educational level, waist circumference, hip circumference, smoking, family history of IHD, baseline SBP and baseline SBP

7.3.2 Medication Adherence Reporting Scale Method

MARS-5 contains five statements on the use of medications and respondents choose the option that best describes their behaviour for each statement through a rating scale from 1 to 5 (1 being the poorest and 5 being the best). At 3-month follow-up, adherence to anti-hypertensive medication estimated through MARS-5 (*Figure 17*) and presented as mean ± SD was significantly higher in the intervention group (18.11 ± 8.49) compared to the control group (15.54 ± 8.85) (p= 0.006).

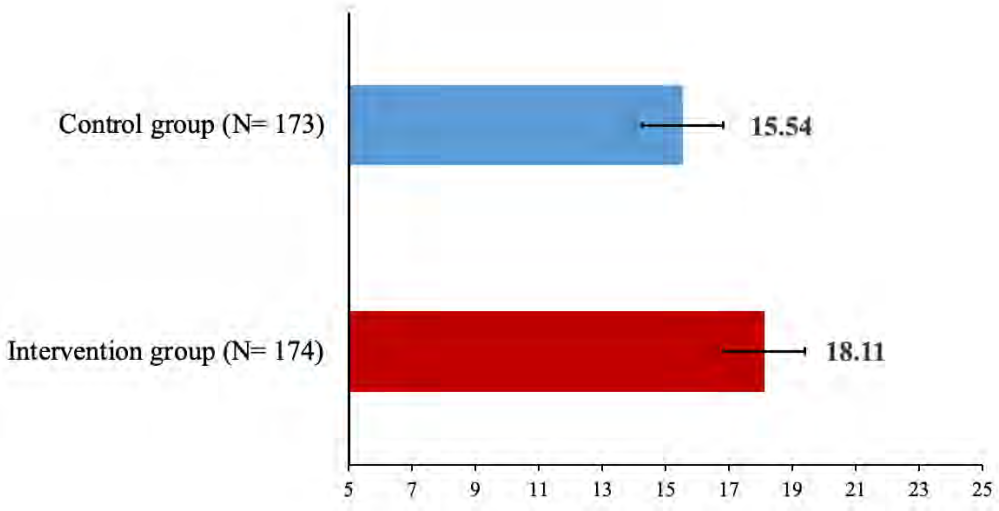


Figure 17: Mean MARS score at 3-month follow-up (5 being the lowest score and poorest adherence and 25 bring the highest score and greatest adherence)

Further, multivariate linear regression analysis showed that at 3-month follow-up EASE-BP trial intervention was significantly associated with increasing the medication adherence (β= 1.897, p= 0.02), after adjusting for age, sex, marital status, educational level, waist circumference, hip circumference, smoking, family history of IHD, baseline SBP and baseline SBP (*Table 14*).

Table 14: Multivariate linear regression assessing the association of the antihypertensive medication adherence with intervention (MARS method at 3-month)

MARS method	**β**	**SE**	***p*-value**
Medication adherence	1.897	0.815	0.020

Adjusted for age, sex, marital status, educational level, waist circumference, hip circumference, smoking, family history of IHD, baseline SBP and baseline SBP

7.4 Result of Secondary Objective 1

"Uptake of the intervention as assessed by frequency of BP monitoring among index participants and family members"

Secondary objective 1 assessed the frequency of BP measurements in the intervention group (number of BP measurements based on self-monitoring) and the control group (number of BP measurements based on monitoring from health-center) among both the index participants and their family members. For index participants, the frequency of BP measurements was identified

from the participant BP logbook and for family members, the frequency of BP measurements was identified from the family BP logbook.

The total number of index participants who measured their BP at least 2 times each month was 189/350 at month-1, 183/350 at month-2, and 169/350 at month-3 *(Figure 18)*. Among them, the frequency of BP measurement was significantly higher in the intervention group as compared to the control group at each follow-up month i.e., at month-1: 157 (89.71%) in intervention group vs. 32 (18.29%) in control group; at month-2: 157 (89.71%) in intervention group vs. 26 (14.86%) in control group; at month-3: 156 (89.14%) in intervention group vs. 13 (7.43%) in control group. The **uptake of intervention (SMBP)** by the study population was 89.71% at month-1 and month-2, and 89.14% at month-3.

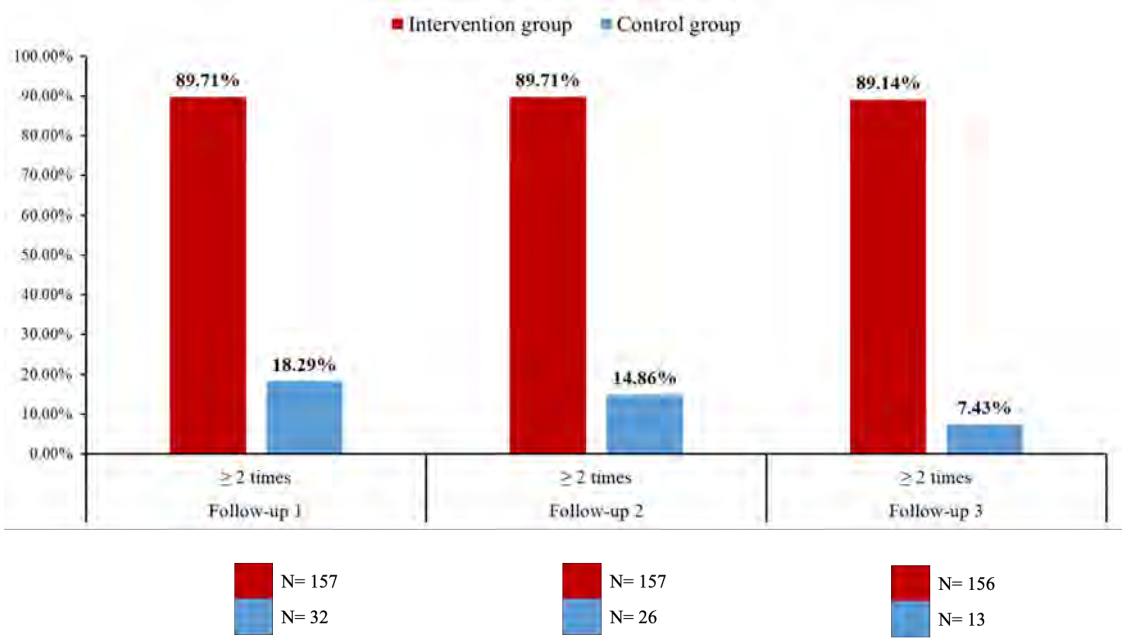


Figure 18: Part-B hypertensive population – Frequency of BP measurements among index participants during the study period between intervention group and control group

The mean number of family members who were 18 years and above in part-B hypertensive population was 3 (range: 0-8). In both the intervention group and control group, the mean number of family members were 3. There were a total of 1067 family members who were 18 years and above, out of which 573 were in the intervention group and 494 were in the control group.

Figure 19 shows the frequency of BP measurements among family members of index participants. The total number of family members who measured their BP at least 2 times each month was 212/1067 at month-1, 135/1067 at month-2, and 97/1067 at month-3. Among them,

the frequency of BP measurement was significantly higher in the intervention group as compared to the control group at each follow-up month i.e., at month-1: 202 (35.25%) in intervention group vs. 12 (2.02%) in control group; at month-2: 134 (23.38%) in intervention group vs. 1 (0.20%) in control group; at month-3: 93 (16.23%) in intervention group vs. 4 (0.81%) in control group. The **uptake of intervention (SMBP)** by the study population was 35.25% at month-1, 23.38% at month-2 and 16.23% at month-3.

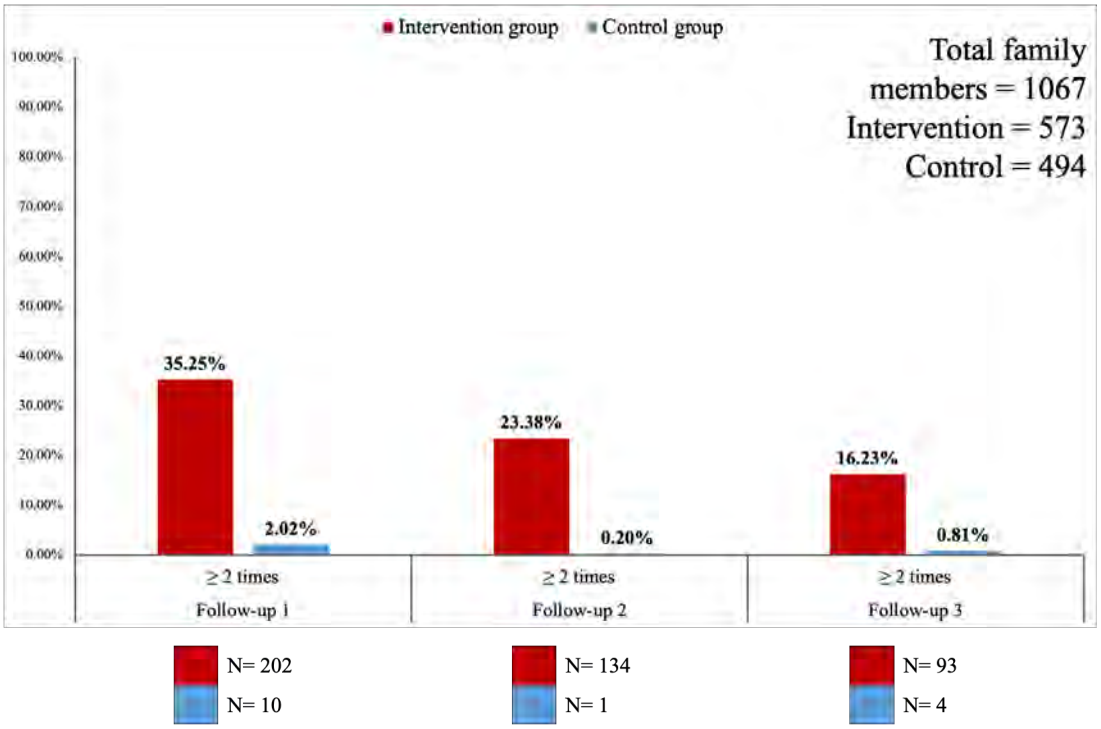


Figure 19: Part-B hypertensive population – Frequency of BP measurements among family members during the study period between intervention group and control group

7.5 Result of Secondary Objective 2

"Any vascular event including stroke, myocardial infarction (MI), or death"

Table 15: Vascular events and/or death between the intervention group and control group in part-B hypertensive population

Events	Follow-up 1		Follow-up 2		Follow-up 3	
	Intervention group	**Control group**	**Intervention group**	**Control group**	**Intervention group**	**Control group**
Stroke	0/175	0/175	0/175	0/175	0/175	0/175
MI	**1/175**	0/175	0/175	**1/175**	**1/175**	0/175
Death	0/175	0/175	0/175	0/175	**1/175**	0/175
Reason for death	NA	NA	NA	NA	**MI**	NA

In the part-B hypertensive population, there were a total of three vascular events (MI) and one mortality due to MI (*Table 15*). During the study period of three months, 3 (1.71%) MI occurred in the intervention group and 1 (0.57%) occurred in the control group.

7.6 Result of Secondary Objective 3

"To measure additional yield of new cases among all the family members, where the denominator will be the total number of household members in each group"

Additional yields of new cases of hypertension among family members of recruited participants were identified based on SBP ≥140mmHg and/or DBP ≥90mmHg from **any BP measurement** among family members with ≥2 BP measurements at each follow-up. The final proportion of newly detected hypertensives are those family members who were detected as hypertensives at least once throughout the study period. Individuals with no BP recordings (SMBP or BP from health center) were considered as not detected. From the total of 1067 family members in the part-B non-hypertensive population who were 18 years and above, 44 (4.12%) had a previous history of hypertension (self-reported) – 25 were in the intervention group and 19 were in the control group. Therefore, the additional yield of new cases of hypertension was estimated from the self-reported non-hypertensive family members. There were 1023 family members with no history of hypertension – 548 were in the intervention group and 475 were in the control group.

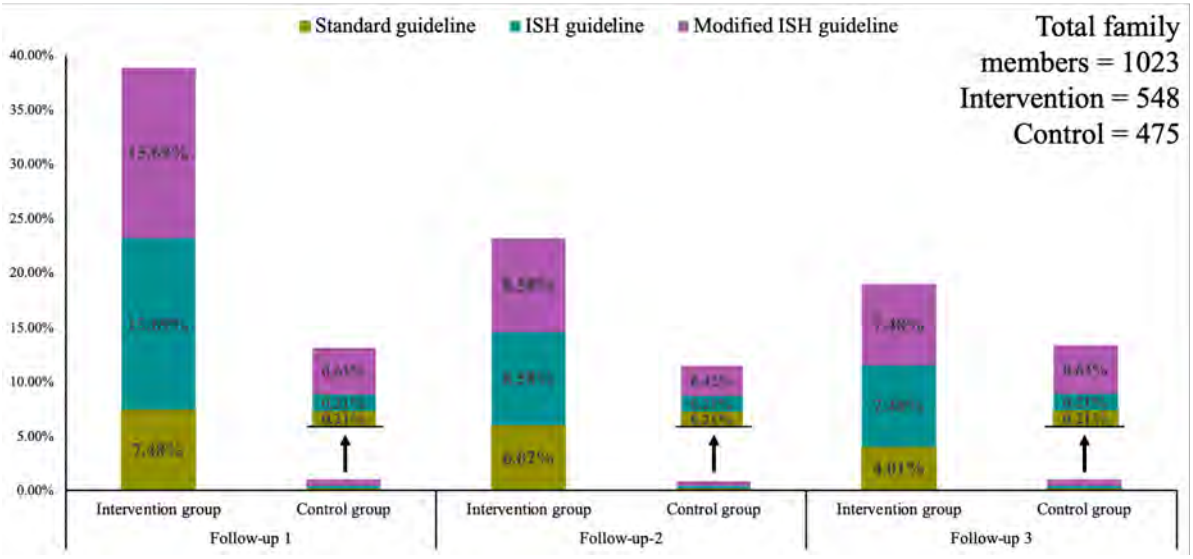


Figure 20: Part-B hypertensive population – Additional yield of new cases of hypertension among the family members of index participant during the study period between intervention group and control group

Figure 20 shows the rate of hypertension detection among family members at each monthly follow-up based on the different hypertension definition between the intervention group and the control group. The rate of hypertension detection was significantly higher in the intervention group compared to the control group at each follow-up (p<0.001). In 1-month follow-up, the proportion of newly detected hypertension was 7.48% in the intervention group vs 0.21% in the control group based on standard guideline definition. Similarly, it was 15.69% in the intervention group vs 0.21% in in the control group, and 15.69% in the intervention group vs 0.63% in the control group based on ISH guideline and modified ISH guideline, respectively. The same trend is observed at 2-month follow-up and 3-month follow-up (Figure 22).

Table 16: New cases of detected hypertension among family members in part-B hypertensive population

Hypertension detection		**Total**	**Intervention group**	**Control group**	***p*-value**
Standard guideline	Not detected	952 (93.06)	480 (87.59)	472 (99.37)	<0.001*
	New case of hypertension	71 (6.94)	68 (12.41)	3 (0.63)	
ISH guideline	Not detected	896 (87.59)	424 (77.37)	472 (99.37)	<0.001*
	New case of hypertension	127 (12.41)	124 (22.63)	3 (0.63)	
Modified ISH guideline	Not detected	891 (87.09)	424 (77.37)	467 (98.32)	<0.001
	New case of hypertension	132 (12.91)	124 (22.63)	8 (1.68)	

Data are presented as number (percentage). *Fisher's exact test

Table 16 presents the proportion of newly detected hypertension among family members during the study period. Out of the 1023 family members, the total number of newly detected hypertension was 71 (6.94%) as per the standard guideline, 127 (12.41%) as per the ISH guideline, and 132 (12.91%) as per the modified ISH guideline. The newly detected hypertension among family members was significantly higher in the intervention group as compared to those in the control group based on all the three guidelines [standard guideline: intervention group (68, 12.41%) vs control group (3, 0.63%); p<0.001], [ISH guideline:

intervention group (124, 22.63%) vs control group (3, 0.63%); p<0.001), [modified ISH guideline: intervention group (124, 22.63%) vs control group (8, 1.68%); p<0.001].

Table 17: Logistic regression showing the association of study intervention with hypertension detection among family members in part-B

Hypertension guidelines	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Standard	22.29	6.96-71.33	<0.001	23.36	7.27-75.08	<0.001
ISH	34.44	12.61-94.01	<0.001	35.38	12.92-96.84	<0.001
Modified ISH	17.07	8.25-35.32	<0.001	17.31	8.34-35.91	<0.001

Adjusted for age and sex

Logistic regression analysis was performed to investigate the likelihood of hypertension detection due to our study intervention (*Table 17*). In the adjusted model, intervention was significantly associated with higher odds of hypertension detection among family members [standard guideline: OR= 23.36 (95% CI 7.27-75.08) p<0.001; ISH guideline: OR= 35.38 (95% CI 12.92-96.84) p<0.001; modified ISH guideline: OR= 17.31 (95% CI 8.34-35.91) p<0.001].

8. SUMMARY & CONCLUSION

EASE-BP trial attempted to investigate the effectiveness of home-based self-monitoring of blood pressure (SMBP) in hypertension detection, BP control, and adherence to anti-hypertensive medication. We anticipated that the results of this study may help us understand if provision of BP instruments helps improve the frequency of BP measurement by the individuals and their family members and reach towards better hypertension detection and BP control, as compared to individuals in the control group who were advised to monitor BP at health centres.

The trial was conducted in a primary care set-up in the villages served by the Ballabgarh Health and Demographic Surveillance System, which is the rural wing of the All India Institute of Medical Sciences, New Delhi. Dayalpur and Atali, two geographically isolated villages were randomly selected for sampling of part-A non-hypertensive population and part-B hypertensive population, respectively. Eligible participants were randomized 1:1 to intervention group (home-based SMBP with health education) or control group (health education with advice to monitor BP at health centre). After baseline assessments, BP from participant's logbook were collected at each follow-up one-, two-, and three-months. At the final follow-up visit, besides noting the BP measurements recorded by participants in their BP logbook, the research staff measured BP of each participant. Data were collected using a physical CRF and managed using REDCap electronic data capture. Initially, sample size in part-A non-hypertensive population was estimated at 393 participants (rounded off to 400) and 332 participants in part-B hypertensive population. The number of total recruitments in the trial was 424 in part-A and 350 in part-B. The loss to follow-up was minimal in both the populations (6 in part-A and 2 in part-B). ITT analysis was used in part-A population and both ITT and per protocol analysis were used in part-B population.

Results of our study supports that utilization of home-based SMBP effectively improves hypertension detection, as opposed to BP monitoring at health centres. Using both standard clinical definition of hypertension as well as the international guideline, identification of new cases of hypertension was significantly higher in the intervention group [(standard guideline: 25%), ISH: 43%)] in comparison to the control group [(standard guideline: 11%), ISH: 11%)] ($p<0.001$). Further, regression analysis revealed that our trial intervention was significantly associated with an increased likelihood of hypertension detection.

Over and above, when our study was extended towards the adult family members of randomized participants (N=1056 in part-A and N=1023 in part-B), similar results were observed whereby the identification of new cases of hypertension among adult family members was substantially higher in the intervention group as compared to the control group ($p<0.001$).

Additionally, results from part-B, by utilizing BP measurements by research staff at baseline and at end of follow-up, revealed that at three-months, mean SBP decreased in both the intervention group and the control group, with mean delta difference of –6.6 mmHg and –6.2 mmHg, respectively ($p=0.878$). Our intervention, however, was not associated with SBP control at three-months (adjusted $\beta= 1.749$; $p=0.368$). Alternately, the per protocol analysis of the BP data from participant's logbook highlighted a significant reduction in mean SBP at three-months, giving a mean delta difference of –9.76 mmHg in intervention group and –2.22 in control group ($p=0.047$).

This positive indication, however, needs further investigation because the number of participants with BP monitoring at health centres in the control group is extremely low. Participants in both groups of our study received thorough health education regarding primordial and primary prevention of hypertension and atherosclerotic cardiovascular diseases. Thus, education may be playing a role in BP control, which in our study may have influenced the participants, balancing the effectiveness of home-based SMBP in the intervention group to the control group.

Our study intervention was also associated with improving the adherence to anti-hypertensive medication. Using both pill-count method and MARS, participants in the intervention group had better performance towards adhering to anti-hypertensive medication.

Findings from our study may fill a major gap in hypertension care continuum, especially in countries like India where hypertension poses serious public health challenge. Hypertension awareness (detection/diagnosis), treatment and control are significantly poor in India. Large proportion of hypertensive inviduals are unaware of their condition. The situation is dire, and without optimizing the hypertension care cascade, health-system in India will face a major challenge in the prevention and management of cerebro-cardiovascular diseases and mortality. Hypertension detection is no doubt the most crucial step in attaining the downstream continuum of care, including initiation of treatment, and control of BP. Although the current national guideline suggests universal screening of all adults >30 years, however, there is still a high unmet need in hypertension detection in India. Our study offers an opportunity to improve

hypertension detection by providing BP apparatus to carry out home-based BP monitoring. As the intervention uptake is high among the participants, this can facilitate the downstream care continuum. Nonetheless, the "push" to initiate anti-hypertensive treatment and subsequent BP control needs further investigations.

In conclusion, provision of BP apparatus increases the uptake of BP measurement and improves hypertension detection in both participants and their family members. It also leads to better control of BP albeit using per protocol analysis of BP measurements from participant's logbook but not from ITT analysis of BP measurements by research staff. Nonetheless, the observed BP control in per protocol analysis is limited by the fact that the frequency of BP monitoring among participants at health centres in the control group is extremely low. Our study also highlighted that provision of BP apparatus significantly improves adherence to anti-hypertensive medication.

Based on the results of our study, we would suggest that, in tandem with the current NCD guidelines, policy makers may implement home-based SMBP to improve hypertension detection and control. This method may enable the individual specifically and population at large to be self-reliant which may lead to better health seeking behaviour. This is an attractive approach to optimize the national NCD goals.

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10. ANNEXURE I

INSTITUTE ETHICS COMMITTEE
ALL INDIA INSTITUTE OF MEDICAL SCIENCES
Room No 102, 1st Floor Old O.T. Block,
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Date: 10-10-2022

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Professor
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Ref. No.: IEC-795/07.10.2022

Sub: Effectiveness of Home-Based Self-Monitoring of Blood Pressure in a Primary Care set-up of India: An Open Label Randomized Controlled Trial.

Dear Dr. Bhatia

This has reference to your above mentioned project. The project was discussed in the Ethics Committee meeting held on 07.10.2022 at 03:00 P.M. in the Ethics Committee Room, AIIMS & the following members of the Ethics Committee attended the meeting:

1.	Dr. T.P. Singh, SERB, Distinguished Professor, Dept. of Biophysics	Chairman
2.	Mr. Rajan Khosla, LLB,- Member Ethics Committee,	Member
3.	Dr. Rama V. Baru, Professor, JNU	Member
4.	Dr. Promila Kumar, Principal, Gargi College Lay Person	Member
5.	Dr. B.K. Mohanti, Director, KIMS Cancer Centre (KIMS), Bhubaneswar	Member
6.	Dr. Sanjay Pandey, Prof. and Head,Deptt. of Neurology,Amrita Hospital, Faridabad	Member
7.	Dr. S.K. Maulik, Former Professor, Deptt. of Pharmacology, AIIMS	Member
8.	Dr. Mamta Sood, Professor, Deptt. of Psychiatry, AIIMS -	Member
9.	Dr. Vijay Zutshi, Professor, Deptt. of Obs. & Gynae., Safdarjung Hospital	Member
10.	Dr. Rakesh Lodha, Professor, Deptt. of Paediatrics, AIIMS	Member
11.	Dr. Subodh Garg, Professor, Deptt. Of Surgery, JPNATC,	Member
12.	Dr. Rohit Saxena, Professor, Deptt of R.P. Centre, AIIMS	Member Secretary

The Project has been approved from ethical angle w.e.f. 07.10.2022 Subject to the following conditions:

- The approval is valid for the period of the conduct of study according to this protocol under the responsibility **Dr. Rohit Bhatia,** Principal Investigator.
- No significant changes to the research protocol should be made and implemented without prior consent of the IEC and any changes/deviations from the protocol which increase the risk for the subjects should be submitted to the IEC and approved by it prior to implementation.
- It is confirmed that the Ethics Committee of AIIMS is composed of and functions as per ICH GCP and other applications regulatory guidelines.
- It is hereby confirmed that neither you nor any of the study team members have participated in the voting/decision making procedures of the committee.
- The study progress report should be made available to the IEC for review annually
- IEC should be informed about all SAE's occurring in the study as per DCGI guidelines, and should be emailed at: iecsc.aiims@gmail.com, ethicssae2022@gmail.com.

With Warm regards
Yours sincerely

(Dr. Rohit Saxena)
Member Secretary Ethics Committee