Effect of community health worker-provided targeted education with regular follow-up of hypertensive patients on blood pressure control: 24-month results of a longitudinal study in Bangladesh

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ABSTRACT

Context: Sustainability of blood pressure (BP) control by trained community health workers (CHWs) in a low awareness setting is yet to be explored.

Aim: The aim of this study is to assess the effect of CHW-provided targeted education with regular follow-up of hypertensive patients on BP control.

Materials and Methods: We conducted a longitudinal study on hypertension in a semi-urban and a rural district in Bangladesh. Adult hypertensive individuals (n = 287) were identified. Trained CHWs regularly followed up and provided specific health messages on BP control through quarterly group meetings and individual counseling. We assessed mean BP changes and control status (systolic BP [SBP] <140 mmHg and diastolic BP [DBP] <90 mmHg) at around every 6 months for 24 months. A subgroup of hypertensive patients (n = 118) age >40 years was compared with an unmatched comparison group (n = 226) under usual care.

Results: Both SBP and DBP of hypertensive patients under intervention were significantly reduced compared to baseline. The intervention subgroup had a significant lower SBP (149.1 ± 17.7 mmHg vs. 141.3 ± 20.34 mmHg; P = 0.004) and DBP (86.7 ± 13.32 mmHg vs. 91.31 ± 13.54 mmHg; P = 0.003) compared to comparison group. Proportion achieved BP control was higher (44.1% vs. 26.7%, P = 0.003) in the intervention subgroup. Patients who visited qualified providers within a year were 2 times more likely to be under better BP control.

Conclusion: Targeted education with regular follow-up of hypertensive patients by trained CHWs has the potential to reduce BP and enhance BP control in settings with low awareness.

Key Words: Bangladesh, blood pressure, community health workers, control, hypertension

Introduction

Nearly 1 billion of the world's adult population has hypertension, and almost three-quarters of them live in developing countries. Global prevalence of hypertension is predicted to increase by 60% (approximately 1.56 billion) by 2025. This increasing burden is expected to be...
disproportionately higher in developing countries where low awareness, poor blood pressure (BP) control, and limited resources are common. Consequently, burden of stroke and ischemic heart disease are likely to increase in developing countries.

Available data suggest that hypertension is prevalent among more than a quarter (25 million) of Bangladeshi adult population (≥25 years). Notably, half of the hypertensive patients (50.2%) are unaware of their high BP status, and only half (27.2%) of those who are aware have their BP under control. Increasing prevalence of hypertension, low awareness, and poor BP control will challenge already limited health resources in terms of burden of cardiovascular, cerebrovascular, and chronic kidney diseases (CKD).

Bangladesh has made remarkable progress in coverage of many health interventions through community health workers (CHWs). Large-scale community-based approaches by CHWs using a door-step delivery approach has resulted in significant improvement of maternal and child health, immunization coverage, and tuberculosis control. Like many countries, Bangladesh is experiencing a decline in infectious diseases and a rapid growth of noncommunicable chronic diseases (NCD) in an increasingly urban and aging population. New approaches are needed to provide CHWs and village doctors with a different set of preventive and curative capacities. Screening of cardiovascular disease (CVD) risk, including hypertension, by CHWs is found to be feasible in different countries including Bangladesh. Continued development of innovative, community-based strategies of health-service delivery, and adaptation of new technologies are recommended to address emerging NCD health challenges.

We reported earlier that raising awareness with simple health messages can increase provider visit and reduce BP in Bangladeshi population. However, a long-term follow-up was needed to verify sustainability and explore the scope of targeted education with regular BP monitoring by CHWs. In this paper, we report the effect of targeted education and regular follow-up of hypertensive patients by CHWs on BP control in Bangladesh.

Materials and Methods

Study design and participants

We conducted a longitudinal study from February 2011 to January 2014 in Bangladesh. The study sites were semi-urban Kamalapur in Dhaka and rural Matlab in Chandpur district, where International Centre for Diarrhoeal Disease Research, Bangladesh (icddr, b) has Health and Demographic Surveillance System (HDSS). The study population was randomly selected men and women aged 20 years or older from the HDSS databases. We excluded participants with any acute illness or history of any vascular events such as stroke or acute myocardial infarction and pregnant women. Sample size for each age group was estimated to measure prevalence within 10% precision with 80% power. We assumed the lowest prevalence of 5% in 20–24 years age group and the highest 20% or higher in 65 years or older age groups. We needed 1600 participants (800 in each site) after considering possible refusal or nonparticipation.

Baseline survey

We conducted the baseline survey from February to August 2011. Structured questionnaire was administered by trained interviewers at participants’ home after informed written consent. Interviewers collected information on socioeconomic, demographic, lifestyle factors and measured BP, weight, height, waist, and hip circumferences following standard procedures. We used Omron M10TM digital BP machines. Participants were restricted from smoking, eating, drinking tea/coffee/ carbonated beverages, and heavy physical activity for at least 30 min. We ensured 10 min rest in the sitting position and measured BP 3 times at 5 min interval on the left arm with the arm supported at the level of the heart. First readings were discarded to avoid possible anxiety effect, and the mean value of the second and third measurements was considered for both systolic BP (SBP) and diastolic BP (DBP). Very few participants refused to participate (3.9% in Kamalapur and none in Matlab). The detailed methodology of the baseline survey has been published elsewhere. We informed the BP status and provided simple health messages to all the hypertensive individuals with emphasis on visiting qualified health-care provider, possible complications if untreated, and lifestyle factors.

Target intervention

The intervention started after 1st follow-up and continued for 12 months until 3rd follow-up. Trained CHWs regularly followed up, and provided specific educational messages on BP control by quarterly (3–4 months interval) group meetings, and individual counseling. We developed an information booklet in local language (Bangla) for hypertensive participants. The booklet contained simplified health messages and pictorial demonstrations on what is high BP, risk associated with uncontrolled BP, importance of visiting qualified provider, how to
monitor BP, lifestyle- and diet-related issues, particularly regular physical activity, restriction of extra salt intake, smoking cessation, and adherence to medication. A team of investigators including principal investigator, three research investigators, and two cardiologists developed the booklet based on available literature.

We trained 12 CHWs (six from each site, median age 30 years) who had minimum 12 years of institutional education. Three-day training workshop was organized that included role play and field testing. A written guideline was provided to deliver the health messages uniformly and precisely. The presence of at least two health workers was mandatory to conduct a group meeting. The CHWs were not involved in providing any prescription or medication. We arranged refresher training for the health workers at month-6 and ensured regular field visits by the supervisors to minimize intra- and inter-individual inconsistency in intervention delivery.

Group discussions were hosted at the field clinics or at suitable community spaces such as schoolyard, city corporation office, community center, or participant’s household yard. Number of participants in each group session ranged from 3 to 11 with an average of five participants at rural site and four at urban site. During individual counseling sessions, CHWs reinforced the messages shared during the group session and discussed individual attributes/risk factors such as consequences of extra salt intake, smoking, physical inactivity, and overweight on BP. Each participant in the intervention group attended at least two group sessions and two individual counseling sessions during intervention period. All three round of group meetings were attended by 201 (70%) hypertensives, and 217 (75.6%) were reached for all three round of one-to-one individual counseling session.

Follow-up and comparison group
We followed up all available hypertensive patients at around every 6 months, for up to 24 months from baseline and documented BP status as well as history of provider visits. Two study nurses measured BP using the same electronic BP monitor following the same procedure as baseline. The nurse did not have access to BP data collected earlier, had no involvement in the intervention, and was not aware of the purpose of the study.

Every hypertensive patient identified at baseline was invited to participate in the intervention, and a comparison group was not considered for ethical obligations. However, a group of hypertensive patients was available from another study implemented in the same community in similar period (February 2011 to April 2012) and identified as hypertensive following same methods. These hypertensive patients were randomly selected participants of another study on chronic obstructive pulmonary diseases (COPD) but were not having COPD. The COPD study enrolled 3759 randomly selected individuals aged 40 years or above from the HDSS database and 1277 individuals were identified with uncontrolled hypertension but not having COPD. Although they were informed about their BP status and referred to usual care (nearby government health facilities or a qualified medical practitioner of patients choice), they were not followed up or under any intervention for hypertension since then. These preidentified hypertensive patients under usual care created a unique opportunity to validate the effect of intervention in a subgroup of hypertensive patient’s aged 40 years or above and were then included as added activity in the last follow-up on month-24. The outcome measures of uncontrolled hypertensive patients aged 40 years or above (n = 118), who were under intervention, were compared with unmatched hypertensive patients (n = 226) on usual care identified in the COPD study. A detail flow chart of the study activities has been included [Figure 1] for better understanding.

Blood pressure outcomes
We reported mean BP changes and proportion achieved BP control (SBP <140 mmHg and DBP <90 mmHg) in hypertensive patients (receiving intervention) from baseline to follow-up at around every 4–6 months up to 24 months. Uncontrolled hypertension was defined as SBP ≥140 mmHg or DBP ≥90 mmHg or both. We considered participants as aware and self-reported hypertensive irrespective of their BP status at baseline if they were on antihypertensive medications and could show the prescription or name antihypertensive medication. Participants, who had high BP according to above-mentioned criteria and were not under any antihypertensive medication or lifestyle modification advice by any provider, were considered as unaware at baseline. We considered BP goal is achieved when SBP and DBP at follow-up were < 140 mmHg and <90 mmHg, respectively.

Data analysis
We entered data using MS access with built in range and consistency check. We presented frequency and percentages for categorical variables and mean and standard deviation (SD) for continuous variables. Chi-square test was used to examine the association between categorical variables. Paired t-test (for continuous outcomes) and Z-test (for proportions) were used for
within-group comparison (pre-post intervention) and independent sample t-test was used for between-group comparisons (between intervention and comparison subgroups). We used conditional logistic regression to determine independent factors associated with BP control at month-24. We included BP control at month-24 as binary outcome variable (yes/no) and targeted intervention (yes/no), age group (10 years age band), sex (male/female), area of residence (urban/rural), income (low-, middle-, and high-income), weight gain (yes/no), extra salt intake (yes/no), weekly cumulative physical activity ≥150 min (yes/no), provider visit in the last 12 months (yes/no), qualified provider visit (yes/no), and antihypertensive medication (yes/no) as independent variables. P < 0.05 was considered statistically significant.

Ethics approval
This study and additional activities during the last follow-up at month-24 were approved by the Ethical Review Committee of icddr, b. An informed written consent was obtained from each participant before enrollment.

Results
Characteristics of the hypertensive patients under intervention
We identified 287 (17.1%) hypertensive individuals from baseline survey of 1678 participants (195 [23.6%] out of 825 urban and 92 [10.8%] out of 853 rural participants). The average age of hypertensive patients was 53 (SD ± 14.6) years, and of study participants was...
43 (SD ± 15) years. Hypertension was 4 times higher in people aged 40 years or above (28.2% vs. 7.5%) and 80.5% patients belonged to that age group. The prevalence of hypertension was significantly higher in urban than in rural participants (23.6% vs. 10.8%; \( P < 0.001 \)) and in women than men (18.3% vs. 15.6%; \( P < 0.005 \)). At baseline, half (49.5%) of the total hypertensive patients were aware about their BP status, but about half of those patients who were aware (27.2%) had their BP under control. Detail characteristics of the study participants were reported earlier.\[9\] Urban hypertensive patients were younger, more educated, had higher income, and more obese. Extra salt and chewing tobacco consumption were higher in rural participants [Table 1]. We were able to follow-up 245 (85.3% out of 287) hypertensive participants on month-6, 224 (78.0%) on month-12, 223 (77.7%) on month-18, and 217 (75.6%) on month-24. The number of respondents decreased as 36 of initial participants migrated out, 11 refused, six died, and 16 could not be reached after repeated attempts due to their work schedule.

**Blood pressure changes within-intervention group (pre-post intervention evaluation)**

Compared to baseline measures, the mean SBP of intervention group was significantly lowered by 3.3 mmHg at month-6; 10.14 mmHg at month-12, and 10.10 mmHg at month-18. The reduction was also significant for the mean DBP (1.95 mmHg at month-6; 6.58 mmHg at month-12; and 6.72 mmHg at month-18). An upward shift was observed from month-18 to month-24 in both SBP and DBP, but the mean DBP at month-24 remained significantly lower (−3.71 mmHg) from baseline [Figure 2a and b].

The proportion of hypertensive’s achieved BP control increased during intervention period from 27% at baseline to 50% \((n = 123)\) at month-6 and up to 66% \((n = 148)\) at month-18 [Figure 3]. However, the proportion of BP controlled fell back to 52% \((n = 112)\) at month-24 after discontinuation of the intervention at month-18. About 35.6% (16 of 45) of aware but uncontrolled hypertensives at baseline and 47.7% (52 of 109) of newly diagnosed hypertensives achieved BP goal by month-24. Conversely, 30.2% (19 of 63) of the hypertensives who had their BP controlled at baseline failed to maintain so at month-24. Self-reported extra salt intake was significantly decreased in the intervention group, but no significant change was observed in weight reduction, physical inactivity, and dietary risk behaviors [Table S1]. At month-6, month-12, and month-18, >50%, 60%, and 50% patients visited qualified provider, respectively [Figure 4]. Less than 40% patients reported visits to a qualified provider while almost 50% patients reported unqualified provider visits at the last follow-up on month-24 [Figure 4].

**Blood pressure and control status between intervention and comparison group (on month-24)**

Characteristics of the subsample of uncontrolled hypertensive patients aged 40 years or more and the comparison group are presented in Table 2. They were similar in respect to education, occupation, body mass index, and BP distribution at baseline [Table 2]. The mean age of the intervention group was significantly higher (57 ± 11 vs. 53 ± 10, \( P = 0.001 \)) with a greater proportion of participants aged 60 years or above (45% vs. 29%). There was no significant difference in mean SBP or DBP between intervention and comparison group at baseline. The mean SBP of intervention group decreased over 24-month period of observation from 149.1 ± 17.7 mmHg to 141.3 ± 20.34 mmHg \((P = 0.001)\) whereas SBP of the comparison group increased significantly from 149.4 ± 17.1 mmHg to 154.7 ± 48.41 mmHg \((P = 0.001)\) [Figure 5a]. The intervention group had significant lower SBP compared to comparison group at month-24 \((P = 0.004)\). DBP of both intervention and comparison group decreased but intervention group had significant lower mean DBP compared to comparison group at month-24 (86.7 ± 13.32 mmHg vs. 91.31 ± 13.54 mmHg; \( P = 0.003 \)) [Figure 5b]. BP goal achievement was also higher among intervention group (44.1% vs. 26.7%, \( P = 0.001 \)) compared to comparison group [Figure 6].
Determinants of blood pressure control on month-24

In a conditional logistic regression model, we identified the factors determining adequate control of BP among adults (≥40 years) with uncontrolled hypertension. Participation in the targeted intervention (odds ratio [OR]: 2.015, \( P = 0.004 \)) and visit to qualified provider within the last 12 months (OR: 2.108, \( P = 0.004 \)) were significantly associated with BP control after adjusting for socioeconomic factors (age, sex, and income), lifestyle changes (weight gain, extra salt intake, weekly cumulative physical activity), and antihypertensive medication use [Table 3]. Hypertensive individuals residing in urban area are 45% less likely (OR: 0.549, \( P = 0.024 \)) to achieve BP control compared to rural residents.

### Table 1: Characteristics of the hypertensive respondents

| Characteristics                              | Total (n=287) | Urban (n=195) | Rural (n=92) | \( P \)   |
|----------------------------------------------|--------------|--------------|-------------|----------|
| **Age†**                                     | 53.0±14.6    | 50.2±14.2    | 58.7±13.8   | <0.001  |
| **Age group (years)**                        |              |              |             |         |
| 20-39                                        | 56 (19.5)    | 46 (23.6)    | 10 (10.9)   | <0.001  |
| 40-59                                        | 133 (46.3)   | 99 (50.8)    | 34 (37.0)   |         |
| 60 or above                                  | 98 (34.1)    | 50 (25.6)    | 48 (52.2)   |         |
| **Sex**                                      |              |              |             |         |
| Male                                         | 115 (40.1)   | 79 (40.5)    | 36 (39.1)   | 0.824   |
| Female                                       | 172 (59.9)   | 116 (59.5)   | 56 (60.9)   |         |
| **Average years of education‡**              | 5 (0-9)      | 6 (0-10)     | 1 (0-6)     | <0.001  |
| **Level of education**                       |              |              |             |         |
| Illiterate                                   | 106 (36.9)   | 61 (31.3)    | 45 (48.9)   | 0.007   |
| Primary (1-5 years)                          | 54 (18.8)    | 36 (18.5)    | 18 (19.6)   |         |
| Secondary (6-10 years)                       | 86 (30.0)    | 63 (32.3)    | 23 (25.0)   |         |
| High educated (>11 years)                    | 41 (14.3)    | 35 (17.9)    | 6 (6.5)     |         |
| **Type of occupation**                       |              |              |             |         |
| Manual                                       | 23 (8.0)     | 13 (6.7)     | 10 (10.9)   | 0.221   |
| Nonmanual                                    | 264 (92.0)   | 182 (93.3)   | 82 (89.1)   |         |
| **Monthly income in (thousand BDT)¶**        | 15 (10-25)   | 20 (12-25)   | 10 (5-15)   | <0.001  |
| **Income group (tk)**                        |              |              |             |         |
| Low (≤10,000)                                | 100 (34.8)   | 42 (21.5)    | 58 (63.0)   | <0.001  |
| Middle (10,001-30,000)                       | 152 (53.0)   | 122 (62.6)   | 30 (32.6)   |         |
| High (≥30,001)                                | 35 (12.2)    | 31 (15.9)    | 4 (4.3)     |         |
| **Dietary practice**                         |              |              |             |         |
| Extra salt intake*                           | 214 (75.1)   | 133 (68.6)   | 81 (89.0)   | <0.001  |
| Less vegetable intake**                      | 209 (73.3)   | 123 (63.4)   | 86 (94.5)   | <0.001  |
| Less fruit intake*                           | 106 (37.2)   | 60 (30.9)    | 46 (50.5)   | 0.325   |
| High protein intake**                        | 19 (6.7)     | 11 (5.7)     | 8 (8.8)     | 0.001   |
| Physical inactivity (<150 min/week)          | 190 (66.2)   | 181 (92.8)   | 9 (9.8)     | <0.001  |
| **Smoking status**                           |              |              |             |         |
| Any form                                     | 160 (55.7)   | 92 (47.2)    | 68 (73.9)   | <0.001  |
| Tobacco smoking                              | 78 (27.2)    | 51 (26.2)    | 27 (29.3)   | 0.570   |
| Smokeless tobacco                            | 120 (41.8)   | 60 (30.8)    | 60 (65.2)   | <0.001  |
| **BMI (kg/m²)†**                             | 25.01±5.40   | 26.48±5.40   | 21.92±3.33  | <0.001  |
| **BMI category**                             |              |              |             |         |
| Normal (18.5-24.9)                           | 125 (43.7)   | 66 (34.0)    | 59 (64.1)   | <0.001  |
| Underweight (≤18.5)                          | 23 (8.0)     | 6 (3.1)      | 17 (18.5)   |         |
| Overweight/obese (≥25.0)                     | 138 (48.3)   | 122 (62.9)   | 16 (17.4)   |         |
| **Waist circumference (cm)†**                | 85.1±12.3    | 88.2±11.5    | 78.5±11.2   | <0.001  |
| **Abdominal obesity**                        | 149 (51.9)   | 122 (62.6)   | 27 (29.3)   | <0.001  |
| **BP (mmHg)**                                |              |              |             |         |
| SBP ‡                                         | 139.6±21.2   | 138.9±21.1   | 141.0±21.5  | 0.427   |
| DBP ‡                                         | 89.6±12.6    | 90.6±12.8    | 87.7±12.1   | 0.071   |

Numbers in the parenthesis are percentage. Non-manual category included sedentary workers, professionals (e.g. doctors, teachers, etc.), housewives, retired persons, those unable to work and unemployed. \( *\)Mean±SD , \( *\)Median [25-75\%] , \( *\)Bangladesh currency Taka—78.00 = USD 1.00 , \( *\)at least once a day \( *\)*<2-3 servings/day , \( *\)Abdominal obesity was defined as waist circumference ≥90 cm for males and ≥80 cm for females. BMI - Body mass index, BP - Blood pressure, SD - Standard deviation, SBP - Systolic blood pressure, DBP - Diastolic blood pressure.

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In conditional logistic regression, variables that did not further contribute in the model (age, sex, income, weight gain, extra salt intake, weekly cumulative physical activity, provider visit in the last 12 months, and antihypertensive medication) were not shown in the table.

Discussion

Key findings

This population-based longitudinal study demonstrated that CHW-provided targeted education with regular follow-up of hypertensive patients resulted in reduced mean BP and improved BP control in hypertensive Bangladeshis. Those who received targeted intervention by CHWs, and visited qualified provider within the last 12 months were twice more likely to be under better BP control. BP control was more pronounced in rural than urban area. To the best of our knowledge, this is the first study reporting community-based longitudinal follow-up of hypertensive patients in Bangladesh.

We observed consistent and significant decrease in both SBP and DBP for up to 12 months, which sustained up to month-18 with continuation of the targeted intervention. The mean BP tended to rise [Figure 2a and b] and proportion achieved BP goals tended to fall between months-18 and 24, once the intervention ended at 18 months. Despite this, both SBP and DBP were significantly lower, and BP goal achievement rate was significantly higher in intervention subgroup than in comparison subgroup of hypertensive patients age ≥40 years [Figure 4a and b]. Similar reduction in mean BP by community intervention using health workers has been reported in Pakistan.\(^\text{[19]}\)
The decrease in BP observed in this study is similar to (or greater than) community-based or lifestyle interventions reported in other countries.[20-25]

The mean age and the proportion of participants older than 60 years were higher in the intervention subgroup of hypertensive patients age ≥40 years than the comparison subgroup. Although the age gradient was higher in the intervention subgroup, which is a known risk factor for hypertension, the mean BP was lower [Figure 5a and b] and the probability of having targets achieved was significantly higher in the intervention than the comparison group [Table 3]. This suggests that the door-step delivery approach of targeted education, with regular follow-up by CHWs, can decrease BP of uncontrolled hypertensive adults, especially of age ≥40 years, after adjustment for sex, income, and education. Multiple behavioral changes and repeated intervention can be more efficacious to sustain lifestyle modifications and improve BP control.[26,27] Such reduction in BP has great implications for hypertension prevalence at the population level as well as on the burden of stroke, CVD, and CKD.[28]

A strong association was observed between BP control and qualified provider visit. SBP increased in the intervention group [Figure 2a and b] when the qualified provider visit decreased below 40% at month-24 [Figure 4]. Drug sellers and unqualified practitioners constitute a large but important group of providers who are consulted by a substantial proportion of hypertensive patients [Figure 4]. However, those who are treated by them achieve lower BP control than those treated by qualified providers. Such care-seeking pattern from unqualified providers was well expected due to pluralistic nature of the health systems in Bangladesh.[8,11] Recent advances in various health indicators in Bangladesh are partially attributed to such pluralism, despite a health system which is often characterized as weak (in terms of physical and human infrastructure, logistics, and supplies).[11] Our observation adds value to the role of unqualified providers including CHWs to address hypertension at community level in Bangladesh. Services of CHWs and other unqualified providers can be effectively utilized by training them on lifestyle changes, and referral based simplified hypertension management guidelines.

Since we did not influence care-seeking behavior or use of medication, the effect we observed was due to high level of awareness and care seeking by the hypertensive patients in the community. The positive effect of this intervention

### Table 2: Baseline characteristics of the 40 years or older hypertensive patients participated in the intervention and comparison groups

| Characteristics                        | Intervention (n=118) | Comparison† (n=226) | P     |
|----------------------------------------|---------------------|---------------------|-------|
| Age (years)                            | 57±11               | 53±10               | 0.001 |
| Age group (years)                      |                     |                     |       |
| 40-59                                  | 67 (56.8)           | 161 (71.2)          | 0.007 |
| 60 or above                            | 51 (43.2)           | 65 (28.8)           |       |
| Sex                                    |                     |                     |       |
| Male                                   | 50 (42.4)           | 77 (34.1)           | 0.13  |
| Female                                 | 68 (57.6)           | 149 (65.9)          |       |
| Area                                   |                     |                     |       |
| Matlab                                 | 46 (39.0)           | 72 (31.9)           | 0.186 |
| Dhaka                                  | 72 (61.0)           | 154 (68.1)          |       |
| Education in years                     | 4±4                 | 5±5                 | 0.304 |
| Level of education                     |                     |                     |       |
| Illiterate                             | 50 (42.4)           | 87 (38.7)           | 0.381 |
| Primary (1-5 years)                    | 24 (20.3)           | 49 (21.3)           |       |
| Secondary (6-10 years)                 | 37 (31.4)           | 64 (28.4)           |       |
| High educated (>11 years)              | 7 (5.9)             | 26 (11.6)           |       |
| Occupation                             |                     |                     |       |
| Manual                                 | 13 (11.0)           | 27 (11.9)           | 0.798 |
| Nonmanual*                             | 105 (89.0)          | 199 (88.1)          |       |
| Income in (thousand BDT)†              | 16.3±13.1           | 19.9±14.7           | 0.026 |
| Income group (BDT)                     |                     |                     |       |
| Low (≤10,000)                          | 50 (42.4)           | 66 (29.3)           | 0.044 |
| Middle (10.001-30,000)                 | 56 (47.5)           | 125 (55.6)          |       |
| High (≥30,001)                         | 12 (10.2)           | 34 (15.1)           |       |
| BMI (kg/m²)                            | 24.7±5.2            | 25.3±5.1            | 0.284 |
| BMI group                              |                     |                     |       |
| Normal (18.5-24.9)                     | 51 (43.2)           | 87 (38.7)           | 0.716 |
| Underweight (<18.5)                    | 11 (9.3)            | 23 (10.2)           |       |
| Overweight/obese (≥25)                 | 56 (47.5)           | 115 (51.1)          |       |
| Waist circumference (cm)               | 84±5.12             | 87.4±13.3           | 0.053 |
| Abdominably obese‡                     | 59 (50.0)           | 134 (59.3)          | 0.099 |
| SBP (mmHg)                             | 149.1±17.7          | 149.5±17.1          | 0.867 |
| DBP (mmHg)                             | 93.6±10.0           | 95.2±10.4           | 0.181 |

Numbers in the parenthesis are percentages. Mean±SD. *Nonmanual category included sedentary workers, professionals (e.g., doctors, teachers, etc.), homemakers, retired persons, those unable to work and unemployed, †Bangladesh currency Taka 78.00=USD 1.00, ‡Abdominal obesity was defined as waist circumference ≥90 cm for males and ≥80 cm for females, †Comparison group were available from our another study on COPD who were identified as hypertensive following BP measurement using the same protocol and the same criteria and implemented in the same study sites around the same time frame. COPD - Chronic obstructive pulmonary diseases, SD - Standard deviation, BMI - Body mass index, SBP - Systolic blood pressure, DBP - Diastolic blood pressure, BP - Blood pressure

### Table 3: Predictors of blood pressure control among uncontrolled hypertensive’s age over 40 years

| Variables                  | OR (95% CI) | P     |
|----------------------------|-------------|-------|
| Targeted intervention      | 2.015 (1.276, 3.279) | 0.003 |
| Qualified provider visit   | 2.108 (1.263, 3.519) | 0.004 |
| Urban residence            | 0.549 (0.326, 0.925) | 0.024 |

OR - Odds ratio, CI - Confidence interval
is also attributable to the support from the health workers during regular interaction. Self-reported extra salt intake was significantly reduced among hypertensive participants under intervention although a significant association was not demonstrated with BP control after adjusting for other possible confounders [Table 3]. This finding was in disagreement with various other studies showing a clear dose-response relationship between salt intake and BP, i.e., the lower the salt intake achieved, the lower the BP.\cite{29,30} This intervention did not exert any significant effect on weight reduction, physical activity, and dietary habits [Table S1]. This may be due to subjective assessment of these secondary outcomes based on self-reporting of respondents. The study was powered enough to test changes in BP but not enough to demonstrate effect of intervention on these secondary outcomes (lifestyle changes). More objective methods of outcome measures or large-scale studies targeting extensive intervention on specific behavioral change could have demonstrated better picture, which were beyond the scope of this study.

**Strength and limitations**
The major strength of our study is the population-based follow-up of hypertension control in daily settings, overcoming the limitations of concurrent evaluation of hypertension control in cross-sectional studies.\cite{6,7} This allowed for a realistic estimation of effect of task shifting and community mobilization intervention in low-income settings. Longitudinal follow-up of the hypertensive cohort allowed valid assessment of pre-post intervention effects. The inclusion of a comparison subgroup allowed validation of effects of intervention on BP control. Participants of both the studies were selected randomly from the surveillance databases, and nonintervention subgroup was selected from the same neighborhood to minimize selection bias. We used multiple measurements following standard operating procedure to assess BP outcomes at different points in time. Outcomes were assessed by a different set of workers. Repeated training of CHWs and frequent field visits by the supervisors ensured proper assessment of outcomes.

This study had some limitations. Although we used validated tools to assess lifestyle changes such as global physical activity questionnaire for physical activity, and food frequency questionnaire to assess dietary habits, no objective measure of lifestyle changes was obtained as this was beyond the scope of this study. Health-seeking behavior and type of medication prescribed by different providers in this population (i.e., high use of beta-blockers by unqualified providers) are described in detail in earlier papers.\cite{31-33} These variables were not in the scope of the COPD study (at baseline or between follow-ups) from where the comparison group was selected, which restricted us to compare lifestyle changes between groups at different points in time. Cost data related to the intervention were unavailable for assessing cost-effectiveness. The CHWs in this study were recruited from same neighborhood solely for the intervention. They did not belong to any public or urban primary health-care system and was engaged in intervention activities full-time.

**Interpretations and implications**
Our findings indicate the potential to integrate target education and regular follow-up of hypertensive patients by CHWs in the primary care system of Bangladesh and other similar settings.
Future research directions

Large-scale implementation trials are recommended to evaluate integration of such interventions in the primary health-care system of Bangladesh and similar settings.

Conclusion

Targeted education and regular follow-up of hypertensive patients by CHWs reduced BP and improved BP control in hypertensive Bangladeshis. Such reduction in BP at community level may have a big impact on the burden of stroke, ischemic heart disease, and CKD. Our findings reflect huge potential for task shifting and community mobilization through CHWs for sustainable control of hypertension in Bangladesh and similar resource-poor settings with low awareness.

Acknowledgment

We gratefully acknowledge the study participants and Health and Demographic Surveillance staff at Matlab and Kamalapur sites.

Financial support and sponsorship

This project has been funded in part with Federal funds from the National Heart, Lung, and Blood Institute, National Institutes of Health, Department of Health and Human Services, under the Contract no. HHSN26820900032C and icddr, b. icddr, b acknowledges with gratitude the commitment of the Centre’s donors for their generous support to its research efforts.

Conflicts of interest

There are no conflicts of interest.

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