AWARENESS AND CONTROL OF HYPERTENSION IN BANGLADESH–FOLLOW UP OF A HYPERTENSIVE COHORT

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ABSTRACT

Objectives To assess the effect of awareness and advice to seek care on BP control among hypertensive patients in Bangladesh.

Design Longitudinal study

Setting The study was carried out in icddr,b surveillance sites at rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh

Participants Randomly selected men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction.

Main outcome measure Hypertension was defined as systolic BP (SBP) ≥ 140 and/or diastolic BP (DBP) ≥90 mmHg or as self-reported hypertension under medication. We advised to seek care from qualified provider and adopt healthy lifestyle. We compared changes in BP from baseline to follow-up at around 6 month.

Results Overall 17.1% (n=287) had hypertension at baseline with significantly higher prevalence in urban than rural population (23.6 % vs 10.8% ; p<0.001) and a half of them were unaware. At follow up, 83% (n=204) reported visit to any health care provider. In urban area, higher proportion of patients visited medically qualified practitioners than in rural area (76.7% vs 36.6% , P<0.000). Both SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were lower at follow up. Those who visited medically qualified practitioners had significant SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) reduction. BP reduction did not reach statistical significance among those visited pharmacy man or village doctors. Overall, half of the hypertensive patients achieved BP control goal (BP<140/90 mmHg).

Conclusions Raising awareness and referral advice to hypertensive patients leads to high provider visits, blood pressure reduction and higher BP target achievement in Bangladesh. Findings need a longer-term follow up to verify the sustainability.

Key Words – Blood pressure, hypertension, awareness, referral advice, treatment, blood pressure control, Bangladesh

Strengths and limitations of the study

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Blood pressure reduction as a result of regression to the mean is unlikely in this study as we took multiple measurements following standardized procedure for characterizing the baseline status as well as that at follow up.

BACKGROUND

Hypertension is the most widely prevalent but largely preventable risk factor for cardiovascular diseases (CVD) accounting for half of deaths due to ischemic heart disease and stroke.[1] Globally, 7.6 million premature deaths annually and 6.0% of the global burden of disease are attributable to hypertension.[2] Elevated blood pressure lower than the standard cut-off for hypertension (SBP 140 /DBP 90 mm Hg) is also associated with increased risk of myocardial infarction, stroke and CVD.[3 4] Hypertension is both a cause and consequence of chronic kidney diseases (CKD). A recent study showed prevalence of chronic kidney disease among 22% of undiagnosed hypertensive and 17% pre-hypertensive subjects in the United States.[5] Therefore, uncontrolled hypertension has huge implications for the disease burden due to CVD and CKD.

Recent report suggest 18% or 12 million 25 years or older adults in Bangladesh suffer from hypertension with higher prevalence in urban than in rural population.[6] Earlier reports also showed that 12-15% of 20 years or older Bangladeshi had hypertension.[7-9] Low awareness is common in populations in low income settings including Bangladesh.[10-12] Research has shown that greater awareness is associated with higher adherence to antihypertensive treatments and BP control.[13] Study in China [14] showed only 30-45% of people with hypertension were aware of their condition and only 8% had achieved target BP goals. However, data are scarce on care seeking behavior and blood pressure target achievement after raising awareness. Despite a huge disease burden attributable to hypertension and very high rate of unawareness, it is largely an unrecognized and under-researched public health problem in Bangladesh.

So far, all studies in Bangladesh reported prevalence data on hypertension, either measured and or self-reported, and awareness, treatment and control from cross-sectional studies which have inherent limitations and fails to provide information on care seeking behavior and level of control after being aware. In this paper we report prevalence, awareness and control of hypertension at baseline and explored the effect of raising awareness coupled with health messages to visit health care provider on, blood pressure and blood pressure goal achievement among individuals with hypertension in urban and rural Bangladesh.

METHODS

Study design and population

The longitudinal study was carried out in rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh. In both the sites, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) has its Health and Demographic Surveillance System (HDSS) in place.[15-17] Study population consisted of men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction. We selected participants at random from the HDSS databases. We replaced randomly selected individuals who were unavailable with age and sex matched participants from the same community who were eligible but were not included in sample. Between February and August 2011, we conducted a baseline survey and identified individuals with hypertension. We informed the blood pressure status and provided simple health messages to the hypertensive individuals with emphasis on visiting health care provider, possible complications if untreated, and lifestyle factors. We followed up these hypertensive patients and measured BP again at 4-6 month after baseline and documented history of provider visits,

medication use and blood pressure status. The study was approved by the Ethical Review Committee (ERC) of icddr,b. An informed voluntary written consent was obtained from each participant before enrolment.

Sample Size

We estimated sample size for each age group to measure prevalence within 10% precision with 80% power. As the prevalence of hypertension increases with age, we assumed the lowest prevalence of 5% in 20-24 years age group and the highest 20% or higher in 65years or older age groups during stratum specific sample size estimation. The estimated total sample size after considering possible refusal or non-participation was 1600 participants (800 in each site).

Data collection

We collected data on socioeconomic, demographic, lifestyle factors using a structured questionnaire. Trained interviewers administered the questionnaire at participants' home. Interviewers also measured weight, height, waist and hip circumferences following standard procedure [18]. We proscribed all participants of drinking tea, coffee, or carbonated beverages, eating, smoking and avoid heavy physical activity at least 30 minutes prior to blood pressure measurement. We allowed 10 minutes rest before measuring blood pressure three times at five minutes interval on left arm in sitting position with the arm supported at the level of the heart using Omron M10^{TM} digital blood pressure machine. The first BP measurement was discarded to avoid possible anxiety effect, and the mean value of the second and third measurements was considered for both systolic and diastolic BP. SBP ≥140 mmHg or DBP ≥90 mmHg or both was defined as hypertension. Participants who were on anti-hypertensive medications and could

show or name antihypertensive medication or produce the prescription, we considered them as aware and self-reported hypertensive irrespective of their BP status at the time of measurement. 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.

Health advices

We informed all hypertensive patients about their blood pressure status and provided them simple health messages in local language, Bengali. The health messages included information on risk factors for hypertension, possible risk associated with uncontrolled BP, lifestyle and diet related issues particularly smoking, physical activity and extra salt intake. We advised them to visit a qualified health care provider. A written outline was followed to deliver the health messages uniformly and adequately. However, study workers were not involved in providing any prescription or medication. Adequate training including periodic refresher training of the health workers and regular field visit by the supervisors were ensured to minimize intra and inter individual inconsistency.

Follow up

We followed up all available hypertensive patients at around 4-6 month and collected data on treatment seeking, provider visits, and medication use. A study nurse or trained Health Workers measured blood pressure using the same electronic blood pressure monitor following the same procedure as that in baseline. The nurse or the health worker did not have access to blood pressure data collected earlier and were not aware of the purpose of the study. We considered

blood pressure goal is achieved when mean value of second and third measurements of SBP and DBP at follow up was <140 mmHg and <90 mmHg respectively.

Data analysis

Data were entered on computer with built in range and consistency check using MS Access. Descriptive data are presented as frequency and percentages for the categorical variables, and as mean and standard deviation for the continuous variables. Chi-square test was used to examine the association between categorical variables. Paired t-test was used to compare within individual change in blood pressure from baseline to follow up. A p-value <0.05 was considered statistically significant.

RESULTS

In total, 1678 participants were interviewed and blood pressure measured in urban Dhaka (n=825) and rural Matlab (n=853) (Figure 1). Characteristics of the study participant are presented in Table 1. On average, participants were 43 years old and 44% were males. Urban participants were younger, more educated, had higher BMI, more abdominal obesity, higher income and of more non-manual occupation than rural participants. However, rural participants used more chewing tobacco and consumed more extra salt.

In total, 287 (17.1%) respondents were finally diagnosed as hypertensive cases (Table 1). Age standardized prevalence of hypertension was 14.8% (Bangladesh standard population as reported by the Bangladesh Bureau of Statistics 2008). The prevalence of hypertension was significantly higher in urban than rural among participants (23.6% vs. 10.8%; p<0.001). More women than men were hypertensive (18.3% vs. 15.6%). At baseline, half (49%) the total

hypertensive patients were aware about their BP status but only half of those who were aware (55%) had their BP under control (SBP<140 and DBP<90 mm Hg) (Figure 2) .

At follow up, we were able to reach 245 (85%) hypertensive respondents (Figure 1). Of the 42 lost to follow up included 16 migrated out, 7 refused, 3 died and 16 could not be reached after repeated attempts due to their day time work schedule. Among those available, 83.3% reported that they visited health care provider at least once after enrolment into the study (Figure 3). Over three quarters of hypertensive patients in Dhaka and a third in Matlab visited professionally qualified doctors (76.7% vs 36.6%, P<0.000) who included MBBS/MD or higher qualified practitioners. The rest visited drug sellers who included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice. This difference in choice of provider visit was significantly different between urban and rural hypertensive patients. Only about a half of those (52.7%) visited care provider could show their prescribed medication during the follow-up visit. About 28% of the patients did not receive any written prescription from their care provider.

Overall, beta-blockers were the highest prescribed antihypertensive drugs either as single or in combination with calcium channel blockers followed by calcium channel blockers and angiotensin receptor blockers (Figure 3). Higher use of beta-blockers was noted among those seen by rural drug sellers. Diuretics were prescribed for only about 1% of the total patients. About 3% patients received sedative or tranquilizer pills although mostly in addition to antihypertensive medications.

Overall, both mean SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were significantly lower at follow up (Figure 4). Those who visited professionally qualified providers had significantly lower SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) as compared to their baseline measure but those who visited drug sellers had no significant reduction in BP.

Overall 50% hypertensive patients achieved BP goal at follow up. About 30% of uncontrolled hypertensives at baseline and 46% of newly diagnosed hypertensives achieved blood pressure goal at follow up. On the other hand 26% of the hypertensives who had their BP controlled at baseline failed to maintain that at follow up. BP goal achievement tended to be higher among those treated by professionally qualified practitioners than drug sellers but the difference did not reach statistical significance. At follow up, the proportion of hypertensive individuals who achieved BP goals were double as compared to those at baseline (Figure 2).

DISCUSSION

Principal findings

This study reports the prevalence, population awareness and subsequent control of hypertension in a general population. We demonstrated that raising awareness and simple health messages result in high provider visits and reduction in blood pressure in Bangladeshi hypertensive population. The modest reduction in blood pressure that we observed has great implications for the hypertension prevalence at population level.[19] To our knowledge this is the first community based longitudinal study in Bangladesh that followed up recently diagnosed hypertensive patients in day-to-day care settings in rural and urban communities.

We found about 88% of hypertensives who were already aware at baseline and 78% of newly diagnosed cases visited health care provider at least once between baseline and the follow up. More urban patients than rural visited qualified health care professionals and the blood pressure reduction was significantly greater in that group. On the contrary, more rural patients (63.4%) visited drug sellers and the difference in blood pressure between baseline and follow up was not significant. It indicates an urgent necessity for training rural drug seller on simplified hypertension management guidelines for effective utilization of this important health care provider group in hypertension control in Bangladesh. Extensive use of beta-blockers by both types of providers has been identified as knowledge gap that need to be addressed and updated urgently. This implies that the development and implementation of a simplified hypertension management guideline and training of providers may ameliorate the problem.

Comparison with other studies

Community-based data on blood pressure levels in open populations are scarce in Bangladesh. We found higher prevalence of hypertension in urban than rural population. Bangladesh Non-communicable Diseases (NCD) risk factor survey also showed higher prevalence of hypertension in urban than rural population (20% vas 16%).[6] The overall prevalence of hypertension in this study was 17.1% and the age adjusted prevalence was 14.5% which is fairly consistent with a similar studies conducted earlier.[6 7] However, a recent systematic review of hypertension studies in Bangladesh conducted between 1994 and 2002 reported 13.5% as a pooled estimate of hypertension prevalence.[20]

Our study confirms others observation in similar settings that a high level of unawareness among hypertensive patients in the community.[21 22] At baseline, we found only less than a half of the hypertensive patients were aware of their blood pressure status and a half of those who were aware had their BP under control. Similar pattern of poor detection and control of hypertension has been reported previously as "the rule of halves" that is half of the hypertensive patients are aware and only half of those aware are treated and half of treated have their BP target achieved.[23] This implies that without further awareness raising campaigns about three quarters of total hypertensive patients in Bangladesh will continue to live with uncontrolled BP.

Our longitudinal observation indicates that better BP control can be achieved through simple community-based efforts to raise awareness. Similar effect of raising awareness on BP control has been reported in different settings.[21 24] These findings need a longer-term follow up to verify the sustainability.

Our present findings do not focus on smoking reduction which is known to increase risk of acute vascular events such as myocardial infarction and stroke in hypertensive patients.[25] Impact of high blood pressure is likely to be much higher in men in Bangladesh as 50% of them are smoker as opposed to less than 2% women. Our recent report showed that 25% of all deaths in Bangladeshi men aged 25 to 69 years are attributable to smoking.[26] This warrants necessity for further intensification of anti-smoking campaigns in combination with awareness raising to promote blood pressure control.

We found improper antihypertensive medication prescription by both qualified providers and drug sellers. Beta-blockers were the single highest prescribed drugs particularly by the drug sellers in rural area which may have implications for long term prognosis as treatment of uncomplicated hypertension with beta-blockers has been reported to be associated with increased risk of stroke without any extra benefit for cardiovascular morbidity and mortality.[27] Major hypertension management guidelines also do not recommend beta-blockers as initial treatment for hypertension.[28] A High beta-blocker prescription by rural informal practitioners was also reported by other investigators in Bangladesh.[29]

Strengths and limitations of the study

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 which allowed for a realistic estimation of effect of a simple campaign in low-income settings.

One of the limitations of our study is that we did not have any control. As the study was conducted in two densely populated areas, it was not possible to keep some hypertensive without any advice or provide different information. Since we did not influence care seeking behavior or use of medication, the effect we observed was due to high level of awareness and seeking care by the hypertensive patients in the community where 50% were unaware about their condition. The second issue could be whether the blood pressure reduction could happen anyway as a result of regression to the mean which we believe unlikely in this study as we took multiple measurements following standardized procedure for characterizing the

baseline status as well as that at follow up. Our trained workers followed the same measurement protocol and used the same equipment to ensure high quality measurements. Also, we did not study the actual rational prescribing and qualifying characteristics of the involved providers. An earlier study in Bangladesh [29] reported in detail their findings on the qualifications and level of knowledge among non-professional health care providers. They found that in Bangladesh the majority of village-level providers are certified by some authority and have some level of understanding of blood pressure measurement and treatment, although the later could be improved. This certainly will not be the case in many other rural and urban low-income settings.

Our findings suggests that simple community-based efforts to raise awareness, increase diagnosing, referral advice as well as access to qualified practitioners may result in better BP control in Bangladesh and similar low income settings. These findings also suggest importance of developing simplified hypertension management guidelines for Bangladesh and needs for appropriate training of health care providers on the guidelines for management of hypertension.

CONCLUSIONS

The implications of our findings are potentially huge in two ways. The high level of unawareness is alarming. With an estimated 12 million hypertensive patients in Bangladesh,[6] these high levels of undiagnosed high blood pressure will have big impact on the total burden of stroke and ischemic heart diseases, which are already the leading causes of adult mortality and morbidity in the country.[30 31] Secondly, our findings of raising awareness, treatment

seeking behavior, and blood pressure reduction in both rural and urban settings in Bangladesh give cause for optimism. Drug sellers are significant health care providers particularly in rural settings who can be effectively utilized for hypertension control by appropriate training on simplified management guideline.

What is already known on this topic

- Low awareness is common among hypertensive patients and is associated with uncontrolled blood pressure and its cardiovascular and renal complications.
- Modest reduction in average blood pressure has great implications for hypertension prevalence at population level.

What this study adds

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Raising awareness through community screening of BP and referral of hypertensive to health care provider appears to be practically feasible approach to control hypertension in low resource settings.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Extensive use beta-blockers in hypertension treatment justify need for the development and implementation of simplified hypertension management guidelines.
- Scope of utilizing drug sellers to control hypertension in rural settings.

List of abbreviations

ARB = Angiotensin receptor blockers

BB = Beta- blockers

BMI = Body Mass Index

BP = Blood pressure

CCB = Calcium channel blockers

CCCD = Centre for Control of Chronic Diseases

CKD = Chronic Kidney Diseases

CVD = Cardiovascular Diseases

DBP = Diastolic Blood Pressure

ERC = Ethical Review Committee

HDSS = Health and Demographic Surveillance System

icddr,b = International Centre for Diarrhoeal Disease Research, Bangladesh

SBP = Systolic Blood Pressure

Contributors Study concept, design & proposal was developed by DSA. All authors contributed equally to the analysis, interpretation and drafting of the manuscript. LWN contributed to revising and finalizing the manuscript. All authors read and approved the final manuscript. DSA is the guarantor.

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Competing Interest The authors declare that they have no competing interests.

Ethical Approval The study was approved by the Ethical Review Committee (ERC) of icddr,b.

Data sharing statement Collected data as described in the methodology are available with DSA (dsalam@icddrb.org) which can be shared following icddr,b data policy (http://www.icddrb.org/who-we-are/data-policies). A detail data set of the study will be made available for public use at the end of contract with National Heart, Lung, and Blood Institute, National Institutes of Health, Department of Health and Human Services (https://www.nhlbighiacc.org).

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TABLE

Table 1: Characteristics of the respondents

	Total n=1678	Dhaka n=825	Matlab n=853	P Value
Age (years)	43.5 ± 15.1	40.7 ± 14.8	46.1 ± 15.0	0.000
Male	736 (43.9)	352 (42.7)	384 (45.0)	0.332
Education in year	5.1 ± 4.7	6.2 ± 5.1	4.0 ± 4.0	0.000
Educational category				0.000
Illiterate	582 (34.7)	245 (29.7)	337 (39.5)	
Primary (1-5 years)	377 (22.5)	145 (17.6)	232 (27.2)	
Secondary (6-10 years)	521 (31.0)	282 (34.2)	239 (28.0)	
High educated (>11 years)	198 (11.8)	153 (18.5)	45 (5.3)	
Occupation				0.000
Manual	368 (21.9)	124 (15.0)	244 (28.6)	
Non-Manual*	1310 (78.1)	701 (85.0)	609 (71.4)	
Income '000 Taka†	15.5 ± 13.5	19.5 ± 15.5	11.6 ± 9.9	0.000
Income Group				0.000
Low (<=10000tk)	846 (50.4)	256 (31.0)	590 (69.2)	
Middle (10001-30000tk)	710 (42.3)	478 (57.9)	232 (27.2)	
High (>=30001)	122 (7.3)	91 (11.0)	31 (3.6)	
Body Mass Index in kg/m2	22.6 ± 7.0	24.2 ± 5.1	21.0 ± 8.1	0.000
BMI Category				0.000
Underweight (<18.5 kg/m^2)	341 (20.3)	92 (11.2)	249 (29.2)	
Overweight/Obese(>=25 kg/m^2)	424 (25.3)	328 (39.8)	96 (11.3)	
Waist Circumference in cm	77.4 ± 11.7	81.0 ± 12.2	73.9 ± 10.1	0.000
Abdominal obesity	466 (27.8)	317 (38.4)	149 (17.5)	0.000
Extra Salt Intake (At least once a day)	1345 (80.4)	564 (68.5)	781 (91.9)	0.000
Tobacco use				
Smokers	500 (29.8)	234 (28.4)	266 (31.2)	0.207
Chewing Tobacco	536 (31.9)	203 (24.6)	333 (39.0)	0.000
Systolic BP	113.1 ± 18.7	117.3 ± 18.9	109.1 ± 17.6	0.000
Diastolic BP	71.6 ± 15.7	72.5 ± 19.4	70.7 ± 10.8	0.021
Blood Pressure Category				0.000
Normal	1053 (62.8)	423 (51.3)	630 (73.9)	
Pre-hypertension	338 (20.1)	207 (25.1)	131 (15.4)	
Hypertension	287 (17.1)	195 (23.6)	92(10.8)	

Mean± SD

Numbers in the parenthesis are percentages.

*Non-manual category included sedentary workers, professionals (e.g. doctors, teachers, etc.), housewives, retired persons, those unable to work and unemployed.

†Bangladesh currency Taka 80.00 = USD 1.00

‡Abdominal obesity was defined as waist circumference ≥90 cm for males and ≥80 cm for females

¥Extra salt intake was referred to table salt consumption at least once a day other than salt used in cooking or food preparation.

FIGURE LEGENDS

Figure 1. Study enrolment and follow up flow diagram

Figure 2. Distribution of awareness and control of blood pressure among hypertensive patients at baseline and at follow up by gender in Bangladesh

Figure 3. Pattern of health care provider visits and medication use in urban Dhaka and rural Matlab, Bangladesh.

Panel A. Distribution of provider visits by area. Panel B. Pattern of medication use by hypertensive patients.

*Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

BB – Beta- blockers, CCB – Calcium channel blockers, ARB – Angiotensin receptor blockers

Figure 4. Change in systolic and diastolic blood pressure between baseline and follow-up by provider type.

* Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

Figure 1.

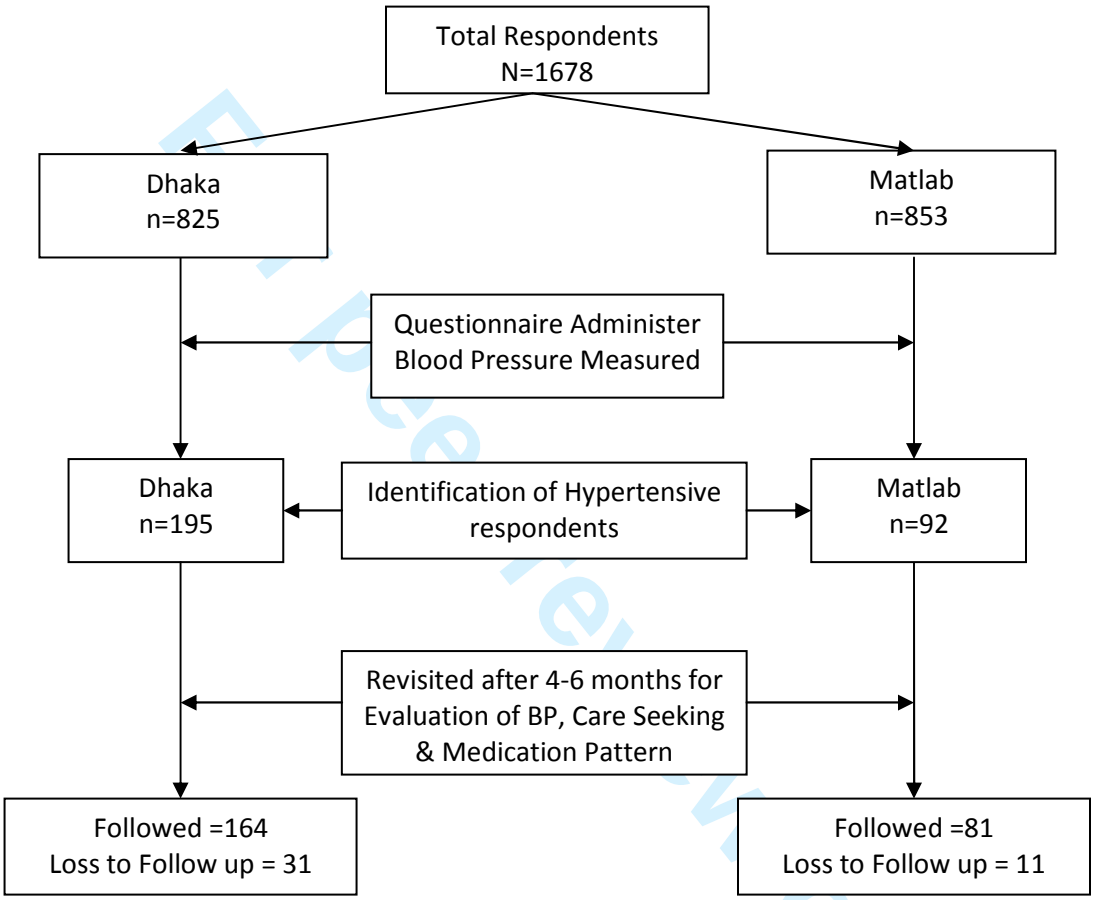


Figure 2.

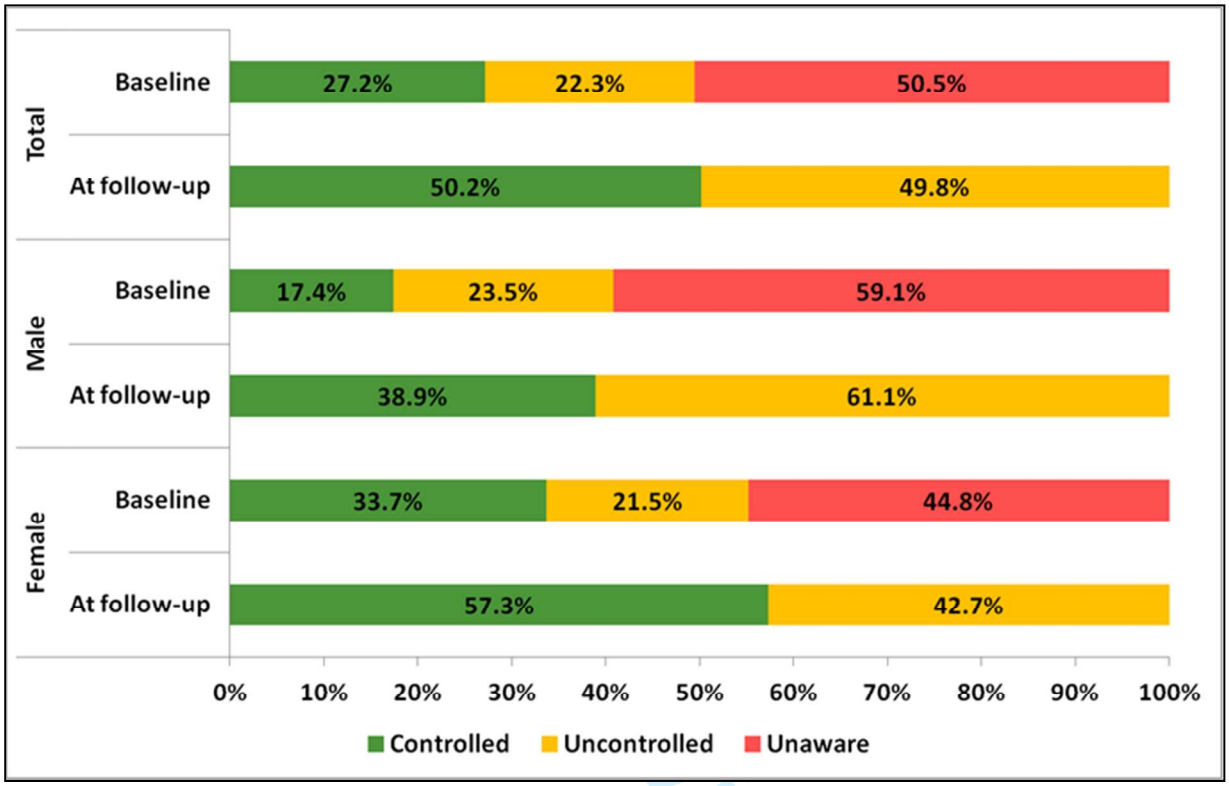


Figure 3.

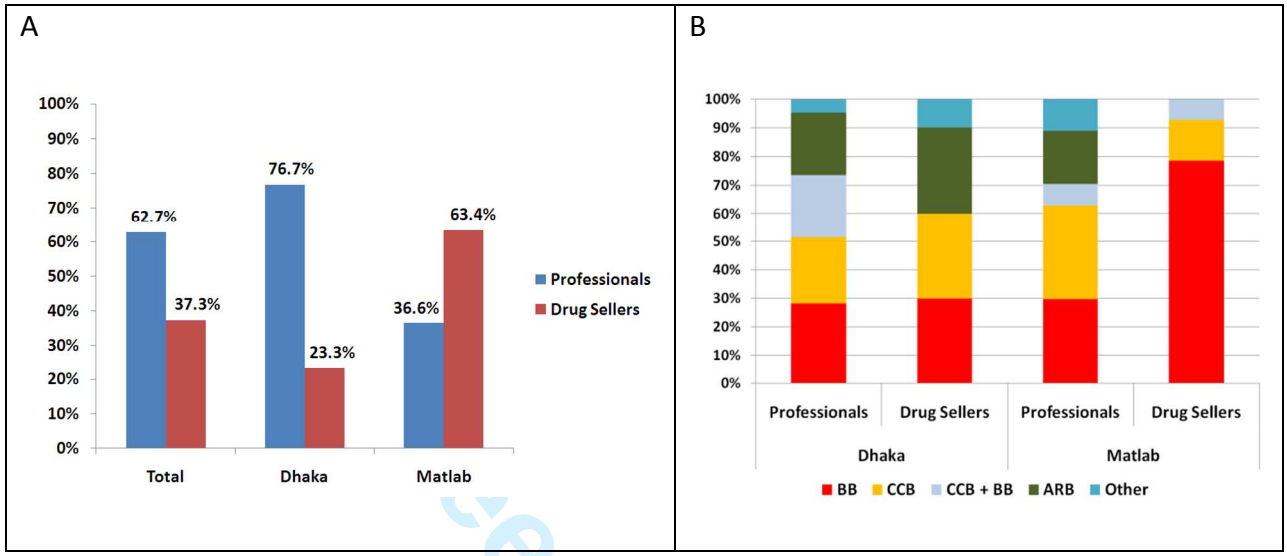
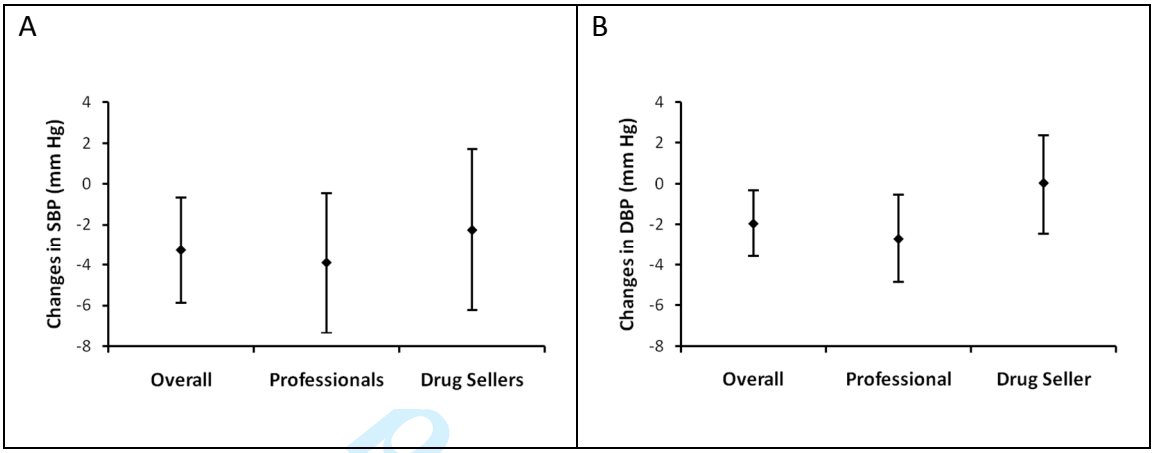


Figure 4.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Page No.	Recommendation
Title and abstract	√1	1, 2	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/ rationale	√2	4	Explain the scientific background and rationale for the investigation being reported
Objectives	√3	5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	√4	5	Present key elements of study design early in the paper
Setting	√5	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	√6	5	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	√7	6	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	√8*	6	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	√9	5, 6,7	Describe any efforts to address potential sources of bias
Study size	√10	6	Explain how the study size was arrived at
Quantitative variables	√11	8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	√12	8	(*a*) Describe all statistical methods, including those used to control for confounding
			(*b*) Describe any methods used to examine subgroups and interactions
			(*c*) Explain how missing data were addressed
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses

Continued on next page

Results			
Participants	√13*	8	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		9	(b) Give reasons for non-participation at each stage
		24	(c) Consider use of a flow diagram
Descriptive data	√14*	8	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		9	(b) Indicate number of participants with missing data for each variable of interest
			(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	√15*	8, 10	*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
			Cross-sectional study—Report numbers of outcome events or summary measures
Main results	√16	8	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		8	(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
Key results	√18	10	Summarise key results with reference to study objectives
Limitations	√19	13	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	√20	11	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	√21	14	Discuss the generalisability (external validity) of the study results
Other information			
Funding	√22	18	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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AWARENESS AND CONTROL OF HYPERTENSION IN BANGLADESH–FOLLOW UP OF A HYPERTENSIVE COHORT

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Title:

AWARENESS AND CONTROL OF HYPERTENSION IN BANGLADESH – FOLLOW UP OF A HYPERTENSIVE COHORT

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Key Words – Blood pressure, hypertension, awareness, referral advice, treatment, blood pressure control, Bangladesh

ABSTRACT

Objectives To assess the effect of awareness and advice to seek care on BP control among hypertensive patients in Bangladesh.

Design Longitudinal study

Setting The study was carried out in icddr,b surveillance sites at rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh

Participants Randomly selected men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction.

Main outcome measure Hypertension was defined as systolic BP (SBP) ≥ 140 and/or diastolic BP (DBP) ≥90 mmHg or as self-reported hypertension under medication. We advised to seek care from qualified provider and adopt healthy lifestyle. We compared changes in BP from baseline to follow-up at around 6 month.

Results Overall 17.1% (n=287) had hypertension at baseline with significantly higher prevalence in urban than rural population (23.6 % vs 10.8% ; p<0.001) and a half of them were unaware. At follow up, 83% (n=204) reported visit to any health care provider. In urban area, higher proportion of patients visited medically qualified practitioners than in rural area (76.7% vs 36.6% , P<0.000). Both SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were lower at follow up. Those who visited medically qualified practitioners had significant SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) reduction. BP reduction did not reach statistical significance among those visited pharmacy man or village doctors. Overall, half of the hypertensive patients achieved BP control goal (BP<140/90 mmHg).

Conclusions Awareness and simple health messages increase provider visit, reduce blood pressure and improve BP control in hypertensive Bangladeshis. Longer-term follow up is required to verify the sustainability.

Strengths and limitations of the study

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Blood pressure reduction as a result of regression to the mean is unlikely in this study as we took multiple measurements following standardized procedure for characterizing the baseline status as well as that at follow up.

BACKGROUND

Hypertension is the most widely prevalent but largely preventable risk factor for cardiovascular diseases (CVD) accounting for half of deaths due to ischemic heart disease and stroke.[1] Globally, 7.6 million premature deaths annually and 6.0% of the global burden of disease are attributable to hypertension.[2] Elevated blood pressure lower than the standard cut-off for hypertension (SBP 140 /DBP 90 mm Hg) is also associated with increased risk of myocardial infarction, stroke and CVD.[3 4] Hypertension is both a cause and consequence of chronic kidney diseases (CKD). A recent study showed prevalence of chronic kidney disease among 22% of undiagnosed hypertensive and 17% pre-hypertensive subjects in the United States.[5] Therefore, uncontrolled hypertension has huge implications for the disease burden due to CVD and CKD.

Recent report suggest 18% or 12 million 25 years or older adults in Bangladesh suffer from hypertension with higher prevalence in urban than in rural population.[6] Earlier reports also showed that 12-15% of 20 years or older Bangladeshi had hypertension.[7-9] Low awareness is common in populations in low income settings including Bangladesh.[10-12] Research has shown that greater awareness is associated with higher adherence to antihypertensive treatments and BP control.[13] Study in China [14] showed only 30-45% of people with hypertension were aware of their condition and only 8% had achieved target BP goals. However, data are scarce on care seeking behavior and blood pressure target achievement after raising awareness. Despite a huge disease burden attributable to hypertension and very high rate of unawareness, it is largely an unrecognized and under-researched public health problem in Bangladesh.

So far, all studies in Bangladesh reported prevalence data on hypertension, either measured and or self-reported, and awareness, treatment and control from cross-sectional studies which have inherent limitations and fails to provide information on care seeking behavior and level of control after being aware. In this paper we report prevalence, awareness and control of hypertension at baseline and explored the effect of raising awareness coupled with health messages to visit health care provider on, blood pressure and blood pressure goal achievement among individuals with hypertension in urban and rural Bangladesh.

METHODS

Study design and population

The longitudinal study was carried out in rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh. In both the sites, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) has its Health and Demographic Surveillance System (HDSS) in place.[15-17] Study population consisted of men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction. We selected participants at random from the HDSS databases. We replaced randomly selected individuals who were unavailable (17% in semiurban Kamalapur and 15% in rural Matlab) with age and sex matched participants from the same community who were eligible but were not included in sample. Between February and August 2011, we conducted a baseline survey and identified individuals with hypertension. Very few participants declined to participate (3.9% in Kamalapur and none in Matlab). We informed the blood pressure status and provided simple health messages to the hypertensive individuals with emphasis on visiting health care provider, possible complications if untreated, and lifestyle factors. We followed up

these hypertensive patients and measured BP again at 4-6 month after baseline and documented history of provider visits, medication use and blood pressure status. The study was approved by the Ethical Review Committee (ERC) of icddr,b. An informed voluntary written consent was obtained from each participant before enrolment.

Sample Size

We estimated sample size for each age group to measure prevalence within 10% precision with 80% power. As the prevalence of hypertension increases with age, we assumed the lowest prevalence of 5% in 20-24 years age group and the highest 20% or higher in 65years or older age groups during stratum specific sample size estimation. The estimated total sample size after considering possible refusal or non-participation was 1600 participants (800 in each site).

Data collection

We collected data on socioeconomic, demographic, lifestyle factors using a structured questionnaire. Trained interviewers administered the questionnaire at participants' home. Interviewers also measured weight, height, waist and hip circumferences following standard procedure [18]. We proscribed all participants of drinking tea, coffee, or carbonated beverages, eating, smoking and avoid heavy physical activity at least 30 minutes prior to blood pressure measurement. We allowed 10 minutes rest before measuring blood pressure three times at five minutes interval on left arm in sitting position with the arm supported at the level of the heart using Omron M10^{TM} digital blood pressure machine. The first BP measurement was discarded to avoid possible anxiety effect, and the mean value of the second and third measurements was considered for both systolic and diastolic BP. SBP ≥140 mmHg or DBP ≥90 mmHg or both was

defined as hypertension. Participants who were on anti-hypertensive medications and could show or name antihypertensive medication or produce the prescription, we considered them as aware and self-reported hypertensive irrespective of their BP status at the time of measurement. 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.

Health advices

We informed all hypertensive patients about their blood pressure status and provided them simple health messages in local language, Bengali. The health messages included information on risk factors for hypertension, possible risk associated with uncontrolled BP, lifestyle and diet related issues particularly smoking, physical activity and extra salt intake. We advised them to visit a qualified health care provider. A written outline was followed to deliver the health messages uniformly and adequately. However, study workers were not involved in providing any prescription or medication. Adequate training including periodic refresher training of the health workers and regular field visit by the supervisors were ensured to minimize intra and inter individual inconsistency.

Follow up

We followed up all available hypertensive patients at around 4-6 month and collected data on treatment seeking, provider visits, and medication use. A study nurse or trained Health Workers measured blood pressure using the same electronic blood pressure monitor following the same procedure as that in baseline. The nurse or the health worker did not have access to blood

pressure data collected earlier and were not aware of the purpose of the study. We considered blood pressure goal is achieved when mean value of second and third measurements of SBP and DBP at follow up was <140 mmHg and <90 mmHg respectively.

Data analysis

Data were entered on computer with built in range and consistency check using MS Access. Descriptive data are presented as frequency and percentages for the categorical variables, and as mean and standard deviation for the continuous variables. Chi-square test was used to examine the association between categorical variables. Paired t-test was used to compare within individual change in blood pressure from baseline to follow up. A p-value <0.05 was considered statistically significant.

RESULTS

In total, 1678 participants were interviewed and blood pressure measured in urban Dhaka (n=825) and rural Matlab (n=853) (Figure 1). Characteristics of the study participant are presented in Table 1. On average, participants were 43 years old and 44% were males. Urban participants were younger, more educated, had higher BMI, more abdominal obesity, higher income and of more non-manual occupation than rural participants. However, rural participants used more chewing tobacco and consumed more extra salt.

In total, 287 (17.1%) respondents were finally diagnosed as hypertensive cases (Controlled-4.6%; Stage 1- 8.2% and Stage 2- 4.3%). Age standardized prevalence of hypertension was 14.8% (Bangladesh standard population as reported by the Bangladesh Bureau of Statistics 2008). The prevalence of hypertension was significantly higher in urban than rural participants

(23.6% vs. 10.8%; p<0.001). More women than men were hypertensive. At baseline, half (49%) the total hypertensive patients were aware about their BP status and half of those who were aware (27.2%) had their BP under control (SBP<140 and DBP<90 mm Hg) (Figure 2).

At follow up, we were able to reach 245 (85%) hypertensive respondents (Figure 1). Of the 42 lost to follow up included 16 migrated out, 7 refused, 3 died and 16 could not be reached after repeated attempts due to their day time work schedule. Among those available, 83.3% reported that they visited health care provider at least once after enrolment into the study (Figure 3A). Over three quarters of hypertensive patients in Dhaka and a third in Matlab visited professionally qualified doctors (76.7% vs 36.6%, P<0.000) who included MBBS/MD or higher qualified practitioners. The rest visited drug sellers who included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice. This difference in choice of provider visit was significantly different between urban and rural hypertensive patients. Only about a half of those (52.7%) visited care provider could show their prescribed medication during the follow-up visit. About 28% of the patients did not receive any written prescription from their care provider.

Overall, beta-blockers were the highest prescribed antihypertensive drugs either as single or in combination with calcium channel blockers followed by calcium channel blockers and angiotensin receptor blockers (Figure 3B). Higher use of beta-blockers was noted among those seen by rural drug sellers. Diuretics were prescribed for only about 1% of the total patients. About 3% patients received sedative or tranquilizer pills although mostly in addition to antihypertensive medications.

Overall, both mean SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were significantly lower at follow up (Figure 4A and 4B). Those who visited professionally qualified providers had significantly lower SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) as compared to their baseline measure but those who visited drug sellers had no significant reduction in BP (Figure 4A and 4B).

Overall 50% hypertensive patients achieved BP control goal at follow up compared to 27% at baseline (Figure 2). About 30% of uncontrolled hypertensives at baseline and 46% of newly diagnosed hypertensives achieved blood pressure goal at follow up. Only 26% of the hypertensives who had their BP controlled at baseline failed to maintain that at follow up. On the other hand 46% of stage 1 and 33% of stage 2 hypertensives achieved blood pressure goal at follow up (data not shown). BP goal achievement tended to be higher among those treated by professionally qualified practitioners than drug sellers but the difference did not reach statistical significance. At follow up, the proportion of hypertensive individuals who achieved BP goals were double as compared to those at baseline (Figure 2).

DISCUSSION

Principal findings

This study reports the prevalence, population awareness and subsequent control of hypertension in a general population. We demonstrated that raising awareness and simple health messages result in high provider visits and reduction in blood pressure in Bangladeshi hypertensive population. The modest reduction in blood pressure that we observed has great implications for the hypertension prevalence at population level.[19] To our knowledge this is the

first community based longitudinal study in Bangladesh that followed up recently diagnosed hypertensive patients in day-to-day care settings in rural and urban communities.

We found about 88% of hypertensives who were already aware at baseline and 78% of newly diagnosed cases visited health care provider at least once between baseline and the follow up. More urban patients than rural visited qualified health care professionals and the blood pressure reduction was significantly greater in that group. On the contrary, more rural patients (63.4%) from all economic strata (Figure 3A) visited drug sellers and the difference in blood pressure between baseline and follow up was not significant. It indicates the scope for training rural drug seller on simplified hypertension management guidelines for effective utilization of this important health care provider group in hypertension control in Bangladesh. Accessibility and cost may have played important role for high drug seller visit in rural area among all socioeconomic strata and need further exploration. Extensive use of beta-blockers by both types of providers has been identified and need to be addressed urgently. Development and implementation of a simplified hypertension management guideline and training of providers may ameliorate the problem.

Comparison with other studies

Community-based data on blood pressure levels in open populations are scarce in Bangladesh. We found higher prevalence of hypertension in urban than rural population. Bangladesh Non-communicable Diseases (NCD) risk factor survey also showed higher prevalence of hypertension in urban than rural population (20% vas 16%).[6] The overall prevalence of hypertension in this study was 17.1% and the age adjusted prevalence was 14.5% which is fairly consistent with a

similar studies conducted earlier.[6 7] However, a recent systematic review of hypertension studies in Bangladesh conducted between 1994 and 2002 reported 13.5% as a pooled estimate of hypertension prevalence.[20]

Our study confirms others observation in similar settings that a high level of unawareness among hypertensive patients in the community.[21 22] At baseline, we found only less than a half of the hypertensive patients were aware of their blood pressure status and a half of those who were aware had their BP under control. Similar pattern of poor detection and control of hypertension has been reported previously as "the rule of halves" that is half of the hypertensive patients are aware and only half of those aware are treated and half of treated have their BP target achieved.[23] This implies that without further awareness raising campaigns about three quarters of total hypertensive patients in Bangladesh will continue to live with uncontrolled BP.

Our longitudinal observation indicates that better BP control can be achieved through simple community-based efforts to raise awareness. Similar effect of raising awareness on BP control has been reported in different settings.[21 24] These findings need a longer-term follow up to verify the sustainability. We know that multiple behavioral changes are possible and repeated intervention can be more efficacious to sustain lifestyle modifications and improve blood pressure control.[25 26] Our findings from onetime intervention indicates the scope of targeted education with regular monitoring through community health workers may result in healthier lifestyle and lower blood pressure in developing country context. Strengthening primary healthcare properly might be another option to address hypertension in resource poor settings.

Our present findings do not focus on smoking reduction which is known to increase risk of acute vascular events such as myocardial infarction and stroke in hypertensive patients.[27] Impact of high blood pressure is likely to be much higher in men in Bangladesh as 50% of them are smoker as opposed to less than 2% women. Our recent report showed that 25% of all deaths in Bangladeshi men aged 25 to 69 years are attributable to smoking.[28] This warrants necessity for further intensification of anti-smoking campaigns in combination with awareness raising to promote blood pressure control.

We found improper antihypertensive medication prescription by both qualified providers and drug sellers. Beta-blockers were the single highest prescribed drugs particularly by the drug sellers in rural area which may have implications for long term prognosis as treatment of uncomplicated hypertension with beta-blockers has been reported to be associated with increased risk of stroke without any extra benefit for cardiovascular morbidity and mortality.[29] Major hypertension management guidelines also do not recommend beta-blockers as initial treatment for hypertension.[30] A High beta-blocker prescription by rural informal practitioners was also reported by other investigators in Bangladesh.[31]

Strengths and limitations of the study

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 which allowed for a realistic estimation of effect of a simple campaign in low-income settings.

One of the limitations of our study is that we did not have any control. As the study was conducted in two densely populated areas, it was not possible to keep some hypertensive without any advice or provide different information. Since we did not influence care seeking behavior or use of medication, the effect we observed was due to high level of awareness and seeking care by the hypertensive patients in the community where 50% were unaware about their condition. The second issue could be whether the blood pressure reduction could happen anyway as a result of regression to the mean which we believe unlikely in this study as we took multiple measurements following standardized procedure for characterizing the baseline status as well as that at follow up. Our trained workers followed the same measurement protocol and used the same equipment to ensure high quality measurements. Also, we did not study the actual rational prescribing and qualifying characteristics of the involved providers. An earlier study in Bangladesh [31] reported in detail their findings on the qualifications and level of knowledge among non-professional health care providers. They found that in Bangladesh the majority of village-level providers are certified by some authority and have some level of understanding of blood pressure measurement and treatment, although the later could be improved. This certainly will not be the case in many other rural and urban low-income settings. In this paper we report the modest blood lowering effect due to awareness and simple health messages at six month after the baseline but further longitudinal observation is needed to assess the effect of repeated interventions on long term blood pressure control which will be reported in due course.

Our findings suggests that simple community-based efforts to raise awareness, increase diagnosing, referral advice as well as access to qualified practitioners may result in better BP

control in Bangladesh and similar low income settings. These findings also suggest importance of developing simplified hypertension management guidelines for Bangladesh and needs for appropriate training of health care providers on the guidelines for management of hypertension which are lacking at present.

CONCLUSIONS

The implications of our findings are potentially huge in two ways. The high level of unawareness is alarming. With an estimated 12 million hypertensive patients in Bangladesh,[6] these high levels of undiagnosed high blood pressure will have big impact on the total burden of stroke and ischemic heart diseases, which are already the leading causes of adult mortality and morbidity in the country.[32 33] Secondly, our findings of awareness, treatment seeking behavior, and blood pressure reduction in both rural and urban settings in Bangladesh give cause for optimism which needs longer follow up to verify sustainability. Drug sellers are significant health care providers particularly in rural settings in Bangladesh. Widening the scope to utilize them effectively through appropriate training on simplified hypertension management guideline should be explored.

What is already known on this topic

- Low awareness is common among hypertensive patients and is associated with uncontrolled blood pressure and its cardiovascular and renal complications.
- Modest reduction in average blood pressure has great implications for hypertension prevalence at population level.

What this study adds

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Raising awareness through community screening of BP and referral of hypertensive to health care provider appears to be practically feasible approach to control hypertension in low resource settings.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Extensive use beta-blockers in hypertension treatment justify need for the development and implementation of simplified hypertension management guidelines.
- Scope of utilizing drug sellers to control hypertension in rural settings.

List of abbreviations

ARB = Angiotensin receptor blockers

BB = Beta- blockers

BMI = Body Mass Index

BP = Blood pressure

CCB = Calcium channel blockers

CCCD = Centre for Control of Chronic Diseases

CKD = Chronic Kidney Diseases

CVD = Cardiovascular Diseases

DBP = Diastolic Blood Pressure

ERC = Ethical Review Committee

HDSS = Health and Demographic Surveillance System

icddr,b = International Centre for Diarrhoeal Disease Research, Bangladesh

SBP = Systolic Blood Pressure

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Contributors All authors substantially contributed to conception and design, collection of data, or analysis and interpretation of data and critical revision of important intellectual content. DSA conceptualized the study, supervised data collection analysis and wrote the 1st draft and all redrafts. MAHC, ATS and SA were involved in data collection analysis, interpretation and revision of all drafts of the manuscript. LWN contributed to critical revising of interpretation and finalizing the manuscript. All authors read and approved the final manuscript. DSA is the guarantor.

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Competing Interest The authors declare that they have no competing interests.

Ethical Approval The study was approved by the Ethical Review Committee (ERC) of icddr,b.

Data sharing statement Collected data as described in the methodology will be available by emailing DSA (dsalam@icddrb.org) which can be shared following icddr,b data policy (http://www.icddrb.org/policies).

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TABLE

Table 1: Characteristics of the respondents

	Total n=1678	Dhaka n=825	Matlab n=853	P Value
Age (years)	43.5 ± 15.1	40.7 ± 14.8	46.1 ± 15.0	0.000
Male	736 (43.9)	352 (42.7)	384 (45.0)	0.332
Education in year	5.1 ± 4.7	6.2 ± 5.1	4.0 ± 4.0	0.000
Educational category				0.000
Illiterate	582 (34.7)	245 (29.7)	337 (39.5)	
Primary (1-5 years)	377 (22.5)	145 (17.6)	232 (27.2)	
Secondary (6-10 years)	521 (31.0)	282 (34.2)	239 (28.0)	
High educated (>11 years)	198 (11.8)	153 (18.5)	45 (5.3)	
Occupation				0.000
Manual	368 (21.9)	124 (15.0)	244 (28.6)	
Non-Manual*	1310 (78.1)	701 (85.0)	609 (71.4)	
Income '000 Taka†	15.5 ± 13.5	19.5 ± 15.5	11.6 ± 9.9	0.000
Income Group				0.000
Low (<=10000tk)	846 (50.4)	256 (31.0)	590 (69.2)	
Middle (10001-30000tk)	710 (42.3)	478 (57.9)	232 (27.2)	
High (>=30001)	122 (7.3)	91 (11.0)	31 (3.6)	
Body Mass Index in kg/m2	22.6 ± 7.0	24.2 ± 5.1	21.0 ± 8.1	0.000
BMI Category				0.000
Underweight (<18.5 kg/m^2)	341 (20.3)	92 (11.2)	249 (29.2)	
Overweight/Obese(>=25 kg/m^2)	424 (25.3)	328 (39.8)	96 (11.3)	
Waist Circumference in cm	77.4 ± 11.7	81.0 ± 12.2	73.9 ± 10.1	0.000
Abdominal obesity	466 (27.8)	317 (38.4)	149 (17.5)	0.000
Extra Salt Intake (At least once a day)	1345 (80.4)	564 (68.5)	781 (91.9)	0.000
Tobacco use				
Smokers	500 (29.8)	234 (28.4)	266 (31.2)	0.207
Chewing Tobacco	536 (31.9)	203 (24.6)	333 (39.0)	0.000
Systolic BP	113.1 ± 18.7	117.3 ± 18.9	109.1 ± 17.6	0.000
Diastolic BP	71.6 ± 15.7	72.5 ± 19.4	70.7 ± 10.8	0.021
Blood Pressure Category				0.000
Normal	1053 (62.8)	423 (51.3)	630 (73.9)	
Pre-hypertension	338 (20.1)	207 (25.1)	131 (15.4)	
Hypertension	287 (17.1)	195 (23.6)	92(10.8)	

Mean± SD

Numbers in the parenthesis are percentages.

*Non-manual category included sedentary workers, professionals (e.g. doctors, teachers, etc.), housewives, retired persons, those unable to work and unemployed.

†Bangladesh currency Taka 80.00 = USD 1.00

‡Abdominal obesity was defined as waist circumference ≥90 cm for males and ≥80 cm for females

¥Extra salt intake was referred to table salt consumption at least once a day other than salt used in cooking or food preparation.

FIGURE LEGENDS

Figure 1. Study enrolment and follow up flow diagram

Figure 2. Distribution of awareness and control of blood pressure among hypertensive patients at baseline and at follow up by area of residence in Bangladesh

Figure 3. Pattern of health care provider visits and medication use in urban Dhaka and rural Matlab, Bangladesh.

Panel A. Distribution of provider visits by area and economic strata. Panel B. Pattern of medication use by area and provider type.

*Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

BB – Beta- blockers, CCB – Calcium channel blockers, ARB – Angiotensin receptor blockers

Figure 4. Change in systolic and diastolic blood pressure between baseline and follow-up by provider type.

* Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

Title:

AWARENESS AND CONTROL OF HYPERTENSION IN BANGLADESH – FOLLOW UP OF A HYPERTENSIVE COHORT

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ABSTRACT

Objectives To assess the effect of awareness and advice to seek care on BP control among hypertensive patients in Bangladesh.

Design Longitudinal study

Setting The study was carried out in icddr,b surveillance sites at rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh

Participants Randomly selected men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction.

Main outcome measure Hypertension was defined as systolic BP (SBP) ≥ 140 and/or diastolic BP (DBP) ≥90 mmHg or as self-reported hypertension under medication. We advised to seek care from qualified provider and adopt healthy lifestyle. We compared changes in BP from baseline to follow-up at around 6 month.

Results Overall 17.1% (n=287) had hypertension at baseline with significantly higher prevalence in urban than rural population (23.6 % vs 10.8% ; p<0.001) and a half of them were unaware. At follow up, 83% (n=204) reported visit to any health care provider. In urban area, higher proportion of patients visited medically qualified practitioners than in rural area (76.7% vs 36.6% , P<0.000). Both SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were lower at follow up. Those who visited medically qualified practitioners had significant SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) reduction. BP reduction did not reach statistical significance among those visited pharmacy man or village doctors. Overall, half of the hypertensive patients achieved BP control goal (BP<140/90 mmHg).

Conclusions ~~.~~ Awareness and ~~-~~simple health messages increase provider visit, reduce blood pressure and improve BP control in hypertensive Bangladeshis. ~~Raising awareness and referral advice to hypertensive patients leads to high provider visits, blood pressure reduction and higher BP target achievement in Bangladesh. Findings need a l~~Longer-term follow up is required to verify the sustainability.

Key Words – Blood pressure, hypertension, awareness, referral advice, treatment, blood pressure control, Bangladesh

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Strengths and limitations of the study

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Blood pressure reduction as a result of regression to the mean is unlikely in this study as we took multiple measurements following standardized procedure for characterizing the baseline status as well as that at follow up.

BACKGROUND

Hypertension is the most widely prevalent but largely preventable risk factor for cardiovascular diseases (CVD) accounting for half of deaths due to ischemic heart disease and stroke.[1] Globally, 7.6 million premature deaths annually and 6.0% of the global burden of disease are attributable to hypertension.[2] Elevated blood pressure lower than the standard cut-off for hypertension (SBP 140 /DBP 90 mm Hg) is also associated with increased risk of myocardial infarction, stroke and CVD.[3 4] Hypertension is both a cause and consequence of chronic kidney diseases (CKD). A recent study showed prevalence of chronic kidney disease among 22% of undiagnosed hypertensive and 17% pre-hypertensive subjects in the United States.[5] Therefore, uncontrolled hypertension has huge implications for the disease burden due to CVD and CKD.

Recent report suggest 18% or 12 million 25 years or older adults in Bangladesh suffer from hypertension with higher prevalence in urban than in rural population.[6] Earlier reports also showed that 12-15% of 20 years or older Bangladeshi had hypertension.[7-9] Low awareness is common in populations in low income settings including Bangladesh.[10-12] Research has shown that greater awareness is associated with higher adherence to antihypertensive treatments and BP control.[13] Study in China [14] showed only 30-45% of people with hypertension were aware of their condition and only 8% had achieved target BP goals. However, data are scarce on care seeking behavior and blood pressure target achievement after raising awareness. Despite a huge disease burden attributable to hypertension and very high rate of unawareness, it is largely an unrecognized and under-researched public health problem in Bangladesh.

So far, all studies in Bangladesh reported prevalence data on hypertension, either measured and or self-reported, and awareness, treatment and control from cross-sectional studies which have inherent limitations and fails to provide information on care seeking behavior and level of control after being aware. In this paper we report prevalence, awareness and control of hypertension at baseline and explored the effect of raising awareness coupled with health messages to visit health care provider on, blood pressure and blood pressure goal achievement among individuals with hypertension in urban and rural Bangladesh.

METHODS

Study design and population

The longitudinal study was carried out in rural Matlab in Chandpur district and semi-urban Kamalapur in Dhaka, Bangladesh. In both the sites, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) has its Health and Demographic Surveillance System (HDSS) in place.[15-17] Study population consisted of men and non-pregnant women aged 20 years or older without any acute illness or history of any vascular events such as stroke or acute myocardial infarction. We selected participants at random from the HDSS databases. We replaced randomly selected individuals who were unavailable (17% in semiurban Kamalapur and 15% in rural Matlab) with age and sex matched participants from the same community who were eligible but were not included in sample. Between February and August 2011, we conducted a baseline survey and identified individuals with hypertension. Very few participants declined to participate (3.9% in Kamalapur and none in Matlab). We informed the blood pressure status and provided simple health messages to the hypertensive individuals with emphasis on visiting health care provider, possible complications if untreated, and lifestyle factors. We followed up

these hypertensive patients and measured BP again at 4-6 month after baseline and documented history of provider visits, medication use and blood pressure status. The study was approved by the Ethical Review Committee (ERC) of icddr,b. An informed voluntary written consent was obtained from each participant before enrolment.

Sample Size

We estimated sample size for each age group to measure prevalence within 10% precision with 80% power. As the prevalence of hypertension increases with age, we assumed the lowest prevalence of 5% in 20-24 years age group and the highest 20% or higher in 65years or older age groups during stratum specific sample size estimation. The estimated total sample size after considering possible refusal or non-participation was 1600 participants (800 in each site).

Data collection

We collected data on socioeconomic, demographic, lifestyle factors using a structured questionnaire. Trained interviewers administered the questionnaire at participants' home. Interviewers also measured weight, height, waist and hip circumferences following standard procedure [18]. We proscribed all participants of drinking tea, coffee, or carbonated beverages, eating, smoking and avoid heavy physical activity at least 30 minutes prior to blood pressure measurement. We allowed 10 minutes rest before measuring blood pressure three times at five minutes interval on left arm in sitting position with the arm supported at the level of the heart using Omron M10^{TM} digital blood pressure machine. The first BP measurement was discarded to avoid possible anxiety effect, and the mean value of the second and third measurements was considered for both systolic and diastolic BP. SBP ≥140 mmHg or DBP ≥90 mmHg or both was

defined as hypertension. Participants who were on anti-hypertensive medications and could show or name antihypertensive medication or produce the prescription, we considered them as aware and self-reported hypertensive irrespective of their BP status at the time of measurement. 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.

Health advices

We informed all hypertensive patients about their blood pressure status and provided them simple health messages in local language, Bengali. The health messages included information on risk factors for hypertension, possible risk associated with uncontrolled BP, lifestyle and diet related issues particularly smoking, physical activity and extra salt intake. We advised them to visit a qualified health care provider. A written outline was followed to deliver the health messages uniformly and adequately. However, study workers were not involved in providing any prescription or medication. Adequate training including periodic refresher training of the health workers and regular field visit by the supervisors were ensured to minimize intra and inter individual inconsistency.

Follow up

We followed up all available hypertensive patients at around 4-6 month and collected data on treatment seeking, provider visits, and medication use. A study nurse or trained Health Workers measured blood pressure using the same electronic blood pressure monitor following the same procedure as that in baseline. The nurse or the health worker did not have access to blood

pressure data collected earlier and were not aware of the purpose of the study. We considered blood pressure goal is achieved when mean value of second and third measurements of SBP and DBP at follow up was <140 mmHg and <90 mmHg respectively.

Data analysis

Data were entered on computer with built in range and consistency check using MS Access. Descriptive data are presented as frequency and percentages for the categorical variables, and as mean and standard deviation for the continuous variables. Chi-square test was used to examine the association between categorical variables. Paired t-test was used to compare within individual change in blood pressure from baseline to follow up. A p-value <0.05 was considered statistically significant.

RESULTS

In total, 1678 participants were interviewed and blood pressure measured in urban Dhaka (n=825) and rural Matlab (n=853) (Figure 1). Characteristics of the study participant are presented in Table 1. On average, participants were 43 years old and 44% were males. Urban participants were younger, more educated, had higher BMI, more abdominal obesity, higher income and of more non-manual occupation than rural participants. However, rural participants used more chewing tobacco and consumed more extra salt.

In total, 287 (17.1%) respondents were finally diagnosed as hypertensive cases (~~Table 1~~Controlled- 4.6%; Stage 1- 8.2% and Stage 2- 4.3%). Age standardized prevalence of hypertension was 14.8% (Bangladesh standard population as reported by the Bangladesh Bureau of Statistics 2008). The prevalence of hypertension was significantly higher in urban

than rural ~~among~~ participants (23.6% vs. 10.8%; p<0.001). More women than men were hypertensive. ~~-~~At baseline, half (49%) the total hypertensive patients were aware about their BP status ~~but only~~and half of those who were aware (~~55~~27.2%) had their BP under control (SBP<140 and DBP<90 mm Hg) (Figure 2)~~-~~.

At follow up, we were able to reach 245 (85%) hypertensive respondents (Figure 1). Of the 42 lost to follow up included 16 migrated out, 7 refused, 3 died and 16 could not be reached after repeated attempts due to their day time work schedule. Among those available, 83.3% reported that they visited health care provider at least once after enrolment into the study (Figure 3A). Over three quarters of hypertensive patients in Dhaka and a third in Matlab visited professionally qualified doctors (76.7% vs 36.6%, P<0.000) who included MBBS/MD or higher qualified practitioners. The rest visited drug sellers who included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice. This difference in choice of provider visit was significantly different between urban and rural hypertensive patients. Only about a half of those (52.7%) visited care provider could show their prescribed medication during the follow-up visit. About 28% of the patients did not receive any written prescription from their care provider.

Overall, beta-blockers were the highest prescribed antihypertensive drugs either as single or in combination with calcium channel blockers followed by calcium channel blockers and angiotensin receptor blockers (Figure 3B). Higher use of beta-blockers was noted among those seen by rural drug sellers. Diuretics were prescribed for only about 1% of the total patients.

About 3% patients received sedative or tranquilizer pills although mostly in addition to antihypertensive medications.

Overall, both mean SBP (-3.3±20.7 mmHg; p<0.01) and DBP (-2.0± 13.0 mmHg; p<0.02) were significantly lower at follow up (Figure 4A and 4B). Those who visited professionally qualified providers had significantly lower SBP (-3.9±22.4 mmHg p<0.03) and DBP (-2.7±14.1 mmHg p<0.02) as compared to their baseline measure but those who visited drug sellers had no significant reduction in BP (Figure 4A and 4B).

Overall 50% hypertensive patients achieved BP control goal at follow up compared to 27% at baseline (Figure 2). About 30% of uncontrolled hypertensives at baseline and 46% of newly diagnosed hypertensives achieved blood pressure goal at follow up. ~~On the other hand~~ Only 26% of the hypertensives who had their BP controlled at baseline failed to maintain that at follow up. On the other hand 46% of stage 1 and 33% of stage 2 hypertensives achieved blood pressure goal at follow up (data not shown). BP goal achievement tended to be higher among those treated by professionally qualified practitioners than drug sellers but the difference did not reach statistical significance. At follow up, the proportion of hypertensive individuals who achieved BP goals were double as compared to those at baseline (Figure 2).

DISCUSSION

Principal findings

This study reports the prevalence, population awareness and subsequent control of hypertension in a general population. We demonstrated that raising awareness and simple health messages result in high provider visits and reduction in blood pressure in Bangladeshi

hypertensive population. The modest reduction in blood pressure that we observed has great implications for the hypertension prevalence at population level.[19] To our knowledge this is the first community based longitudinal study in Bangladesh that followed up recently diagnosed hypertensive patients in day-to-day care settings in rural and urban communities.

We found about 88% of hypertensives who were already aware at baseline and 78% of newly diagnosed cases visited health care provider at least once between baseline and the follow up. More urban patients than rural visited qualified health care professionals and the blood pressure reduction was significantly greater in that group. On the contrary, more rural patients (63.4%) from all economic strata (Figure 3A) visited drug sellers and the difference in blood pressure between baseline and follow up was not significant. It indicates ~~an urgent necessity~~ the scope for training rural drug seller on simplified hypertension management guidelines for effective utilization of this important health care provider group in hypertension control in Bangladesh. Accessibility and cost may have played important role for high drug seller visit in rural area among all socioeconomic strata and need further exploration. Extensive use of beta-blockers by both types of providers has been identified ~~as knowledge gap that~~and need to be addressed ~~and updated~~ urgently. ~~This implies that the d~~ Development and implementation of a simplified hypertension management guideline and training of providers may ameliorate the problem.

Comparison with other studies

Community-based data on blood pressure levels in open populations are scarce in Bangladesh. We found higher prevalence of hypertension in urban than rural population. Bangladesh Non-

communicable Diseases (NCD) risk factor survey also showed higher prevalence of hypertension in urban than rural population (20% vas 16%).[6] The overall prevalence of hypertension in this study was 17.1% and the age adjusted prevalence was 14.5% which is fairly consistent with a similar studies conducted earlier.[6 7] However, a recent systematic review of hypertension studies in Bangladesh conducted between 1994 and 2002 reported 13.5% as a pooled estimate of hypertension prevalence.[20]

Our study confirms others observation in similar settings that a high level of unawareness among hypertensive patients in the community.[21 22] At baseline, we found only less than a half of the hypertensive patients were aware of their blood pressure status and a half of those who were aware had their BP under control. Similar pattern of poor detection and control of hypertension has been reported previously as "the rule of halves" that is half of the hypertensive patients are aware and only half of those aware are treated and half of treated have their BP target achieved.[23] This implies that without further awareness raising campaigns about three quarters of total hypertensive patients in Bangladesh will continue to live with uncontrolled BP.

Our longitudinal observation indicates that better BP control can be achieved through simple community-based efforts to raise awareness. Similar effect of raising awareness on BP control has been reported in different settings.[21 24] These findings need a longer-term follow up to verify the sustainability. We know that multiple behavioral changes are possible and repeated intervention can be more efficacious to sustain lifestyle modifications and improve blood pressure control.[25 26] Our findings from onetime intervention indicates the scope of targeted

education with regular monitoring through community health workers may result in ~~to improve~~ healthier lifestyle and lower blood pressure in developing country context. Strengthening primary healthcare properly might be another option to address hypertension in resource poor settings~~.~~.

Our present findings do not focus on smoking reduction which is known to increase risk of acute vascular events such as myocardial infarction and stroke in hypertensive patients.[27] Impact of high blood pressure is likely to be much higher in men in Bangladesh as 50% of them are smoker as opposed to less than 2% women. Our recent report showed that 25% of all deaths in Bangladeshi men aged 25 to 69 years are attributable to smoking.[28] This warrants necessity for further intensification of anti-smoking campaigns in combination with awareness raising to promote blood pressure control.

We found improper antihypertensive medication prescription by both qualified providers and drug sellers. Beta-blockers were the single highest prescribed drugs particularly by the drug sellers in rural area which may have implications for long term prognosis as treatment of uncomplicated hypertension with beta-blockers has been reported to be associated with increased risk of stroke without any extra benefit for cardiovascular morbidity and mortality.[29] Major hypertension management guidelines also do not recommend beta-blockers as initial treatment for hypertension.[30] A High beta-blocker prescription by rural informal practitioners was also reported by other investigators in Bangladesh.[31]

Strengths and limitations of the study

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 which allowed for a realistic estimation of effect of a simple campaign in low-income settings.

One of the limitations of our study is that we did not have any control. As the study was conducted in two densely populated areas, it was not possible to keep some hypertensive without any advice or provide different information. Since we did not influence care seeking behavior or use of medication, the effect we observed was due to high level of awareness and seeking care by the hypertensive patients in the community where 50% were unaware about their condition. The second issue could be whether the blood pressure reduction could happen anyway as a result of regression to the mean which we believe unlikely in this study as we took multiple measurements following standardized procedure for characterizing the baseline status as well as that at follow up. Our trained workers followed the same measurement protocol and used the same equipment to ensure high quality measurements. Also, we did not study the actual rational prescribing and qualifying characteristics of the involved providers. An earlier study in Bangladesh [31] reported in detail their findings on the qualifications and level of knowledge among non-professional health care providers. They found that in Bangladesh the majority of village-level providers are certified by some authority and have some level of understanding of blood pressure measurement and treatment, although the later could be improved. This certainly will not be the case in many other rural and urban low-income settings. In this paper we report the modest blood lowering effect due to

awareness and simple health messages at six month after the baseline but further longitudinal observation is needed to assess the effect of repeated interventions on long term blood pressure control which will be reported in due course.

Our findings suggests that simple community-based efforts to raise awareness, increase diagnosing, referral advice as well as access to qualified practitioners may result in better BP control in Bangladesh and similar low income settings. These findings also suggest importance of developing simplified hypertension management guidelines for Bangladesh and needs for appropriate training of health care providers on the guidelines for management of hypertension which are lacking at present.

CONCLUSIONS

The implications of our findings are potentially huge in two ways. The high level of unawareness is alarming. With an estimated 12 million hypertensive patients in Bangladesh,[6] these high levels of undiagnosed high blood pressure will have big impact on the total burden of stroke and ischemic heart diseases, which are already the leading causes of adult mortality and morbidity in the country.[32 33] Secondly, our findings of ~~raising~~ awareness, treatment seeking behavior, and blood pressure reduction in both rural and urban settings in Bangladesh give cause for optimism which needs longer follow up to verify sustainability. Drug sellers are significant health care providers particularly in rural settings in Bangladesh. ~~who can be effectively utilized~~ Widening the scope to utilize them effectively ~~for hypertension control by~~through appropriate training on ~~o~~and ~~s~~simplified hypertension management guideline should be explored.

What is already known on this topic

- Low awareness is common among hypertensive patients and is associated with uncontrolled blood pressure and its cardiovascular and renal complications.
- Modest reduction in average blood pressure has great implications for hypertension prevalence at population level.

What this study adds

- Results based on follow-up study in low income settings overcoming some limitations of cross-sectional studies.
- Raising awareness through community screening of BP and referral of hypertensive to health care provider appears to be practically feasible approach to control hypertension in low resource settings.
- Realistic estimation of effect of raising awareness on hypertension control in low-income setting.
- Extensive use beta-blockers in hypertension treatment justify need for the development and implementation of simplified hypertension management guidelines.
- Scope of utilizing drug sellers to control hypertension in rural settings.

List of abbreviations

ARB = Angiotensin receptor blockers

BB = Beta- blockers

BMI = Body Mass Index

BP = Blood pressure

CCB = Calcium channel blockers

CCCD = Centre for Control of Chronic Diseases

CKD = Chronic Kidney Diseases

CVD = Cardiovascular Diseases

DBP = Diastolic Blood Pressure

ERC = Ethical Review Committee

HDSS = Health and Demographic Surveillance System

icddr,b = International Centre for Diarrhoeal Disease Research, Bangladesh

SBP = Systolic Blood Pressure

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Contributors All authors substantially contributed to conception and design, collection of data, or analysis and interpretation of data and critical revision of important intellectual content. ~~Study concept, design & proposal was developed by~~ DSA conceptualized the study, supervised data collection analysis and wrote the 1st draft and all redrafts. MAHC, ATS and SA were involved in data collection ~~All authors contributed equally to the analysis, interpretation and drafting of the manuscript.~~analysis, interpretation and revision of all drafts of the manuscript. LWN contributed to critical revising of interpretation and finalizing the manuscript. All authors read and approved the final manuscript. DSA is the guarantor.

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Competing Interest ~~-~~The authors declare that they have no competing interests.

Ethical Approval The study was approved by the Ethical Review Committee (ERC) of icddr,b.

Data sharing statement Collected data as described in the methodology will be ~~are~~ available by emailing ~~with~~ DSA (dsalam@icddrb.org) which can be shared following icddr,b data policy (http://www.icddrb.org/policies)~~http://www.icddrb.org/who-we-are/data-policies)~~. ~~A detail data set of the study will be made available for public use at the end of contract with National Heart, Lung, and Blood Institute, National Institutes of Health, Department of Health and Human Services (https://www.nhlbighiacc.org).~~

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TABLE

Table 1: Characteristics of the respondents

	Total n=1678	Dhaka n=825	Matlab n=853	P Value
Age (years)	43.5 ± 15.1	40.7 ± 14.8	46.1 ± 15.0	0.000
Male	736 (43.9)	352 (42.7)	384 (45.0)	0.332
Education in year	5.1 ± 4.7	6.2 ± 5.1	4.0 ± 4.0	0.000
Educational category				0.000
Illiterate	582 (34.7)	245 (29.7)	337 (39.5)	
Primary (1-5 years)	377 (22.5)	145 (17.6)	232 (27.2)	
Secondary (6-10 years)	521 (31.0)	282 (34.2)	239 (28.0)	
High educated (>11 years)	198 (11.8)	153 (18.5)	45 (5.3)	
Occupation				0.000
Manual	368 (21.9)	124 (15.0)	244 (28.6)	
Non-Manual*	1310 (78.1)	701 (85.0)	609 (71.4)	
Income '000 Taka†	15.5 ± 13.5	19.5 ± 15.5	11.6 ± 9.9	0.000
Income Group				0.000
Low (<=10000tk)	846 (50.4)	256 (31.0)	590 (69.2)	
Middle (10001-30000tk)	710 (42.3)	478 (57.9)	232 (27.2)	
High (>=30001)	122 (7.3)	91 (11.0)	31 (3.6)	
Body Mass Index in kg/m2	22.6 ± 7.0	24.2 ± 5.1	21.0 ± 8.1	0.000
BMI Category				0.000
Underweight (<18.5 kg/m^2)	341 (20.3)	92 (11.2)	249 (29.2)	
Overweight/Obese(>=25 kg/m^2)	424 (25.3)	328 (39.8)	96 (11.3)	
Waist Circumference in cm	77.4 ± 11.7	81.0 ± 12.2	73.9 ± 10.1	0.000
Abdominal obesity	466 (27.8)	317 (38.4)	149 (17.5)	0.000
Extra Salt Intake (At least once a day)	1345 (80.4)	564 (68.5)	781 (91.9)	0.000
Tobacco use				
Smokers	500 (29.8)	234 (28.4)	266 (31.2)	0.207
Chewing Tobacco	536 (31.9)	203 (24.6)	333 (39.0)	0.000
Systolic BP	113.1 ± 18.7	117.3 ± 18.9	109.1 ± 17.6	0.000
Diastolic BP	71.6 ± 15.7	72.5 ± 19.4	70.7 ± 10.8	0.021
Blood Pressure Category				0.000
Normal	1053 (62.8)	423 (51.3)	630 (73.9)	
Pre-hypertension	338 (20.1)	207 (25.1)	131 (15.4)	
Hypertension	287 (17.1)	195 (23.6)	92(10.8)	

Mean± SD

Numbers in the parenthesis are percentages.

*Non-manual category included sedentary workers, professionals (e.g. doctors, teachers, etc.), housewives, retired persons, those unable to work and unemployed.

†Bangladesh currency Taka 80.00 = USD 1.00

‡Abdominal obesity was defined as waist circumference ≥90 cm for males and ≥80 cm for females

¥Extra salt intake was referred to table salt consumption at least once a day other than salt used in cooking or food preparation.

FIGURE LEGENDS

Figure 1. Study enrolment and follow up flow diagram

Figure 2. Distribution of awareness and control of blood pressure among hypertensive patients at baseline and at follow up by ~~gender~~ area of residence in Bangladesh

Figure 3. Pattern of health care provider visits and medication use in urban Dhaka and rural Matlab, Bangladesh.

Panel A. Distribution of provider visits by area and economic strata. Panel B. Pattern of medication use by ~~hypertensive patients~~area and provider type.

*Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

BB – Beta- blockers, CCB – Calcium channel blockers, ARB – Angiotensin receptor blockers

Figure 4. Change in systolic and diastolic blood pressure between baseline and follow-up by provider type.

* Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

Figure 1.

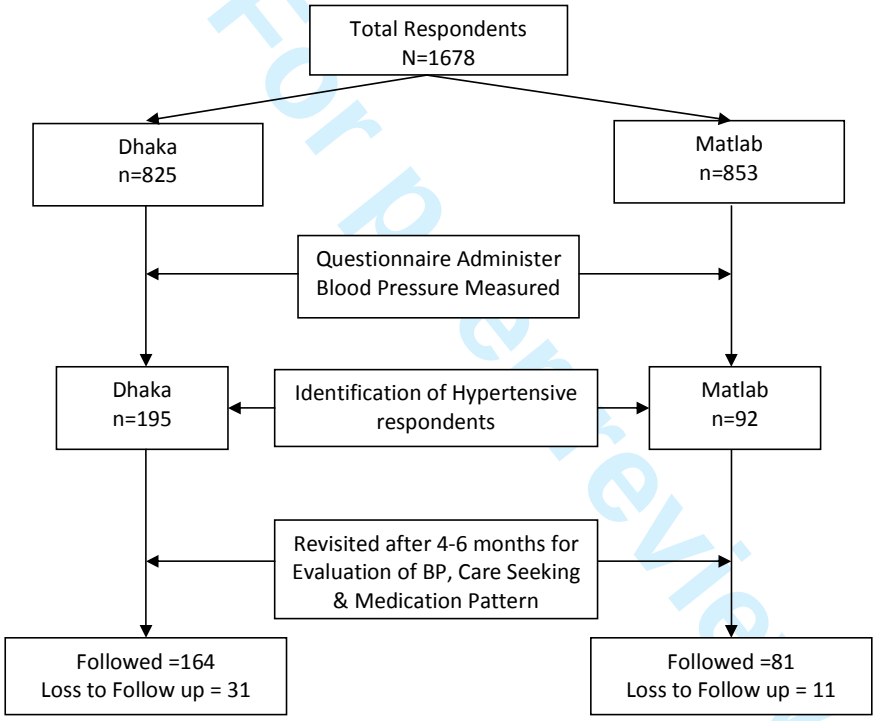
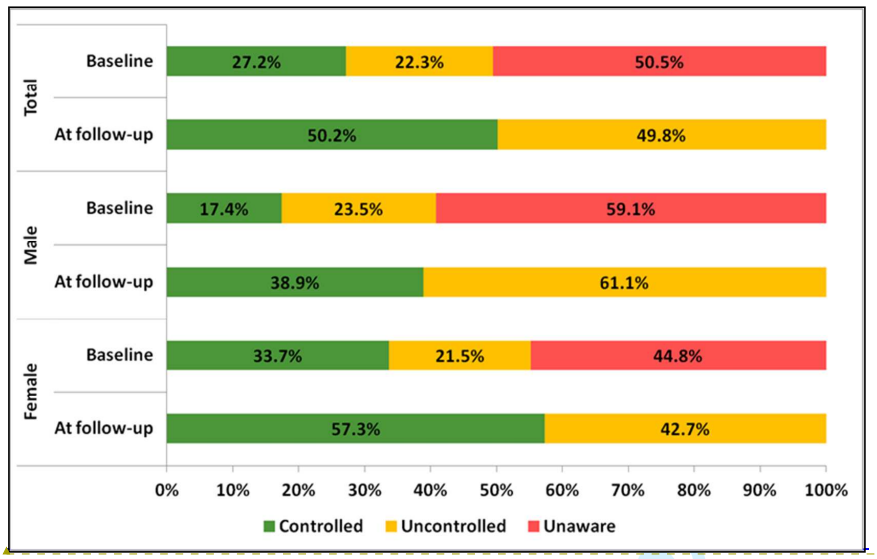


Figure 2.



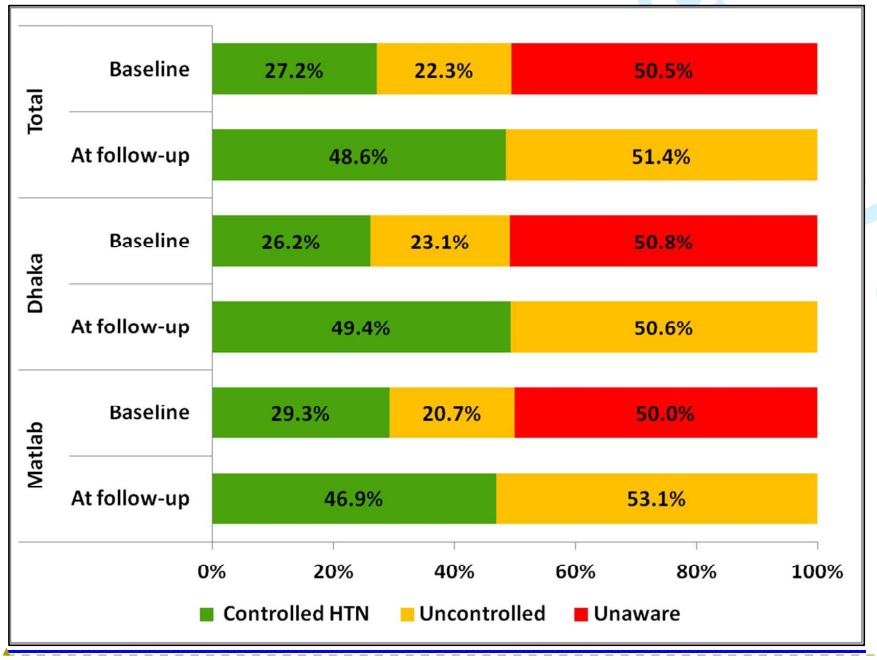


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Figure 3.

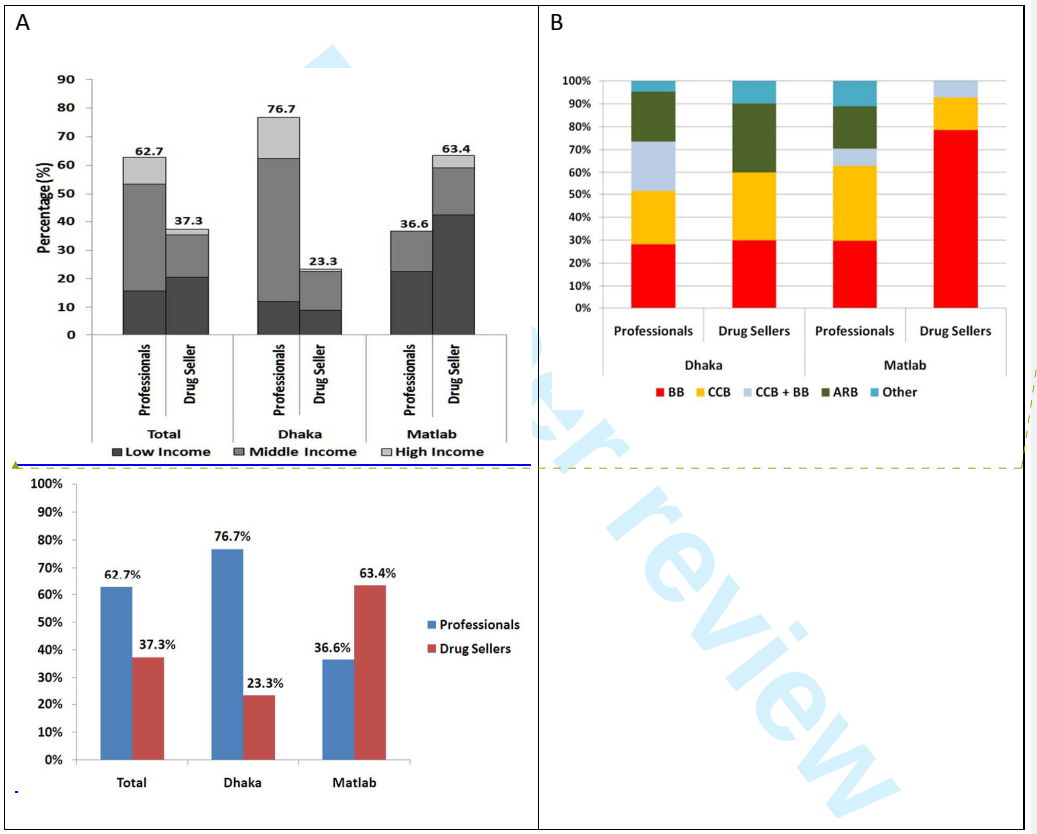

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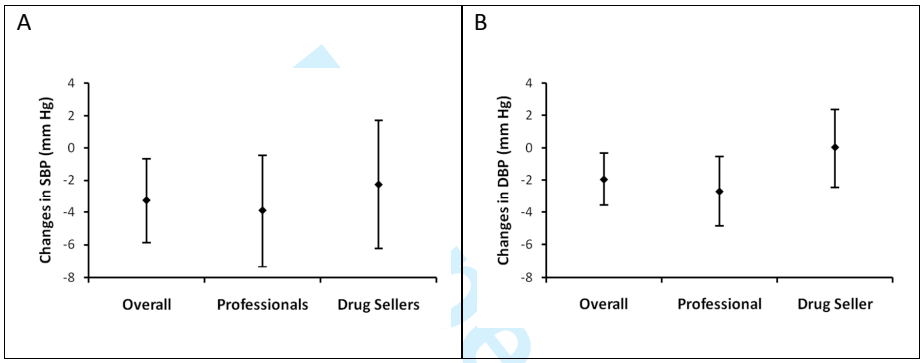
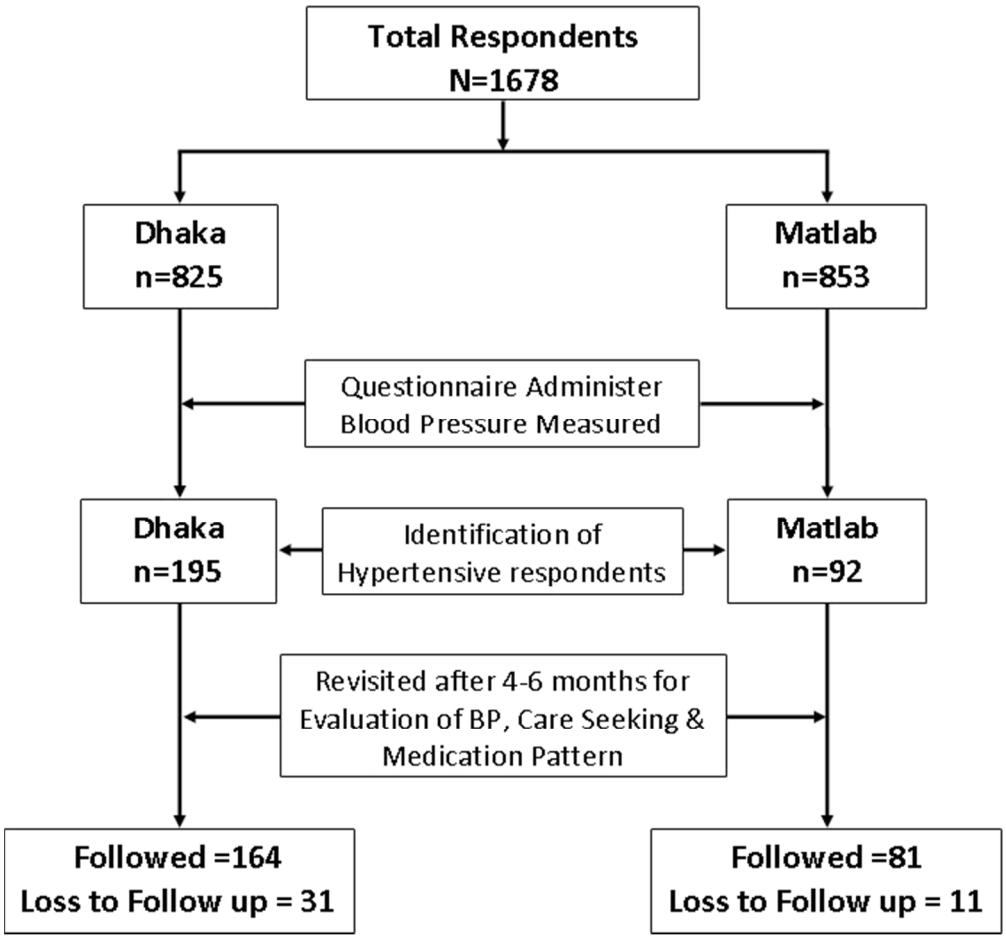
Figure 4.





Study enrolment and follow up flow diagram
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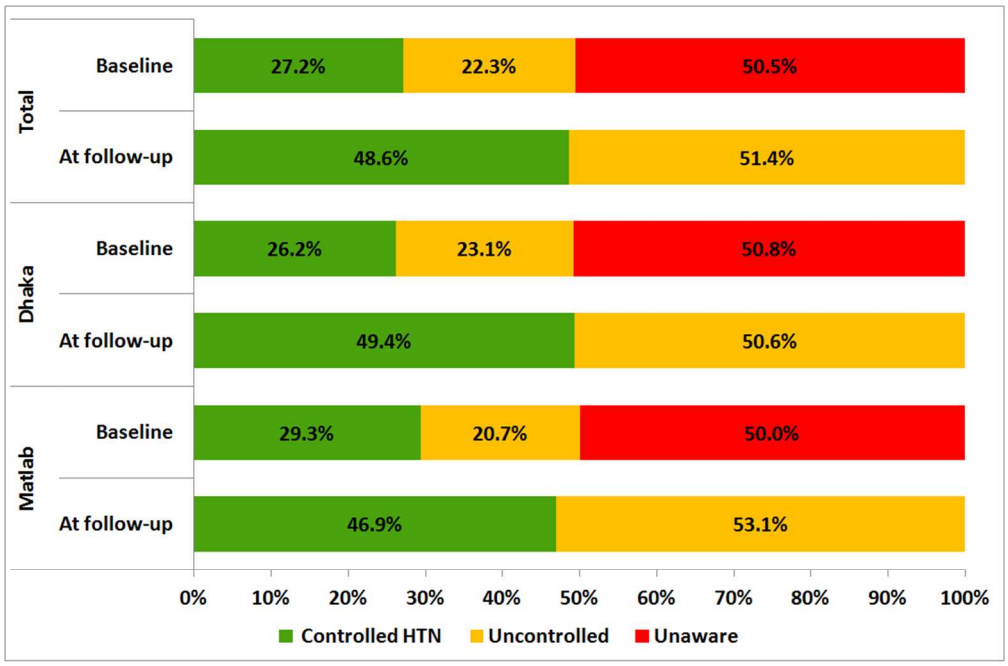

Distribution of awareness and control of blood pressure among hypertensive patients at baseline and at follow up by area of residence in Bangladesh
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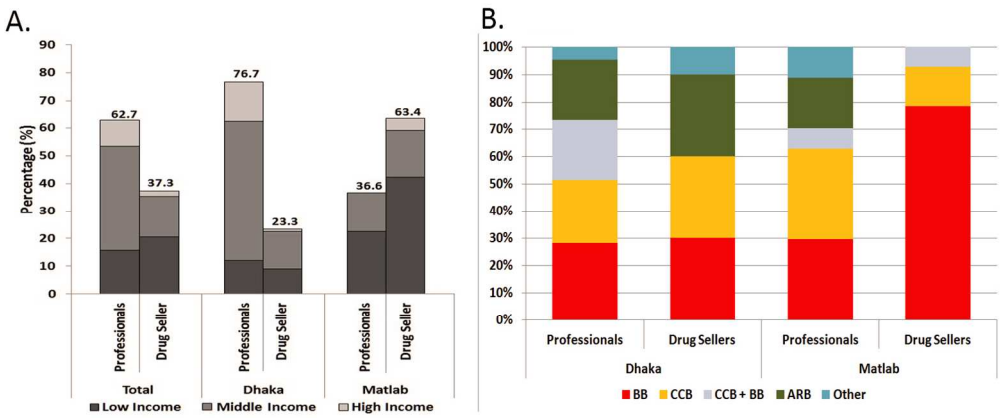

Pattern of health care provider visits and medication use in urban Dhaka and rural Matlab, Bangladesh. Panel A. Distribution of provider visits by area and economic strata. Panel B. Pattern of medication use by hypertensive patients.

*Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.

BB – Beta- blockers, CCB – Calcium channel blockers, ARB – Angiotensin receptor blockers

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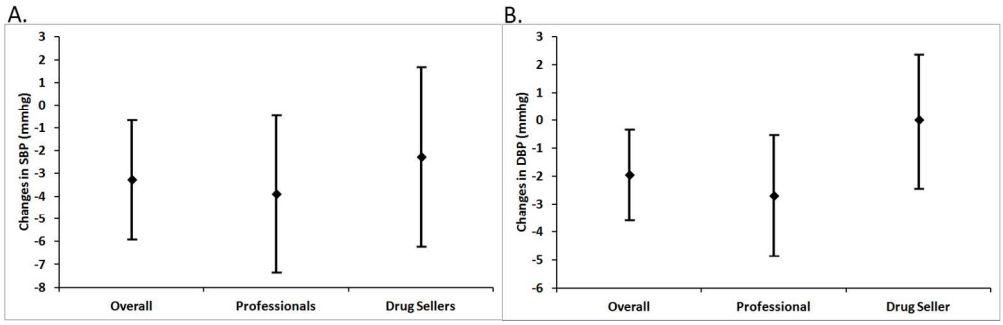

Change in systolic and diastolic blood pressure between baseline and follow-up by provider type.
* Professionals included MBBS/MD or higher educated health care providers. Drug sellers included pharmacy men, village doctors or owner of small drug outlets with or without any diploma or certificate for medical practice.
142x44mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Page No.	Recommendation
Title and abstract	√1	1, 2	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/ rationale	√2	4	Explain the scientific background and rationale for the investigation being reported
Objectives	√3	5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	√4	5	Present key elements of study design early in the paper
Setting	√5	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	√6	5	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	√7	6	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	√8*	6	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	√9	5, 6,7	Describe any efforts to address potential sources of bias
Study size	√10	6	Explain how the study size was arrived at
Quantitative variables	√11	8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	√12	8	(*a*) Describe all statistical methods, including those used to control for confounding
			(*b*) Describe any methods used to examine subgroups and interactions
			(*c*) Explain how missing data were addressed
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses

Continued on next page

Results			
Participants	√13*	8	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		9	(b) Give reasons for non-participation at each stage
		24	(c) Consider use of a flow diagram
Descriptive data	√14*	8	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		9	(b) Indicate number of participants with missing data for each variable of interest
			(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	√15*	8, 10	*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
			Cross-sectional study—Report numbers of outcome events or summary measures
Main results	√16	8	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		8	(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
Key results	√18	10	Summarise key results with reference to study objectives
Limitations	√19	13	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	√20	11	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	√21	14	Discuss the generalisability (external validity) of the study results
Other information			
Funding	√22	18	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.