Research

Prevalence, awareness, treatment and control of hypertension among the elderly in Bangladesh and India: a multicentre study

Hypertension Study Group*

Objective To evaluate the prevalence, awareness, treatment and control of hypertension among elderly individuals in Bangladesh and India.

Method A community-based sample of 1203 elderly individuals (670 women; mean age, 70 years) was selected using a multistage cluster sampling technique from two sites in Bangladesh and three sites in India.

Findings The overall prevalence of hypertension (WHO–International Society for Hypertension criteria) was 65% (95% confidence interval = 62–67%). The prevalence was higher in urban than rural areas, but did not differ significantly between the sexes. Multiple logistic regression analyses identified a higher body mass index, higher education status and prevalent diabetes mellitus as important correlates of the prevalence of hypertension. Physical activity, rural residence, and current smoking were inversely related to the prevalence of hypertension. Among study subjects who had hypertension, 45% were aware of their condition, 40% were taking anti-hypertensive medications, but only 10% achieved the level established by the US Sixth Joint National Committee on Detection, Evaluation and Treatment of Hypertension (JNC VI)/WHO criteria. A visit to a physician in the previous year, higher educational attainment and being female emerged as important correlates of hypertension awareness.

Conclusions Our findings emphasize the need to implement effective and low cost management regimens based on absolute levels of cardiovascular risk appropriate for the economic context. From a public health perspective, the only sustainable approach to the high prevalence of hypertension in the Indian subcontinent is through a strategy to reduce the average blood pressure in the population.

Keywords Hypertension/drug therapy; Aged; Prevalence; Awareness; Risk factors; Cross-sectional studies; Multicenter studies; India (*source: MeSH*).

Mots clés Hypertension artérielle/chimiothérapie; Sujet âgé; Prévalence; Prise conscience; Facteur risque; Etude section efficace; Inde (*source: INSERM*).

Palabras clave Hipertensión/quimioterapia; Anciano; Prevalencia; Toma de conciencia; Factores de riesgo; Estudios transversales; India (*fuente: BIREME*).

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Voir page 499 le résumé en français. En la página 499 figura un resumen en español.

Introduction

The size of the elderly segment of the population is increasing in developing countries as the latter undergo a demographic transition, with a concomitant increase in life expectancy. Indeed, it is estimated that by the year 2025 the majority of the elderly people worldwide will reside in developing countries (*1*, *2*). Developing countries are thus likely to face an enormous burden of chronic non-communicable diseases in the near future. Of these diseases, hypertension is one of the most important treatable causes of mortality and morbidity in the elderly population (*3*) and accounts for a large proportion of cardiovascular diseases in the elderly population (*4*–*6*).

A number of randomized control trials in developed countries have established that treatment of high blood pressure in the elderly population significantly reduces cardiovascular morbidity and

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mortality (*7–10*). Several community-based investigations have served to emphasize that hypertension is rapidly emerging as a major public health problem also in developing countries (*11*). However, only a few of these studies included elderly people, and fewer still have focused exclusively on this segment of the population. The objectives of the present investigation were to evaluate the prevalence, awareness, treatment and control of hypertension among elderly individuals living in the community in selected regions of the Indian subcontinent. We also examined the impact of sociodemographic characteristics and known risk factors for high blood pressure on the prevalence, awareness, treatment and control of hypertension in the elderly population.

Methods

Study design and setting

We conducted cross-sectional community-based surveys of non-institutionalized elderly individuals (age $\geqslant$ 60 years) in five regions of the Indian subcontinent: three in India and two in Bangladesh. Selection of the study sites was based on convenience; the four health professionals who conducted the survey had extensive prior experience working in the specific regions chosen. The urban sites chosen in India were as follows: Thiruvananthapuram city corporation area, Kerala State; and Pune city corporation area, Maharashtra State. The rural site from India was within Thiruvananthapuram district, Kerala State. In Bangladesh, the urban site was the Mymensingh municipal corporation area of Mymensingh district, Dhaka division; and the rural site was within the Muktagacha Thana of Mymensingh district, Dhaka division. Both urban and rural sites were selected because previous studies have reported that the prevalence of hypertension is higher in urban areas (*12–14*). "Rural" and "urban" areas were based on criteria defined in the reports of the most recent censuses of India and Bangladesh (*15*, *16*).

Sample size

Using the formula for calculating sample size described by Bennet et al. (*17*), we estimated that a total of about 240 elderly men and women at each site would provide acceptable precision in estimating the prevalence of hypertension. For example, the estimated 95% confidence interval (CI) for a crude prevalence of hypertension of 52% reported previously in Kerala (*12*) was 46–58%. The 240 study subjects at any given site could be obtained by randomly sampling 30 household clusters at the site, with 8 elderly subjects selected per household cluster.

Sampling design and methods

We did not stipulate that the sites chosen for the survey would be typical of either India or Bangladesh. Rather, we used a random multistage cluster sampling strategy to ensure that the study samples at the chosen sites were representative of the communities in the geographical regions studied. In the first stage, we identified the five sites for our investigation as explained above. In the second stage, the sampling unit was a "ward" (urban regions) or a "*panchayath*" (rural regions), i. e. major subunits within a district, selected randomly with probability of selection proportional to the size of their population. In the third stage, we chose a cluster of households within each selected ward; and in the fourth stage, we identified elderly subjects within the household clusters.

At each of the five chosen study sites, we used the 1991 census population data for the individual corporations (or *thana*) as the sampling frame. For example, in the Thiruvananthapuram city corporation there were 50 wards and the population by ward was reported in the census report. We enumerated the corporation wards and their individual population sizes, and obtained the cumulative total population by summation. Next, we divided the cumulative total population (within the city corporation) by 30 to derive the "sampling interval". Then, we randomly chose a number between 0 and the "sampling interval" number. The first cluster of households was identified in the ward whose cumulative population was greater than or equal to the random number. Subsequently, we added the sampling interval to the random number chosen; the second cluster of households was identified in a ward whose cumulative population was greater than or equal to the number thus obtained. The procedure was repeated to identify wards in which the remaining 28 household clusters were selected. In each cluster of households, we identified at least 8 elderly individuals who were aged $\geqslant$ 60 years by analogy to the cluster sampling scheme used to assess the immunization coverage of children in the community (*18*). The same sampling procedure was followed at all the other sites with the following sampling frames: 84 constituent village *panchayaths* in the Thiruvananthapuram rural site; 124 wards in the Pune City Corporation; 30 wards in the Muktagacha Thana; and 7 wards in the Mymensingh Municipal Corporation. At the last-mentioned site, we selected clusters from each of the 7 wards in proportion to the population size of the ward.

Survey design

At each of the five sites, a doctor (*M.I.Q.* in urban Dhaka, *M.S.S.* in urban Maharashtra, *A.K.N.* in rural Dhaka), or a nursing graduate (*S.C.A.* in rural and urban Kerala) performed a door-to-door survey of the participant households. All the elderly individuals in the selected households (except one in urban Maharashtra) participated in the investigation. We conducted the surveys simultaneously at all five sites between 15 December 1999 and 15 February 2000.

Survey questionnaire

By modifying a previously validated questionnaire (*12*), we developed a multi-item structured ques-

tionnaire to elicit the following information from the study participants: demographic characteristics (e.g., age, marital status, religion, education and monthly expenditure of both the participant and his/her family members); medical history of the participant (self-reported health conditions such as hypertension or diabetes mellitus, medications used, and history of visits to physicians over the year immediately preceding the survey); life-style related information (specifically, smoking and level of physical activity). A current smoker was defined as a subject who smoked any number of cigarettes regularly, while any history of smoking in the past defined a past smoker. Education was defined as a dichotomous variable: $\geqslant$ 10 years of schooling (completion of secondary education), or <10 years of schooling. Physical activity was assessed using open-ended questions inquiring about the average activity during work and leisure time. Physical activity was coded into the following categories thus: sedentary (walking, job involving desk work, mainly domestic activities, viewing television, or reading); mild level of physical activity (home maintenance activities, gardening, feeding cattle or livestock, washing linen/clothes by hand, carrying firewood, etc.); moderate or greater level of physical activity (agricultural work in fields, pulling a cart or rickshaw, quarry work, cycling; rowing; carpentry; masonry, etc.).

Measurement of blood pressure and anthropometry

During the course of the interview, the individual survey physician made two measurements of blood pressure on each study participant with a mercury column sphygmomanometer (Diamond Co., Industrial Electronics and Allied Products, Electronics Cooperative Estate, Pune, Maharashtra, India) using a standardized technique (*19*). Study participants were instructed to refrain from drinking any caffeinated beverage and from smoking during the half-hour preceding the interview. Both blood pressure measurements were obtained after the subject had rested for at least 5 min in a seated position. The first blood pressure measurement was recorded after obtaining sociodemographic information from the study subject, while the second was recorded after a brief clinical examination. All blood pressure measurements were made on the left arm of each study subject, using a cuff of appropriate size at the level of the heart. The cuff pressure was inflated 30 mm Hg above the level at which the radial pulse disappeared, then deflated slowly at the rate of about 2 mm per sec and the readings recorded to the nearest 2 mm Hg. The first (appearance) and the fifth (disappearance) Korotkoff sounds were recorded as indicative of the systolic (SBP) and the diastolic blood pressure (DBP), respectively. We used the average of two readings of SBP and DBP to describe the blood pressure of the participant. In cases where the two readings differed by over 10 mm of Hg, the examiner obtained a third reading, and the three measurements were averaged.

Body weight was measured (to the nearest 0.5 kg) with the subject standing motionless on the weighing scale, feet about 15 cm apart, and weight equally distributed on each leg. Subjects were instructed to wear minimum outerwear (as culturally appropriate) and no footwear while their weight was being measured. Height was measured (to the nearest 0.5 cm) with the subject in an erect position against a vertical surface, and with the head positioned so that the top of the external auditory meatus was level with the inferior margin of the bony orbit.

Training of personnel and other quality control measures

In order to ensure the accuracy, completeness, and comparability of blood pressure and anthropometric measurements, and of interviewee responses across the five study sites, we built in several quality control measures into our survey design and protocol. Briefly, all three doctors and the nursing graduate underwent a common training programme at the Achutha Menon Centre at which a team of cardiologists instructed the investigators regarding measurements of blood pressure, weight, and height. The sphygmomanometers, weighing scales and the graduated plumb lines were purchased before the training and a common written study protocol was distributed. The common study questionnaire was translated into the regional vernaculars and back translated into English. The questionnaire items and format were pilot-tested for clarity and face validity; all questions were reviewed by a cardiologist, epidemiologists, public health experts, and by investigators experienced in conducting community-based surveys in India.

Definitions of hypertension, and of awareness, treatment and control of hypertension

The hypertension status and blood pressure distribution of the study sample were assessed using standard criteria formulated by WHO–International Society of Hypertension (WHO–ISH) (*20*) and the US Sixth Joint National Committee on Detection, Evaluation and Treatment of Hypertension (JNC–VI) (*21*). We defined *hypertension* as either an SBP $\geqslant$ 140 mm Hg, and/or a DBP $\geqslant$ 90 mm Hg, and/or treatment with antihypertensive medication (*20, 21*). *Awareness of hypertension* was based on the subjects' report of a prior diagnosis of hypertension (or high blood pressure) made by a health professional (*22*). Current use of prescription medication for lowering elevated blood pressure among hypertensive subjects in our sample was considered as treatment of hypertension; we considered only pharmacological treatment (*22*), including allopathic or any alternative medicine medications. In order to avoid misclassification of non-hypertensive individuals taking cardiovascular medications for indications other than hypertension, a diagnosis of *treated hypertension* was made only if the subject reported a prior diagnosis of hypertension and was using antihypertensive agents. We defined

Table 1. **Characteristics of the study sample**

Variable	Total sample	Urban sites						Rural sites			
		Dhaka		Maharashtra		Kerala		Kerala		Dhaka	
		Men (n=133)	Women (n=107)	Men (n=107)	Women (n=136)	Men (n= 96)	Women (n=144)	Men (n=151)	Women (n= 89)	Men (n= 108)	Women (n=132)
Age (%)											
<70 years	54	54	71	46	68	45	63	48	53	31	52
70–79 years	32	32	21	40	28	39	27	33	33	36	36
⩾ 80 years	14	14	8	14	4	17	10	19	15	33	12
Mean ± SD	70 ± 8	70± 9	67± 7	71±7	67±7	71±8	69± 7	71± 9	70± 8	74±9	69±8
Education (%)											
⩾ 10 years of schooling	15	33	1	22	15	43	21	6	3	4	0
Marital status (%)											
Currently married	61	86	26	85	55	88	39	91	38	87	44
Smoking history (%)											
Current smokers	14	32	2	15	2	19	0	43	3	44	2
Past smokers	19	47	2	23	0	43	1	40	4	48	2
Diabetes mellitus (%)											
Self-reported diabetes	13	14	12	9	14	33	19	15	15	1	0
Physical activity (%)											
Sedentary	66	75	86	56	67	63	69	79	66	57	47
Mild	28	15	12	40	32	37	31	19	34	6	51
Moderate	6	10	2	4	1	1	0	2	1	38	2
Body mass index (kg/m^2)[a] (%)											
<18.09	33.3	34	36	14	19	19	11	39	26	69	69
18.09– 22.25	33.3	42	36	40	29	37	28	42	31	27	26
>22.25	33.4	24	27	46	52	44	61	19	43	4	5
Mean ± SD (kg/m^2)	21±5	20± 3	20 ± 4	22±4	23±5	22±3	24±5	19 ± 3	22 ± 6	17±2	17±3

[a] Tertiles of BMI from our study sample

control of hypertension as pharmacological treatment associated with an SBP <140 mmHg and a DBP <90 mmHg (*22*). Control rates were calculated separately for all hypertensive subjects and for the subgroup of hypertensives being treated with antihypertensive medications, since awareness and treatment are prerequisites for the control of hypertension. Since international blood pressure targets for treatment of diabetic hypertensives are lower than the above values, we performed additional analyses of the adequacy of blood pressure control among diabetics with hypertension in our study sample using the goals of SBP and DBP <130 mmHg and <85 mmHg, respectively, as indicative of adequate control (*20, 21*).

Statistical methods

For our primary analyses, we pooled data from all the study sites. The decision to pool data was made a priori, and was supported by the use of a similar sampling strategy, a common questionnaire, identical definitions of key variables, and by the standardized measurement techniques at each individual site. Prevalence of hypertension and risk factors for high blood pressure are presented as percentages (with their 95% CI). Continuous variables are presented as means (with the corresponding standard deviations). For the various age groups and at study sites, we compared mean values of SBP and DBP (ignoring antihypertensive treatment) among men and women using one-way ANOVA. A χ^2 test for trend was used to compare the prevalence of hypertension among different age groups, while a χ^2 test was used to compare the prevalence of hypertension between men and women, as well as by place of residence. Similarly, we compared the awareness, treatment and control of hypertension at the different study sites using a χ^2 test. We also studied the distribution of blood pressure in the study sample according to WHO defined grades (*20*) (or JNC–VI stages) (*21*) of hypertension. The prevalence of isolated systolic hypertension, defined as an SBP ⩾ 140 mmHg with a DBP < 90 mmHg (*20, 21*), was determined only for subjects who were not on any antihypertensive medication.

To study the impact of selected sociodemographic factors, anthropometric measurements {body mass index (BMI) calculated as weight in kg divided by the square of height in m}, and other risk factors on the prevalence of hypertension, we performed multiple logistic regression analyses on the pooled sample with hypertension status as the dichotomous outcome (dependent variable) and with age, sex, place of

Table 2. **Prevalence of hypertension in the study sample, by location**

Location	Prevalence of hypertension (%)
Urban sites	
Dhaka	75 (69–80)[a]
Maharashtra	72 (69–75)
Kerala	69 (63–75)
Rural sites	
Kerala	55 (49–61)
Dhaka	53 (47–59)
Total sample	**65 (62–67)**

[a] Figures in parentheses are 95% confidence intervals.

residence (rural or urban), educational level, marital status, smoking, physical activity, diabetes mellitus, and BMI as the independent variables. Additionally, we performed multiple logistic regression analyses to investigate the factors associated with increased awareness of hypertension among individuals identified as hypertensive in our survey. In these analyses, awareness of hypertension was the dichotomous dependent variable, while age, sex, education level, place of residence and a visit to a doctor in the previous year were the independent variables. All statistical analyses were performed using SPSS for Windows release 6.1 software. $P < 0.05$ was used as the definition of statistical significance.

Results

Study sample characteristics

The demographic and clinical characteristics of the 1203 individuals aged ⩾ 60 years who were identified at the five study sites (about 240 per site) are shown in Table 1. Overall, there were more women than men, both in the composite sample (sex ratio 1.26) and at each individual study site other than rural Kerala. The majority of participants were aged <70 years, but 14% were over 80 years of age. Most study subjects were literate, though only about 15% reported having had received 10 years' school education. Two-thirds of the subjects reported a sedentary life style. A high prevalence of self-reported diabetes mellitus was noted in our pooled sample, with the prevalence being particularly high in urban Kerala. The study sample was overwhelmingly lean (mean BMI 20.8 ± 4.6), with women having a significantly higher body mass than men.

Prevalence of hypertension and mean blood pressure levels

The overall prevalence of hypertension in our sample was 65% (95% CI = 62– 67%; Table 2). There were 777 subjects (333 men and 444 women) with hypertension according to current WHO–ISH/JNC–VI criteria. If we used the "older" criteria for hypertension, i.e. SBP > 160 mm Hg, and/or DBP > 95 mmHg (*23*), and/or use of antihypertensive medications, the prevalence of hypertension was 47% (95% CI = 44–49%; 230 men and 330 women). Of the 157 individuals with self-reported diabetes mellitus in our study, 128 had hypertension (82%) by current WHO–ISH criteria.

Prevalence of hypertension was similar for both men and women, and did not differ in the three age groups examined (Table 3). Although the prevalence of hypertension was higher among urban residents than their rural counterparts (Table 3), it did not differ among the three urban sites, or between the two rural sites (see Table 2). The mean systolic and diastolic blood pressures in our study sample, according to the sex and place of residence of the study subjects, and in different age groups, are also shown in Table 3. These levels did not vary according to sex but were higher among urban residents. The mean diastolic blood pressure decreased with increasing age.

Distribution of blood pressure levels by WHO grades

The blood pressure levels of study subjects classified according to WHO-defined grades are shown in (Table 4). The distribution of blood pressure grades was similar for men and women, but varied among the different study sites. Overall, only 12.1 % of study subjects had optimal blood pressure, with the urban areas having a lower prevalence of such individuals than the rural sites. A total of 13.1% of subjects had high normal blood pressure, with the highest proportion being noted in rural Kerala. Approximately 30 % study subjects had mildly raised blood pressure (grade 1), and almost the same proportion had stage II or higher levels of hypertension, with the highest proportion being observed in urban Dhaka. Among hypertensives not on any treatment ($n = 469$), 190 (41%; 95% CI = 36–45%) had isolated systolic hypertension. This figure may be an underestimate because some elderly hypertensives who were on medications may have been treated for isolated systolic hypertension.

Sociodemographic and clinical correlates of hypertension

The results of our multivariable logistic regression models that examined the cross-sectional correlates of hypertension are presented in Table 5. A higher BMI, self-reported diabetes mellitus and a higher education level (⩾ 10 years of schooling) were associated with increased odds of being hypertensive. Factors associated with lower odds of being hypertensive included self-reported physical activity (mild or moderate level), rural residence and a history of current smoking. Sex, age, and marital status were not correlated with the prevalence of hypertension.

Awareness, treatment and control of hypertension

Table 6 shows data on the awareness, treatment and control of hypertension among hypertensives in the study sample. Only 45 % of the hypertensive subjects were aware of their elevated blood pressure status,

Table 3. **Prevalence of hypertension and mean blood pressure levels in selected study subgroups**

Variable	Sex			Age group (years)				Place of residence		
	Men	Women	*P*- value	<70	70–79	>80	*P*- value	Urban	Rural	*P*-value
Hypertension (%)	63	66	0.17[a]	64	67	61	0.66[b]	72	54	<0.001[a]
Mean systolic BP ± SD (mmHg)	142 ± 25	145 ± 27	0.09[c]	142 ± 25	146 ± 26	142 ± 28	0.12[c]	147 ± 24	138 ± 28	<0.001[c]
Mean diastolic BP ± SD (mmHg)	84 ± 14	85 ± 14	0.09[c]	86 ± 13	84 ± 14	81 ± 17	<0.001[c]	86 ± 13	83 ± 15	<0.001[c]

[a] χ^2 test.

[b] χ^2 test for trend.

[c] One-way ANOVA.

Table 4. **Distribution of blood pressure in the study sample, by WHO grades (JNC–VI stages)**

Group	No. with optimal BP[a]	No. with normal BP[b]	No. with high normal BP[c]	No. with hypertension[d]			
				Controlled	Grade 1	Grade 2	Grade 3
Pooled sample							
Total (*n* =1203)	146 (12.1)[e]	123 (10.2)	157 (13.1)	79 (6.6)	358 (29.8)	203 (16.9)	137 (11.4)
By sex							
Men (*n* =533)	69 (12.9)	53 (10)	78 (14.6)	29 (5.4)	174 (32.6)	82 (15.4)	48 (9)
Women (*n* =670)	77 (11.5)	70 (10.4)	79 (11.8)	50 (7.5)	184 (27.5)	121 (18.1)	89 (13.3)
By place of residence							
Urban areas							
Dhaka (*n* =240)	11 (4.6)	19 (7.9)	31 (12.9)	8 (3.3)	66 (27.5)	60 (25)	45 (18.8)
Maharashtra (*n* =243)	14 (5.8)	21 (8.6)	34 (14)	20 (8.2)	84 (34.6)	47 (19.3)	23 (9.5)
Kerala (*n* =240)	30 (12.5)	20 (8.3)	25 (10.4)	23 (9.6)	88 (36.7)	37 (15.4)	17 (7.1)
Rural areas							
Kerala (*n* =240)	41 (17.1)	25 (10.4)	42 (17.5)	24 (10)	63 (26.3)	27 (11.3)	18 (7.5)
Dhaka (*n* =240)	50 (20.8)	38 (15.9)	25 (10.4)	4 (1.7)	57 (23.8)	32 (13.3)	34 (14.2)

[a] SBP <120 mmHg and DBP <80 mmHg.

[b] SBP =120–129 mmHg, and/or DBP = 80–84 mmHg.

[c] SBP = 130–139 mmHg or DBP = 85–89 mmHg.

[d] Grade 1: SBP = 140–159 mmHg or DBP = 90–99 mmHg; Grade 2: SBP = 160–179 mmHg or DBP = 100–109 mmHg; Grade 3: SBP ⩾ 180 mmHg and DBP ⩾ 110 mm Hg. Note: When SBP and DBP fell into different categories, the higher category was selected to classify the individual's BP status. For example, 145 mmHg/100 mmHg was classified as Grade 2 hypertension and 160 mmHg/120 mmHg is classified as Grade 3 hypertension.

[e] Figures in parentheses are percentages.

Table 5. **Correlates of prevalent hypertension among the study subjects: results of multiple logistic regression analyses[a]**

Variable	Referent category	β-coefficient	Odds ratio	*P*-value
BMI 2nd tertile[b]	BMI 1st tertile	0.54 (0.15)[c]	1.72; *1.26–2.35*[d]	<0.001
BMI 3rd tertile	BMI 1st tertile	0.88 (0.17)	2.4; *1.71–3.4*	<0.001
Diabetes mellitus[e]	Non-diabetic	0.58 (0.23)	1.8; *1.14–2.8*	0.01
⩾10 years of schooling	<10 years of schooling	0.47 (0.22)	1.6; *1.03–2.49*	0.03
Mild physical activity	Sedentary group	–0.42 (0.15)	0.66; *0.49–0.89*	0.005
Moderate physical activity	Sedentary group	–0.61 (0.28)	0.54; *0.31–0.96*	0.03
Rural residence	Urban residence	–0.33 (0.14)	0.72; *0.54–0.95*	0.02
Current smoker	Non-smoker	–0.58 (24)	0.56; *0.35–0.91*	0.02

[a] Age, sex, marital status, religion, past history of smoking were not statistically significant

[b] BMI = body mass index.

[c] Figures in parentheses are standard errors.

[d] Figures in italics are 95% confidence intervals.

[e] By self-report.

Table 6. **Awareness, treatment, and adequacy of control of hypertension in study sample**

Group	All hypertensives			Treated hypertensives/total	
	No. aware	No. treated	No. controlled[a]	No. controlled[a]	No. uncontrolled, severe hypertension[b]
Pooled sample					
Total (n =777)	347 (44.7)[c]	308 (39.6)	79 (10.2)	79/308 (25.6)	55/308 (17.9)
Sex					
Men (n =333)	133 (39.9)	118 (35.4)	29 (8.7)	29/118 (24.6)	15/118 (12.7)
Women (n =444)	214 (48.2)	190 (42.8)	50 (11.3)	50/190 (26.3)	40/190 (21.1)
P-value[d]	0.02	0.04	0.24	0.73	0.06
Place of residence					
Urban (n =518)	245 (47.3)	210 (40.5)	51 (9.8)	51/210 (24.3)	33/210 (15.7)
Rural (n =259)	102 (39.4)	98 (37.8)	28 (10.8)	28/98 (28.6)	22/98 (22.4)
P-value[d]	0.04	0.47	0.67	0.42	0.15
Urban centres					
Dhaka (n = 179)	87 (48.6)	69 (38.5)	8 (4.5)	8/69 (11.6)	22/69 (31.9)
Maharashtra (n =174)	77 (44.3)	76 (43.7)	20 (11.5)	20/76 (26.3)	8/76 (10.5)
Kerala (n =165)	81 (49.1)	65 (39.4)	23 (13.9)	23/65 (35.4)	3/65 (4.6)
P-value[d]	0.61	0.58	0.009	0.005	< 0.001
Rural centres					
Kerala (n =132)	81 (61.4)	70 (53)	24 (18.2)	24/70 (34.3)	7/70 (10)
Dhaka (n =127)	21 (16.5)	28 (22)	4 (3.1)	4/28 (14.3)	15/28 (53.6)
P-value[d]	< 0.001	< 0.001	< 0.001	0.047	< 0.001

[a] SBP <140 mmHg and DBP <90 mm Hg on treatment.

[b] Indicates Grade 3 hypertension as defined in footnote d, Table 4.

[c] Figures in parentheses are percentages.

[d] χ^2 test.

and the majority of these individuals were taking pharmacological treatment for the condition, mostly (97%) allopathic medicines. However, only about 10% of hypertensive subjects were having their blood pressure controlled according to current JNC–VI recommendations (*21*). Even when we limited our analysis to treated hypertensives; only a quarter of the treated subjects had adequately controlled blood pressure levels. Furthermore, 7 % of all hypertensives (and 18% of treated hypertensives) had blood pressure levels indicative of severe hypertension (SBP $\geqslant$ 180 mmHg or DBP $\geqslant$ 110 mmHg).

Subgroup analyses demonstrated that women were more aware of their hypertensive status and more likely than men to be treated. However, rates of control of hypertension did not differ among the two sexes. Rural residents with hypertension in our sample were less likely than urban residents to be aware of their condition, although they were equally likely to be treated for elevated blood pressure. Levels of awareness about and treatment of hypertension did not differ among the three urban sites; however, elderly hypertensive individuals in rural Kerala demonstrated a greater awareness of their condition and were more likely to be treated than their counterparts in rural Dhaka.

Rates of control of hypertension did not vary between pooled urban sites and pooled rural sites. However, within the urban sites there was substantial heterogeneity in hypertension control rates, with very low rates being documented in urban Dhaka. Similarly, hypertension control rates were higher in rural Kerala than in rural Dhaka. Overall, control rates were highest in Kerala, and lowest at the two Dhaka sites.

Of the 128 subjects with both diabetes mellitus and hypertension, 80 (62.5 %) were being treated for elevated blood pressure; however, only 15 subjects (11.7 % of all diabetic hypertensives; 18. 8 % of treated diabetic hypertensives) achieved the recommended therapeutic blood pressure goal (SBP <130 mmHg and DBP< 85 mmHg).

Correlates of awareness of hypertension

The results of the multiple logistic regression analyses examining the association of select variables with awareness of hypertension status are presented in Table 7. A visit to a doctor's office in the previous year (adjusted OR = 6.5), a higher education level (adjusted OR = 3.1), and being female (adjusted OR = 1.8) were positively associated with increased awareness of hypertension (Table 7). Age or place of residence (urban versus rural) did not influence awareness of hypertension.

Discussion

Prevalence and correlates of hypertension

Our findings provide direct evidence of an increasing burden of hypertension among the elderly population

Table 7. **Correlates of hypertension awareness: results of multiple logistic regression analysis**

Variable[a]	Referent category	β-coefficient	Odds ratio	*P*-value
⩾ one physician visit in previous year	No physician visit in previous year	1.87 (0.21)[b]	6.54; *4.2– 0.1*[c]	< 0.001
Female	Male	0.56 (0.14)	1.76; *1.3–2.4*	< 0.001
⩾ 10 years of schooling	<10 years of schooling	1.12 (0.22)	3.1; *2.0–4.8*	< 0.001

[a] Other variables which were considered but which were not statistically significant included age, place of residence (urban versus rural), and marital status.

[b] Figures in parentheses are the standard errors.

[c] Figures in italics are the 95% confidence intervals.

in the Indian subcontinent. The association of hypertension with BMI, diabetes mellitus, and physical activity has been reported previously on numerous occasions (*24–29*). The association of higher educational levels with increased odds of hypertension is in contrast to findings from developed countries, where risk factors for cardiovascular diseases, including hypertension, are more pronounced among the less educated groups (*30, 31*). However, it is important to note that our study was cross-sectional and the communities surveyed are at an early stage of epidemiological transition. Longitudinal observations from developed countries suggest a direct relation between better educational status and hypertension in the early stages of epidemiological transition. However, this pattern reverses in the later stages of epidemiological transition, with the burden of chronic disease (including hypertension) and risk factors shifting to the less educated groups (*32*).

Awareness, treatment and control of hypertension and its correlates

The overall awareness, treatment and adequacy of control of hypertension in our sample was low (45%, 40% and 10%, respectively). Although these proportions are lower than those reported from some developed countries (*22*, *33, 34*), they are quite similar to those reported from other developing countries (*35–37*). Competing health priorities (such as the co-existing burden of communicable diseases) and scarce health resources affect the availability, accessibility and affordability of physician services in both the public and private sectors in developing countries *(38*). Furthermore, health perceptions (such as the belief that health changes are a natural consequence of aging, constructs of acute versus chronic illness), socioeconomic factors (increased dependence, burden of drug costs), reduced physical mobility, attitudes towards pill taking, and a low level of overall education, in general, and health education, in particular, impact the health-seeking behaviour of the elderly. A combination of these factors possibly contributes to the low level of awareness, treatment and control of hypertension in our study sample. Not surprisingly, we identified visits to a doctor in the previous year, better educational attainment and being female as important correlates of hypertension awareness.

The better awareness and treatment of hypertension among women has been consistently documented (*11*, *39*) but the reasons are not entirely clear. Differences in health seeking behaviour, and a greater opportunity for casual blood pressure screening due to more frequent contacts with the health care system may contribute to this gender-related difference. The heterogeneity of hypertension treatment and control rates across the five study sites emphasizes the need for additional studies designed specifically to investigate the factors contributing to these differences. The low rates of hypertension control are a matter of concern particularly for physicians and policy-makers. Different degrees of knowledge about current hypertension guidelines among physicians, and variations in physicians' attitudes towards health problems of the elderly (such as therapeutic nihilism) probably contribute to our observations. The low level of control among diabetic hypertensives, a high-risk group, indicates that current international guidelines have not been adopted by physicians in the study areas.

It is important to note that in rural Kerala nearly 20% of all hypertensives (and 35% of treated hypertensives) could control their hypertension in line with current guidelines. This is close to the proportion of such control achieved in the USA (24% of all hypertensives and 45% of treated hypertensives). It is noteworthy, however, that the results in rural Kerala are probably achieved at a much lower cost, since the annual per capita expenditure on health in the US is about US$ 3925 (*40*) compared with only US$ 28 in Kerala (*41*).[a] Factors that may contribute to a better degree of hypertension control in Kerala (relative to other study sites) are probably the same as those responsible for the general good level of health in this state, i.e., high female literacy, universal access to health care, and a high utilization of health care facilities.

[a] The per capita health expenditure for Kerala was estimated from the state planning board figure for 1997, which provides only government expenditure. The *World Health Report 2000* estimated that government health expenditure in India constitutes only 13% of the total. We used the same proportion for Kerala to arrive at US$ 28.

Strengths and limitations of the study

Our study was not designed to determine the prevalence of hypertension among the elderly in the Indian subcontinent. Rather, we described the prevalence of hypertension in five different, well-characterized communities in order to provide estimates of the probable magnitude of the problem in the region. The study's modest sample size, adequate representation of women and the very old, standardized methods, use of a door-to-door survey and of health professionals for blood pressure measurement are strengths of our investigation. Nonetheless, certain limitations of our approach need to be acknowledged. The use of a single visit to ascertain hypertension status can result in an overestimation of its prevalence. The use of an "open question" to assess physical activity may be criticized, but we chose this approach because there are no previously validated physical activity questionnaires that are specific for developing countries.

Public health implications

According to current WHO guidelines, hypertension is very widespread among the elderly population of our study sample in the Indian subcontinent. Even with the previous criteria (SBP $\geqslant$ 160 mmHg or DBP $\geqslant$ 95 mmHg) nearly half of our study population was classified as hypertensive. It is important to acknowledge that estimation of the prevalence of hypertension is only the first step towards the tackling the condition. Formulation of effective treatment strategies is the logical next step. In this regard it is clear from our data that the sheer magnitude of the problem of hypertension among the elderly poses a major economic challenge to health care systems in the region. If recourse is made to international hypertension guidelines for possible solutions, it is clear that different guidelines have recommended different approaches towards the cost of treating hypertension, all with good reason. While Canadian hypertension treatment guidelines specifically exclude economic considerations (*42*), US and WHO guidelines lay the onus for cost considerations on the individual treating physician (*20, 21*). The British Hypertension Society guidelines relate the risk level at which treatment is recommended to the availability of resources (*43*). We believe it to be crucial that health planners, clinicians, community representatives, and public health practitioners in developing countries formulate country-specific guidelines based on local competing health care priorities and economic realities. These regional guidelines should identify realistic goals, such as the thresholds for treatment, the "desirable" level of blood pressure control, the "affordable" degree of hypertension control, the "acceptable" extent of hypertension control (based on a balance between aspiration for the ideal and what is feasible and achievable), and the likely strategies for achieving these targets. While controversy has raged over the dangers of applying economic considerations in the management of hypertension and the need for social justice and equity, we agree with Swales that the treatment of the hypertensive patient has to take place in the real world of constrained health care systems (*44*). Consequently, it is important to assess the resources available for detecting and treating hypertension in the Indian subcontinent, given that nearly two-thirds of elderly individuals have elevated blood pressure levels. While mass screening of the elderly population (or for that matter, any segment of the population) is neither feasible nor sustainable, the existence of a nationwide infrastructure of community health centres offers a unique possibility in the Indian subcontinent. At present, these health centres focus on communicable diseases and family planning programmes but they could also be used to promote "opportunistic screening" during routine visits in order to identifying patients at high risk of cardiovascular diseases. The development of affordable screening programmes should be accompanied by an evaluation of the efficacy, acceptability and affordability of low cost treatment regimens. At the individual level, it is important to target for treatment individuals with an increased absolute risk of cardiovascular disease (*20*). The feasibility of treating these individuals with a fixed dose generic drug combination (such as diuretic plus an angiotensin-converting enzyme inhibitor to lower blood pressure plus a statin to lower cholesterol) merits exploration (*45*). These individual level strategies must be combined with population level efforts directed at reducing the average blood pressure of the population (primary prevention of hypertension). ■

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Résumé

Une étude multicentrique de l'hypertension chez les personnes âgées au Bangladesh et en Inde : prévalence, sensibilisation, traitement et normalisation de la tension

Objectif Evaluer la prévalence, le degré de sensibilisation, le traitement et la normalisation des chiffres tensionnels chez des sujets âgés hypertendus, au Bangladesh et en Inde.

Méthodes Un échantillon de 1203 sujets âgés (670 femmes ; âge moyen 70 ans) a été sélectionné en communauté par sondage en grappes à plusieurs degrés à partir de deux sites au Bangladesh et de trois sites en Inde.

Résultats La prévalence globale de l'hypertension (définie d'après les critères OMS – Société internationale de l'Hypertension) était de 65 % (intervalle de confiance à 95 % : 62-67 %). La prévalence était plus élevée en secteur urbain qu'en secteur rural, mais ne différait pas significativement suivant le sexe. La régression logistique multiple a mis en évidence une corrélation importante entre d'une part la prévalence de l'hypertension et d'autre part un indice de Quételet élevé, un niveau de scolarisation élevé et la présence du diabète sucré. L'activité physique, la résidence en secteur rural et le tabagisme en cours étaient inversement liés à la prévalence de l'hypertension. Parmi les hypertendus de l'étude, 45 % se savaient atteints d'hypertension, 40 % prenaient des antihypertenseurs, mais seuls 10 % avaient atteint le niveau de normalisation fixé par le Sixth Joint National Committee on Detection, Evaluation and Treatment of Hypertension (JNC VI) américain/ l'OMS. Une consultation médicale dans l'année précédente, un niveau de scolarisation élevé et le sexe féminin sont apparus comme des variables fortement corrélées à la sensibilisation.

Conclusion Nos résultats soulignent la nécessité de mettre en œuvre des protocoles de prise en charge efficaces et peu coûteux basés sur le risque cardiovasculaire absolu, appropriés à la situation économique. Sur le plan de la santé publique, seule une stratégie visant à réduire la tension artérielle moyenne dans la population permettra sur le long terme de résoudre le problème de la prévalence élevée de l'hypertension dans le sous-continent indien.

Resumen

Estudio multicéntrico sobre la prevalencia, el tratamiento y el control de la hipertensión y sobre el conocimiento de este problema entre las personas de edad en Bangladesh y la India

Objetivo Evaluar la prevalencia, el tratamiento y el control de la hipertensión, así como el conocimiento de este problema, entre las personas de edad en Bangladesh y la India.

Métodos Se seleccionó una muestra comunitaria de 1203 personas de edad avanzada (entre ellas 670 mujeres; edad media: 70 años) empleando una técnica de muestreo por conglomerados polietápico de dos sitios en Bangladesh y tres sitios en la India.

Resultados La prevalencia general de hipertensión (criterios OMS/Sociedad Internacional de la Hipertensión) era del 65% (intervalo de confianza del 95% = 62%–67%). La prevalencia era mayor en los entornos urbanos que en las zonas rurales, pero no difirió significativamente entre los sexos. Los análisis de regresión logística múltiple revelaron que la prevalencia de hipertensión estaba correlacionada marcadamente con un mayor índice de masa corporal, con un mayor nivel de instrucción y con la prevalencia de diabetes mellitus. La actividad física, la residencia en zonas rurales y la condición de fumador a la sazón eran factores inversamente relacionados con la prevalencia de hipertensión. Entre las personas estudiadas que tenían hipertensión, el 45% sabían que la padecían y el 40% estaban tomando medicación antihipertensiva, pero sólo un 10% había alcanzado los niveles estipulados en los criterios del Sexto Comité Nacional Mixto de los EE.UU. sobre la Detección, la Evaluación y el Tratamiento de la Hipertensión. El hecho de haber visitado a un médico durante el año precedente, la posesión de un nivel de instrucción alto y la condición de mujer resultaron ser factores notablemente correlacionados con el conocimiento de la propia hipertensión.

Conclusión Nuestros resultados subrayan la necesidad de aplicar regímenes terapéuticos eficaces y de bajo costo basados en los niveles absolutos de riesgo cardiovascular teniendo en cuenta el contexto económico. Desde una perspectiva de salud pública, la única manera de abordar de forma sostenible la alta prevalencia de hipertensión en el subcontinente indio es una estrategia orientada a reducir la presión arterial promedio en la población.

References

1. United Nations world population projections to 2150. *Population and Development Review*, 1998, **24**: 183–189.
2. **Kumar V.** Ageing in India — an overview. *Indian Journal of Medical Research*, 1997, **106**: 257–264.
3. **National High Blood Pressure Education Program Working Group.** National High Blood Pressure Education Program Working Group Report on Hypertension in the Elderly, *Hypertension*, 1994, **23**: 275–285.

4. **Burt VL et al.** Prevalence of hypertension in the US adult population. Results from the Third National Health and Nutrition Examination Survey, 1988–1991. *Hypertension,* 1995, **5**: 305–313.
5. **Trenkwalder P et al.** Prevalence, awareness, treatment and control of hypertension in a population over the age of 65 years: Results from the Starnberg Study on epidemiology of Parkinsonism and hypertension in the elderly (STEPHY). *Journal of Hypertension,* 1994, **12**: 709–716.
6. **O'Donnel CJ, Kannel WB.** Cardiovascular risks of hypertension: Lessons from observational studies. *Journal of Hypertension*, 1998, **16** (suppl): S3–S7.
7. **Amery A et al.** Mortality and morbidity results from the European Working Party on High Blood Pressure in the Elderly Trial. *Lancet,* 1985, **1**: 1349–1354.
8. **Dahlof B et al.** Morbidity and mortality in the Swedish trial in old patients with hypertension (STOP-Hypertension). *Lancet,* 1991, **338**: 1281–1285.
9. **SHEP Cooperative Research Group.** Prevention of stroke by antihypertensive drug treatment in older persons with isolated systolic hypertension. Final results of the Systolic Hypertension in the Elderly Program (SHEP). *Journal of the American Medical Association*, 1991, **265**: 3255–3264.
10. **Staessen JA et al.** Randomized double-blind comparison of placebo and active treatment for older patients with isolated systolic hypertension. The Systolic Hypertension in Europe (Syst-Eur) Trial Investigators. *Lancet*, 1997, **350**: 757–764.
11. **Fuentes R et al.** Hypertension in developing economies: a review of population-based studies carried out from 1980 to 1998. *Journal of Hypertension*, *2000*, **18**: 521–529.
12. **Kalavathy MC et al.** Prevalence, awareness, treatment and control of hypertension in an elderly community-based sample in Kerala, India. *National Medical Journal of India*, 2000; **13**: 9–15.
13. **Chadha SL, Gopinath N, Shekhawat S.** Urban-rural differences in the prevalence of coronary heart disease and its risk factors in Delhi. *Bulletin of the World Health Organization*, 1997, **75**: 31–38.
14. **Singh RB et al.** Prevalence of coronary artery disease and coronary risk factors in rural and urban populations of north India. *European Heart Journal*, 1997, **18**: 1728–1735.
15. *Census 1991, Series 12, Kerala.* Delhi, Registrar General of India, 1991.
16. *Statistical Yearbook of Bangladesh,* 14th edit. Dhaka, Director General Bangladesh Bureau of Statistics, 1993: 64–65
17. **Bennet S et al.** A simplified general method for cluster-sample surveys of health in developing countries. *World Health Statistics Quarterly,* 1991, **44**: 98–106.
18. **Henderson RH, Sundaresan T.** Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. *Bulletin of the World Health Organization*, 1982, **60**: 253–260.
19. **Perloff D et al.** Human blood pressure determination by sphygmomanometry. *Circulation*, 1993, **88**: 2460–2470.
20. 1999 World Health Organization–International Society of Hypertension Guidelines for the Management of Hypertension. Guidelines Subcommittee. *Journal of Hypertension*, 1999, **17**: 151–183.
21. The Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure. *Archives of Internal Medicine*, 1997, **157**: 2413–2446.
22. **Burt VL et al.** Trends in the prevalence, awareness, treatment and control of hypertension in the adult US population. Data from the health examination surveys, 1960 to 1991. *Hypertension*, 1995, **26**: 60–69.
23. *Arterial hypertension: Report of a WHO Expert Committee.* Geneva, World Health Organization, 1978 (WHO Technical Report Series No. 628).
24. **Stamler J.** Epidemiological Findings on Body Mass and Blood Pressure in Adults. *Annals of Epidemiology*, 1991, **1**: 347–362.
25. **Stamler J, Caggiula AW, Grandits GA.** Relation of body mass and alcohol, nutrient fiber and caffeine intakes to blood pressure in the special intervention and usual care groups in the Multiple Risk Factor Intervention Trial. *American Journal of Clinical Nutrition*, 1997, **65** (suppl): 338 S–365 S
26. **Hu FB et al.** Body mass index and cardiovascular risk factors in a rural Chinese population. *American Journal of Epidemiology*, 2000, **151**: 88–97.
27. **Epstein M, Sowers J R.** Diabetes mellitus and hypertension. *Hypertension*, 1992, **19**: 403–418.
28. **Deedwania PC.** Mechanism of the deadly quartet. *Canadian Journal of Cardiology,* 2000, **16** (suppl E): 17E–20E.
29. **Blair SN et al.** Physical fitness and incidence of hypertension in healthy normotensive men and women. *Journal of the American Medical Association* 1984; **252**: 487–490.
30. **Leino M et al.** Association of education with cardiovascular risk factors in young adults: the Cardiovascular Risk in Young Finns Study. *International Journal of Epidemiology*, 1999, **28**: 667–675.
31. **Sorel J et al.** Educational Status and Blood Pressure: The Second National Health and Nutrition Examination Survey, 1976 – 1980, and the Hispanic Health and Nutrition Examination Survey, 1982–1984. *American Journal of Epidemiology,* 1992, **135**: 1339–1348.
32. **Reddy KS, Yusuf S.** Emerging epidemic of cardiovascular disease in developing countries. *Circulation*, 1998, **97**: 596–601.
33. **Kastarinen MJ et al.** Trends in blood pressure levels and control of hypertension in Finland from 1982 to 1997. *Journal of Hypertension*, 1998, **16**: 1379–1387.
34. **Bursztyn M et al.** Hypertension in the Jerusalem 70-year-olds study population: prevalence, awareness, treatment and control. *Israel Journal of Medical Science*, 1996, **32**: 629–633.
35. **Ibrahim MM et al.** Hypertension prevalence, awareness, treatment and control in Egypt. Results from the Egyptian National Hypertension Project (NHP). *Hypertension*, 1995, **26**: 886–890.
36. **Przygoda P et al.** Lack of effective blood pressure control among an elderly hypertensive population in Buenos Aires. *American Journal of Hypertension*, 1998, **11**: 1024–1027.
37. **Tao S et al.** Hypertension prevalence and status of awareness, treatment and control in China. *Chinese Medical Journal*, 1995, **108**: 483–489.
38. **Reddy KS.** Hypertension control in developing countries: generic issues. *Journal of Human Hypertension*, 1996, **10** (suppl 10): S33–S38.
39. **Klungel OH et al.** Sex differences in the pharmacological treatment of hypertension: a review of population-based studies. *Journal of Hypertension*, 1997, **15**: 591–600.
40. **Anell A, Willis M.** International comparison of health care systems using resource profiles. *Bulletin of the World Health Organization*, 2000, **78**: 770–778
41. **Government of Kerala State Planning Board.** *Economic Review, 1999.* Thiruvananthapuram, Government Press, 1999: 166–172.
42. **Feldman RD et al.** 1999 Canadian recommendations for the management of hypertension. Task Force for the Development of the 1999 Canadian Recommendations for the Management of Hypertension. *Canadian Medical Association Journal*, 1999, **161** (suppl 12): S1–S39.
43. **Ramsay LE et al.** Guidelines for management of hypertension: report of the Third Working Party of the British Hypertension Society. *Journal of Human Hypertension*, 1999, **13**: 569–592.
44. **Swales JD.** Hypertension in the political arena. *Hypertension*, 2000, **35**: 1179–1182.
45. **Chockalingam A et al.** Prevention of cardiovascular diseases in developing countries: agenda for action (statement from a WHO–ISH Meeting in Beijing, October 1999. *Journal of Hypertension*, 2000, **18**: 1705–1708.