

A 3-year follow-up of hypertension in Delhi*

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A follow-up study of hypertension was carried out among adults in Delhi 3 years after an initial community-based epidemiological survey of the same population. The treatment and the severity status of 1115 out of 1749 individuals with hypertension detected in the initial survey were compared with those observed in the follow-up. The proportion of treated cases with controlled blood pressure rose from 10.8% to 60.8%. Among the cohort of 3611 subjects aged 25–64 years who were normotensive in the initial survey, 132 new cases of hypertension, were detected. The annual incidence of hypertension was the same in men and women (12.2 per 1000). Diabetes and regular alcohol consumption were significant risk factors for hypertension, being present in 13 and 7 cases, respectively. Electrocardiograms (ECGs) were recorded for 871 of the 1115 cases of hypertension. Abnormal ECGs were exhibited by 307 cases (35.2%), of which 24 (2.7%) had had myocardial infarction, 133 (15.3%) had ischaemic ST–T changes, 54 (6.2%) had left ventricular hypertrophy, and 96 (11.0%) had conduction defects and arrhythmias.

Introduction

Over the period 1985–87 a community-based epidemiological study on coronary heart disease and hypertension was carried out in Delhi among 25–64-year-olds using a randomized house-to-house survey. Electrocardiograms (ECGs) were obtained for clinically detected cases of hypertension, and normotensive adults were selected as controls from every second household. The methodology and results of this study have been reported elsewhere (1).

We carried out a follow-up of the same population 3 years after the initial investigation. Our findings on coronary heart disease have already been published (2). The present article concerns the re-evaluation of normotensive adults and patients with hypertension.

Materials and methods

The same cohort of adults that we studied in 1985–87 was re-examined after an average interval

of 3 years. This community-based follow-up study had the following objectives:

- to evaluate the progress of hypertensive patients detected in the initial epidemiological study; and
- to identify new cases of hypertension in adults who had been normotensive in the initial survey, and hence to determine the incidence of hypertension in the study population.

Mild hypertension was defined as a diastolic blood pressure of 90–104 mmHg (12–13.9 kPa), moderately severe hypertension as 105–114 mmHg (13.8–15.2 kPa), and severe hypertension as ≥ 115 mmHg (≥ 15.3 kPa). Isolated systolic hypertension was defined as systolic blood pressure > 160 mmHg (> 21.3 kPa) and diastolic blood pressure < 90 mmHg (< 12.0 kPa). The blood pressures of those who exhibited hypertension were measured twice, with 10-minutes' complete rest between the measurements. The average of the two readings was then calculated.

General information on the study subjects' age, sex, socioeconomic status, marital status, occupation, physical activity, height, weight, dietary habits including salt intake, smoking, and alcohol consumption had already been obtained during the initial epidemiological investigation, and any changes in these factors were noted during the follow-up study on the same forms that had been used previously. Suitable forms were designed for recording other data. The medical and family histories of hypertension and

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findings of detailed clinical examinations were recorded. Efforts were made to obtain 12-lead ECGs from known hypertension cases, from newly detected cases, and from a subsample of individuals who had been normotensive in the initial survey. All ECGs were interpreted using the Minnesota codes (3). The cluster sampling method and the criteria for diagnosing hypertension were the same as those employed in the initial survey (1). Obesity was expressed as body mass index (weight in kg/(height)² in m²), values >25 being taken as the cut-off point. Diabetes was assessed on the basis of clinical history supported by documentary evidence of drug and dietary therapy.

Results

The age and sex distributions of the resurveyed subjects are shown in Table 1. Of the 1749 cases of hypertension detected in the initial epidemiological survey, 1115 were available for re-examination. A total of 309 cases had left Delhi and were not traceable, while 74 had died. The remaining 251 cases were not available, despite repeated efforts to contact them.

Severity status

The severity of hypertension in the 1115 patients re-examined is shown in Table 2. The proportion of cases with controlled blood pressure rose from 10.8% in the initial survey to 60.8% in the follow-up. Of the 732 subjects previously categorized as having mild hypertension, 460 were found to be normotensive upon follow-up, while 231, 34, and 7 respectively, had mild, moderate, and severe hypertension. Similarly, of the 142 subjects with moderate hypertension in the initial survey, 68 were controlled, whereas 7, 17 and 50, respectively, had mild, moderate, and severe hypertension at follow-up. Of the 58 individuals who had had severe hypertension, 21 were controlled, and 20, 8, and 9, respectively, had mild, moderate, and severe hypertension in the follow-up examination. Of the 62 cases of isolated systolic hypertension recorded in the initial study, 11

had developed diastolic hypertension (mild in 10 cases and moderate in 1 case); 37 had become normotensive; and for the remaining 14 there was no change. Of the 678 cases with controlled hypertension in the follow-up study, 116 (108 with mild hypertension and 8 with isolated systolic hypertension) had not received any antihypertensive drug therapy but had followed nonpharmacological measures for the control of hypertension.

Treatment

The treatment and control status of the 1115 subjects with hypertension who were re-examined is shown in Table 3. The control status improved in each category of severity of hypertension. The proportion who were treated but had uncontrolled hypertension fell from 35% to 24.7%, whereas the proportion who were treated and controlled rose from 10.8% to 60.8%. The proportion of subjects with untreated and uncontrolled hypertension fell from 54.2% to 14.5%.

Complications

There was a history of angina pectoris in 71 of the subjects with hypertension who were re-examined, myocardial infarction had occurred in 16, and stroke had affected 13 individuals. The severity of hypertension in the subjects who developed complications is shown in Table 4.

ECG findings for the re-examined subjects with hypertension

In the initial epidemiological survey, 1417 of the 1749 detected cases of hypertension had ECGs recorded, and of these 1011 gave normal ECG traces. Of the 406 cases with abnormal ECGs, left ventricular hypertrophy was present in 80; ST-T changes (Minnesota codes 4.1.2, 5.1, and 5.2) occurred in 117; left ventricular hypertrophy (Minnesota codes 3.1 and 3.3) and ischaemic ST-T changes were present in 40; changes associated with myocardial infarction in 59; and conduction defects (various

Table 1: Distribution of the hypertensive and normotensive study subjects, by age group and sex

Age group (years)	No. with hypertension			No. with normotension ^a			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
25-34	56	55	111	449	952	1 401	505	1 007	1 512
35-44	94	152	246	338	667	1 005	432	819	1 251
45-54	162	220	382	279	428	707	441	648	1 089
55-64	146	230	376	242	256	498	388	486	874
Total	458	657	1 115	1 308	2 303	3 611	1 766	2 960	4 726

^a No. who were normotensive at time of initial epidemiological survey.

Table 2: Comparison of the severity status of the cases of hypertension among the study subjects in the initial survey and upon re-evaluation

Severity on re-evaluation	Initial severity:		Mild	Moderate	Severe	Controlled	ISH ^a	Total
	No.		732 (65.7) ^b	142 (12.7)	58 (5.2)	121 (10.8)	62 (5.6)	1 115
Mild		231 (31.6)	7 (4.9)	20 (34.5)	25 (20.7)	10 (16.1)	293 (26.3)	
Moderate		34 (4.6)	17 (12.0)	8 (13.8)	4 (3.3)	1 (1.6)	64 (5.7)	
Severe		7 (1.0)	50 (35.2)	9 (15.5)	66 (5.9)	—	—	
Controlled		460 (62.8)	68 (47.9)	21 (36.2)	92 (76.0)	37 (59.7)	678 ^c (60.8)	
ISH ^a		—	—	—	—	14 (22.6)	14 (1.3)	

^a Isolated systolic hypertension.

^b Figures in parentheses are percentages.

^c Includes 116 cases not taking antihypertensive drug therapy.

types of bundle branch block) and arrhythmias (tachycardia, bradycardia, ventricular premature beats, and atrial fibrillation) in 110 cases. Of the 117 cases with ST-T changes in the initial survey, 72 were re-examined: myocardial infarction had occurred in 8 cases and angina pectoris in 41. Of the 80 cases with left ventricular hypertrophy, 49 were re-examined: two had had a myocardial infarction and 16 had developed angina pectoris. Of the 40 with left ventricular hypertrophy and ischaemic changes, 28 were re-examined: six had had a myocardial infarction and 14 had developed angina pectoris. Thus of 237 subjects with abnormal ECGs in the initial survey, 149 were re-evaluated and 16 and 71, respectively, had developed the clinical manifestations of myocardial infarction and angina pectoris during the 3-year interval between the studies.

ECGs were obtained for 871 of the cases of hypertension who were re-examined. The ECGs were abnormal in 307 cases (35.2%), with evidence of myocardial infarction in 24 (2.7%), ST-T changes in 133 (15.3%), left ventricular hypertrophy in 54 (6.2%), and conduction defects and arrhythmias in 96 cases (11.0%).

Causes of death

The responses of relatives to questions about the causes of death among subjects were not satisfactory. On occasions, information given by different family members was conflicting and unreliable. Nor were death certificates always helpful in this regard. However, for 35 of the 74 deaths, the documentary evidence and the statements of relatives revealed that 24 had died of a heart attack, 7 had had a stroke, and 4 had died of renal failure. The exact causes of death for the remaining 39 subjects could not be established. Data collected during the initial survey showed that, of the 74 persons who died, 35, 17, 12, and 3 respectively, had had mild, moderate, severe, and isolated systolic hypertension. The hypertension of the remaining seven individuals who died had been controlled. ECGs had been obtained for 63 of these 74 patients during the initial survey. A total of 40 had exhibited abnormal findings: 8 had typical myocardial infarction patterns, 12 had ST-T changes; 4 had left ventricular hypertrophy; 2 had left ventricular hypertrophy with strain; and 14 had conduction defects and arrhythmias.

Table 3: Comparison of the treatment and control status of 1115 cases of hypertension examined in the initial and follow-up studies

	Initial survey			Follow-up survey		
	Males	Females	Total	Males	Females	Total
Treated and uncontrolled	144 (31.4) ^a	246 (37.4)	390 (35.0)	115 (25.1)	160 (24.3)	275 (24.7)
Treated and controlled	55 (12.0)	66 (10.0)	121 (10.8)	276 (60.3)	402 (61.2)	678 ^b (60.8)
Untreated and uncontrolled	259 (56.6)	345 (52.6)	604 (54.2)	67 (14.6)	95 (14.5)	162 (14.5)
Total	458	657	1 115	458	657	1 115

^a Figures in parentheses are percentages.

^b Includes 116 who did not use antihypertensive drug therapy.

Table 4: Distribution of complications at follow-up among patients found to have hypertension in the initial survey

Severity status	At initial survey:		No. with complications at follow-up:		
	No. of cases		Angina pectoris	Myocardial infarction	Stroke
Mild	732		41 (5.6) ^a	5 (0.7)	2 (0.3)
Moderate	142		9 (6.3)	4 (2.8)	5 (3.5)
Severe	58		3 (5.2)	3 (5.2)	6 (10.3)
ISH ^b	62		11 (17.7)	4 (6.4)	—
Controlled blood pressure	121		7 (5.8)	—	—
Total	1 115		71 (6.4)	16 (1.4)	13 (1.2)

^a Figures in parentheses are percentages.

^b Isolated systolic hypertension.

Incidence of hypertension

On re-examination of the cohort of 3611 adults (1308 males, 2303 females) who were normotensive in the initial survey, 132 new cases (48 males, 84 females) of hypertension were detected. The overall incidence was thus 12.2 per 1000 adults per annum, and this value held for both sexes. The incidences by age and sex are shown in Table 5. Of these new cases, 90 were mild, 10 were moderate, 10 were of isolated systolic hypertension, and 22 were controlled using pharmacological measures.

Risk factors for hypertension

The prevalences of risk factors for the newly identified cases of hypertension and the controls are given in Table 6. A total of 190 cases of coronary heart disease were excluded from the control groups because of the existence of common risk factors. There were statistically significant differences between those with hypertension and the controls for the following major factors: diabetes mellitus (9.8% of those with hypertension, 1.0% of controls); and regular alcohol consumption (5.3% of those with hypertension, 1.2% of controls). Regular alcohol consumption was defined as at least two drinks per day, 5–6 days per week; casual drinkers were not included. Of individuals who had hypertension, 24.2% were obese, compared with 22.1% of the control group. Smoking was not identified as a risk factor.

Discussion

To the best of our knowledge the present study is the first community-based follow-up investigation of hypertension carried out in India. Our findings provide information on the incidence of hypertension, the pattern of severity, and the treatment status of patients 3 years after an initial survey.

The sharp rise in the proportion of treated patients whose blood pressure was controlled at the time of the follow-up (60.8%) compared with the situation at the time of the initial survey (10.8%) is due to the health education and strong motivation of patients by field survey staff, who emphasized the importance of regular antihypertensive therapy, non-pharmacological measures, and monitoring of blood pressure. Since hypertension by itself is asymptomatic, the importance of its long-term effects that can lead to serious complications is generally not realized by patients. Many patients do not seek treatment because of ignorance, carelessness, inadequate counselling by health care professionals, and the lack of a strong patient–doctor relationship. The link between elevated blood pressure and the incidence of coronary heart disease and stroke is well recognized. In the present study, 41 of the 71 cases of angina pectoris and 5 of the 16 cases of myocardial infarction who developed these complications between the two studies had had mild hypertension in the initial survey. The duration of hypertension among these cases with complications is not known precisely. The

Table 5: Annual incidence of hypertension among study adults, by age and sex

Age group (years)	Males			Females			Total		
	<i>n</i>	No. of new cases	Incidence (per 1000)	<i>n</i>	No. of new cases	Incidence (per 1000)	<i>n</i>	No. of new cases	Incidence (per 1000)
25–34	449	10	7.4	952	19	6.7	1 401	29	6.9
35–44	338	16	15.8	667	24	12.0	1 005	40	13.3
45–54	279	11	13.1	428	28	21.8	707	39	18.4
55–64	242	11	15.2	256	13	16.9	498	24	16.1
Total	1 308	48	12.2	2 303	84	12.2	3 611	132	12.2

Table 6: Prevalence of risk factors in newly detected cases of hypertension and the control group

Risk factor	New hypertension cases (n = 132)	Control group ^a (n = 3 289)
Smoking	10 (7.6) ^b	408 (12.4)
Family history	16 (12.1)	478 (14.5)
Obesity	32 (24.2)	727 (22.1)
Diabetes mellitus	13 ^c (9.8)	32 (1.0)
Alcohol consumption	7 ^c (5.3)	39 (1.2)

^a Free of hypertension and coronary heart disease at the time of initial survey and follow-up survey.

^b Figures in parentheses are percentages.

^c $P < 0.001$.

initial survey records of 13 of the cases of hypertension who had a stroke showed that 2, 5, and 6 cases, respectively, had mild, moderate, and severe hypertension. The association between severity and the risk of vascular complication was more significant for stroke than for coronary heart disease (see Table 4).

There were 11 cases of angina pectoris and 4 cases of myocardial infarction among those with isolated systolic hypertension. This indicates that the severity of blood pressure cannot be completely characterized by the levels of diastolic blood pressure. Raised systolic blood pressure is an independent risk factor for coronary heart disease (4). In the present study, the blood pressure of 7 of the 87 cases of coronary heart disease was controlled by adequate antihypertensive therapy.

Our findings indicate that cases of hypertension with ECG abnormalities such as ST-T changes and left ventricular hypertrophy are potentially at risk of developing complications. Of the 149 persons with abnormal ECGs in the initial survey who were re-examined, 58.4% had developed coronary heart disease. The findings are consistent with the observation that the presence of abnormal ST-T segments or left ventricular hypertrophy in ECG traces is an indicator of future coronary heart disease. Previously, it has been reported that subjects whose ECGs indicated left ventricular hypertrophy had a higher incidence of clinically manifest coronary heart disease than those without this condition (5). Five persons whose ECGs in the initial survey were consistent with typical left ventricular hypertrophy had normal ECGs upon follow-up evaluation. Their records showed that their blood pressure was controlled by regular treatment. Regular antihypertensive therapy can therefore reverse ventricular hypertrophy and result in a normal ECG trace (6).

The incidence of hypertension was the same in male and female study subjects (see Table 5). Among men the maximum incidence (15.8 per 1000)

occurred for the age group 35–44 years, whereas among women the highest incidence (21.8 per 1000) was for the age group 45–54 years. The incidence was low for both sexes in the age group 25–34 years. In the USA an epidemiological follow-up study based on data obtained during a national survey showed that after average follow-up times of 9.5 years the incidence of hypertension for white men and women was 5.3% and 4.4%, respectively, for the age group 25–34 years, and 18% and 23%, respectively, for the age group 55–64 years (7). In other age groups the rates for men and women were almost equal. The interpretation of studies of the incidence of hypertension depends on the case definition used. The cut-off points in the present study were 160 mmHg (21.3 kPa) and 90 mmHg (12.0 kPa) for systolic and diastolic blood pressure, respectively. Apart from treated individuals, the study included people with isolated systolic hypertension.

The present study had the following limitations: a high proportion of patients with hypertension were not available for re-evaluation; poor responses to questions about causes of death were often given by family members; and many death certificates were inadequate. However, the major limitation of the initial epidemiological study was that the diagnosis of hypertension was based on the measurement of blood pressure during a single visit. Some patients placed in the mild category might have exhibited normal blood pressure on repeated measurements (8). However, such patients could still be placed in the potentially high-risk category for developing hypertension. Kannel & Dawber have proposed that in adults of any age and either sex, even modest elevation of blood pressure — systolic or diastolic, casual or basal — are associated with a substantial increase in the risk of coronary heart disease (4).

Conclusions

The present study shows that there is a need to organize a community-based programme for identifying individuals with hypertension, bringing them into medical facilities for further evaluation, and maintaining a high proportion of them in a long-term control programme. Family physicians have a vital role to play in this respect since the majority of cases of hypertension are treated by them. Health education through the mass media should be designed to warn people about this common public health problem, and to persuade them to have their blood pressure regularly monitored, to seek treatment if required, and to ensure the continuity of such treatment. Hypertension is a chronic condition with serious complications, among which are coronary heart disease, stroke, and renal failure. Systematic man-

agement of hypertension therefore has great potential for reducing morbidity and mortality among large numbers of people with high blood pressure, including the large proportion with mild hypertension.

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Résumé

Hypertension: étude de suivi au bout de 3 ans à Delhi

Une étude de suivi a été menée à Delhi 3 ans après une étude épidémiologique sur l'hypertension, basée dans la communauté, effectuée selon une méthode d'enquête de porte-en-porte randomisée. Les sujets atteints d'hypertension et les adultes normotendus identifiés lors de la première étude ont été réévalués. Sur les 1749 hypertendus identifiés lors de la première enquête, 1115 ont pu être réexaminés et 74 étaient décédés. On a analysé la sévérité de l'hypertension et le traitement de ces 1115 patients. La proportion de cas dont la tension artérielle était bien contrôlée est passée de 10,8% dans la première enquête à 60,8% dans l'étude de suivi. Sur les 732 cas d'hypertension légère relevés dans la première étude, 460 se sont avérés normotendus lors du suivi, 231 ont montré une hypertension légère, 34 une hypertension modérée et 7 une hypertension sévère. Au total, 58 sujets présentaient une hypertension sévère lors de la première étude; lors de l'examen de suivi, 21 d'entre eux ont montré une tension artérielle contrôlée, 20 une hypertension légère, 8 une hypertension modérée et 9 une hypertension sévère, alors que la proportion des hypertendus non traités et non contrôlés est passée de 54,2% à 14,5%. Sur les 74 décès enregistrés, 24 ont été dus à des crises cardiaques, 7 à des accidents cérébrovasculaires et 4 à une insuffisance rénale; les causes de décès des cas restants sont mal connues.

Lors du réexamen des 1115 hypertendus de l'étude initiale, 71 (6,4%) ont montré des antécédents d'angine de poitrine, 16 (1,4%) des antécédents d'infarctus du myocarde et 13 (1,2%) des antécédents d'accident cérébrovasculaire. Sur les 237 sujets hypertendus et qui présentaient des anomalies de l'électrocardiogramme (ECG) (modi-

fications du segment ST-T, hypertrophie ventriculaire gauche et hypertrophie ventriculaire gauche accompagnée de modifications ischémiques) lors de l'enquête initiale, 149 ont été réévalués; 16 d'entre eux présentaient les manifestations cliniques d'un infarctus du myocarde et 71 celles d'une angine de poitrine.

Sur les 3611 sujets normotendus de l'enquête initiale, 132 se sont avérés hypertendus au bout de 3 ans. L'incidence annuelle de l'hypertension a été la même chez l'homme que chez la femme (12,2 pour 1000). Parmi les facteurs de risque de l'hypertension, le diabète et la consommation régulière d'alcool tiennent une place importante et sont présents dans 9,8% des nouveaux cas pour le premier et 5,3% des nouveaux cas pour la seconde. La proportion de sujets obèses dans le groupe des hypertendus et le groupe témoin était de 24,2% et 22%, respectivement.

On a fait des électrocardiogrammes chez 871 des 1115 hypertendus de l'étude initiale. Les tracés ont été anormaux chez 307 d'entre eux (35,2%): 24 (2,7%) avaient eu un infarctus du myocarde, 133 (15,3%) avaient présenté des modifications ischémiques du segment ST-T, 54 (6,2%) une hypertrophie ventriculaire gauche et 96 (11,0%) des troubles de la conduction et des arythmies.

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