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ORIGINAL ARTICLE

Prevalence, awareness, treatment, control and risk factors for hypertension in a rural population in South India

Prabhdeep Kaur · Sudha Ramachandra Rao · Ezhil Radhakrishnan · Daniel Rajasekar · Mohan D. Gupte

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Abstract
Objectives Hypertension is a major public health problem with prevalence ranging 22–30% in urban India. There are few data on hypertension epidemiology in rural India. We conducted a survey to estimate prevalence, awareness, treatment, control and risk factors for hypertension in a rural population in south India.
Methods We did cross-sectional survey in 11 villages in Tamil Nadu. We collected data on behavioral risk factors, anthropometric and blood pressure measurements. We defined hypertension according to WHO criteria.
Results Study population included 10,463 subjects aged 25–64 years. Among them, 4,900 (46.8%) were males. Hypertension was present for 2,247 (21.4%) subjects and 1,682 (74.9%) among hypertensives were newly detected. Overall 20% were on treatment and 6.6% had blood pressure control. Age ≥35 years, BMI ≥ 23 kg/m^2 and central obesity were risk factors significantly associated with hypertension ($p < 0.05$). In addition, alcohol consumption, higher education level were risk factor among males and family history of hypertension was risk factor among females ($p < 0.05$).
Conclusion Hypertension is an emerging challenge in rural India. We need health promotion programs and reorientation of primary health care to improve hypertension detection and management.

P. Kaur (✉) · S. R. Rao · E. Radhakrishnan · D. Rajasekar · M. D. Gupte
National Institute of Epidemiology (Indian Council of Medical Research), # R-127, 3rd Avenue, Tamil Nadu Housing Board, Ayapakkam, Chennai, India
e-mail: kprabhdeep@gmail.com

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Introduction

Hypertension globally affects one in four individuals (Kearney et al. 2005). Hypertension leads to development of cardiovascular and cerebrovascular disease and accounts for two-thirds of all strokes and one half of all ischaemic heart disease (Perkovic et al. 2007). Burden of hypertension is a challenge not only for high income countries but also for countries like China and India where the total number of persons with hypertension are expected to increase more than 500 million by 2,025 (Perkovic et al. 2007).

Prevalence of hypertension in urban India ranged from 22 to 30% based on studies conducted in subpopulations (Reddy et al. 2006; Prabhakaran et al. 2005; Mohan et al. 2007; Kaur et al. 2007; Gupta et al. 1995). There are urban rural differences in prevalence of hypertension with prevalence being higher in urban areas (Thankappan et al. 2010; Kumar et al. 2006). A meta-analysis of studies from rural India done between 1995 and 2002 showed prevalence of 15.7% (Indian Council of Medical Research 2004). But prevalence has increased to nearly 20% in more recent surveys from various rural subpopulations (Agarwal et al. 2006; Chow et al. 2007; Krishnan et al. 2008; National Nutrition Monitoring Bureau 2006). Increasing prevalence of hypertension is consistent with change in mortality pattern in the recent years with shift towards non-communicable diseases in better developed states in India (Indian Council of Medical research 2009).

Tamil Nadu is one of the southern states in India with population of 62 million and 44% population living in urban areas (Directorate of Census Operation 2001).

Diseases of circulatory system accounted for 24.4% of the deaths in rural Tamil Nadu in 45–59 year age group in a recent verbal autopsy study (Indian Council of medical research 2009). Studies from urban Tamil Nadu showed high burden of non-communicable diseases such as hypertension and various non-communicable disease risk factors (Mohan et al. 2007; Kaur et al. 2007). There were few data on prevalence of hypertension in rural Tamil Nadu (National Nutrition Monitoring Bureau 2006). However comprehensive information regarding awareness, treatment and control rates was required for establishing baseline for various proposed interventions for hypertension (Ministry of Health and Family Welfare 2008; Department of Health and Family Welfare 2008). Our objective was to estimate prevalence, awareness, treatment, control and risk factors for hypertension in a rural population in a southern state, Tamil Nadu.

Methods

Study design, setting and participants

We conducted a cross-sectional survey in eleven villages in districts Kancheepuram and Thiruvallur (Tamil Nadu state). These villages are approximately 50 km west of Chennai city, fourth largest metropolitan city in India. In the study villages, all adults aged 25–64 years were considered eligible for the study.

Sample size

This was a baseline survey to establish surveillance and study trends in hypertension prevalence, awareness, and treatment and control trends in the field practice area of our institution. Therefore, we used WHO recommendation for surveillance of non-communicable disease risk factors. According to the recommendations, minimum sample size was 250 subjects in each 10 year age and sex group (25–34, 35–44, 45–54, 55–64 years) (Bonita et al. 2001). We further increased the sample size taking into account attrition of the cohort over period of time.

Questionnaire for demographic and behavioral risk factors

We used questionnaire to collect data on demographic and behavioral risk factors. Questionnaire included socio-demographic data (age, gender, education, occupation, and income), personal medical history of hypertension and family history of hypertension. Tobacco and alcohol questionnaire included self-reported duration and frequency of tobacco and alcohol consumption.

Anthropometric and blood pressure measurements

Weight was measured in the upright position to the nearest 0.1 kg using calibrated weighing scale. Height was measured without shoes to the nearest 0.1 cm using calibrated stadiometer. Body mass index (BMI) was calculated by dividing observed weight by height squared (kg/m^2). Waist circumference (WC) was measured to the nearest 0.1 cm at the narrowest point between lower end of the rib cage and iliac crest. Blood pressure was measured from the right arm after the subject had been sitting for at least 5 min using electronic automatic blood pressure apparatus (Omron MX3). The average of the two readings taken 5 min apart was recorded.

Definitions

Socio-economic factors

Education level was defined in the categories namely not attended school, 5 years of schooling, 8 years of schooling, 12 years of schooling and college level education. Per capita annual income was computed as total annual income divided by family size. Occupation was divided in categories namely home maker, manual labor, artisan, private sector employee, self employed, government sector employee, retired and others.

Smoker

Smoker was defined as a person who had smoked at least 100 cigarettes over their lifetime. In addition, current smoker was defined as a person who continued to smoke at the time of survey daily or occasionally and ex-smoker was defined as a person who had quit smoking (Schoenborn et al. 2003).

Alcohol consumption

Current consumer was defined as a person who has consumed alcohol in the past 12 months. Past consumer was defined as a person who consumed alcohol previously, but did not consume alcohol in past 12 months. Alcohol consumption was stratified as less than once a week and at least once a week among current consumers.

Body mass index (BMI) classification

Subjects were classified using classification recommended for Asians for BMI. Categories according to the classification were <18.5 kg/m^2 as below normal, 18.5–22.99 kg/m^2 as normal, 23.0–27.4 kg/m^2 as increased risk and ≥ 27.5 kg/m^2 as high risk (WHO expert consultation 2004).

Central obesity was defined as either WC $\geq$ 90 cm for men or WC $\geq$ 80 cm for women (WHO/IASO/IOTF 2000).

Hypertension

Hypertension was defined as systolic blood pressure (SBP) $\geq$140 mmHg or diastolic blood pressure (DBP) $\geq$90 mmHg according to the WHO criteria or history of previously diagnosed disease. Grades of hypertension were defined as follows: Grade I: SBP 140–159 or DBP 90–99; Grade II: SBP 160–179 or DBP 100–109; Grade III: SBP $\geq$ 180 or DBP $\geq$ 110 (Whitworth 2003). Awareness was defined as history of hypertension based on diagnosis by doctor or treatment with antihypertensive drugs. Treatment was defined as intake of antihypertensive drugs in the month prior to the survey. Control was defined as blood pressure <140 and <90 mmHg at the time of survey.

Ethical standards

The study was carried out according to the recommended ethical standards in the country. We obtained free and informed consent for the study. We referred patients with newly detected hypertension to the closest primary health center for further management.

Statistical methods

We evaluated linear trend in various age groups for newly detected hypertension, awareness, treatment and control by trend chi square. We analyzed risk factors for newly detected hypertension separately for males and females. We did univariate analysis and computed unadjusted odds ratio. We used logistic regression method and adjusted each of the risk factors for age in separate models. We computed adjusted odds ratios with 95% confidence intervals. All analyses were two tailed and $p < 0.05$ was considered significant. SPSS version 13.0 was used for data analysis.

Results

The survey was conducted in eleven villages from March 2005 to 2007. We enumerated these villages and covered 5,919 households with the total population of 25,513. Among them, 11,504 (45%) were in 25–64 years of age. Of these, data are available for 10,463 (91%) subjects. The reasons for exclusion were absence after three visits [960 (92.2%)], lack of availability of data on blood pressure [37 (3.6%)], pregnancy [18 (1.7%)], refusal [16 (1.5%)] and physically handicapped [10 (1.0%)].

Among the 5,919 households included in the survey, 1,863 (31.5%) households lived in Kutcha (house made with mud) house. Family size was less than five for 3,350 (56.6%) households. We collected data for 10,463 subjects of which 4,900 (46.8%) were males. The age distribution showed 3,746 (35.8%) were 25–34 years, 3,180 (30.4%) were 35–44 years and the rest were above 45 years. 614 (12.5%) males and 1,845 (33.2%) females had never attended school. Only 288 (5.9%) males and 90 (1.6%) females had college level education. Marital status of males showed 4,446 (90.7%) were married and 56 (1.1%) were widowed. On the other hand, 4,460 (80.2%) females were married and 974 (17.5%) were widowed. The median per capita annual income was 160 $ (Interquartile range: 113–237 $). Prevalence of behavioral risk factors and overweight in the study population has been reported elsewhere (Kaur et al. 2011).

Hypertension was present for 2,247 (21.5%) subjects nearly equal among males [1,062 (21.7%)] and females [1,185 (21.3%)]. Among those with hypertension, 1,682 (74.9%) were newly detected. Proportion of subjects with newly detected hypertension was significantly higher among males as compared to females (80.5 vs. 69.8%, $p < 0.01$). Proportion of newly detected hypertension decreased with age and awareness about the hypertension status increased with age for both males and females ($p < 0.05$). Overall only 20% of the patients were on treatment. Treatment rates were higher among females as compared to males (24.9 vs. 15.3%, $p < 0.05$). There was increase in treatment rates among males and females with age ($p < 0.05$). Overall control rate was 6.6% and control among those aware was 26.4% and among those on treatment was 32.6%. Control rates were low among both males and females in all age groups (Table 1).

We analyzed distribution of newly detected patients with hypertension in various grades/categories of hypertension. Using WHO classification for grades of hypertension, 1,194 (71%), 342 (20.3%) and 146 (8.7%) had grade I, II and III hypertension respectively. Grade I hypertension was higher in 25–44 year age group and grade II, III hypertension was higher in 45–64 year age group. Distribution of grades of hypertension was similar in males and females. Overall, 481 (28.6%) had isolated systolic hypertension and 524 (31%) had isolated diastolic hypertension. Proportion of patients with isolated systolic hypertension increased with age and the reverse trend was observed for isolated diastolic hypertension with age (Table 2).

We analyzed risk factors for hypertension after excluding patients who were already aware of hypertension status. The reason for exclusion was the fact that drug treatment or life-style modification might change the risk factors in favorable direction. We included 4,693 (95.7%) males and 5,205 (93.6%) females in the analysis.

Table 1 Proportion of patients newly detected with hypertension, awareness of hypertension, treatment and control among all patients with hypertension in a rural population in Tamil Nadu, India, 2005–2007 ($N = 2,247$)

	N	Newly detected*		Awareness†		Treatment‡		Control§	
		n	%	*n*	%	*n*	%	*n*	%
Age (years)									
25–34	355	308	86.8	47	13.2	26	7.3	12	3.4
35–44	593	459	77.4	134	22.6	104	17.5	53	8.9
45–54	670	488	72.8	182	27.2	148	22.1	42	6.3
55–64	629	427	67.9	202	32.1	179	28.5	42	6.7
Overall	2,247	1,682	74.9	565	25.1	457	20.3	149	6.6
Males									
25–34	214	197	92.1	17	7.9	12	5.6	5	2.3
35–44	308	248	80.5	60	19.5	44	14.3	23	7.5
45–54	318	247	77.7	71	22.3	54	17.0	16	5.0
55–64	222	163	73.4	59	26.6	52	23.4	21	9.5
Overall	1,062	855	80.5	207	19.5	162	15.3	65	6.1
Females									
25–34	141	111	78.7	30	21.3	14	9.9	7	5.0
35–44	285	211	74.0	74	26	60	21.1	30	10.5
45–54	352	241	68.5	111	31.5	94	26.7	26	7.4
55–64	407	264	64.9	143	35.1	127	31.2	21	5.2
Overall	1,185	827	69.8	358	30.2	295	24.9	84	7.1

* *P* value (trend chi square) <0.01 overall and separately for males and females

† *P* value (trend chi square) <0.01 overall and separately for males and females

‡ *P* value (trend chi square) <0.01 overall and for females

§ *P* value (trend chi square) <0.01 overall and for females

Age ≥35 years, retired or government employee, being widower, alcohol consumption, BMI ≥ 23 kg/m^2 and central obesity were significantly associated with hypertension in the univariate analysis among males. We identified age as confounder in the stratified analysis. We adjusted each of the risk factors for age in separate models. All risk factors except being widower and retired remained significant after adjusting for age. In addition, education above primary level was also significant. There was increase in odds ratio (OR) with increase in frequency of alcohol intake (Table 3).

Age ≥35 years, being widow, lack of school education, family history of hypertension, smokeless tobacco use, BMI ≥ 23 kg/m^2 and central obesity were significantly associated with hypertension in the univariate analysis among females. We identified age as confounder in the stratified analysis. Smokeless tobacco use, being widow and lack of school education were not significant after adjusting for age and all other risk factors were significant (Table 4).

Discussion

We observed high prevalence of hypertension along with low awareness, treatment and control rates in a rural population in South India. This study indicated hypertension is an emerging public health problem in rural population in a better developed state Tamil Nadu. This information can be used as baseline for two chronic disease programs that have been recently initiated in the state (Ministry of Health and Family welfare 2008; Department of Health and Family Welfare 2008).

High prevalence and low awareness of hypertension in our study was comparable to recent studies done in rural population in Tamil Nadu as well as in other states such as Maharashtra (18.5%) and Andhra Pradesh (20%) (Agarwal et al. 2006; Chow et al. 2007; Krishnan et al. 2008; National Nutrition Monitoring Bureau 2006; Hypertension Study Group 2001). Our findings were also consistent with

Table 2 Proportion of newly detected patients with hypertension in various blood pressure categories in a rural population in Tamil Nadu, India, 2005–2007 ($N = 1,682$)

	N	Grades of hypertension						Isolated systolic hypertension		Isolated diastolic hypertension		Both systolic and diastolic hypertension	
		Grade I		Grade II		Grade III							
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Sex													
Male	855	616	72.0	173	20.2	66	7.7	204	23.9	287	33.5	364	42.6
Female	827	578	69.9	169	20.4	80	9.7	277	33.5	237	28.6	313	37.8
Age group (years)													
25–34	308	250	81.2	49	15.9	9	2.9	45	14.6	168	54.5	95	30.8
35–44	459	353	76.9	76	16.5	30	6.5	61	13.3	207	45.1	191	41.6
45–54	488	325	66.6	123	25.2	40	8.2	150	30.7	112	22.9	226	46.3
55–64	427	266	62.3	94	22.0	67	15.7	225	52.7	37	8.6	165	38.6
Overall	1,682	1,194	71.0	342	20.3	146	8.7	481	28.6	524	31.1	677	40.2

Table 3 Risk factors associated with newly detected hypertension among males in a rural population in Tamil Nadu, India, 2005–2007 ($n = 4{,}693$)

	Proportion with hypertension (%)	Unadjusted odds ratio	Age adjusted odds ratio	95% Confidence intervals	
				LL	UL
Age (years)					
<35	11.2	1.00			
35–44	17.3	1.66			
45–54	25.4	2.70			
55–64	31.1	3.59			
Marital status					
Married/ unmarried/ separated	18	1.00			
Widower	41.2	3.20	1.88	1.05	3.35
Education					
Not attended school	17.9	1			
5 years of schooling	18.3	1.03	1.16	0.89	1.51
8 years of schooling	18.1	1.01	1.45	1.11	1.92
12 years of schooling and above	18.4	1.03	1.79	1.39	2.33
Occupation					
Manual labor	17	1.00			
Artisan	17.7	1.05	1.43	0.96	2.14
Private employee	29.5	2.04	1.86	1.32	2.62
Self employed	16.5	0.96	1.48	1.21	1.81
Other employment	20.3	1.24	1.47	1.15	1.87
Govt. employee	20.3	1.24	1.52	1.02	2.27
Retired	39	3.11	1.56	0.90	2.70
Family history hypertension					
No	18	1.00			
Yes	19.8	1.12	1.35	1.07	1.70
Smoking					
Non-smoker	16.9	1.00			
Passive smoker	19.1	1.16	0.82	0.62	1.08
Current smoker	19.9	1.22	0.91	0.77	1.07
Alcohol consumption					
Non-consumer	14.7	1.00			
≤ once a week	15.8	1.10	1.18	0.98	1.44
At least once a week	25.4	1.98	1.96	1.63	2.35
Body mass index (kg/m^2)					
<23.0	13.2	1.00			
23.00–27.49	26.9	2.43	2.95	2.48	3.50
≥27.50	39	4.21	5.14	3.89	6.80
Central obesity (cm)					
Waist circumference <90.0	14.7	1.00			
Waist circumference ≥90.0	36.1	3.29	3.34	2.80	3.98

studies conducted in rural populations in other developing countries (Mohamed et al. 2000; Dong et al. 2008; Richard et al. 2000). One of the key findings was very low awareness in certain sub groups such as males and younger age group. This could be due to low perception of disease risk among young individuals and therefore lack of periodic blood pressure measurement. Another reason could be poor utilization of existing facilities by males and young working females. Outpatient services in the primary care centers are mostly offered before noon in this setting reducing the accessibility for these groups. Access to community-oriented primary care is associated with increased likelihood of detection, treatment and control in other settings (O'Connor et al. 1990). Chronic disease programs in the state need to evolve innovative strategies to improve detection, treatment and follow up in the population with special focus on these groups.

We observed a large proportion of those who were aware of their hypertension status took treatment, but only one-third of those on treatment achieved control. Poor control was possibly be due to the combination of patient factors such as poor compliance, inability to visit the facility regularly for follow up and physician factors such as inadequate training in treating hypertension leading to inadequate dose titration. There are existing models of chronic disease management in rural settings where control of hypertension has been achieved using combination of interventions at the village level (Mani 2006; Coleman et al. 1998). These models can be scaled up for improving the hypertension control rates.

Alcohol emerged as an important risk factor for hypertension among males consistent with observations made in other cross-sectional studies (MacMohan 1987; Marmot et al. 1994). This risk factor may assume more importance in rural Indian context where there is rising trend of alcohol use among males in several states including Tamil Nadu (Isaac 1998). Lower educational level and poor socio-economic strata can further increase the vulnerability to

Table 4 Risk factors associated with newly detected hypertension among females in a rural population in Tamil Nadu, India, 2005–2007 ($n = 5,205$)

	Proportion with hypertension (%)	Unadjusted odds ratio	Age adjusted odds ratio	95% confidence intervals	
				LL	UL
Age (years)					
<35	5.7	1.00			
35–44	13.1	2.48			
45–54	23.8	5.13			
55–64	41.1	11.49			
Marital status					
Married/unmarried/separated	13.1	1.00			
Widow	30	2.85	1.18	0.97	1.43
Education					
Not attended school	20.9	1			
5 years of schooling	13.9	0.61	0.98	0.82	1.2
8 years of schooling	14	0.62	1.38	1.08	1.8
12 years of schooling and above	11.8	0.51	1.37	1.05	1.8
Occupation					
Home maker	17.3	1.00			
Manual labour	14.3	0.80	0.73	0.60	0.88
Other occupational categories	13.7	0.76	0.90	0.72	1.12
Family history hypertension					
No	15.5	1.00			
Yes	18.8	1.26	1.58	1.24	2.02
Smokeless tobacco use					
No	14.6	1.00			
Yes	23.5	1.80	0.92	0.75	1.13
Body mass index (kg/m^2)					
<23.0	11.9	1.00			
23.00–27.49	21.6	2.05	2.32	1.94	2.78
≥27.50	26	2.60	3.25	2.57	4.11
Central obesity (cm)					
Waist circumference <80.0	12.8	1.00			
Waist circumference ≥80.0	26.9	2.51	2.51	2.12	2.98

alcohol related harm (Blas and Kurup 2010). Public health policy interventions for alcohol are difficult to implement due to dependency of the governments on revenue from alcohol in many developing countries including India. This is also true for Tamil Nadu where government is the sole distributor of alcohol and had significant revenue from alcohol for the past few years (Tamil Nadu State Marketing Corporation Ltd. 2010). Under these circumstances, community mobilization and enhancing access to rehabilitation services are some of the other possible interventions that may be initiated in our setting. Hypertension screening programs need to focus on this high risk group to increase treatment and control rates and in addition, regular counseling may be required to reduce or stop the alcohol use. In addition to alcohol, higher education was also risk factor among males. Higher education is a proxy for better socio-economic status that may lead to changes in the diet and physical activity levels leading to higher risk of various non-communicable diseases such as hypertension. We need further research to understand the role of these factors in context of hypertension in this population.

We observed risk of hypertension with central obesity and above lower BMI cut off of 23 kg/m^2. Positive association between BMI and blood pressure has been documented in Caucasians and Asian population (Stamler et al. 1978). Studies from Singapore showed Asians have multiple cardiovascular risk factors including hypertension at low BMI (Deurenberg-Yap et al. 1999). Consistency of our findings with observations from other Asian populations strengthens the evidence for lower cut offs for BMI even for rural populations. Community based weight reduction programs need to be developed to address this

problem. There are few examples of such programs in rural settings (Parker et al. 2010). Overweight may culturally be considered as a sign of wealth and prosperity in rural settings making the interventions less acceptable to the people. We need to develop qualitative research studies to understand attitudes, perceptions of obesity and preferences for weight loss interventions for designing culturally appropriate programs.

The strength of our study was that study was conducted in a large sample of rural population with high response rate. However, limitation of our study was purposive sample of rural population 40–50 km from city that may not be representative of general rural population.

Hypertension is an emerging public health challenge in rural India. Low awareness and poor control will translate into high cardiovascular disease morbidity and mortality in the rural population if appropriate interventions are not initiated. We need comprehensive health promotion programs to encourage life-style modification and reorientation of primary health care system to improve availability and accessibility to hypertension screening and treatment.

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Conflict of interest The authors declare there is no conflict of interest.

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