

Prevalence of Hypertension in India: A Review

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Abstract: Worldwide, hypertension is a silent risk factor for cardiovascular morbidity and mortality. In the present article, an attempt has been made to review the prevalence of hypertension in various urban and rural populations of India. 88 cross-sectional studies which defined hypertension as an average blood pressure $\geq 140/90$ mm Hg have been reviewed with sample size varied from 200–1,67,331 subjects. It is apparent from the literature that there are no nationwide studies to determine the prevalence of hypertension but small sporadic studies from the different regions of India provided data which has shown wide variation in the prevalence of hypertension. The present review has highlighted high prevalence of hypertension in India. An increasing trend in the prevalence of hypertension overtime was observed within different regions of India and in both sexes. The prevalence of hypertension is higher in urban populations of India compared to rural populations but the prevalence of hypertension in rural populations is steadily increasing and approaching to the trends as in urban populations. The proportion of hypertensive subjects in urban and rural populations in some regions was about 50% which is a challenge to the Indian health system. Therefore, accurate estimates of prevalence of hypertension are necessary which can help in shaping the preventive programmes and management strategies for the hypertension in both urban and rural populations.

Key words Blood pressure, cross-sectional studies, hypertension, India, prevalence, rural population, urban population

Introduction

Hypertension is a silent and invisible killer that rarely causes symptoms but is an important public health challenge because of its high prevalence and concomitant risk of coronary artery diseases, heart failure, cerebrovascular diseases and chronic renal failure (Devi, *et al.*, 2013; Krishnan, *et al.*, 2013; Mohan, *et al.*, 2013; El-Din, *et al.*, 2012; D'Agonisto, *et al.*, 2008; Kearney, *et al.*, 2005; Chobanian, *et al.*, 2003). In the year 2010, worldwide it has been identified as the leading risk factor for death and disability and accounted for 9.4 million deaths and 7% of disability life adjusted years (Lim, *et al.* 2013). In India, hypertension is directly responsible for 57% of all stroke deaths, 24% of all coronary heart disease deaths and 10% of all deaths (Patel, *et al.*, 2011). It was also anticipated by Reddy, *et al.* (2005) that the number of hypertensive individuals will double from 118 million in 2000 to 213 million in India by 2025.

No nationwide studies to determine the prevalence and absolute burden of hypertension have been done in India. However, various small studies from different parts of the country carried out on the diverse populations have provided information about the epidemiology of hypertension. First epidemiological study to determine blood pressure pattern in India was

performed by Chopra and Chopra (1942) and they observed that people of North India (Punjab, Uttar Pradesh and Delhi) have higher systolic blood pressure (SBP) and diastolic blood pressure (DBP) than the people of South India (Madras) and East India (Bengal, Bihar and Orissa). Few other subsequent studies conducted by Dotto, B.B. (1949), Dubey, V.D. (1954) and Padmawati, *et al.*, (1958) also concentrated on measuring blood pressure and used ill-defined methodology and criteria for the assessment of hypertension and reported the prevalence of hypertension as 1.24%, 4.24% and 1.99% in Calcutta, Kanpur and Delhi, respectively. After the publication of WHO (1959) guidelines on proper measurement technique of blood pressure and the criteria for detection of hypertension, the uniformity was achieved. According to these guidelines, hypertension is defined as SBP ≥ 160 mm Hg and/or DBP ≥ 95 mm Hg. Using this criteria of hypertension, 24 studies were available from published literature from urban and rural populations of India and details of these studies were summarized in Table-1. It is evident from this table that the prevalence of hypertension varied among different regions of India ranging from 3.03% - 18.85% in urban populations and 0.36% - 7.89% in rural populations. The maximum prevalence (18.85%) of hypertension was reported by Beegom, *et al.* (1995) in the urban population of Trivandrum (Kerala) whereas the lowest

prevalence (0.36%) was reported by Verma and Srivastava (1983) in the rural population of Uttar Pradesh. It is noticeable from all these studies that there has been a significant increase in the prevalence of hypertension in both urban and rural populations over the time. Later on, various investigators observed that blood pressure lower than the above mentioned criteria of hypertension was also important in the genesis of cardiovascular diseases. Stamler, *et al.* (1993) analyzed US studies of correlation of blood pressure with cardiovascular risks and showed that both SBP and DBP have a continuous, graded, strong, independent and etiologically significant relationship with cardiovascular morbidity and all cause mortality. Then, another criteria for the diagnosis of hypertension was suggested by fourth US Joint

National Committee (JNC IV, 1988). According to this, hypertension is diagnosed when SBP ≥ 140 mmHg and/or DBP ≥ 90 mm Hg or any level of blood pressure in patients taking anti-hypertensive medication. The fifth and sixth US Joint National Committees and the WHO-ISH (1999) have also adopted these guidelines. In the year 2003, the normal and borderline stages in the JNC VI (1997) were replaced in the JNC VII (2003) report by a prehypertensive stage for describing people with a SBP of 120-139 mm Hg or a DBP of 80-89 mm Hg and the criteria for the detection of hypertension remained the same. According to these guidelines, heart risk begins at 115/75 mm Hg and double with each increment of 20 point mm Hg of SBP and 10 point mm Hg of DBP. Thus, people in the

Table 1. Prevalence of Hypertension in India according to WHO (1959) guidelines
(BP $\geq 160/95$ mm Hg)

Place	Investigator	Age Group	Sample Size			Hypertension Prevalence		
			Male	Female	Total	Male	Female	Total
URBAN								
Bombay	Sathe, (1959)	20-80	2362	1758	4120	2.03	4.38	3.03
Agra	Mathur, <i>et al.</i> (1963)	20-80	1408	226	1634	3.98	6.64	4.35
North and South India	Malhotra, (1971)	20-58	4232	-----	4232	9.24	-----	9.24
Rohtak	Gupta, <i>et al.</i> (1978)	20-69	1151	872	2023	5.90	6.99	6.43
Bombay	Dalal, (1980)	20-80	3148	2575	5723	15.63	15.38	15.52
Andhra Pradesh	Sambasiva Rao, (1981)	15-75	300	236	536	14.67	21.19	17.93
Delhi	Wasir, <i>et al.</i> (1984)	20-60	1767	688	2455	3.85	1.45	3.18
Ludhiana	Sharma, <i>et al.</i> (1985)	20-75	803	205	1008	15.44	8.78	14.08
Trivandrum	Beegom, <i>et al.</i> (1995)	25-64	737	760	1490	19.60	18.10	18.85
Jaipur	Gupta, <i>et al.</i> (1995)	20-80	1415	797	2212	10.32	12.17	10.99
Delhi	Chadha, <i>et al.</i> (1997)	25-64	616	1116	1732	4.10	3.30	3.7
Chandigarh	Thakur, <i>et al.</i> (1999)	≥ 30	-----	-----	1727	-----	13.10	13.17
RURAL								
Bombay	Shah and Kumjannam, (1959)	30-60	5996	-----	5996	0.52	-----	0.52
Haryana	Gupta, <i>et al.</i> (1977)	20-69	1184	891	2075	3.55	3.59	3.57
Delhi	Wasir, <i>et al.</i> (1983)	20-69	464	441	905	3.20	7.50	5.41
Uttar Pradesh	Verma and Srivastava (1983)	30-70	1523	1809	3332	0.20	0.49	0.36
Rajasthan	Baldwa, <i>et al.</i> (1984)	21-60	447	465	912	6.93	8.81	7.89
Punjab	Sharma, <i>et al.</i> (1985)	20-75	3340	-----	3340	2.63	-----	2.63

Haryana	Chadha, <i>et al.</i> (1989)	25-64	1214	2161	3375	2.90	2.80	2.85
Rajasthan	Kumar and Chaudhary (1991)	21-70	3742	3098	6840	4.01	3.62	3.83
Maharashtra	Joshi, <i>et al.</i> (1993)	16-60	227	221	448	4.85	3.17	4.02
Maharashtra	Jajoo, <i>et al.</i> (1993)	20-69	2247	1798	4045	2..89	4.00	3.41
Rajasthan	Gupta, <i>et al.</i> (1994)	20-80	1982	1166	3148	7.60	6.20	7.08
Varanasi	Goel and Kaur (1996)	≥ 30	790	782	1575	5.57	8.82	7.19

prehypertensive category also require health promoting lifestyle modifications to prevent heart diseases. They do not need medication but require lifestyle changes which include losing weight if they are overweight/obese, regular exercise, less intake of salt and saturated fat and getting rid of smoking. However, the term prehypertension includes a wide range of blood pressure from normal to high normal and it is felt by various scientists that the term prehypertension is likely to create anxiety in a large set of populations and they suggested dropping of this idea. Indian guidelines on hypertension (IGH-III, 2013) also do not recommend the use of term prehypertension in prevalence studies. Therefore, in the present review article, studies related with only hypertension were included.

The purpose of this review article was to assemble information about the prevalence of hypertension in different regions of India as accurate estimates of prevalence of hypertension are necessary to plan effective control measures.

Materials and Methods

A study protocol, search strategies and study eligibility criteria were prepared. A comprehensive literature search was conducted. The studies were identified using internet search "Pubmed" (US. National Library of Medicine, USA) and Research gate using the key words: prevalence, hypertension, blood pressure, cross-sectional and India. A manual search was also made using cross-references mentioned in the various research papers and contacted scientists for further information. The search was restricted to the cross-sectional studies published from the year 1994 to 2014. For the present review article, 133 epidemiological studies were identified of which 45 were excluded based on the inclusion criteria and 88 were considered for data extraction. The sample size of these studies ranged from 200–1,67,331 individuals. The eligibility criteria for inclusion in this review article were (i) hypertension was defined as an average BP

≥140/90 mm Hg, (ii) two/three blood pressure measurements in a single visit at least ten minutes apart were done on each subject using the auscultatory method with a mercury column sphygmomanometer in sitting position and the mean of two/three readings were used for analysis, (iii) population based cross-sectional studies in which the prevalence of hypertension was reported and (iv) studies conducted among adult Indians (≥ 18 years). On the other hand, 45 studies which did not satisfy the inclusion criteria were excluded like case-control studies, hospital based studies and cohort studies.

Results

The studies that reported prevalence rates of hypertension in various regions of India defined by JNC VII (2003) and IGH (2001) criteria is summarized in Table 2 and 3. For studying the prevalence rates of hypertension in India all the collected studies were categorised into five groups (Northern, Southern, Western, Eastern and Central Region) on the basis of regional background where the studies were conducted. Out of 88 cross-sectional studies, 21 from Northern Region, 25 from Southern Region, 28 from Western Region, 11 from Eastern Region and 3 from Central Region were included. The number of participants in all these studies ranged from 200 to 1,67,331.

It is apparent from the literature that till date two multicentric studies were conducted for the assessment of prevalence of hypertension in India. Gupta, *et al.* (2013) conducted a multicentric study during the period 2006-2010 in 11 cities from all regions of India on 6,106 subjects of urban middle class and reported the prevalence of hypertension as 33.40% in males and 39.10% in females. Joshi, *et al.* (2012) also conducted a large cross-sectional study on 15,662 subjects from 8 states of India (Maharashtra, Delhi, Tamil Nadu, West Bengal, Karnataka, Andhra Pradesh, Gujarat and Madhya Pradesh) and reported the prevalence of hypertension as 46.00% in the pooled sample. In this study the highest prevalence prevalence

Table 2. Prevalence of Hypertension in Urban population of India (BP \geq 140/90 mm Hg)

Place/ Area/ State	Age group	Sample size			Percentage Prevalence			Invest igator
		Male	Female	Total	Male	Female	Total	
NORTHERN REGION								
Slums of Delhi	\geq 20	170	362	532	11.80	11.60	12.00	Misra, <i>et al.</i> (2001)
Chandigarh	\geq 35	416	521	937	43.70	45.80	44.90	Ahlawat, <i>et al.</i> (2002)
Punjab	\geq 20	-----	-----	458	51.30	51.00	51.15	Gupta (2004)
Punjab	20-60	-----	2000	2000	-----	20.15	20.15	Sidhu, <i>et al.</i> (2005)
Delhi	20-59	2122	-----	2122	30.00	-----	30.00	Prabhakaran, <i>et al.</i> (2005)
Delhi	20-59	-----	-----	1213	-----	-----	27.50	Chathurvedi, <i>et al.</i> (2007)
Lucknow/ Uttar Pradesh	\geq 30	557	555	1112	42.90	34.20	38.60	Yadav, <i>et al.</i> (2008)
Lucknow/ Uttar Pradesh	\geq 20	-----	-----	400	-----	-----	32.80	Midha, <i>et al.</i> (2009)
Chandigarh and Haryana	\geq 30	-----	-----	400	37.00	34.00	35.50	Kar, <i>et al.</i> (2010)
Delhi	\geq 18	-----	-----	1980	-----	-----	48.20	Joshi, <i>et al.</i> (2012)
Amritsar/ Punjab	30-50	200	200	400	25.50	09.50	17.50	Kaur, <i>et al.</i> (2013)
Rishikesh// Uttaranchal	\geq 30	-----	-----	327	-----	-----	38.50	Bamrara and Mittal (2013)
Lucknow /Uttar Pradesh	\geq 18	306	1203	1509	42.48	44.97	44.46	Mahmood, <i>et al.</i> (2013)
NandNagri/S lum Area/Delhi	20-59	146	164	310	17.80	17.10	17.40	Panesar, <i>et al.</i> (2013)
SOUTHERN REGION								
Trivandrum/ Kerala	20-89	76	130	206	31.00	41.20	36.10	Joseph, <i>et al.</i> (2000)
Chennai/ Tamil Nadu	\geq 20	557	705	1262	23.90	19.90	22.10	Deepa, <i>et al.</i> (2003)
Chennai/ Tamil Nadu	\geq 20	557	705	1262	22.80	19.70	21.10	Shanthirani, <i>et al.</i> (2003)
Tirupati / Andhra Pradesh	20-60	500	500	1000	09.60	07.60	08.60	Reddy and Prabhu (2005)
Tirupati /Andhra Pradesh	\geq 20	539	980	1519	-----	-----	26.06	Latheef and Subramanyam (2006)
Chennai/ Tamil Nadu	\geq 20	1096	1254	2350	23.20	17.10	20.00	Mohan, <i>et al.</i> (2007)
Kerala	\geq 10	212	270	482	46.00	48.00	47.00	Vimala, <i>et al.</i> (2009)
Thiruvanantha puram/Kerala	15-64	1229	1246	2475	36.20	33.60	34.90	Thankappan, <i>et al.</i> (2010)
Trivandrum/ Kerala	35-90	-----	-----	167331	-----	-----	45.00	Sauvaget <i>et al.</i> (2010)
Andhra Pradesh	\geq 18	-----	-----	1895	-----	-----	49.40	Joshi, <i>et al.</i> (2012)

Tirupati/Andhra Pradesh	20-70	670	-----	670	05.41	-----	05.41	Naik, <i>et al.</i> (2012)
Tamil Nadu	≥18	-----	-----	1972	-----	-----	39.50	Joshi, <i>et al.</i> (2012)
Nellore /Andhra Pradesh	25-64	463	470	933	30.90	27.70	29.30	Prabakaran, <i>et al.</i> (2013)
Warangal/Andhra Pradesh	≥30	95	105	200	03.00	02.00	04.00	Kumar, <i>et al.</i> (2013)
WESTERN REGION								
Rajasthan	≥20	2887	2255	5142	06.10	07.30	06.70	Hussain, <i>et al.</i> (1988)
Jaipur/Rajasthan	20-80	1415	797	2212	29.47	33.50	30.92	Gupta, <i>et al.</i> (1995)
Mumbai	≥18	40067	59522	99589	43.80	44.50	44.15	Gupta and Gupta (1999)
Mumbai	≥30	1512	141	1653	26.78	27.65	26.90	Anand (2000)
Mumbai	≥35	767	665	1432	09.52	18.95	13.90	Gurav, <i>et al.</i> (2001)
Orissa	≥20	105	117	222	50.50	32.50	41.00	Banerji, <i>et al.</i> (2003)
Mumbai	≥20	1099	1316	2415	32.80	39.40	36.40	Bharucha and Kuruvilla (2003)
Bhatia community/ Jaipur/ Rajasthan	≥20	226	232	458	51.30	51.70	51.50	Gupta, <i>et al.</i> (2004)
Malda/ West Bengal	≥18	-----	-----	1609	-----	-----	24.90	Das, <i>et al.</i> (2005)
JHW-1(1993-1994)	≥20	1294	655		29.10	21.70	25.40	Gupta and Gupta (2009)
JHW-2(1999-2000)	≥20	469	486	M-4102	29.60	25.50	27.55	
JHW-3(2002-2003)	≥20	179	195	F-2872	42.50	35.20	38.85	
JHW-4(2004-2005)	≥20	413	433		45.10	38.20	41.65	
Mumbai	≥20	-----	-----	148178	47.30	45.70	46.50	Pednekar, <i>et al.</i> (2009)
Surat/ Gujarat	≥20	1177	316	1493	32.50	23.10	30.40	Mohammedirfan, <i>et al.</i> (2011)
Vadodara Godhra Gujarat	25-60 25-60	101 44	149 57	250 101	28.70 47.70	20.80 26.30	24.00 35.60	Iyer, <i>et al.</i> (2011)
Maharashtra	≥18	-----	-----	1842	-----	-----	56.40	Joshi, <i>et al.</i> (2012)
Gujarat	≥18	-----	-----	2161	-----	-----	45.30	Joshi, <i>et al.</i> (2012)
Surat/Gujarat	≥30	1441	1739	3180	33.20	33.40	33.30	Rujul, <i>et al.</i> (2012)
Jaipur/Rajasthan	≥18	502	698	1200	24.30	24.21	24.25	Kumar, <i>et al.</i> (2013)
EASTERN REGION								
West Bengal	≥20	444	428	872	16.70	23.10	19.80	Mandal, <i>et al.</i> (2010)
Orissa	20-80	-----	-----	1178	-----	-----	36.00	Prasad, <i>et al.</i> (2012)

West Bengal	≥18	-----	-----	1930	-----	-----	46.50	Joshi, <i>et al.</i> (2012)
Cuttack/ Orissa	30-74	135	165	300	24.40	26.00	25.30	Mishra, <i>et al.</i> (2013)
CENTRAL REGION								
Madhya Pradesh	≥18	-----	-----	1903	-----	-----	52.00	Joshi, <i>et al.</i> (2012)

of hypertension (56.40%) was observed in Maharashtra state of Western Region and the lowest prevalence (32.10%) in Karnataka state of Southern region.

Gupta and Gupta (2009) published a research paper on the hypertension prevalence in India: lessons from Jaipur Heart Watch (JHW). It is an ongoing cross-sectional epidemiological study from Western India. Successive studies have been performed in rural (JHW-R, 1992-93) and urban locations (JHW-1, 1993-1994; JHW-2, 1999-2000; JHW-3, 2002-03 and JHW-4, 2004-05) on adults above the age of 20 years. These studies reported a rising trend in the prevalence of hypertension as 29.10%, 29.60%, 42.50% and 45.10% in men and 21.70%, 25.50%, 35.20% and 38.20% in women. This clearly demonstrates that there was a low prevalence of hypertension in rural population and

high prevalence in urban populations of Jaipur. These prevalence rates were similar to those observed in recent studies conducted in various regions of India.

Table 2 and 3 show that the prevalence of hypertension in India varies considerably from one region to another region with rates as low as 4.50% in rural population of Haryana (Malhotra, *et al.* 1999) and as high as 56.40% in urban population of Maharashtra (Joshi, *et al.* 2012). In urban Indian studies, the maximum prevalence (56.40%) of hypertension was observed in the population of Maharashtra followed by population of Madhya Pradesh (52.00%), Rajasthan (51.50%), Punjab (51.15%), Kerala (49.40%), Delhi (48.20%) and West Bengal (46.50%) whereas the minimum prevalence (6.70%) of hypertension was reported

Table 3. Prevalence of Hypertension in Rural population of India (BP ≥140/90 mm Hg)

Place/ Area/ State	Age group	Sample size			Percentage Prevalence			Investigator
		Male	Female	Total	Male	Female	Total	
NORTHERN REGION								
Haryana	16-70	----	----	2559	03.00	05.80	4.50	Malhotra, <i>et al.</i> (1999)
Lucknow/ Uttar Pradesh	≥20	-----	-----	400	-----	-----	14.50	Midha, <i>et al.</i> (2009)
Jammu	≥30	1081	1135	2216	11.19	14.71	13.00	Raina and Jamwal (2009)
Himachal Pradesh	≥18	-----	-----	1092	39.80	33.20	35.90	Bhardwaj, <i>et al.</i> (2010)
Bareilly/Utt ar Pradesh	≥15	289	215	504	26.29	28.83	27.40	Esam and Hussain (2012)
Bihar	≥20	527	470	997	13.09	09.57	11.43	Ghosh, <i>et al.</i> (2013)
Hamirpur/H imachal Pradesh	≥20	1156	1593	2794	41.60	34.60	37.40	Bhardwaj, <i>et al.</i> (2014)
SOUTHERN REGION								
Kancheepur an/Tamil Nadu	≥30	357	393	750	22.60	27.40	25.20	Kannan and Satyamoorthy (2009)
Davangere/ Karnataka	≥18	-----	-----	1900	19.10	17.50	18.30	Yuvaraj, <i>et al.</i> (2010)

Thiruvananthapuram/Kerala	15-64	1186	1324	2510	34.40	30.80	32.50	Thankappan, <i>et al.</i> (2010)
Nicobarese Tribe/Nicobar Island	≥18	424	551	975	50.70	50.30	50.50	Manimunda, <i>et al.</i> (2011)
Andhra Pradesh	≥30	683	796	1479	-----	-----	11.40	Thrift, <i>et al.</i> (2011)
Nellore / Andhra Pradesh	28-56	120	380	500	12.00	10.40	22.40	Subramanian, <i>et al.</i> (2012)
Tamil Nadu	≥30	950	955	1905	19.60	18.50	19.10	Rajsekar, <i>et al.</i> (2012)
Bangalore/Karnataka	≥15	845	656	1501	09.60	06.09	08.06	Madhukumar, <i>et al.</i> (2012)
Kerala	≥20	1891	2302	4193	45.00	36.00	40.00	Meshram, <i>et al.</i> (2012)
Kerala	15-64	-----	-----	297	-----	-----	23.60	Sathish, <i>et al.</i> (2012)
Chittoor /Andhra Pradesh	20-70	139	147	286	5.70	4.08	4.89	Rao, <i>et al.</i> (2013)
WESTERN REGION								
Rajasthan	20-75	-----	-----	3148	24.00	17.00	21.00	Gupta, <i>et al.</i> (1994)
Rajasthan	20-75	1982	1166	-----	23.70	16.90	20.30	Gupta (1997)
Wardha/Maharashtra	≥18	1059	1641	2700	21.80	19.80	20.60	Deshmukh, <i>et al.</i> (2005)
Aurangabad / Maharashtra	≥19	641	656	1297	6.5	7.9	7.24	Todkar, <i>et al.</i> (2009)
Jaipur Heart Watch (1992-1993)	≥20	1700	1063	2763	21.60	15.70	18.65	Gupta and Gupta (2009)
Nomad Tribes/Rajasthan	≥18	-----	-----	1286	-----	-----	22.80	Sachdev (2011)
Chanai/Maharashtra	≥18	870	1326	2196	13.10	12.52	12.75	Vinay, <i>et al.</i> (2012)
Vadodara/Gujarat	≥21	156	104	260	19.20	22.10	20.40	Parekh, <i>et al.</i> (2012)
Nagpur/Maharashtra	≥15	1964	1807	3771	15.00	15.90	15.40	Bhardwaj, <i>et al.</i> (2012)
Jaipur/Rajasthan	≥18	492	708	1200	13.01	03.28	13.17	Kumar, <i>et al.</i> (2013)
Maharashtra	≥20	2089	2259	4348	27.70	19.30	23.00	Meshram, <i>et al.</i> (2014)
EASTERN REGION								
Assam	≥30	1441	1739	3180	33.20	33.40	33.30	Hazarika, <i>et al.</i> (2004)
Tribal Islands/Assam	25-65	179	153	332	27.90	22.90	25.60	Misra (2012)
Haridwar/Uttarakhand	≥30	-----	-----	500	10.00	12.00	11.00	Hasan, <i>et al.</i> (2012)
Uttarakhand	≥15	-----	-----	968	30.90	27.80	29.35	Bansal, <i>et al.</i> (2012)

Hoogly/ West Bengal	≥18	598	603	1201	25.50	26.30	25.90	Sadhukhan and Khan (2012)
Dehradun/ Uttarakhand	≥30	185	155	340	32.40	34.20	33.20	Pooja and Mittal (2013)
Hoogly/We st Bengal	15-64	414	316	730	22.00	21.80	21.90	Basu and Biswas (2013)
CENTRAL REGION								
Central India	≥30	-----	-----	4711	-----	-----	22.10	Jonas, <i>et al.</i> (2010)
Central India	≥30	445	479	924	14.40	23.40	19.04	Kokiwar and Gupta (2011)

from the population of Rajasthan followed by the population of Tirupati, Andhra Pradesh (8.60%), slums of Delhi (12.00%), Mumbai (13.90%), and West Bengal (19.80%). On the other hand, among rural populations of India, the maximum prevalence (50.50%) of hypertension was observed in the population of Nicobarese tribe in the Car Nicobar Island followed by the Kerala (40.00%), Hamirpur of Himachal Pradesh (37.40%), Assam (33.30%) and Central India (22.10%) whereas the minimum prevalence (4.50%) of hypertension was reported from the population of Haryana followed by population of Chittoor in Andhra Pradesh (4.89%), Aurangabad in Maharashtra (7.24%), Bangalore in Karnataka (8.06%), Rajasthan (13.17%) and Tamil Nadu (19.10%).

Among urban females of India, the prevalence rate of hypertension varied from 9.50% - 51.00% in Northern Region, 2.00% - 48.00% in Southern Region, 7.30% - 51.70% in Western Region and 23.10% - 26.00% in Eastern Region whereas among rural females of India, the prevalence rate of hypertension ranged from 5.80% - 34.60% in Northern Region, 4.80% - 50.30% in Southern Region, 3.28% - 22.10% in Western Region and 12.00% - 34.20% in Eastern Region. A similar trend was observed among urban males where the prevalence rate of hypertension varied from 11.80% - 51.30% in Northern Region, 5.41% - 46.00% in Southern Region, 6.10% - 50.50% in Western Region and 16.70% - 24.40% in Eastern Region whereas among the males of rural India, the prevalence rates of hypertension ranged from 3.00% - 41.60% in Northern Region, 5.70% - 50.70% in Southern Region, 6.5% - 27.70% in Western Region and 10.00% - 33.20% in Eastern Region. Overall, the maximum prevalence of hypertension was found to be 51.70% and 51.30% among urban females and males of Rajasthan, respectively (Gupta, *et al.* 2004) whereas the minimum prevalence of hypertension was found to be 3.28% among females of rural population of Jaipur (Kumar, *et al.* 2013) and 5.41% among males of urban population of Tirupati, Andhra Pradesh (Naik, *et al.* 2012).

Discussion

To our knowledge, this is the first large systematic review that has investigated the prevalence of hypertension in India. In this review, we selected and extracted data from 88 cross-sectional studies according to the specified criteria. All these studies were classified systematically in order to facilitate comparison of studies. Due to the extensive heterogeneity among studies, meta-analysis was not performed. The observations of the present review provide an insight into the magnitude of the burden of hypertension in India.

Our results indicated that there is wide range in the prevalence of hypertension in various populations of India. The pooled estimates (males and females) of prevalence of hypertension in India among urban adults yielded the highest prevalence (56.40%) in Maharashtra (Joshi, *et al.*, 2012) and the lowest (5.41%) in Tirupati, Andhra Pradesh (Naik, *et al.*, 2012). On the other hand, among rural adults, the highest prevalence (50.50%) of hypertension was reported in the population of Nicobar Island (Manimunda, *et al.*, 2011) and the lowest (4.50%) in the population of Haryana (Malhotra, *et al.*, 1999). These differences in the prevalence of hypertension in these studies might be due to the variation in socio-economic status, lifestyle, genetic make-up and biological diversity.

From the available studies, it is clear that in some regions of India hypertension is more prevalent among males than females (Bhardwaj, *et al.*, 2014; Meshram, *et al.*, 2014; Kaur, *et al.*, 2013; Mohmmedirfan, *et al.*, 2011; Gupta and Gupta, 2009; Yadav, *et al.* 2008; Banerji, *et al.*, 2003;). In other regions, reverse was also observed. (Parekh, *et al.*, 2012; Kokiwar and Gupta, 2011; Mandal, *et al.*, 2010; Gurav, *et al.*, 2001; Joseph, *et al.*, 2000) However, few studies showed no sex-specific differences (Panesar, *et al.*, 2013; Rujul, *et al.*, 2012; Manimunda, *et al.*, 2011; Gupta, *et al.*, 2004; Hazarika, *et al.*, 2004) This pattern of variation among males and females of hypertension is observed in both urban and rural populations. All studies reviewed in this article used the cross-

sectional study design and therefore susceptible to reverse causation bias. Advanced studies, utilizing analytic epidemiological designs such as prospective cohort, are needed to explore the prevalence of hypertension in depth.

It can be concluded from the present review article that the prevalence of hypertension in both sexes and in urban and rural populations is increasing at an alarming rate similar to that in developed countries or more than that (Kearney, *et al.*, 2005; Chobanian, *et al.*, 2003). If this increasing trend in the prevalence of hypertension would go with the same pace then after few years more than fifty percent population of India would be under the trap of cardiovascular diseases. The effective control and hypertension in India will require a centralized campaign with policy strategies applied at multiple levels. Thus, there is an urgent need to develop suitable strategies for prevention of hypertension in India.

Conclusion

In this large systematic review, an attempt has been made to report the prevalence of hypertension in

India. For the present review article, 88 cross-sectional studies were included in which sample size varied from 200 to 1,67,331 individuals. Higher prevalence rates of hypertension were observed in urban populations as compared to rural populations of various regions of India, but the prevalence of hypertension in rural populations is increasing to the trends as in urban populations. On studying sex-specific prevalence rates of hypertension among urban populations in most of the studies the prevalence was almost similar in both sexes except Eastern and Western regions where females have more prevalence of hypertension than males. On the other hand, in majority of the studies among rural populations the prevalence of hypertension was more in males than females. In some regions of India, proportion of hypertensive subjects in urban and rural populations was almost similar (50%). The current results suggest that the prevalence of hypertension in both sexes and in urban and rural populations of India is emerging as a major health problem which requires intervention.

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