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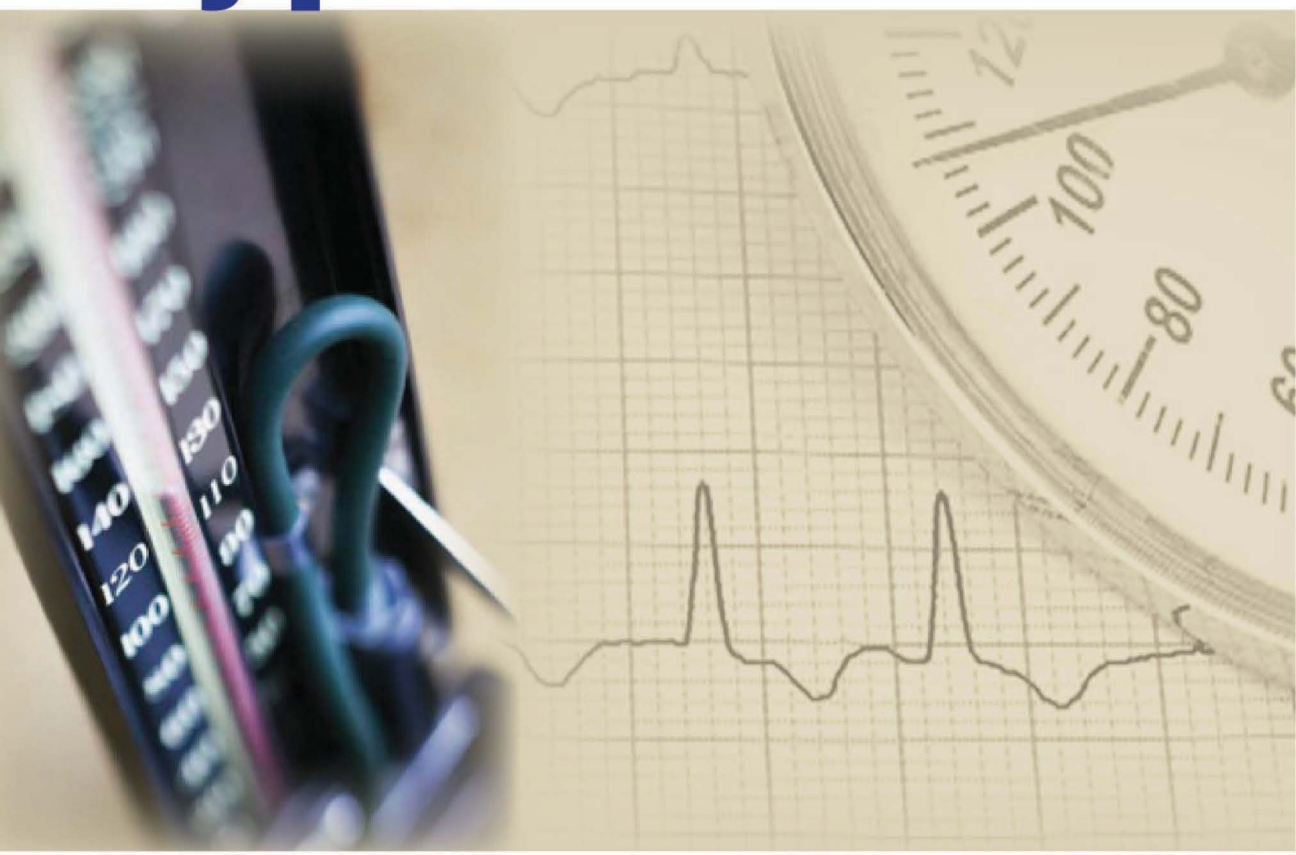
SECOND EDITION

Hypertension Society of India
Manual of Hypertension



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CHAPTER 3

Social Determinants of Hypertension Treatment and Control in India

Rajeev Gupta, Shreya Gupta

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INTRODUCTION

High blood pressure (BP) and hypertension is now the most important risk factor for global disease burden. The latest iteration of Global Burden of Diseases (GBD) study has reported that in 2017, high systolic BP was the leading risk factor accounting for 10.2 million [95% uncertainty intervals (UI) 9.2–11.3 million] deaths and 208 million (UI 188–227 million) disability-adjusted life years (DALYs). Overall, 8.6% (UI 7.7–9.6) of total DALYs were attributable to high systolic BP. Most of the burden attributable to high systolic BP was due to ischemic heart disease and stroke and high systolic BP accounted for 55% (UI 48–63%) and 56% (UI 49–63%) of DALYs due to ischemic heart disease and stroke, respectively.[1] In India also, it has emerged as the most important risk factor for deaths and disability.[2] According to hypertension-focused reports from the World Health Organization (WHO),[3] GBD study,[4] and Non-Communicable Disease Risk Factor Collaboration (NCDRiSC)[5] the prevalence of hypertension is increasing globally and currently more than 1 billion people have NCDRiSC study reported that number of adults with high BP increased from 594 million in 1975 to 1·13 billion in 2015 and the increase was mostly in low-income and middle-income countries.[5]

BURDEN OF HYPERTENSION IN INDIA

Gupta R et al. reviewed 50-year trends in the prevalence of hypertension in India and reported escalating burden of this condition from the 1950s to 1990s in both the urban and rural areas.[6] Population-based epidemiological studies, conducted during mid-1950s and early 1960s, among the urban subjects used the older WHO criteria for making diagnosis (known hypertension or systolic BP more than or equal to 160 mm Hg and/or diastolic BP 95 mm Hg). Prevalence of hypertension was reported to be 1–4%. Since then, in many Indian locations, the prevalence of hypertension has been evaluated. It has been documented that steady increase in prevalence was observed from 3% to 4% in early 1960s to 11% to 15% in mid-1990s.[6]

Earlier studies reported lower prevalence of hypertension in rural populations in India. However, there has been a significant increase of hypertension in these populations as well, from less than 1% in early 1960s to 5–7% in late 1990s. It has been reported that at the turn

of the century hypertension prevalence in India was much more in urban as compared to rural populations.[7] Recent reviews in urban and rural populations of India have reported persistent urban-rural gradient.[8] It is observed that more than one-third of adult urban subjects and a quarter of rural adults have hypertension in India.[8] Trend analysis reveals that in the last 20 years (1995–2015) there has been a convergence of hypertension prevalence in urban and rural populations.[9] While the prevalence of hypertension has remained stable at 28–33% among Indian urban subjects, in rural subjects it increased significantly from 10–12% at turn of the century to 24–27% by 2010s.[9,10]

Two recent studies have used proper nationwide sampling and uniform tools to determine the true prevalence of hypertension in India and have been reviewed recently.[10] NFHS-4 (National Family Health Survey) evaluated hypertension prevalence in younger men (15–54 years) and women (15–49 years) and reported hypertension in 13.8% men and 8.8% women with an overall prevalence of 11.3%.[11] Further age-representative data from the District Level Household Study-4 (DLHS-4) documented presence of hypertension in 25.3% of the adults. The prevalence was greater in men (27.4%) in comparison to the women (20.0%), the urban-rural difference being narrow.[12]

These proportions would translate into a large number of hypertensive males and females in the country. Total Indian population is 1.34 billion; out of this 61% are above 18 years (n = 819 million). This age group, with an age-adjusted prevalence of 25.3%, would translate into 207.1 million people (males 112.2 million, females 94.9 million) with hypertension in the country.[10] There was a suggestion in recent US hypertension guidelines to lower the threshold to define hypertension as BP >130 mm Hg and/or >80 mm Hg.[13] If this new definition were to be applied to the Indian subcontinent, the prevalence of hypertension will increase steeply. The European hypertension guidelines, however, maintain the older criteria for diagnosis of hypertension.[14]

AWARENESS, TREATMENT AND CONTROL OF HYPERTENSION

Though there is a high prevalence of hypertension in India, treatment, awareness, and control status are low in rural as well as urban populations of India.[8] Hypertension awareness status has improved in India over the past 30 years, but remains very low, particularly among rural areas. There is an increase in awareness about hypertension from less than 30% among urban areas in the 1980s to around 60% at present and from less than 10% in rural regions in the 1980s to 35–40% at the present.

Anchala et al.[8] reviewed hypertension awareness, treatment and control status including all the recent studies in India. Overall estimates (95% UI) for awareness of hypertension in India were 42% (UI 35–49%) for urban and 25% (UI 21–29%) for rural populations. The awareness levels for hypertension were consistently above 35% in almost all studies from urban areas. In urban populations the treatment and control status of those with known hypertension was 38% (UI 24–51%) and control in 20% (UI 12–29%). While in rural populations, the treatment status for those with known hypertension was 25% (17–33%), and control status was in 11% (6–15%) (Fig. 1). In the urban parts of India, treatment status showed variation by location with percentage treated for the hypertension ranging from low 19% to high 80%. The percentage of patients who received treatment for hypertension showed high variability in rural southern parts of India, varying from 1% to 47% compared to urban parts. Overall,

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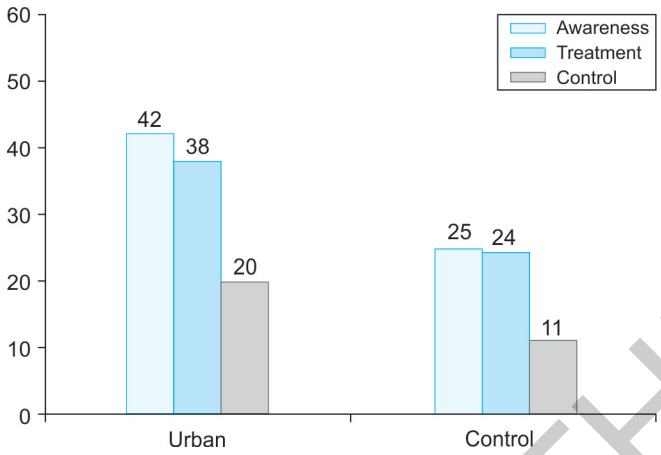

Fig. 1: Meta-analysis of hypertension awareness, treatment and control in Indian urban and rural populations.

nearly 38% of hypertensive urban Indians are receiving treatment. The control of BP among both the rural areas and the urban areas has been very poor ranging from 12% to 29% in urban and 6% to 15% in rural populations. No data on hypertension awareness, treatment and control are available from the NFHS-4 and DLHS studies so far.

The India Heart Watch study on urban populations reported prevalence of awareness, treatment, and control of hypertension in middle class sites in 11 cities in India and enrolled more than 6,000 subjects.[15]

An age-adjusted analysis revealed that there was awareness of hypertension in 53.8% of males and 57.3% of females. Among hypertensive subjects, there were 37.9% of the men and 34.5% of the women who were undergoing treatment. Among subjects with hypertension, in 25.6% of the men and 31.6%of the women (total 28.2%), controlled BP was present (systolic BP <140 mm Hg and diastolic BP <90 mm Hg). There was an increase in awareness of hypertension with age in both the men and the women; less than a quarter of men and women with age less than 30 years were aware of hypertension in comparison to two-thirds of those more than 60 years of age. There was also an increase in treatment status with age; less than 20% of those below age 40 years but more than 50% of those above age 60 years were undergoing treatment. No significant change was noted in hypertension control status with age. Among the subjects who were aware of having hypertension, 78.6% of males and 76.1% of females underwent treatment. Among subjects who received treatment for hypertension, <50% (41.5% of males and 41.6% of females) had controlled BP. This study indicated that there is a low treatment and control status of hypertension even among the urban middle class.

In India, the only long-term prospective cross-sectional hypertension and other cardiovascular risk factor epidemiology study is Jaipur Heart Watch (JHW).[16] Gupta R et al. (2018) studied trends in hypertension awareness, treatment and control over a 25-year period in a series of cross-sectional studies in Jaipur (Rajasthan, India). While the crude prevalence of hypertension has varied from 30% to 50% in these studies, awareness of hypertension has increased significantly (Table 1). In these studies, crude prevalence of hypertension showed variation from 30% to 50%, but there is a significant increase in

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TABLE 1: 25-year trends in age and sex-adjusted hypertension prevalence and awareness in among urban subjects in India according to serial Jaipur Heart Watch (JHW) studies.

	JHW-1 (n = 2,212)	JHW-2 (n = 1,123)	JHW-3 (n = 458)	JHW-4 (n = 1,127)	JHW-5 (n = 739)	JHW-6 (n = 1,781)
Years of study and reporting	1992–1994; 1995	1999–2001; 2002	2003–2004; 2004	2005–2006; 2007	2010–2011; 2012	2012–2013; 2015
Age-adjusted prevalence rate (%)	30	30	37	42	34	36
Awareness (% of total hypertensives)	13	33	49	44	49	56
Treatment (% of total hypertensives)	9	22	38	34	41	36
Control (BP <140/90 mm Hg as % of total hypertensives)	2	14	13	18	21	22

awareness of hypertension (Table 1). In early 1990s, the awareness of hypertension was 40%. Presently, it has increased to more than 55%. However, there is a tremendous need to enhance the diagnosis of hypertension via screening and awareness in India so that we can achieve the level of awareness of more than 70% of developed countries.[3] In JHW studies, the reasons for increased awareness of hypertension are not evident; further studies are needed. Better health literacy as a result of public health campaigns could be crucial. Another important finding in this study is increasing treatment and control status (Table 1). However, both these rates are low. At this rate hypertensive people in urban India are unlikely to achieve the WHO and UN Sustainable Development Goal targets of more than 50% hypertension control by the year 2030.[16]

SOCIOLOGY OF HYPERTENSION CONTROL

Socioeconomic factors are important drivers of cardiovascular diseases including hypertension.[17,18] It is well documented in high-income countries that cardiovascular disease and risk factors, comprising hypertension, tend to cluster in the people of low social classes having less education and low income. However, it is less evident why this is the case and several explanations have been proposed for this. Often, adverse social factors are related with poor lifestyle, along with less exercise, less healthy diet, more smoking, and thus an enhanced preponderance of the abdominal obesity and metabolic syndrome. This will lead to an increase in the risk of development of hypertension among susceptible individuals. More explanations were also suggested. In many settings, influence of psychosocial stress on the regulation of BP has been evaluated. As reported by a population-based study from Sweden, there can be an increase in BP because of job strain at the workplace; it was found to be more in men as compared to women.[11] It has been reported by other studies that psychosocial stress can be linked to enhanced levels of cardiovascular risk by a number of biochemical pathways, which include activation of the sympathetic nervous system.[19,20]

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Adverse social factors, such as less education, could also affect self-help knowledge and how patients seek and receive medical care for different medical needs, along with control of risk factors. For instance, this could imply that individuals from the population's less socially privileged strata might have less chance of engaging in hypertension screening activities or get less healthcare. Furthermore, compliance with medical treatment in these topics could also be suboptimal and thus control of the risk factor less effective. This is affected not only by the accessibility of healthcare resources, but also by the economy and the level of knowledge of people, which will affect awareness and understanding of risk, affecting the motivation to remain on prescribed medication or adhere to lifestyle advice.

Even the factors present in early life have the potential impact on these relationships.[21] For instance, it has been shown that a poor fetal growth pattern [small for gestational age (SGA) babies] combined with enhanced weight development during postnatal growth (mismatch hypothesis) could be harmful for enhanced cardiovascular risk, including hypertension, and type 2 diabetes mellitus and metabolic syndrome. These relationships are not only affected by social, genetic and nutritional factors, but also by the mother's medical condition, such as hypertension in pregnancy. Thus, in the view of life course, adverse influences from early life like an adverse social environment during childhood, adolescence, and adulthood may increase programming on biology and health. This is a fertile zone for further studies given the huge incidence of low birth babies in India.

Recently, a more controversial research line has been defined as the study of cognitive epidemiology and its health effects.[22] This basically includes analyzing connections between results of early life cognitive function measurements (e.g. IQ, intellectual capacity, or mental ability in particular), academic accomplishments, and negative health outcomes in adult life. In fact, in studies from the UK and Sweden, but also from other nations, it has been shown repeatedly that a reduced than average early-age intellectual ability, based on college grade assessment, is an independent risk factor for adverse health outcomes, even adjusted for personal characteristics and social background. It has been suggested that factors in early life, such as in utero nutrition, may be important for the development of mental and cognitive functions. It was shown in one study that stress susceptibility at conscript testing in young males, as assessed by trained military psychologists, was inversely related with low birth weight, adjusted for gestational age (poor fetal growth), as well as for family social class.[21] Other explanations focused on the problems of adjusting exposures to poor mental stimulation during the childhood and other psychosocial correlates of poor cognitive function.

This remains to be elucidated in more rigorous studies on the importance of genetic predictors of hypertension in a putative relationship with both fetal growth patterns and cognitive function. In a large study, influence of adverse social factors on the development of hypertension in a large cohort of 27,207 women working as health professionals was evaluated.[23] The finding in general was that a lower educational level was associated with an increased risk of hypertension after follow-up. Educational level, but not income, remained significantly associated with BP progression and incident hypertension.

There is, thus, in developed countries, a large evidence that risk of hypertension is greater in those with low educational status.[24,25] This demonstrates that negative social factors are not mediated by income alone for public health. These negative patterns for provoking

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disease cannot be treated with drugs provided to the people. Instead, they should be the goals of public health initiatives to improve educational accessibility for all and counteract social inequities. Hopefully, this will lead to risk factors like hypertension that are less common. An evidence of this perspective is the steady decline in mean BP in the population that has been defined in Western populations over recent decades.[26] One explanation for this might be that conditions in early life during the latter half of the 20th century have gradually improved in consecutive birth cohorts. This is a promising prospect for less common cardiovascular morbidity and hypertension in the population's middle-aged strata even though there will be no absolute reduction in the number of patients with cardiovascular disease manifestations or hypertension owing to enhanced longevity and an increasing percentage of elder people.

INDIAN SCENARIO

In India there is limited evidence of association of social and economic factors with hypertension. The authors for the first time, reported greater prevalence of hypertension in illiterate rural populations in Rajasthan in 1994.[27] Subsequently many studies have reported on greater prevalence of multiple lifestyle risk factors and some have reported greater hypertension in illiterate and poor communities.[28] Low status of hypertension, awareness and control has been reported among less educated participants in the India Heart Watch study.[29] Greater cardiovascular and hypertension-related mortality has been reported in the Mumbai Cohort Study.[30,31]

Poor status of hypertension awareness, treatment and control of high BP has been attributed to variety of socioeconomic factors. These factor include lack of political will, bureaucratic apathy, no focus in national programs, poorly developed healthcare system and primary healthcare, rural residence, cost of therapy and affordability as well as individual factors such as women gender, low educational status and poverty (Table 2).

There have been only a few studies in India that determined determinants of hypertension awareness, treatment and control. The Indian Women Health Study was conducted on middle-aged (35–70 years) low and low-middle socioeconomic status of women in India at various urban and rural sites.[32] Prevalence of known hypertension was reported to be low. Among the urban females, only 56.8% were aware of the condition and in rural women 24.6% were familiar about the disease. Among the women aware of hypertension, only 38.6% received drug therapy (rural 46.5%; urban 38.6%). Hypertension control as defined by systolic BP less than 140 mm Hg and diastolic BP less than 90 mm Hg, among the women who received treatment, was extremely low; only 28.3% of the urban women and 10.2% of the rural women had controlled values of BP. In total, out of the 1,672 hypertensive women (urban 926, rural 746), only 18.3% received treatment (urban 22.5%; rural 13.1%). Control to target was achieved in 3.9% women (urban 5.9%; rural 1.3%) ($p < 0.05$, for rural-urban difference). Significant lifestyle determinants of hypertension awareness, treatment and control revealed that the most important risk factor for low awareness was rural location [age-adjusted odds ratio (OR) 3.13, confidence interval (CI) 2.49–3.93], treatment (1.59, 1.18–2.13), and control (5.11, 2.22–11.74). Low educational level and educational status of spouse have insignificant association respectively with awareness (age- and location-adjusted OR and 95% CI 1.39, 0.92–2.09 and 1.14, 0.75–1.74), treatment (0.62, 0.38–1.03 and 1.74, 0.94-3.25), and control

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TABLE 2: Factors associated with treatment and control of low hypertension.

Individual patient	Health systems related	Healthcare providers
• Old age • Female gender • Low socioeconomic status • Social isolation (particularly in elders) • Lack of commitment and motivation • Lack of realization of the seriousness of the issue • Lack of quality information • Finance-related factors and costs • Comorbid conditions which are significant • Failure to sustain lifestyle changes • Confusing multistakeholder messages • Not covered by insurance • Factors related to distance and geography	• Government policies related to tobacco and food • Lack of health-friendly infrastructure • Low perceived need by healthcare managers and bureaucrats • Low access and availability of medicines and medical staff • Media apathy and conflicting messages • Constraints of resource and cost of equipment and drugs, in particular for noncommunicable diseases • Lack of advocacy • Not covered by insurance for management of cardiovascular disease • Frequent changes and use of nonstandardized formulary • Less focus of undergraduate medical education on noncommunicable diseases • Overburdening of healthcare system with communicable diseases	• Less continuity of care • Fixed clinician perception • Lack of motivation and proper education • Overburdened due to large number of patients • Lack of continuing medical education programs • Less understanding of needs of patients • Costs • Prescription of complex regimens • Lack of referrals to clinician • Overtreatment • Avoiding to involve patients in choices • Lack of explanation of benefits and side effects • Less focus on lifestyle changes

(0.55, 0.21–1.42 and 0.60, 0.20–1.80). In most of the developed countries, hypertension awareness, treatment and control is more among women in comparison to men.[3] The Indian Women Health Study showed that in India in both urban and rural women there is low awareness, treatment and control of hypertension.

In India Heart Watch study 6,198 men and women in 11 cities of India, were studied.[15] Educational status was inversely associated with hypertension awareness, treatment and control.[29] Age-adjusted and sex-adjusted prevalence (%) of hypertension in low, medium, and high educational status groups was 31.8, 29.5 and 34.1%, respectively. Significantly increasing trends with low, medium and high educational status were observed for hypertension awareness (30.7, 37.8 and 47.0%), treatment (24.3, 29.2 and 35.5%) as well as control (7.8, 11.6 and 15.5%) (Fig. 2). The authors concluded that in India low educational status subjects have lower awareness, treatment and control of hypertension as well as other cardiovascular risk factors, e.g. diabetes, hypercholesterolemia and smoking quit rates. Clearly, there is a need to focus on low educational status subjects for improving hypertension treatment and control.

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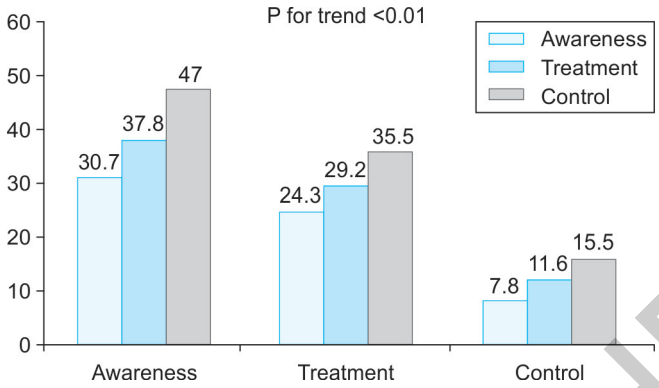

Fig. 2: Educational status and hypertension awareness, treatment, and control in India Heart Watch study.

In a qualitative study to evaluate sociological determinants of low hypertension treatment and control in rural women the authors performed a study in Rajasthan.[33] The authors interviewed 30 women (age-range 20–70, mean age 56.1 years). Majority of women were from low socioeconomic status households and were illiterate (63.3%) and were housewife. Adherence using Morisky scale was determined as low, observed in 12 (36.7%) and medium in 10 women (30.0%). The most commonly prescribed drugs were angiotensin receptor blockers and calcium channel blockers while low-cost drugs such as diuretics and beta blockers were used in low proportions. Although all these patients had access to a medical college hospital only a third had visited a community health center. More than half used public transport system for travel to hospital. All the patients had to pay for medicines out-of-pocket and only two women had some sort of insurance or social security. A large proportion of women borrowed money from relatives or friends to reach the hospital and pay for medicines. Awareness of hypertension and its risk factors was adequate in very few women. Thus, the authors found that a low adherence to medicines as well as healthy lifestyles was observed in Indian rural women with hypertension. Reasons for these include low awareness of complications of hypertension, poor access to care, out-of-pocket payments, borrowing money, lack of insurance, prescriptions of more expensive medicines, and low use of combination pharmacotherapy. Similar situation is likely to be prevalent in other parts of the country.

Association of macrolevel sociodemographic factors with hypertension prevalence has not been well studied in India. To determine association of prevalence of hypertension in different states in India with various social determinants the authors performed a macrolevel analysis. They used data on hypertension prevalence available from the DLHS-4 and correlated it with various social determinants of health, healthcare availability, and other factors and reported the results in a recent review.[10]

The sociodemographic factors include state-level urbanization index, human development index and social development index. Results show that there is a significant positive association (R^2) of state-level hypertension prevalence with urbanization (men 0.17, women 0.08) and human development index (men 0.36, women 0.26) while relationship of social development

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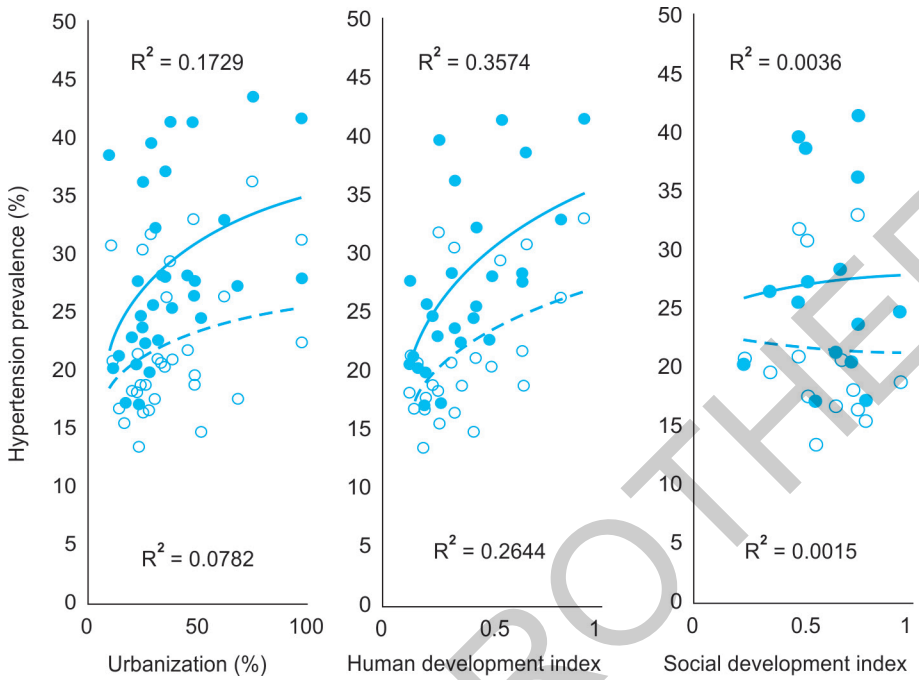

Fig. 3: Association of macrolevel socioeconomic factors with hypertension prevalence in Indian states.

index with hypertension is not significant (Fig. 3).[34] These findings are also similar to results from 11-city India Heart Watch study where it was reported that hypertension prevalence was greater in cities with greater human and social development indices.[35] The authors also determined the association of hypertension with healthcare access and healthcare quality indices. There is poor association of hypertension prevalence with healthcare availability although there is positive association with healthcare access and quality.[34] These findings suggest that healthcare access is to be improved for hypertension management including its detection, treatment and control.

CONCLUSION

It is difficult to eradicate socially patterned risk factors and adverse health outcomes, but based on favorable development in age-adjusted trends of cardiovascular disease in developed countries, it appears that better conditions in childhood could reduce the impact of other negative circumstances in adult life for most people. Thus, in studies on the impact of adverse social factors on adult health, a life course perspective should be implemented.[36] Although people may vary in personal characteristics such as cognitive function and academic achievement, equal healthcare resources need to be provided and customized to personal requirements for better hypertension control.

By improvement in detection and management of hypertension, thousands of premature deaths, heart attacks and strokes can be prevented every year. Hypertension can be better managed by innovative systems-based strategies; these are outlined in Table 3. For lowering risk, a combined approach with changes in lifestyle and use of antihypertensive

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TABLE 3: Preventive health measures to improve control of hypertension in India.

Strategy	Examples
Lifestyle changes	• Reduction in high salt in diet, decreasing consumption of alcohol, weight reduction, and more physical activity should be focused • Cessation of use of smoking/tobacco should be done for overall risk reduction
Patient empowerment	• Lifelong commitment to antihypertensive therapy and lifestyle changes in hypertensive patients • Self-monitoring of blood pressure
Opportunistic screening	• Hypertension screening by physicians or other healthcare workers among all adults at all levels of care (universal opportunistic screening) • Measurement of blood pressure once a year in adults by trained nonphysician healthcare workers in rural and urban regions during home visits
Control of vascular risk factors	• Focus should be on the management of all vascular risk factors (such as high cholesterol, smoking, diabetes, other lipids—in every hypertensive) • Polypharmacy approach in high-risk people
Public education	• Hypertension is one of the major cardiovascular risk factors and an important cause of heart disease and strokes • It is most often silent; regular checking of blood pressure is necessary in all adults (>35 years) • It can be prevented and controlled by adopting prudent lifestyle along with safe, simple, and not expensive medications
Low-dose combination pharmacotherapy	• Low doses of two or more individual drug combination as initial therapy should be used • Evidence-based combinations should be used
Physician education	• More focus should be shifted toward noncommunicable diseases in undergraduate education. Hypertension should be focused in public health curriculum • Hypertension should be focused as a primary care issue. Knowledge about the proper management and long-term care should be given. Physician inertia should be managed • Importance of ambulatory blood pressure measurement, home monitoring, and combination therapy should be understand. Focus on vascular risk management should be given

and lipid lowering therapy in combination can decrease the risk of cardiovascular by as much as 75%.[37] We need improved healthcare systems for extensive hypertension screening in order to detect it. Once identified, adequate pharmacotherapy with good compliance will best achieve efficient BP control and decreased cardiovascular disease risk. Such an approach to public health will lead to major modifications in India's clinical outcomes of hypertension.

REFERENCES

1. GBD 2016 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390:1345-422.

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2. Gupta R, Xavier D. Hypertension: the most important non-communicable disease risk factor in India. Indian Heart J. 2018;70:565-72.
3. World Health Organization. Global Status Report on Non-Communicable Diseases 2014. Geneva: World Health Organization. 2014.
4. Farouzanfar MH, Ng M, Biryukov S, et al. Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990-2015. JAMA. 2017;317:175-82.
5. NCD Risk Factor Collaboration (NCD-RiSC). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. Lancet. 2017;389:37-55.
6. Gupta R, Al-Odat NA, Gupta VP. Hypertension epidemiology in India: Meta-analysis of fifty-year prevalence rates and blood pressure trends. J Human Hypertens. 1996;10:465-472.
7. Gupta R. Trends in hypertension epidemiology in India. J Human Hypertens. 2004;18:73-8.
8. Anchala R, Kannuri NK, Pant H, et al. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens. 2014;32:1170-7.
9. Gupta R. Convergence in urban-rural prevalence of hypertension in India. J Human Hypertens. 2016;30:79-82.
10. Gupta R, Gaur K, Ram CVS. Emerging trends in hypertension epidemiology in India. J Human Hypertens. 2019;33(8):575-87.
11. National Family Health Survey. Available from http://rchiips.org/nfhs/abt.html. [Last accessed August, 2019].
12. Geldsetzer P, Manne-Goehler J, Theilmann M, et al. Diabetes and hypertension in India: a nationally representative study of 1.3 million adults. JAMA Intern Med. 2018;178:363-72.
13. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABS/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation and management of high blood pressure in adults: executive summary. J Am Coll Cardiol. 2018;71:2199-269.
14. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J. 2018;39(33):3021-104.
15. Gupta R, Deedwania PC, Achari V, et al. Normotension, prehypertension and hypertension in Asian Indians: prevalence, determinants, awareness, treatment and control. Am J Hypertens. 2013;26:83-94.
16. Gupta R, Gupta VP, Agrawal A, et al. 25-year trends in hypertension prevalence, awareness, treatment and control in an urban population in India. Indian Heart J. 2018;70(6):802-7.
17. Fuster V, Kelly BB, Board for Global Health. Promoting cardiovascular health in developing world: a critical challenge to achieve global health. Washington: Institute of Medicine; 2010.
18. Kaplan GA, Keil JE. Socio-economic factors and cardiovascular disease: a review of the literature. Circulation. 1993;88:1973-98.
19. Öhlin B, Nilsson PM, Nilsson J-Å, et al. Self-reported psychosocial stress predicts cardiovascular morbidity and mortality in middle-aged subjects—a long-term follow-up. Eur Heart J. 2004;25:867-73.
20. Bairey Merz CN, Dwyer J, Nordstrom CK, et al. Psychosocial stress and cardiovascular disease: pathophysiological links. Behav Med. 2002;27:141-7.
21. Gluckman PD, Hanson MA. Developmental plasticity and human disease: research directions. J Intern Med. 2007;261:461-71.
22. Deary IJ, Batty GD. Cognitive epidemiology: Glossary. J Epidemiol Comm Health. 2007;61:378-84.
23. Conen D, Glynn RJ, Ridker PM, et al. Socioeconomic status, blood pressure progression, and incident hypertension in a prospective cohort of female health professionals. Eur Heart J. 2009;30:1378-84.
24. Rozanski A, Blumenthal JA, Davidson KW, et al. The epidemiology, pathophysiology, and management of psychosocial risk factors in cardiac practice: the emerging field of behavioural cardiology. J Am Coll Cardiol. 2005;45:637-51.
25. Rozanski A. Behavioural cardiology: current advances and future. J Am Coll Cardiol. 2014;64:100-10.
26. Danaei G, Finucane MM, Lin JK, et al. National, regional and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5.4 million participants. Lancet. 2011;377:568-77.
27. Gupta R, Gupta VP, Ahluwalia NS. Educational status, coronary heart disease and coronary risk factor prevalence in a rural population of India. BMJ. 1994;309:1332-6.
28. Prabhakaran D, Jeemon P, Reddy KS. Poverty and cardiovascular disease in India: do we need more evidence for action? Int J Epidemiol. 2013;42:1431-5.
29. Gupta R, Sharma KK, Gupta BK, et al. Education status related disparities in awareness, treatment and control of cardiovascular risk factors in India. Heart Asia BMJ. 2015;7:1-7.
30. Pednekar M, Gupta R, Gupta PC. Illiteracy, low educational status and cardiovascular mortality in India. BMC Public Health. 2011;11:e568.
31. Pednekar MS, Gupta R, Gupta PC. Association of blood pressure and cardiovascular mortality in India: Mumbai Cohort Study. Am J Hypertens. 2009;22:1076-84.
32. Gupta R, Pandey RM, Misra A, et al. High prevalence and low hypertension awareness, treatment and control in Asian Indian women. J Hum Hypertens. 2012;26:585-93.
33. Gupta S, Dhamija JP, Mohan I, et al. Barriers for adherence to anti-hypertensive medicines among rural women in

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India: a qualitative study. Indian Heart J. 2018;70(Suppl 2):S10.
34. Gupta R, Gaur K. Epidemiology of hypertension in India: the real scenario. In: Goswami KC (Ed). Cardiological Society of India: Cardiology Update 2018. New Delhi: Jaypee Brothers Medical Publishers; 2019. p. 103-12.
35. Gupta R, Sharma KK, Gupta BK, et al. Geographic epidemiology of cardiometabolic risk factors in urban middle-class residents in India: A cross sectional study. J Global Health. 2015;5:10411.
36. Olson MH, Angell SY, Asma S, et al. A call to action and a lifecourse strategy to address the global burden of raised blood pressure on current and future generations: the Lancet Commission on hypertension. Lancet. 2016;388:2665-712.
37. Gupta R, Yusuf S. Towards better hypertension control in India. Indian J Med Res. 2014;139:657-60.

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