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Regional variation in the prevalence of overweight/obesity, hypertension and diabetes and their correlates among the adult rural population in India

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Abstract

A community-based, cross-sectional study was carried out in five regions of India by adopting a multistage random sampling procedure. Information was collected from the participants about socio-demographic particulars such as age, sex, occupation, education, etc. Anthropometric measurements such as height, weight and waist and hip circumferences were measured and three measurements of blood pressure were obtained. Fasting blood sugar was assessed using a Glucometer. Data analysis was done using descriptive statistics, χ^2 test for association and logistic regression analysis. A total of 7531 subjects were covered for anthropometry and blood pressure. The overall prevalence of overweight/obesity and abdominal obesity was 29 and 21 %, respectively, and was higher in the Southern region (40 % each) as compared with other regions. The prevalence of hypertension was 18 and 16 % and diabetes was 9·5 % each among men and women, respectively. The risk of hypertension and diabetes was significantly higher among adults from the Southern and Western regions, the among elderly, among overweight/obese individuals and those with abdominal obesity. In conclusion, the prevalence of overweight/obesity and hypertension was higher in the Southern region, whereas diabetes was higher in the Southern and Western regions. Factors such as increasing age, male sex, overweight/obesity, and abdominal obesity were important risk factors for hypertension and diabetes. Appropriate health and nutrition education should be given to the community to control these problems.

Key words: **Overweight/obesity: Hypertension: Diabetes: Regional variation**

The CVD epidemic has emerged in economically developing countries during the recent decades, which is responsible for 48 % of death globally and responsible for 80 % of death in low- and middle-income countries in 2008[(1)].

Economic transition, rapid urbanisation and changes in life-style, tobacco use, unhealthy dietary habits, insufficient physical activity and alcohol abuse have led to increased burden of CVD and other chronic diseases[(2)]. The rapidly growing burden of non-communicable diseases in low- and middle-income countries is accelerated by the negative effects of globalisation, rapid unplanned urbanisation and increasing sedentary lifestyle[(2)].

An increase in life expectancy because of control of communicable diseases as well as access to healthcare services and improved medical services has also led to an increase in non-communicable diseases all over the world[(3)].

The global epidemic of overweight and obesity is rapidly becoming a major public health problem in many parts of the world. Paradoxically co-existing with under-nutrition in developing countries, the increasing prevalence of overweight and obesity – an important modifiable risk factor – is associated with many diet-related chronic diseases including diabetes mellitus, CVD, stroke, hypertension and certain cancers[(1)] and is an emerging problem in Asian countries including India[(4)].

As per the WHO report of 2008, about 35 and 11 % of adults aged 20 years and over were overweight and obese globally, whereas in India the corresponding figure was 12 and 2 %, respectively[(1)].

Hypertension is an important modifiable risk factor for CVD and is responsible for at least 45 % of deaths due to heart disease (total ischaemic heart disease mortality) and 51 % of deaths due to stroke[(5)], whereas in India hypertension is directly responsible for 57 % of deaths due to stroke and 24 % of deaths from CHD[(6)].

Diabetes mellitus is another chronic metabolic disorder in most of the urban and rural areas and is important risk factor for CVD.

Abbreviations: FBS, fasting blood sugar; HH, household; NIN, National Institute of Nutrition; NNMB, National Nutrition Monitoring Bureau.

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It is estimated that the prevalence of diabetes worldwide will increase by 39 %, from 4·6 % in 2000 to 6·4 % in 2030[7].

The number of diabetes cases is predicted to double globally from 171 million in 2000 to 366 million in 2030 with 79·4 million in India[7].

In India, regional variations in cardiovascular risk factors such as obesity, hypertension, diabetes and lipid abnormalities have not been systematically studied. There have been a number of *ad hoc* population-based surveys for the estimation of CVD risk factor prevalence in India. All these studies have been performed by local investigators using different age groups, variable sample sizes, non-uniform methodology, improper statistical techniques and have reported results inconsistently. The multisite prevalence of diabetes in India study focused on the epidemiology of diabetes prevalence in the country and performed study in all large Indian states, but did not report on regional variations[8].

The study used for the present communication was carried out by the National Institute of Nutrition (NIN) on 'consumption of processed and non-processed food among urban and rural population in India & prevalence of obesity, hypertension, diabetes and cardio-metabolic risk factors' during 2011–2012. The study was carried out in five regions, namely the East, West, North, South and Northeast, which are distinct in their language, culture, food and living habits. Data on prevalence of hypertension, diabetes and overweight/obesity among rural population in five regions of India are presented in this communication.

Methods

Study design and study population

The present community-based, cross-sectional study was carried out in five geographical regions of India – that is, North, South, East, West and Northeast – by adopting a multistage stratified random sampling method. From each of these regions, two states were randomly selected (Fig. 1), and from each selected state three districts were selected. From each district, two blocks were selected, and from each selected block five

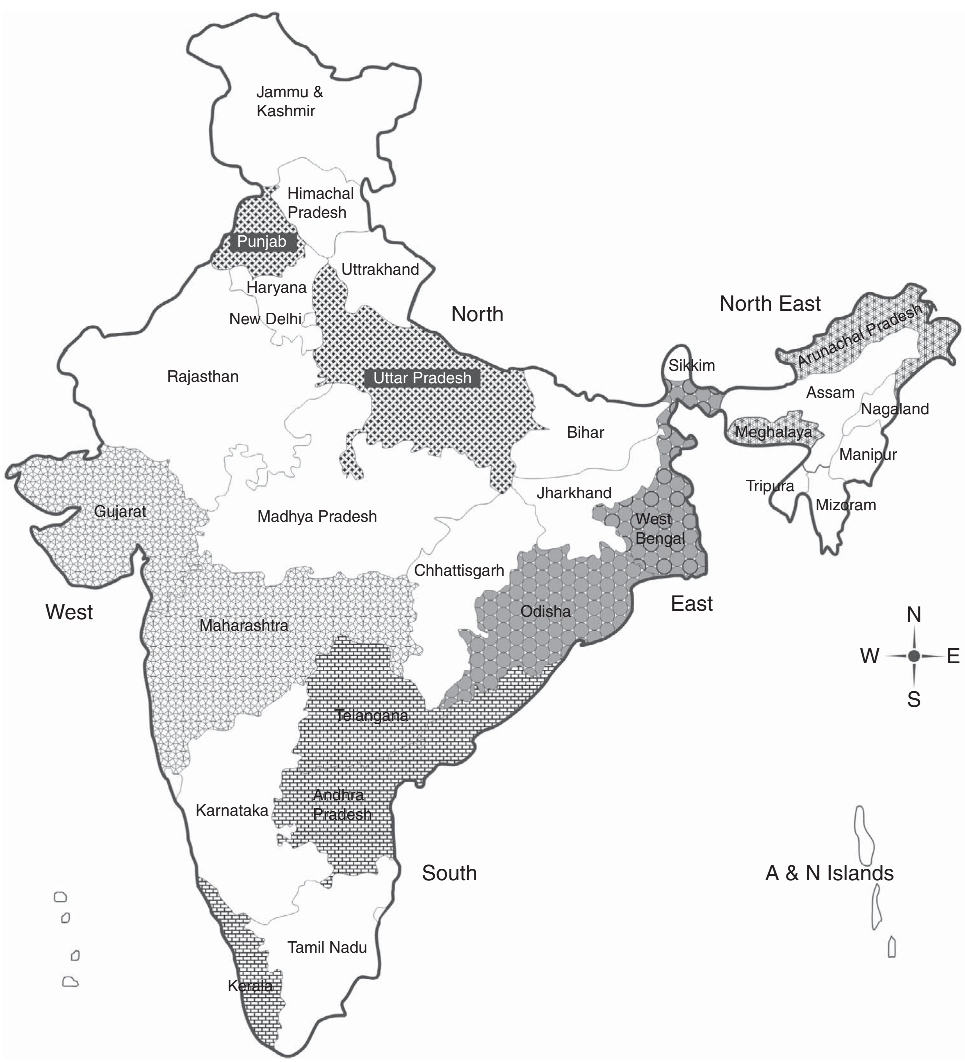

Fig. 1. Map of India showing selected states from each region.

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villages were selected. From each village, ten households (HH) were selected randomly by dividing the village into five areas, and from each area two HH were covered. Thus, a total of 600 HH were covered in each state. In the Eastern region, only 500 HH were covered. Thus, a total of 2900 HH were covered for the present study. From each of the selected HH, all adults (≥18 years) were included in this study. The required sample was determined based on the prevalence of hypertension, which was considered as 20 % in rural India.

Data collection

The data were collected by a team comprised of nutritionists, research assistants and laboratory technicians, who were trained in survey methodology at the NIN, Hyderabad, for a week. The data were collected from the selected HH on socio-demographic and economic characteristics, such as education and occupation of the subject, annual income, type of house, etc. The educational status of the subjects was classified as follows: no formal education, primary school, upper primary school completed, secondary school completed, high school (or equivalent) completed and college educated. Subjects were categorised based on their occupation such as labour, service (government or private), business and housewife. Anthropometric measurements such as weight (nearest to 0·1 kg) using a SECA weighing scale (Deutschland, Medical Scales and Measuring System) and height (nearest to 0·1 cm) using an anthropometer rod were obtained using standard procedures[9]. Waist and hip circumferences were measured of all the adults covered for anthropometry by the standard procedure using a fibre-re-inforced non-elastic tape[10]. Waist circumference was measured at a point midway between the lower rib margin and the iliac crest. Three measurements of blood pressure (BP) at 5-min intervals in the sitting position were obtained using an Omron digital BP Apparatus (HEM-7080 model; Omron Healthcare Co. Ltd), and the average of the three readings was used for classification of hypertension. Fasting blood samples were collected for the estimation of fasting glucose levels in a sub-sample of subjects (in alternate HH) and was estimated using glucometers on capillary blood (Accu-Chek Active; Roche diagnostics GmbH). For this purpose, the subjects were asked to fast overnight, and blood sugar levels were tested early in the morning (without tea or any other beverages except water). The subjects with high FBS were referred to the nearest primary healthcare centre or hospital for further management.

A total of 8969 adults (men: 4524; women: 4445) were included in this study; however, data are available only on 7531 individuals for anthropometric measurements. BP measurement was available for 7222 individuals, whereas FBS values were available for 3947 individuals.

Definition and diagnostic criteria

Hypertension. Individuals with systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg and/or currently on treatment for hypertension were categorised as hypertensive. Hypertension was also defined as per the Joint National Committee (JNC 7) criteria, which excludes prevalent cases of hypertension[11].

Diabetes mellitus. FBS <110 mg/dl (<6·1 mmol/l) was considered as normal, blood sugar levels between 110 and 125 mg/dl (6·1 and 6·9 mmol/l) as impaired fasting glucose and FBS ≥126 mg/dl (≥7·0 mmol/l) was considered as diabetic[12].

BMI was calculated as weight (kg)/height (m^2). Individuals with BMI <18·5 were classified as 'chronic energy deficiency' patients, BMI between 18·5 and 22·99 kg/m^2 as 'normal', BMI ≥23–27·49 kg/m^2 as 'overweight' and BMI ≥27·5 kg/m^2 as 'obese'[13]. Waist circumference of ≥90 cm for men and ≥80 cm for women were considered cut-off points for abdominal obesity as per Asian cut-off values, whereas waist:hip ratio of ≥0·90 for men and ≥0·80 for women were considered as cut-off points for central obesity[14].

Data analysis

The data were scrutinised, cleaned and entered into the computers at the NIN, Hyderabad. The data were analysed using SPSS version 17.0. Proportion test for studying association across the groups was carried out using χ^2 analysis, and multivariate logistic regression analysis was carried out to know the important risk factors associated with hypertension and diabetes, which were considered as dependant variables, and socio-demographic factors and overweight/obesity were considered as independent variables.

Results

Mean and standard deviation for anthropometric measurements, blood pressure and fasting blood sugar levels

The mean age of the subjects included in the present study was 38·2 (SD 15·4) years, with mean BMI of 21·2 (SD 3·9) kg/m^2. Mean SBP was 120·6 (SD 16·9) mmHg, whereas the mean DBP was 78·4 (SD 9·9) mmHg. The mean FBS was 102·9 (SD 31·3) mg/dl (5·71 (SD 1·74) mmol/l), and the mean waist circumference was 77·4 (SD 10·5) cm among men and 73·8 (SD 11·3) cm among women. The mean hip circumference was 86·4 (SD 8·6) cm among men and 87·4 (SD 9·6) cm among women.

Prevalence of overweight/obesity. The prevalence of overweight/obesity (BMI ≥23 kg/m^2) was about 29 % among adults (men 28·2 %; women 29·5 %), and ranged from a low (21 %) in the East to a high (40 %) in the Southern region. The overall prevalence of abdominal obesity was 21 % and was significantly higher among women (27 %) as compared with men (14 %). The prevalence was 39 % in the Southern region, followed by the Northern (19·4 %), Western and Eastern regions (18·8 % each), and was lowest in the Northeastern (12·2 %) region (Table 1).

The prevalence of central obesity was 59 % and was significantly higher among women (70·9 %) as compared with men (47 %). The prevalence was higher in the Southern region

Table 1. Prevalence (%) of chronic energy deficiency (CED), overweight/obesity, abdominal and central obesity, according to sex and regions

Regions… Sex	East	North	Northeast	South	West	Pooled
CED						
n	1682	1603	1383	1413	1450	7531
Men	30·1	17·8	10·9	19·4	30·4	22·0
Women	33·1	21·7	16·4	22·4	33·7	25·7
Pooled	31·6	19·7	13·8	21·2	32·2	24·0
P			<0·001			
Overweight/obesity						
n	1682	1603	1383	1413	1450	7531
Men	20·3	27·3	33·3	36·4	26·9	28·2
Women	21·1	28·8	28·0	42·2	27·0	29·5
Pooled	20·7	28·0	30·4	40·0	27·0	28·9
P			<0·001			
Abdominal obesity						
n	1673	1596	1374	1017	1406	7066
Men	10·5	14·0	8·7	23·1	16·5	14·1
Women	26·8	25·3	15·3	58·0	20·9	27·0
Pooled	18·8	19·4	12·2	39·0	18·8	20·6
P			<0·001			
Central obesity						
n	1670	1596	1373	1015	1388	7042
Men	47·4	44·6	48·5	59·1	40·8	47·6
Women	74·8	73·4	87·1	82·7	40·6	70·9
Pooled	61·4	58·5	68·8	69·9	40·7	59·3
P			<0·001			
Hypertension						
n	1628	1488	1335	1367	1404	7222
Men	13·0	9·9	26·3	26·2	18·3	17·9
Women	11·9	8·6	17·8	21·6	18·8	15·8
Pooled	12·4	9·3	21·7	23·5	18·6	16·8
P			<0·01			
Diabetes						
n	893	826	766	744	718	3947
Men	5·5	9·4	5·7	12·0	17·6	9·6
Women	7·1	7·0	5·3	12·4	15·8	9·5
Pooled	6·3	8·2	5·5	12·2	16·6	9·5
P			<0·01			

(69·9 %) and in the Northeastern region (68·8 %) and lowest in the Western region (40·7 %) (Table 1).

Prevalence of hypertension and diabetes. The prevalence of hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg) was 18 and 16 % among men and women, respectively. The prevalence was higher in the Southern (23·5 %) and Northeastern regions (21·7 %) and lowest in the Northern region (9·3 %) (men: 9·9 %; women: 8·6 %) (Table 1).

The prevalence of diabetes (FBS ≥126 mg/dl; ≥7·0 mmol/l) was 9·5 % each among men and women, respectively. The prevalence was higher in the Western region (16·6 %) and was lowest in the Northeast region (5·5 %). Impaired fasting glucose was observed in 13 % of the population (Table 1).

Association of overweight/obesity, abdominal obesity, hypertension and diabetes with socio-demographic characteristics. The prevalence of overweight/obesity, abdominal obesity and central obesity was observed to be significantly ($P < 0·01$) higher among elderly (≥60 years) (28, 28, 72·5 %, respectively) as compared with young adults (25, 15, 51 %, respectively). The prevalence of obesity was also significantly ($P < 0·01$) higher among women as compared with men. The prevalence of overweight/obesity and abdominal obesity was significantly ($P < 0·01$) higher among educated as compared with subjects with no formal education, among housewives and those engaged in service and business (Table 2).

The prevalence of hypertension was significantly ($P < 0·01$) higher among elderly (38·8 %) as compared with 18- to 39-year-old subjects and among subjects with no formal education (20·3 %) as compared with educated subjects (12·7 %). The prevalence of hypertension was also significantly ($P < 0·01$) higher among those engaged in service and business (21·8 %) and others (21·4 %) as compared with those engaged in labour (15·5 %).

Similarly, the prevalence of diabetes was higher among the elderly (22·9 %) and among subjects with no formal education (11·3 %). No significant association was observed between diabetes and occupation of subjects (Table 2).

In order to know the variation between age, sex, education, occupation and obesity among subjects who had FBS results and those who did not undergo FBS tests, analyses were

Table 2. Association (%) of overweight/obesity, hypertension and diabetes in urban population with age and socio-demographic factors

	n	Overweight/obese	Abdominal obesity	Central obesity	Hypertension	Diabetes
Age groups						
18–39 years	4269	24·6	14·6	50·6	9·0	4·1
40–59 years	2319	37·0	28·4	69·7	21·4	12·6
≥60 years	941	28·2	27·8	72·5	38·8	22·9
Pooled	7529	28·9	20·6	59·3	16·8	9·5
P		0·001	0·001	0·001	0·001	0·001
Sex						
Men	3522	28·2	14·1	47·6	17·9	9·6
Women	4009	29·5	27·0	70·9	15·8	9·5
P		0·001	0·001	0·001	0·01	0·99
Education						
No formal education	2397	23·8	18·4	66·6	20·3	11·3
Up to upper primary	2341	29·4	21·8	60·6	17·9	9·1
Secondary and above	2793	32·8	21·2	52·4	12·7	8·3
P		0·001	0·01	0·001	0·001	0·02
Occupation						
Labour	3029	24·6	13·6	50·1	15·5	8·9
Housewife	2517	32·0	28·9	67·5	14·7	9·8
Service + business	905	44·6	27·0	61·8	21·8	8·6
Others	1080	20·6	14·9	63·5	21·4	11·9
P		0·001	0·001	0·001	0·001	0·24

carried out and we observed that there was a no difference in age, education, occupation and abdominal obesity, but there was difference in BMI and sex between the two groups (with FBS results versus without). This may be due to non-random allocation of the subjects between the groups because of non-response or non-cooperation from the subjects during blood collection, although it was decided to select alternate HH for blood collection.

Logistic regression analysis. Multiple logistic regression analysis was carried out to assess the important risk factors for hypertension and diabetes. It was observed that the risk for hypertension was two times higher among subjects belonging to the Northeast, South and Western regions (OR 2·06; CI 1·64, 1·70, respectively) as compared with those from the Eastern region. The risk of hypertension was five times (OR 5·4; CI 4·41, 6·78) higher among the elderly as compared with 18- to 39-year-old subjects and 1·5 times higher in men as compared with women (OR 1·5; CI 1·27, 1·84). The risk of hypertension was significantly ($P < 0·01$) lower among educated (secondary school level and above) (OR 0·67; CI 0·55, 0·83) as compared with subjects with no formal education. The risk of hypertension was 1·4 times higher among those engaged in service/business (OR 1·43; CI 1·14, 1·78) as compared with labourers and agriculture workers. Overweight/obese individuals (BMI ≥ 23 kg/m^2) had 2·1 times higher risk of hypertension (2·17; CI 1·68, 2·81), and individuals with abdominal obesity had two times higher risk (OR 1·96; CI 1·61, 2·42), whereas individuals with central obesity had 1·4 times higher risk of hypertension (OR 1·35; CI 1·13, 1·62) (Table 3).

Similarly, the risk for diabetes was 2–3 times higher among populations from the South and Western regions (OR 1·79 and 3·04) as compared with subjects from the Eastern region. The risk of diabetes was six times (OR 5·86; CI 4·29, 8·01) higher among the elderly as compared with 18- to 39-year-old subjects. Individuals with abdominal obesity had two times higher risk of diabetes (OR 2·10; CI 1·63, 2·68) (Table 3). Overweight/obesity (BMI ≥ 23 kg/m^2) and central obesity was not observed to be significantly associated with diabetes.

Discussion

The present study revealed that there is a regional variation in the prevalence of overweight/obesity, hypertension and diabetes among the rural population in India. It was observed that the overall prevalence of overweight/obesity, hypertension and diabetes was 29, 17 and 9 %, respectively. The prevalence of hypertension was higher in the Southern and Northeastern regions, whereas the prevalence of diabetes was higher in the Western and Southern regions.

The high prevalence of hypertension and diabetes in the Southern region may be attributed to the high prevalence of overweight/obesity and abdominal obesity and also high intakes of fats, sugar and jaggery among the population, as was observed during diet surveys. High prevalence of hypertension in the Northeast region may be attributed to high prevalence of overweight/obesity (BMI ≥ 23 kg/m^2), higher consumption of meat (i.e. beef and pork) and also high consumption of tobacco and alcohol, although abdominal obesity was low among these populations.

High prevalence of diabetes in the Western region may be attributed to the high prevalence of abdominal obesity (19 %) and high fat intake in diet, especially in Gujarat, as was observed in the National Nutrition Monitoring Bureau (NNMB)[15] study in rural areas in 2012, although abdominal obesity was low. Low prevalence of diabetes in the Northeastern population may be attributed to the low prevalence of abdominal obesity due to low consumption of fats and oils and spices as well as low intake of sweeteners and more intake of red rice in the diet. Recent studies suggest that there is an association between high white rice consumption and a higher risk of type 2 diabetes in both Western[16] and Asian populations[17,18].

Table 3. Multiple logistic regression analysis between hypertension and diabetes among the study population with socio-demographic factors, BMI and obesity*
(Odds ratios and 95 % confidence intervals)

	Hypertension		Diabetes	
Particulars	OR	95 % CI	OR	95 % CI
Regions				
East	1·0	–	1·0	–
North	0·58	0·45, 0·74	1·28	0·87, 1·87
Northeast	2·06	1·65, 2·56	0·94	0·60, 1·45
South	1·64	1·31, 2·07	1·89	1·29, 2·78
West	1·70	1·37, 2·12	3·04	2·13, 4·33
Age groups (years)				
20–39	1·0		10	
40–59	2·20	1·85, 2·59	2·88	2·17, 3·84
≥60	5·47	4·41, 6·78	5·86	4·29, 8·01
Sex				
Men	1·53	1·27, 1·84	–	–
Women	1·0	–	–	–
Education				
No formal education	1·0	–	–	–
Up to upper primary	0·97	0·81, 1·16	–	–
Secondary and above	0·67	0·55, 0·83	–	–
Occupation				
Labour/agriculture	1·0			
Housewife and elderly	1·22	0·99, 1·50	–	–
Service + business	1·43	1·14, 1·78	–	–
Others	1·04	0·81, 1·31	–	–
BMI (kg/m^2)				
CED	1·0		–	
Normal	1·38	1·11, 1·72	–	–
Overweight	2·17	1·68, 2·81	–	–
WC				
Normal	1·0		1·0	
Obese	1·98	1·61, 2·42	2·10	1·63, 2·68
WHR				
Normal	1·0			
Obese	1·35	1·13, 1·62	–	–

CED, chronic energy deficiency; WC, waist circumference; WHR, waist:hip ratio.
* Variables included: age groups, sex, education, occupation, activity status, BMI, WC, WHR.

Lower prevalence of hypertension and diabetes in the Eastern and Northern regions may be attributed to the low prevalence of overweight/obesity, abdominal obesity and low consumption of fat among the rural populations of these regions. The NNMB study of 2012 observed lower prevalence of hypertension and diabetes in a Northern state – that is, Uttar Pradesh – where the prevalence of hypertension was 17 and 14·5 %, whereas the prevalence of diabetes was 3·6 and 2·2 % among men, and women, respectively; in contrast, the prevalence of hypertension was high in the Eastern states such as Odisha (24 and 27·7 % among men and women, respectively) and West Bengal (29·9 and 29 % among men and women, respectively), whereas the prevalence of diabetes was low (Odisha: 4·7 and 3·4 %; West Bengal: 3·3 and 3·2 % among men and women, respectively)[15].

In the Southern region, Kerala is more developed with high literacy and low mortality, whereas Andhra Pradesh is a developing state. These regions include rice-eating populations, mostly dependent on agriculture, and use coconut oil (Kerala) and cotton seed oil (Andhra Pradesh) for cooking. Maharashtra and Gujarat of the Western region are also in the stage of development with high literacy and declining mortality, and these states have mixed dietary patterns and a changing lifestyle. Most of the Gujaratis are vegetarians. The climate varies between tropical wet, tropical wet and dry and semi arid. The Eastern states such as West Bengal and Odisha are less developed with high mortality, fertility and illiteracy and the population mostly subsists on rice with fish and other cereals. The Northeast is a backward enclave in a progressing economy in India. The population of this region includes tribals, who enjoy a Western lifestyle and eating pattern, consuming more non-vegetarian food including beef, pork and wild animals, but low intake of spices, sugar and oil, and they have low prevalence of abdominal obesity and truncal obesity[19]. Recent study by the NIN in Meghalaya and Nagaland also reported lower prevalence of abdominal obesity and low intake of fat, oil and sugar among the populations (unpublished results).

Thankappan *et al.*[20] in their study observed 21, 32·5 and 20·6 % prevalence of overweight (BMI ≥25 kg/m^2), hypertension and diabetes among the rural populations of Kerala, whereas another study by the NNMB reported 18–30, 18–19 and 14–16 % prevalence of overweight (BMI ≥25 kg/m^2), hypertension and diabetes among rural men and women in Kerala[16], which is similar to the present study.

Anchala *et al.*[21] in their meta-analysis reported 18 % prevalence of hypertension in rural areas of the Western region, 16·7 % in

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North India, 33 % in East India and 28 % in the Southern region of India. Midha *et al.*[22] in their study in Uttar Pradesh reported 14·5 % prevalence of hypertension in rural areas.

The NNMB study of 2012 also reported higher prevalence of diabetes in Kerala (14–16 %) and Gujarat in Western India (8–11 %) among men and women, respectively, whereas it was low in Eastern and Northern India[15].

Moser *et al.*[24] in their study carried out in six states of India observed 22–26 % prevalence of hypertension among men and women in rural areas and the risk was higher among those with higher secondary education and above as compared with subjects with no formal education. Studies by Reddy *et al.*[23] have shown that hypertension is significantly more prevalent in the lower education group as compared with higher education group. High prevalence of hypertension among subjects with no formal education may be due to low awareness of the condition among the population and high consumption of tobacco, alcohol and smoking among this group; these findings are in contrast with the findings of the NNMB study[15]. The risk was also observed to be higher among overweight and obese individuals as reported by others[20,24,25].

The strength of the study lies in its uniform methodology in the selection procedure and all the data were collected by a local team who were trained at a time in survey methodology by scientists from the NIN. Moreover, standard equipments were used for measuring BP, blood sugar and other variables. FBS was done only in half of the subjects covered for anthropometry, which is one of the limitations of this study, to validate the estimate of diabetes prevalence region wise.

In conclusion, the prevalence of overweight/obesity and hypertension was higher in the Southern region, whereas diabetes was higher in the South and Western regions. Factors such as increasing age, male sex, overweight/obesity and abdominal obesity were important risk factors for hypertension and diabetes. There is a need to increase awareness about the disease through appropriate information, education and communication that will help in promoting preventive measures, early diagnosis and control of these diseases.

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I. I. M. prepared the manuscript, M. V. V. R. carried out data analyses. All others were involved in study design, supervision and report writing.

The authors declare that there are no conflicts of interest.

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