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Prevalence of Hypertension and its Relationship with Adiposity among Rural Elderly Population in India

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Abstract

Background: The world has witnessed the demographic transition in which there is increased proportion of elderly (≥ 60 years) population. This increased longevity is associated with the burden of chronic non-communicable diseases.

Objective: To assess the prevalence of hypertension and its relationship with adiposity among the elderly in rural India.

Subjects and methods: A community based cross-sectional study was carried out among 3133 elderly (Men: 1677; Women: 1456). Height, weight, waist circumference (WC), and blood pressure were recorded on selected subjects.

Results: The overall prevalence of hypertension was 50% among rural elderly and significantly ($p<0.001$) a higher proportion of women (53.3%) had hypertension compared to men (47.3%). Prevalence of hypertension was significantly ($p<0.001$) higher among overweight / obese elderly and it increased significantly ($p<0.001$) with increasing body mass index (BMI), waist circumference and age. According to un-adjusted odds ratio (OR), higher BMI had twice the risk of having hypertension among both elderly men (OR=1.9; CI: 1.4-2.5) and women (OR=2.2; CI: 1.7-2.8). However, abdominal obesity, in terms of WC had higher risk (OR=2.6; CI: 2.0-3.3) of having hypertension compared to high BMI among elderly women. Similarly, other covariates such as older age, sedentary physical activity, wealth index in both genders and high consumption of sugar and salt in case of elderly women were significantly ($p<0.05$ to 0.01) associated with hypertension.

Conclusions: Prevalence of hypertension is a serious public health problem among elderly in India. Overweight/obesity is significantly associated with the high prevalence of hypertension in elderly. Therefore, effective preventive interventions, such as healthy lifestyles, regular physical activity and prudent dietary practices have to be adopted during middle age for the health promotion during old age.

Keywords

Hypertension, Elderly, BMI, WC, Overweight, Obesity

Abbreviations

BMI: Body Mass Index; WC: Waist Circumference; NNMB: National Nutrition Monitoring Bureau

Introduction

The size of the elderly segment of the population is increasing in developing countries, with a concomitant increase in life expectancy [1]. This development in demographic transition is associated with an epidemiological shift from communicable to non-communicable disease [2] leading to an enormous economical burden on households as well as on nations. Of these, hypertension is one of the most important causes of mortality and morbidity in the elderly [3], and accounts for a large proportion of cardiovascular diseases in the elderly [4]. As per the World Health Organization reports, the prevalence of hypertension among elderly was 69% and 55% respectively, in urban and rural areas of India [1].

Anthropometric evaluation is an essential feature of geriatric nutritional evaluation for determining malnutrition, being overweight, obesity, muscular mass loss, fat mass gain and adipose tissue redistribution [5]. The study of nutritional status of elderly is of particular importance, as they are at greater risk of malnutrition [6], and at the same time have an increased prevalence of many chronic diseases, which may be associated with nutritional status [7,8]. The prevalence of obesity is increasing drastically in many countries in the recent decade, [9] and it has become particularly high in the elderly population [10-12], and in India about 54% (Body mass index >22.25) of elderly had overweight/obesity [1]. In the elderly, obesity has been associated not only with increased mortality [13,14], but also with elevated risks of type 2 diabetes, impaired glucose tolerance [15], hypertension [16], lipid abnormalities [17], stroke [18], and coronary heart disease [19]. Obesity also contributes to functional decline and disability in elderly people [20].

Anthropometric indicators are used to evaluate the prognosis of chronic and acute diseases, and to guide medical intervention in the elderly [21]. The use of simple anthropometric measures as health outcome indicators, suitable for population screening, has aroused much interest [22]. Body Mass Index (BMI), waist Circumference (WC), and Waist-to-Hip Ratio (WHR) have been used as simple Anthropometric Indices (AI) for assessing the amount and distribution of body fat [23,24] and are useful indices in predicting the risks of type 2 diabetes, hypertension, and Cardio Vascular Diseases

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(CVDs) in adults [25,26]. Therefore, obesity represents a serious health concern that needs to be addressed to improve the health and well-being of the present and the future elderly population [27].

There is a limited data on the relationship between the prevalence of hypertension and indices of obesity among the elderly residing in rural areas of India. Therefore, keeping in view, this communication is prepared with the objectives to assess the prevalence of hypertension and adiposity, and their relationship among the elderly in rural India.

Methods

A community based cross-sectional study adopting the multi-stage stratified random sampling procedure was carried out by National Nutrition Monitoring Bureau (NNMB) during 2006 in the rural areas of nine States of India. The villages covered by National Sample Survey Organisation (NSSO) for its 54th round of consumer expenditure survey 1998 were taken as the sampling frame. The NSSO adopted two-stage random sampling method. The villages formed the First Stage-Sampling Units (FSU), while the households formed the Second Stage-Sampling Units (SSUs). The State was divided into different strata based on agro-climatic variables and one district or part of the district with a population of 1.8 million was considered as one stratum. For the purpose of the present survey, 16 strata were selected randomly from each State, and a sub-sample of 80 villages (@5 villages per stratum) was selected randomly from 16 strata. Thus, 713 (seven villages were not covered from the state of West Bengal due to various reasons) villages were covered from nine states.

Estimation of sample size

Assuming the prevalence of hypertension among rural adults (≥ 18 years) as 8%, with 95% confidence interval and 20% relative precision, a sample size of 1104 adults was arrived for each state. However, for this communication, data pertaining to elderly (≥ 60 years) was analysed and presented.

Selection of households and subjects

For the purpose of the study, each selected village was divided into five geographical areas based on natural groups of houses or streets. Households (HHs) belonging to Scheduled Caste (SC)/ Scheduled Tribe (ST) community, who generally live as a group, constituted one of the five areas. All HHs in each geographical area were enumerated starting from northeast corner. The first HH from each area was selected randomly using random number tables. Starting from the first HH, four consecutive HHs were covered for the survey. Adjacent HH was covered, in case the selected HH was door locked. Thus, 20 HHs were covered from each selected village. The original study was designed to assess the prevalence of hypertension among rural adults (18 years and over). However, we analysed the data pertaining to of 3133 older adults (Men: 1677; Women: 1456) aged 60 years and over for the present communication.

Information, on household demographic and socio-economic particulars was obtained from all the selected households (HHs). Anthropometric measurements such as height, weight and Waist Circumference (WC) were recorded on all available adults in selected HHs. Weight were measured with minimum clothing using SECA digital weighing scale (nearest to 0.1 kg)). Height was measured using anthropometric rod, with the subject made to stand erect on a flat surface (without footwear) with feet together. BMI was calculated as weight (kgs) divided by height in meters square. The WHO recommended BMI cut-off values for Asian adults' were used to calculate overweight and obesity [28], while the WC cut-off values of ≥ 90 cm and ≥ 80 cm were considered for men and women respectively, to calculate abdominal or central obesity [29]. Dietary intakes of individuals were obtained by one-day 24-hour re-call method of diet survey. Blood pressure was measured thrice at five-minute interval on left arm using appropriate size cuff of standardized mercury sphygmomanometer (Diamond Deluxe BP apparatus, Industrial Electronic and Allied products, Pune, India). Subjects were given rest for 10 minutes prior to recording of blood pressure and the measurement was taken on subjects in supine position as study was conducted in the rural area that is limited by seating furniture. The cuff was wrapped closely to the arm and kept at the level of heart. The mean blood pressure was considered. Elderly with systolic BP of ≥ 140 mmHg and/or diastolic BP of ≥ 90 mmHg and/or those on medication for high BP [30] were considered as hypertensive. The information of knowledge and practice on hypertension was also obtained from all the elderly.

Statistical Analysis

Statistical analysis was performed using SPSS version 19.0 [31]. Mean (with 95% CI) height, weight, BMI and WC were calculated for each gender and age groups. Mean comparisons of these variables done by age groups as well as gender using ANOVA 'F' with post-hoc test of LSD. An association of hypertension with socioeconomic variables were assessed by chi- square test. The risk of hypertension with adiposity and other covariates such as wealth index, diet, physical activity status and life style variables was estimated by Odds ratio using logistic regression analysis. A p-value of <0.05 was considered as statistically significant.

Household wealth was assessed by constructing an index generated with a statistical procedure known as principal components analysis. The variables included in the factor analysis were household socio-demographic variables such as type of house, occupation, per capita income as quintiles, source of drinking water, type of fuel used for cooking, electricity and sanitary latrine that are related to wealth status. The first component that explains most (23%) of the variance in the observed set of variables includes type of house, per capita income, electricity and sanitary latrine. This weighed the heaviest (>0.5) and was shown to be in positive direction and is expected to reflect an unobserved dimension, within the given model 'wealth'. This method was established in epidemiology during the 1990s and has been used as proxy for wealth assessment in the literature [32,33]. The regression scores from the first component were used to create an index that was divided into quintiles and then grouped as highest 20%, middle 40% and lowest 40%. This was chosen in line with Filmer and Prichett's work where the majority of the population was described, as poor according to most definition and only small proportion of population possess items associated with high standard of living [32,34,35].

Training and Standardization

The investigators of nine NNMB State units, comprising medical officer, nutritionist and social worker were trained and standardized for three weeks at National Institute of Nutrition (NIN) in recording of blood pressure and anthropometric measurements.

Ethical Clearance and consent

The Scientific Advisory Committee of the Indian Council of Medical Research (ICMR) has approved the study and ethical clearance was obtained from Ethical Review Board of National Institute of Nutrition. Informed oral consent was obtained from all the subjects.

The variables 'community' and "type of house" mentioned in the text is defined below

Community (Caste): Indian community is categorized into different castes that evolved historically based on their occupations. These were mainly divided into socially and economically underdeveloped poorer sections of the society like Scheduled Caste (SC) and Scheduled Tribe (ST), who are provided with certain social guarantees schemes by the Government of India. Other communities are socially developed and economically well off.

Types of house

Kutcha house: It comprises of mud wall and thatched roof. Semi-Pucca house: Brick/stone wall with asbestos or tin roof.

Pucca house: Brick wall with reinforced concrete cement (RCC) roof.

Table 1: Mean (95% CI) height, weight, body mass index and waist circumference of rural elderly.

Age group (Yr)	Men			Women		
	n	Mean	95% CI	n	Mean	95% CI
Height (cm)						
60-69	1123	161.1	160.8-161.6	1028	148.6	148.2-149.0
70-79	453	160.5	159.9-161.0	351	147.5	146.8-148.2
≥ 80	101	155.5	158.2-160.8	77	145.0	143.5-146.4
Total	1677	160.9	160.6-161.2	1456	148.1	147.8-148.5
Weight (Kg)						
60-69	1123	51.5	50.9-52.1	1028	45.6	44.9-46.2
70-79	453	49.9	48.9-50.8	351	43.7	42.5-44.8
≥ 80	101	48.5	46.6-50.5	77	39.5	37.6-41.3
Total	1677	50.8	50.3-51.3	1456	44.8	44.3-45.4
BMI						
60-69	1123	19.8	19.5-20.0	1028	20.6	20.3-20.9
70-79	453	19.3	19.0-19.6	351	20.0	19.5-20.4
≥ 80	101	19.0	18.4-19.7	77	18.7	17.9-19.5
Total	1677	19.6	19.4-19.8	1456	20.4	20.1-20.6
WC						
60-69	1123	75.8	75.1-76.5	1028	71.7	71.0-72.4
70-79	453	76.1	75.0-77.1	351	71.1	69.8-72.4
≥ 80	101	75.0	73.0-77.2	77	69.0	66.5-71.5
Total	1677	75.8	75.3-76.4	1456	71.4	70.8-72.0

BMI: Body Mass Index; **WC:** Waist Circumference.

Table 2: Prevalence (%) of hypertension among elderly by age group and gender.

Age group (Yr)	n	Systolic only	Diastolic only	Hypertension
Men				
60-69	1123	38.6	24.0	46.0
70-79	453	43.0	17.7	47.9
≥ 80	101	54.5	23.8	58.4
Pooled	1677	40.8	22.3	47.3
		χ^2=10.9	χ^2=7.7	χ^2=5.8
		(P<0.01)	(P<0.05)	(P=0.055)
Women				
60-69	1028	44.4	25.1	49.2
70-79	351	56.4	27.1	61.8
≥ 80	77	63.6	28.6	68.8
Pooled	1456	48.3	25.8	53.3
		χ2=22.9	χ2=0.9	χ2=24.8
		(P<0.01)	(P>0.05)	(P<0.01)
Pooled				
60-69	2151	41.4	24.5	47.6
70-79	804	48.9	21.8	54.0
≥ 80	178	58.4	25.8	62.9
Pooled	3133	44.3	23.9	50.1
		χ2=28.7	χ2=2.9	χ2=22.1
		(P<0.01)	(P>0.05)	(P<0.01)

Results

Mean (with 95% CI) height, weight, BMI and WC by age groups and gender are presented in Table 1. In general, the mean values of height, weight, BMI and WC tended to decrease with increase in age. Prevalence of hypertension by age group and gender is presented in Table 2. Systolic blood pressure (SBP) increased significantly (p<0.001) with increase in age in both genders, while such trend was not observed with the Diastolic Blood Pressure (DBP). The prevalence of hypertension increased significantly (p<0.01) with increasing age in elderly women. Though statistically not significant (p>0.05), an increasing trend in the prevalence of hypertension with age was observed in elderly men. Significantly (p<0.001) a higher proportion of elderly women (53.3%) had hypertension as against their male counterparts (47.3%).

Prevalence of hypertension among different BMI and WC groups by gender is presented in Table 3. Prevalence of hypertension increased significantly (p<0.001) with increase in BMI and waist circumference and this trend was observed in both genders. Similarly,

Table 3: Prevalence (%) of hypertension according to BMI and WC by Gender.

MEN			
BMI	**Hypertension**	**WC**	**Hypertension**
<18.5	38.8	< 90	45.8
18.5-23.0	51.2	≥ 90	57.0
≥ 23	58.7		
Total	47.3		47.3
Chi-square	χ^2=48.6		χ^2=9.7
P- value	P<0.001		P<0.002
WOMEN			
<18.5	42.2	< 80	48.3
18.5-23.0	55.4	≥ 80	70.6
≥ 23	65.6		
Total	53.3		53.3
Chi-square	χ^2=55.2		χ^2=51.3
P- value	P<0.001		P<0.001

BMI: Body Mass Index; **WC:** Waist Circumference.

Table 4: Prevalence (%) of adiposity and hypertension among elderly by States and gender.

State	MEN			WOMEN		
	BMI>23	WC>90	HTN	BMI>23	WC>80	HTN
Kerala	20	10.6	68.3	38.2	45.9	77
Tamil Nadu	17.6	15	38.7	28	26.8	49.4
Karnataka	15.7	14.1	40.2	18.6	15.2	49.2
AP	21.2	19.7	55.8	25.9	22.9	69.5
Maharashtra	19.3	14.3	47.8	25.5	20.2	42.9
Gujarat	18.9	15.3	24.7	22.3	12.7	16.8
MP	5.9	3.8	38.5	22.2	21.4	35.7
Orissa	7.9	7.6	51.3	8.1	5.1	64.1
West Bengal	7.6	5.3	42.9	12.2	6.1	59.2
Average	16.6	13.2	47.2	24.9	22.9	53.3
Chi-square	$\chi^2$3.8=	$\chi^2$6.82=	$\chi^2$1.98=	$\chi^2$7.74=	$\chi^2$3.621=	$\chi^2$9.202
P- Value	P<0.000	P<0.000	P<0.000	P<0.00	P<0.000	P<0.000

Note: AP: Andhra Pradesh; MP: Madhya Pradesh

BMI: Body Mass Index; **WC:** Waist Circumference; **HTN:** Hypertension

the prevalence of hypertension was significantly (p<0.001) higher among overweight /obese elderly of both genders as compared to non-overweight /obese.

The prevalence of adiposity and hypertension among elderly by State and gender is presented in Table 4. The prevalence of adiposity and hypertension was highest among the elderly of both genders residing in the State of Kerala, followed by Andhra Pradesh and West Bengal. The prevalence was lowest in the state of Gujarat followed by Madhya Pradesh. In general, the prevalence of adiposity and hypertension was statistically significant (p<0.001) between states and genders.

Association of hypertension with different socio-demographic variables

The prevalence of hypertension was significantly (p<0.01) lower among the elderly belonging to low socio-economic communities, those residing in kutcha type of houses, in HHs where the major occupation of head of the household was labour and among the household with land holding 2.5 to 5.0 acres compared to their counterparts. While, significantly (p<0.01) a higher proportion of elderly had hypertension in the HHs, with head of the HH being literate and with small family size (Table 5).

Estimation of risk of hypertension among elderly in terms of adiposity and other covariates

Risk of hypertension in relation to adiposity, socio-demographic, dietary and life style variables was assessed in both the genders and presented in Table 6. According to un-adjusted odds ratio, higher BMI had twice the risk of having hypertension in both elderly men (OR=1.9; CI: 1.4-2.5) and women (OR=2.2; CI: 1.7-2.8). However, in elderly women, abdominal obesity in terms of WC had higher risk (OR=2.6; CI: 2.0-3.3) of having hypertension compared to

Table 5: Prevalence (%) of hypertension by Socio-demographic variables.

	N	%	P-Value
Community			
Scheduled Tribe	175	31.4	P<0.001
Scheduled Caste	589	47.9	
Backward Caste	1225	52.8	
Others	1144	51.1	
Type of House			
Kutcha	609	46.1	P<0.01
Semi-Pucca	1988	49.8	
Pucca	536	55.6	
Occupation			
Labour	948	44.4	P<0.001
Cultivation	1089	48.0	
Service/Business	1096	57.0	
Literacy Status			
Illiterate	959	44.8	P<0.001
Literate	2174	52.4	
Family size			
1-4	1196	51.8	P<0.01
5-7	1488	50.6	
≥ 8	449	43.4	
Land holdings (Acers)			
No land	1213	48.7	P<0.001
<2.5	1083	55.3	
2.5-5.0	333	42.3	
>5.0	504	47.2	

BMI. Similar trend was observed when adjusted for confounding variables such as age, community, type of house, major occupation and literary status of head of the household, family size and land holding. Similarly, a significant (p<0.05 to 0.01) association was observed between hypertension and other covariates such as age, sedentary physical activity, wealth index in both genders and higher consumption of sugar and salt in case of elderly women. However, such association was not reported in case of other foods and substance abuse of tobacco and alcohol.

Discussion

An epidemiological shift in the prevalence of hypertension in developing countries as compared to developed countries has been observed (34,35). Several community-based studies revealed that hypertension is rapidly emerging, as public health problem in developing countries [36], and it becomes an increasing burden among the elderly in the Indian subcontinent [1].

The relationship between anthropometric indices and cardiovascular risk factors have been studied extensively in adults, and their positive relationship with hypertension was recognised [24-26,37,38]. However, few studies reported this relationship among the elderly [22,25,27], and there is paucity of such data in India, particularly among the elderly residing in rural areas. Though a few studies have reported the prevalence of hypertension and obesity among the elderly in India, they are urban based [39,40]. This study, perhaps, for the first time, comprehensively carried out exclusively in rural areas of nine major states of India, covering large sample size. In general, half of the elderly population residing in the rural areas of India had hypertension (Men: 47.3%; Women: 53.3%), and 17% men and 25% women were overweight /obese in terms of BMI, while about 13% of men and 23% of women, respectively had abdominal obesity as per WC. The prevalence of hypertension in the present study was higher as compared to rural elderly of Puducherry (40.5%) [41] and Karnataka (30-32%) [42] and comparable with the figures reported for the elderly (51.8%) in the state of Kerala [43]). Whereas, the prevalence of hypertension was lower compared to the prevalence reported for the elderly (58%) in north India [40]) and rural elderly of Himachal Pradesh (61%) [44]) and Tamilnadu (59%) [45]. While, the figures reported by the WHO hypertension study group [1] for rural elderly of Kerala (55%) and Bangladesh (53%) were relatively higher. Similarly, the prevalence of hypertension was higher among Chinese rural elderly (57-65%) [46] as compared to their Indian counterparts.

Table 6: Estimation of risk (OR)¥ between hypertension and different covariates among elderly by gender.

Variables	Men	Women
WC	1.6 (1.2-2.1) **	2.6 (2.0-3.3) **
WC †	1.5 (1.1-2.0) **	2.3 (1.8-3.1) **
BMI (≥ 23)	1.9 (1.4-2.5) **	2.2 (1.7-2.8) **
BMI (≥ 23) †	2.0 (1.6-2.7) **	2.0 (1.6-2.7) **
Age (70-80 yrs)	1.1 (0.9-1,3)	1.7 (1.3-2.2) **
Age (≥ 80 yrs)	1.6 (1.1-2.5) *	2.3 (1.4-3.8) **
Tobacco	1.0 (0.8-1.2)	0.9 (0.7-1.1)
Alcohol	1.0 (0.8-1.2)	0.7 (0.4-1.5)
Salt (5-7g)	1.1 (0.7-1.6)	1.6 (1.1-2.4) **
Salt (>7g)	1.0 (0.7-1.5)	1.8 (1.2-2.6) **
Sugar (2nd tertile)	1.1 (0.7-1.8)	1.5 (0.9-2.4)
Sugar(3rd tertile)	1.1 (0.7-1.8)	1.9 (1.2-3.1) **
Sedentary physical activity	1.7 (1.4-2.1) **	3.1 (2.2-4.4) **
Wealth index(2nd tertile)	0.9 (0.7-1.1)	1.5 (1.1-2.0) **
Wealth index(3rd tertile)	1.5 (1.1-2.0) **	2.9 (2.1-3.9) **

Note: Figures in parenthesis indicate 95% Confidence Interval. ¥ OR: Odds ratio. Symbol * indicated p<0.05 and ** indicates p<0.01

† Confounding variables are age, community, type of house, head occupation and education, family size and land holding.

BMI: Body Mass Index; **WC:** Waist Circumference

Adiposity in terms of BMI and WC was significantly higher in elderly with hypertension, compared to non-hypertensive, and a significant relationship (p<0.01) was observed between adiposity and both systolic and diastolic blood pressure in both the genders, which is consistent with the findings reported by other studies [47-50]. Though both BMI and WC had significant correlation with hypertension, it was relatively higher with BMI (Men: SBP r=0.204: DBP r=0.203 & Women: SBP r=0.202: DBP r=0.190) compared to waist circumference. However, the correlation of WC with SBP was higher in elderly women (SBP r=0.205). In general, the odds of having hypertension was more among obese elderly of both genders in terms of BMI and WC; and Huang et al reported the similar findings among the elderly in Taiwan [27]. However, in the present study, the odds of having hypertension are relatively higher in females compared to males. Thus, this study revealed that there is strong relationship between adiposity and hypertension, which is in similar lines with the findings reported by other studies [51-53].

Similarly, other covariates such as age, sedentary physical activity, wealth index in both genders and high consumption of sugar and salt in case of elderly women were significantly (p<0.05 to 0.01) associated with the prevalence of hypertension. Deshmukh et al. also reported age group and sedentary physical activity as risk factors for the hypertension [54]. Smoking and alcohol did not show significant association with hypertension, which is consistent with the observations reported by other studies [54,55]. The prevalence of hypertension was significantly (p<0.01) different among various socio-demographic variables such as community, type of house, literacy status, occupation, family size and land holding. The knowledge and practice (K&P) of elderly on hypertension revealed that only 59% of 3133 elderly were aware of the term high blood pressure or hypertension, and majority (64%) did not know their blood pressure status. Only 12.4% of elderly hypertensives were aware that they had hypertension, and 9.5% of them were on regular treatment. Therefore, elderly population needs periodic screening for early detection of hypertension and initiation of appropriate treatment, because untreated or uncontrolled high blood pressure in elderly lead to organ damage and clinical cardio-vascular diseases [56].

Conclusions

The prevalence of hypertension is a serious public health problem among the rural elderly in India. The prevalence of overweight/obesity is also increasing in alarming proportions among the elderly. Overweight/obesity in terms of BMI and WC strongly correlated with the prevalence of hypertension, one of the major risk factors for cardiovascular diseases. Therefore, it reiterated the need for

primordial prevention through Behavioural Change Communication (BCC) strategies for the prevention of emergence of modifiable risk factors for obesity and hypertension by adopting healthy lifestyles, regular physical activity and prudent dietary practices during early adulthood. Majority of elderly hypertensives were not aware of their blood pressure as well as nutritional status. Thus, they are at risk of development of cardio-vascular and renal complications associated with untreated hypertension, which would adversely affect the health status of elderly and economic status of communities. Hence, there is a need for primary prevention through which we could avoid the complications of hypertension and obesity through early detection and appropriate interventions or treatment.

Limitations of the study

This communication was prepared utilising the original study designed to assess the prevalence of hypertension among the rural adult (18 years and over) population. The data pertaining to elderly (60 years and over) was analysed for this communication. Information of cardio-vascular and other non-communicable diseases was not collected in the present study, which could have useful for assessment of relationship with adiposity. Relevant bio-chemical parameters, especially, the lipid profile of subjects were also not estimated.

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