World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 6.129

CO-RRELATION OF GENERAL AND ABDOMINAL OBESITY WITH CORONARY HEART DISEASE RISK FACTORS AMONGST URBAN AND RURAL MEN FROM CENTRAL INDIA-A PROSPECTIVE STUDY AT TERTIARY CARE HOSPITAL

Prof. Premshanker Singh*[1], Mridu Singh[2], Vikram Singh[3] and Nikhil Gupta[4]

[1]FMR Prof and Head Medicine, [2]Assoc Prof Medicine, [3]Prof and Head Medicine, [4]Assoc Prof Medicine
Dr. RML Institute of Medical Sciences, Lucknow, India-226010.

Corresponding Author: Prof. Premshanker Singh
FMR Prof and Head Medicine Dr. RML Institute of Medical Sciences, Lucknow, India-226010.

Article Received on 26/12/2021 **Article Revised on 16/01/2022** **Article Accepted on 06/02/2022**

ABSTRACT

The relationship of body mass index (BMI) and waist circumference to coronary heart disease (CHD) risk factors eg blood pressure,total cholesterol and high-density lipoprotein (HDL) cholesterol levels was examined in urban (n = 220) and rural (n = 204) men aged ≥ 20 years amongst study population of urban and rural central India. Using ANCOVA we found significant difference (p< 0.01) for systolic blood pressure, total cholesterol and HDL cholesterol between the urban and rural samples. The Pearson's correlation coefficients suggest that BMI and waist circumference had significant relationships with most of the risk factors in both the populations. In multiple linear regression, BMI showed significant positive association with systolic and diastolic blood pressures (p< 0.01) and HDL cholesterol p(< 0.05) in the rural population . Comparing the association of abdominal obesity and waist circumference) with CHD risk factors, waist circumference better correlated with most of the risk factors.

KEYWORDS: Abdominal obesity, Coronary heart disease risk, Total cholesterol, Waist Circumference.

INTRODUCTION

Overweight and obesity are defined by the World Health Organization as abnormal or excessive fat that accumulate and present a risk to health.[1] Obesity is measured as body mass index (BMI), which is a person's weight (in kilograms) divided by the square of his or her height (in meter). A person with a BMI of 30 or more is generally considered obese. A person with a BMI equal to or more than 25 is considered overweight.[1,2]

The degree and incidence of obesity in the U.S. has been increasing in both adults and children.[3] In the United States, nearly 70% of adults are classified as overweight or obese.[3] An estimate of 2.6 million deaths worldwide and 2.3% of the global burden of disease are caused by obesity.[4,5] Obesity was found to be a major risk factor for the development of type-2 diabetes, hypertension, stroke, coronary artery disease, cancer and cancer-related mortality, liver and gallbladder diseases, sleep apnea, osteoarthritis, and gynecological complications.[2,6] Obesity also adds to risk once the levels of coexisting risk factors are taken into account. Obesity is associated with elevated blood pressure, blood lipids, and blood glucose; changes in body weight are coincident with changes in these risk factors for disease.[7,8]

Cardiovascular disease (CVD) mortality and morbidity has been shown to be elevated in individuals who are overweight, particularly with central deposition of adipose tissues.[4] Abdominal obesity has been shown to be a risk factor for CVD worldwide.[8] Obesity may be associated with hypertension, dyslipidemia, diabetes, or insulin resistance, and elevated levels of fibrinogen and C-reactive protein, all of which increase the risk of CVD events.[9]

In addition to CVD, obesity has been shown to increase the risk of high blood pressure (HBP).[2,8] Persistent hypertension is one of the risk factors for stroke, myocardial infarction (MI), heart failure arterial aneurysm and is a leading cause of chronic kidney failure. Moderate elevation of arterial blood pressure leads to shortened life expectancy, which also increases the risk of heart diseases.[2]

The highest rates of obesity are usually found among African American and Latino, especially the youth.[10,11] For the past three years Mississippi was named the most obese state in the country.[12] Racial and ethnic disparities of obesity, in addition to regional.

Cardiovascular disease is a major public health problem bothin developed and in developing countries, like India. Coro- nary heart disease (CHD) is now on the increase in India, possibly due to the changing lifestyle, and is causing grave concern. It has been predicted that cardiovascular diseases will be the most important cause of mortality in India by the year 2025.[1,2] The WHO,[3] expert committee on cardio- vascular disease and hypertension recommended epidemio- logical surveys in as many countries as possible to analyze the risk factors and prevalence of the disease in different countries. Many risk factors are responsible for this disease. However, the major and significant risk factors for CHD are hypertension, hypercholesterolemia, diabetes, obesity and sedentary lifestyle.[4] In addition, the role of body-fat distrib- ution in human disease has recently attracted much attention from epidemiologists, physiologists and anthropomologists. Obesity is considered to be a predisposing factor for several chronic diseases, including cardiovascular disease,[5,6] hyper- tension,[6] stroke,[6] and noninsulin-dependent diabetes melli- tus.[8,9] An understanding of the underlying etiology of obesity may be useful in reducing morbidity and mortality. The body mass index (BMI) refers to overall obesity whereas waist-to- hip ratio (WHR) refer to abdominal adiposity. Abdominal obesity and WHR have significant associations with most of the CHD risk factors in south Asian populations.[10]

Hypertension (or high blood pressure) is the most com- mon risk factor for CHD and stroke, affecting 20% of the adult populations in both developed and developing coun- tries.[11,12] It is a well known fact that high levels of choles- terol and low levels of high-density lipoprotein cholesterol (HDLc) are predictors of CHD. The purpose of this study was twofold: firstly, to examine the association of obesity with CHD risk factors and to observe the differences in the influence of obesity on these CHD risk factors in urban and rural Indian men, and secondly, to ascertain whether overall obesity or abdominal obesity is better correlated with CHD risk factors.

MATERIALS AND METHODS

The data were collected from adult men aged ≥ 20 years from urban and rural population of Lucknow, India. The aims and objectives of the study were explained to all the subjects and their consent was obtained. Only normal and healthy individuals were included in this study. A total of 110 and 102 men from urban and rural areas, respectively were included in the study

The data on anthropometry includes height, weight and waist (abdominal) circumference. Height was measured to the nearest 0.1 cm with a standard anthropometer and weight to the nearest 0.1 kg with a portable weighing machine and light clothing. By using standard non-elastic tape, waist circumference was measured to the nearest 0.1 cm at the umbilicus. Standard landmarks and methodology were fol- lowed in recording the anthropometric measurements.[13] The body mass index (BMI), to estimate overall obesity, was calculated by dividing body-weight in kilograms by height in metres squared (kg/m^2).The abdominal girth was measured in meters, weight (W) in kg and height (H) in meters,[10] A body mass index ≥ 30 kg/m^2 was considered overweight.

Data on the age, smoking habits and physical activity of each individual were also collected. The smoking habits were categorised as smokers or non-smokers. Current smokers, past smokers and users of all forms of tobacco were pooled together as smokers. Physical activity was classified into three levels. Low/sedentary activity referred to people involved in office work, research, teaching, business and land ownership; medium activity was attributed to dual jobs and land owners involved in agriculture work; and high activity referred to farmers actively involved in the field and in agri- culture labours.[10]

Systolic and diastolic blood pressures were measured by recording the appearance and disappearance of Korotkoff's sounds to the nearest 2 mmHg on a seated subject. Subjects were identified as hypertensive,[15] if their blood pressure ≥ 140 mmHg systolic or 90 mmHg diastolic.

Total cholesterol and HDLc levels were estimated using standard protocols.[17,18] Hypercholesterolemia and low high-density cholesterol levels were determined according to the definitions of the United States National Cholesterol Education Programme.[19] Based on this criteria, high serum total cholesterol (TC) was taken as ≥ 200 mg/dL and low HDLc was taken as < 40 mg/dL.

RESULTS

Table 1 shows the descriptive statistics for anthropometry, blood pressures, TC and HDLc levels. The urban population showed significantly higher mean values for all variables except DBP. The difference in prevalence of various risk fac-tors between the urban and the rural samples are presented in Table 2. The results showed that obesity, hypertension, hypercholesterolemia and sedentary life style were more prevalent in urban men, although smoking was more preva- lent in the rural sample. Comparison of x-2-values showed that the prevalence of obesity and sedentary lifestyle were significantly greater in the urban sample, but no significant difference was found for hypertension, hypercholesterolemia and low HDLc levels. Since there were differences in age, smoking habit and physical activity between the urban and rural populations, the mean values of the four risk factors (SBP, DBP, TC and HDLc) between these two populations were compared through ANCOVA adjusting for age, smoking and physical activity. The results suggest that the variance was significant for SBP (F = 5.873, P = 0.000); TC(F = 2.804, P = 0.002) and HDLc (F = 3.036, P = 0.001).

While no significant variance was found for DBP (F =

1.543, P = 0.117). The R^2 values suggest that the factors and covari-ate together explain about 24, 8, 13 and 14% of the variation in SBP, DBP, TC and HDLc, respectively.

Table 3 shows the Pearson's correlation coefficients between age and body composition measures with blood pressures, TC and HDLc levels. Age showed a significantly positive correlation with SBP and TC and a significantly negative correlation with HDLc in the urban population, whereas in the rural population, age had a positive significant association with SBP and DBP only. The BMI was positively.

Table 1: Physical characteristics of the study population.

Characteristic	Urban (*n* = 220)	Rural (*n* = 204)	*P*-value
Age	47.4 ± 9.1	40.8 ± 14.2	< 0.01
Height	168.3 ± 6.5	166.2 ± 6.4	< 0.05
Weight	68.4 ± 11.2	59.9 ± 11.8	< 0.01
Waist circumference	89.9 ± 10.0	79.9 ± 11.1	< 0.01
Body mass index	24.1 ± 3.8	21.6 ± 3.6	< 0.01
Systolic blood pressure	128.6 ± 18.7	120.6 ±14.8	< 0.01
Diastolic blood pressure	86.8 ± 11.3	84.6 ± 9.9	NS
Total cholesterol (mg/dL)	176.7 ± 45.8	163.0 ± 47.5	< 0.05
(mmol/L)	4.6 ± 1.2	4.2 ± 1.2	
HDL cholesterol (mg/dL)	42.2 ± 8.7	46.5 ± 9.0	< 0.01
(mmol/L)	1.1 ± 0.2	1.2 ± 0.2	

HDL, high-density lipoprotein; NS, not significant.

Table 2: Different cardiovascular disease risk factors between the urban and rural study population.

Characteristic	Urban (*n* = 220) *n* (%)	Rural (*n* = 204) *n* (%)	*P*-value
Overweight BMI ≥ 30	20 (9.0)	0 (0.0)	< 0.01
Hypertension ≥ 140/90	100 (46.0)	34 (33.0)	NS
Hypertension ≥ 160/95	52 (24.0)	16 (16.0)	NS
Total cholesterol ≥ 200	32 (15.0)	10 (10.0)	NS
HDL cholesterol < 35	36 (17.0)	10 (10.0)	NS
Smoking	60 (27.0)	34 (33.0)	NS
Low/sedentary physical activity	108 (49.0)	24 (26.0)	< 0.01

BMI, body mass index; HDL, high-density lipoprotein; NS, not significant.

Table 3: Comparisons between age, body composition measures, blood pressure and lipid levels.

	Urban				Rural			
Characteristic	Age	BMI	CI	Waist circumference	Age	BMI	CI	Waist circumference
SBP	0.326**	0.228*	0.173	0.242*	0.468**	0.579**	0.354**	0.502**
DBP	0.176	0.323**	0.163	0.566**	0.225*	0.578**	0.208*	0.443**
TC	0.327**	0.081	0.147	0.130	0.137	0.442**	0.290**	0.445**
HDLc	– 0.224*	– 0.054	– 0.036	– 0.035	– 0.049	– 0.331**	– 0.016	– 0.250*

Two-tailed statistical significance (Pearson's correlation coefficient): * 0.05 > P > 0.01; ** 0.01 > P > 0.01; *** P < 0.001. BMI, body mass index; DBP, diastolic blood pressure; HDLc, high-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol.

and significantly associated only with both the blood pres- sures in the urban sample but in the rural sample, BMI had a significant positive association with both the blood pressures and TC and an inversely significant association with HDLc. Waist circumference had a significant positive association with SBP and DBP in the urban population while in the rural population it had a significant positive association with SBP, DBP and TC and a significant inverse relation with HDLc. Further, we calculated partial correlation coefficients between adiposity measures, blood pressures and lipid levels corrected for age, smoking habit and physical activity. These results are presented in Table 4. Even after correcting for these factors, the relationship between adiposity measures and CHD risk factors remained constant in the urban and rural samples.

The results of the multiple linear regression analysis with SBP, DBP, TC and HDLc as dependent variables is presented in Table 5. The SBP was significantly positive in relation to age in the urban population and age and BMI in the rural The DBP was significantly positive in association with BMI in the rural population only. The TC.

Table 4: Comparisons between body composition measures, blood pressure and lipid levels ; controlling for age, smoking and physical activity.

Variable	BMI	UrbanCI	Waist circumference	BMI	RuralCI	Waist circumference
SBP	0.227**	0.109	0.216*	0.547**	0.157	0.404**
DBP	0.324**	0.124	0.288**	0.556**	0.113	0.400**
TC	0.071	0.096	0.102	0.424**	0.255	0.427**
HDLc	– 0.057	– 0.012	– 0.023	– 0.326**	– 0.012	– 0.249**

Two-tailed statistical significance (partial correlation coefficients): * $0.05 > P > 0.01$; ** $0.01 > P > 0.001$; *** $P < 0.001$. BMI, body mass index; DBP, diastolic blood pressure; HDLc, high-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol.

Table 5: Multiple linear regression analysis of data in study population.

Dependent variable	Variables in equation	Urban *B*	*P*-value	Rural *B*	*P*-value
SBP	Age	0.320	0.001	0.367	0.000
	BMI	0.050	0.891	1.182	0.001
	CI	–0.088	0.740	0.359	0.224
	Waist circumference	0.224	0.660	–0.990	0.059
	Smoking	0.153	0.100	0.027	0.714
	Physical activity	–0.042	0.966	0.014	0.850
		$R^2 = 0.180$		$R^2 = 0.488$	
DBP	Age	0.172	0.065	0.162	0.101
	BMI	0.225	0.544	1.047	0.005
	CI	–0.075	0.781	0.062	0.848
	Waist circumference	0.140	0.788	–0.604	0.288
	Smoking	0.054	0.569	0.056	0.492
	Physical activity	–0.089	0.336	–0.001	0.993
		$R^2 = 0.146$		$R^2 = 0.389$	
TC	Age	0.316	0.001	0.080	0.464
	BMI	–0.113	0.763	–0.407	0.311
	CI	–0.028	0.918	–0.640	0.075
	Waist circumference	0.217	0.678	1.314	0.039
	Smoking	0.103	0.279	–0.112	0.216
	Physical activity	0.070	0.452	–0.071	0.435
		$R^2 = 0.132$		$R^2 = 0.248$	
HDLc	Age	–0.222	0.023	–0.192	0.078
	BMI	–0.536	0.167	0.818	0.042
	CI	–0.321	0.257	1.383	0.000
	Waist circumference	0.690	0.203	–2.073	0.001
	Smoking	0.086	0.385	0.142	0.114
	Physical activity	0.029	0.762	0.059	0.514
		$R^2 = 0.072$		$R^2 = 0.257$	

BMI, body mass index ; DBP, diastolic blood pressure; HDLc, high-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol.

Showed a significant positive relationship with age in the urban population and waist circumference in the rural popu- lation. The HDLc was inversely significantly associated with age in the urban population and BMI and waist circum- ference in the rural population. The age, smoking habit, physical activity and adiposity measures among the urban and rural population, explained 18% and 49% of variation for SBP, 15% and 39% of variation for DBP, 13% and 25% of variation for TC, and 7% and 26% of variation for HDLc, respectively.

DISCUSSION

The prevalence of cardiovascular disease risk factors (i.e. obesity, hypertension and hypercholesterolemia) was higher among urban men in the present study. However, smoking was more prevalent in rural men. Most of the urban pop- ulation led a sedentary lifestyle comparable to the rural population. The differences in lifestyle may be the cause for differences in obesity, abdominal obesity, hypertension and hypercholesterolemia. The ANCOVA (adjusting for age, smoking and physical activity) suggested that there was a significant difference between the urban and rural populations in SBP, TC and HDLc ($P < 0.01$). Earlier studies on Indian populations[20–22] also showed a greater prevalence of coronary heart disease and risk factors in urban subjects. In a population-based study among Marwaris of Calcutta,[23] the Marwaris had 17% of hypertension and the means of SBP, DBP, TC and HDLc were 125.30 mmHg, 82.28 mmHg,176.86 mg/dL and 41.06 mg/dL, respectively. Although the results of our study showed similar findings, no significant difference was observed for hypertension and smoking habit between the urban and rural populations (Table 2).

In the present study BMI and waist circumference were significantly associated with many CHD risk factor.[10] Pertaining to BMI and WHR, our results were consistent with other studies of black,[24,25] and white,[27-30] populations from outside India. The BMI of the women of Thailand showed significant association with TC and HDLc, while WHR had a significant association with HDLc only.[31] Lean *et al.*[32] showed that men with a large waist circumference (>102cm) may develop several disorders including shortness of breath, hypercholesterolemia, hypertension and difficulty with the basic activities of daily life.

Considering the Indian data, the abdominal obesity mea sured through WHR showed a significant association with blood pressure, but not with lipid levels, in rural men of Rajasthan State, India.[33] In another study, the BMI significantly influenced the lipid levels but not the WHR of men and women of Andhra Pradesh State.[34,35] The present study supports the earlier studies conducted on Indian populations,[33,35] but not on European and American populations.[10] In general though, South Asians as a group are not more obese than other ethnic groups as assessed by their BMI. What certainly distinguishes the southern Asians from other ethnic groups is their predisposition to develop abdominal obesity, resulting in an increased WHR. Abdominal obesity,therefore, appears to be a strong independent risk factor for coronary artery disease among South,[36] Asians and may go some way in explaining the high mortality rate due to coronary artery disease in this ethnic group. We concluded that BMI and abdominal obesity measured by waist circumference were more powerful in influencing CHD risk factors and were more reliable risk factors in the present study.

Conflict of interest- None.
Ethical clearance- Taken from ethical committee of Institute.
Funding-None.

REFERENCES

1. WHO Expert Committee on cardiovascular disease and hyper-tension. Geneva, Tech Rep Ser No, 1959; 158.
2. Enas EA, Yusuf S, Mehta JL. Prevalence of coronary artery disease in Asian Indians. Am J Cardiol, 1992; 70: 945–949.
3. Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjostrom L. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow-up of participants in the population study of women in Gothenburg, Sweden. BMJ, 1984; 289: 1257–1261.
4. Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Bjorntorp P, Tibblin G. Abdominal adipose tissue distribution, obesity and risk of cardiovascular disease and death. 13 year follow-up of participants in the study of men born in 1913. BMJ, 1984; 288: 1401–1404.
5. Williams DP, Going SB, Lohman TG, Harsha DW, Srinivasan SR, Webber LS, Berenson GS. Body fatness and risk for elevated blood pressure, total cholesterol and serum lipoprotein ratios in children and adolescents. Am J Public Health, 1992; 82: 358–363.
6. Baxa CA, Sha RS, Buelt MK, Smith AJ, Matarese V, Chinander LL, Boundy KL, Bernlohr DA. Human adipocyte lipid-binding protein: purification of the protein and cloning of its complementary DNA. Biochemistry, 1989; *28*: 8683
7. Lundgren H, Bengtsson C, Blohme G, Lapidus L, Sjostrom L. Adiposity and adipose tissue distribution in relation to incidence of diabetes in women: results from a prospective study in Gothenburg, Sweden. Int J Obes, 1989; 13: 413–423.
8. Ohlsson LO, Larsson B, Svardsudd K, Welin L, Eriksson H, Wilhelmsen L, Bjorntorp P, Tibblin G. The influence of body fat distribution on the incidence of diabetes mellitus. 13.5 years of follow-up of the participants in the study of men born in 1943. Diabetes, 1985; 34: 1055–1058
9. Valdez R, Seidell JC, Ahn YI, Weiss KM. A new index of abdomi- nal adiposity as an indicator of risk for cardiovascular disease. A cross-population study. Int J Obes, 1993; 17: 77–82.
10. Mitchell LE, Nirmala A, Rice T, Reddy PC, Rao DC. The impact of energy intake and energy expenditure of activity on the familial transmission of adiposity in an Indian population. Am J Hum Biol, 1993; 5:

331–339.
11. National High Blood Pressure Education Programme. Working group report on primary prevention of hypertension, US Depart- ment of Health and Human Services, NIH Publication, 1993; 93: 2669.
12. WHO. Arterial hypertension and ischaemic heart disease. Preven- tive aspects. Geneva, Tech Rep Ser No, 1962; 231.
13. Zlatkis A, Zak B, Boyle A. A new method for the direct determina- tion of serum cholesterol. J Lab Chem, 1953; 41: 486–492.
14. Burstein M, Scholnick HR, Morfin R. Estimation of high density lipoprotein cholesterol. J Lipid Res, 1970; 19: 583–595.
15. National Cholesterol Education Programme. Second report of the expert panel on detection, evaluation and treatment of high blood cholesterol in adults. Circulation, 1994; 89: 1329–1445.
16. Gupta R, Gupta VP. Meta-analysis of coronary heart disease preva- lence in India. Ind Heart J, 1996; 48: 241–245.
17. Chada SL. Urban–rural differences in prevalence of coronary heart disease and its risk factors. Curr Sci., 1998; 74: 1069–1073.
18. Gupta R, Gupta VP. Lessons for prevention from a coronary heart disease epidemiological study in Western India. Curr Sci., 1998; 74:1074–1077.
19. Majumdar PP, Nayak S, Bhattacharya SK, Ghosh KK, Pal S, Mukhejee BN. An epidemiological study of blood pressure and lipid levels among Marwaris of Calcutta, India. Am J Hum Biol., 1994; 6: 183–194.
20. Folsom AR, Burke GL, Ballew C, Jacobs DR, Haskell WL, Donahue RP, Liu K, Hilner JE. Relation of body fatness and its dis- tribution to cardiovascular risk factors in young black and whites: the role of insulin. Am J Epidemiol, 1989; 130: 911–924.
21. Lackland DT, Orchard TJ, Keil JE, Saunders DE, Wheelers FC, Adams-Campbell LL, McDonald RH, Knapp RG. Are race differ- ences in the prevalence of hypertension explained by body mass index and fat distribution? A survey in a biracial population. Int J Epidemiol, 1992; 21: 236–245.
22. Despres JP, Moorjani S, Lupien PJ, Tremblay A, Nadeau A, Bouchard C. Regional distribution of body fat, plasma lipo- proteins, and cardiovascular disease. Arteriosclerosis, 1990; 10: 497–511.
23. White FM, Pereira LH, Garner JB. Associations of body mass index and waist: hip ratio with hypertension. Can Med Assoc J, 1986; 135: 313–320.
24. Hartz AJ, Rupley DC, Rin AA. The association of girth measure- ments with disease in 32,856 women. Am J Epidemiol, 1984; 119: 71–80.
25. Kenchaiah S, Evans JC, Levy D, Wilson PW, Benjamin EJ, Larson MG, Kannel WB, Vasan RS. Obesity and the risk of heart failure. N Engl J Med, 2014; 5(2): 231-235.
26. Folsom AR, Burke GL, Ballew C, Jacobs DR, Haskell WL, Donahue RP, Liu K, Hilner JE. Relation of body fatness and its ditribution to cardiovascular risk factors in young black and whites:the role of insulin. Am J Epidemiol, 1989; 130: 911–924.
27. Lackland DT, Orchard TJ, Keil JE, Saunders DE, Wheelers FC, Adams-Campbell LL, McDonald RH, Knapp RG. Are race differ- ences in the prevalence of hypertension explained by body mass index and fat distribution? A survey in a biracial population. Int J Epidemiol, 1992; 21: 236–245.
28. Despres JP, Moorjani S, Lupien PJ, Tremblay A, Nadeau A,Bouchard C. Regional distribution of body fat, plasma lipo- proteins, and cardiovascular disease. Arteriosclerosis, 1990; 10: 497–511.
29. White FM, Pereira LH, Garner JB. Associations of body mass index and waist : hip ratio with hypertension. Can Med Assoc J, 1986; 135: 313–320.
30. Hartz AJ, Rupley DC, Rin AA. The association of girth measure- ments with disease in 32,856 women. Am J Epidemiology, 1984; 119: 71–80.
31. Kenchaiah S, Evans JC, Levy D, Wilson PW, Benjamin EJ, Larson MG, Kannel WB, Vasan RS. Obesity and the risk of heart failure. N Engl J Med, 2002; *347*: 305–309
32. MEJ, Han TS, Seidell JC. Impairment of health and quality of life in people with large waist circumference. Lancet, 1998; 351: 853–856.
33. Gupta R, Majumdar S. Correlation of waist-hip ratio with coronary heart disease and risk factor prevalence in a rural male population. Ind Heart J, 1994; 46: 145–148.
34. Reddy KK, Papa Rao A, Reddy TPK. Effects of age, sex and life styles on CHD risk factors: influence of obesity and body fat dis- tribution. J Hum Ecol, 1998; 9: 593–601.
35. Venkatramana P, Geethavani C, Chengal Reddy P. Association of body mass index, body fat distribution and fat patterning with blood pressure in two populations of Andhra Pradesh. J Hum Ecol, 2001; 12: 63–68.
36. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardio- vascular risk in South Asians. Lancet, 1991; 337: 382–386.