STUDY OF BLOOD PRESSURE PATTERNS VERSUS SERUM LIPID PARAMETERS IN OBESE HUMAN SUBJECTS

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SUMMARY: A study was conducted to determine relationship of obesity with the blood pressure patterns and lipid parameters in preview of its unique local diet patterns. A total of 200 non-diabetic human subjects of either sex were included in the study. They were categorized on the basis of body mass index (BMI) as obese and non-obese. Each group was further divided into 2 subgroups; hypertensive and normotensive. Fasting lipid profile (total cholesterol, LDL-and HDL-Cholesterols and total triglycerides) in each group was determined to compare the levels among various groups. BMI was calculated from height and weight, while blood pressure was measured with a sphygmomanometer. Lipid profile was determined with Merck kits. Diet and related information was also collected from the patients directly.

Means of all parameters, except LDL-C, were higher in females than males; among these BMI and HDL-C showed significant difference. There was a significant negative correlation of diastolic blood pressure with HDL-C in obese subjects; all the other parameters were non-significantly correlated. In the non-obese subjects, there was a significant positive correlation between systolic (SBP) and diastolic (DBP) blood pressures and LDL-C. All other parameters were found non-significantly correlated. The analysis of variance was done in four groups namely, obese non-hypertensives, obese hypertensives, non obese non-hypertensives and non obese hypertensives. BMI, SBP, DBP, LDL-C and total cholesterol had significantly different means in the above four groups, while HDL-C and total triglycerides were statistically non-significant ($p>0.05$) among four groups.

Key Words: Blood pressure, Serum lipids, Obesity.

INTRODUCTION

Keeping hereditary aspects aside, obesity has been found to be the most prevalent nutritional disorder in prosperous and even underdeveloped countries (1). It increases the risk of developing several diseases, partly through mechanical effect of the mass of extra tissues on the functions of various organs and systems and partly as consequence of changes in metabolism (2).

Hypercholesterolemia in humans usually involves an elevation in the plasma concentration of low density lipoprotein cholesterol (LDL-C) and/or its defective clearance (3). The levels of serum triglycerides and LDL-C as weight increases but the high density lipoprotein cholesterol (HDL-C) falls, thus amplifying the LDL-C/HDL-C ratio (4). Obesity has been accepted as an established risk factor for higher systolic and diastolic blood pressures (5). Sowers (6) has shown that obesity, dyslipidaemia and hypertension are interrelated medical problems associ-

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ated with an increased risk of cardiovascular diseases. Obesity markedly enhances the cardiovascular risk associated with other risk factors, such as hypertension.

Becque *et al.* (7) have reported that 80% of obese adolescents had elevated blood pressure and that 97% of obese adolescents showed elevated serum triglyceride levels, decreased HDL-C and increased total cholesterol levels alongwith elevated systolic or diastolic blood pressures. Mortality from these causes increases dramatically if the body mass index (BMI) exceeds 30 (8). Many experiments have shown that plasma cholesterol is raised by the dietary saturated fatty acids, lowered by polyunsaturated ones and slightly affected by monounsaturated fatty acids. Plasma cholesterol falls if the percentage of dietary energy provided by fats is reduced, while diets high in starch do not increase triglycerides unless individuals are obese. Sucrose in large amounts may exert greater effect than starch in raising plasma triglycerides in some susceptible individuals. Plasma cholesterol usually falls with the increase of carbohydrates in diet (2). Therefore, blood pressure patterns against serum lipid parameters in local obese human subjects in relation to their dietary patterns have been described in the present paper.

MATERIALS AND METHODS

Selection of subjects

A total of 200 human volunteers of either sex, visiting different hospitals and clinics of Sialkot were included in the study. They were categorized on the basis of body mass index (BMI) as obese (BMI $\geq$ 30) and non-obese (BMI $\leq$ 30). Each group had hypertensive and normotensive individuals. They were considered hypertensive if systolic blood pressure was $\geq$140 mm Hg or diastolic blood pressure was $\geq$ 90 mm Hg or the subjects were currently using antihypertensive medication (9). The lipid profile in individuals of each group was determined to compare the levels among various groups. The parameters included: systolic and diastolic blood pressure, LDL-C, HDL-C, total cholesterol (TC) and triglycerides (TG).

A standard proforma diet was used to record the frequency of eating and types of food the individual habitually consumed weekly, as already used by Bano *et al.* (10). Blood pressure in each case was measured by using a portable, large cuffed mercury sphygmomanometer.

Calculation of BMI

For the calculation of BMI, weights and heights were determined. The weight of each subject was taken by using a weighing machine. Whereas, the height was measured with the help of an inch tape, while the subject stood bare-footed against a wall in an upright position, with heels, buttocks and head firmly touching the wall and hands freely hanging along the sides.

Determination of lipid profile

Serum LDL-C, HDL-C, TC and TG levels were determined under a fasting state of 12-14 hours by using kit method (11). For this purpose, about 5 ml of blood was drawn from the peripheral vein of each individual with a disposable syringe and was allowed to clot to separate the serum. The samples were centrifuged at 1000 rpm for 10 minutes. The supernatant (serum) was processed for different parameters.

Statistical analysis

The data were analyzed for means, analysis of variance and correlation coefficient by using Microsoft Excel and Minitab packages. All the parameters were compared in four groups as under:

1. Obese non-hypertensive
2. Obese hypertensive
3. Non-obese non-hypertensive
4. Non-obese hypertensive

RESULTS

BMI and blood pressure

In females, mean BMI was 32.02 $\pm$ 6.24 kg/m^2 whereas in males it was 28.79 $\pm$ 4.16 kg/m^2 . The difference in BMI of male and female subjects was significant ($p<0.05$, Table 1). The difference in systolic blood pressure (SBP) of male and female subjects was non-significant. In females, the mean systolic blood pressure was 141.2 $\pm$ 19.9 mm Hg and in males it was 137.2 $\pm$ 15.2 mm Hg. Similarly, the difference of mean diastolic blood pressure of male and female subjects was also non-significant, as in females it was 90.2 $\pm$ 12.6 mm Hg versus 90.1 $\pm$ 10.2 mm Hg in males (Table 1).

Serum lipid parameters

The difference of means of LDL-C was also non-significant for males and females as in females mean LDL-C was 111.7 $\pm$ 41.9 mg/dL and in males it was 112.6 $\pm$ 27.9 mg/dL. However, the difference of means of HDL-C was significant for males and females as in females, mean HDL-C was 40.42 $\pm$ 9.89 mg/dL; whereas in males it was 36.08 $\pm$ 8.60 mg/dL (Table 1).

The difference of means of total cholesterol in male and female subjects was non-significant as in females

Table 1: Mean values (± SD) of different parameters in the test male and female subjects.

Parameters	Females (n=112)	Males (n=83)	T value	P value
Body mass index	32.02 ± 6.24	28.79 ± 4.16	4.39*	< 0.05
Systolic blood pressure	141.2 ± 19.9	137.2 ± 15.2	1.6 NS	> 0.05
Diastolic blood pressure	90.2 ± 12.6	90.1 ± 10.3	0.09 NS	> 0.05
Low density lipoprotein - cholesterol	111.7 ± 41.9	112.6 ± 27.9	0.18 NS	> 0.05
High density lipoproretin - cholesterol	40.42 ± 9.89	36.08 ± 8.60	3.3*	< 0.05
Total cholesterol	182.3 ± 45.3	173.9 ± 31.2	1.56 NS	> 0.05
Triglycerides	172.4 ± 84.7	159.7 ± 57.1	1.26 NS	> 0.05

* : Significant (p < 0.05), NS : Non-significant

mean total cholesterol was 182.3 ± 45.3 mg/dL and in males it was 173.9 ± 31.2 mg/dL. The difference of means of triglycerides was also non-significant for male and female, it was 172.4 ± 84.7 mg/dL in females and 159 ± 57.1 mg/dL in males (Table 1).

Correlation coefficients of blood pressure with serum lipid parameters in obese and non-obese subjects

In obese subjects, all parameters except serum HDL-C against DBP showed non significant correlations (Table 2). Serum HDL-C was negatively correlated with DBP and the correlation was significant (--0.2435, $p \leq 0.05$). In non-obese subjects, LDL-C showed positive and significant correlation (0.2008 and 0.2006, respectively, $p \leq 0.05$) with both systolic and diastolic blood pressures. The correlation of SBP and DBP with total cholesterol, HDL-C and triglycerides was statistically non-significant (Table 2).

Correlation coefficients of blood pressure with serum lipid parameters in obese and non-obese male and female subjects

In obese males, both DBP and SBP showed non-significant correlation with all the lipid parameters i.e. TC, HDL-C, LDL-C and TG. Whereas in obese females HDL-C showed a significant negative correlation with DBP (γ = --0.3507, $p \leq 0.05$). All other parameters showed non-significant correlation. All parameters were non-significantly correlated in non-obese males and females (Table 3).

The effects of body conditions on various parameters were also investigated. For this purpose test subjects were divided into four groups viz obese non-hypertensive (I), obese hypertensive (II), non-obese non-hypertensive (III) and non-obese hypertensive (IV). The difference in means of the above four groups for BMI was highly significant ($p<0.01$). Mean BMI was 34.64 ± 3.54 in Group I, 34.45 ± 5.25 in Group II, 26.57 ± 3.68 in Group III, and

Table 2: Correlation coefficients of blood pressure with serum lipid parameters in obese and non-obese subjects.

	TC	HDL-C	LDL-C	TG
Obese subjects				
Diastolic blood pressure	0.1412 NS	- 0.2435 *	0.1025 NS	0.0487 NS
Systolic blood pressure	0.084 NS	- 0.1641 NS	0.0866 NS	0.0815 NS
Non-obese subjects				
Diastolic blood pressure	0.0223 NS	- 0.1879 NS	0.2006*	- 0.1378 NS
Systolic blood pressure	0.04832 NS	- 0.0931 NS	0.2008*	- 0.0896 NS

* : Significant (p < 0.05), NS : Non-significant

Table 3: Spearman's correlation coefficient of blood pressure with serum lipid parameters in obese males and females.

	TC	HDL	LDL	TG
Obese males				
Diastolic blood pressure	- 0.0667 NS	- 0.321NS	0.0675 NS	- 0.1499 NS
Systolic blood pressure	0.1025 NS	- 0.0662 NS	0.0229 NS	0.1256 NS
Obese females				
Diastolic blood pressure	0.2123 NS	- 0.3507*	0.1269 NS	0.1070 NS
Systolic blood pressure	0.1455 NS	- 0.1806 NS	0.1299 NS	0.0653 NS

* : Significant, NS : Non-significant

27.15 ± 2.19 in Group IV, the highest being of obese non hypertensive and very close to it was obese hypertensive. Non-obese hypertensive had greater BMI than non-obese non-hypertensive subjects.

The means SBP for groups I, II, III and IV were 127.64 ± 6.64; 147.04 ± 17.63, 125.34 ± 5.75 and 143.54 ± 16.51 mm Hg, respectively, the difference was highly significant. Highest value was recorded in obese, followed by non-obese hypertensives, obese non-hypertensives and non-obese non-hypertensives. The mean DBP for Group I was 82.64 ± 11.47 mm Hg; 95.24 ± 11.63 mm Hg for Group II; 81.12 ± 9.01 mm Hg for Group III and 92.18 ± 7.97 mm Hg for Group IV ($p < 0.01$). The highest value was in obese hypertensives followed by obese non-hypertensives and non-obese non-hypertensives.

The analysis of variance for LDL-C in the four groups showed a significant effect ($p \leq 0.05$). The mean LDL-C levels in the four groups were 106.07 ± 25.32, 123.34 ± 41.96, 102.98 ± 26.58 and 105.31 ± 33.91 mg/dL, respectively. The highest value was for obese hypertensives, followed by obese non hypertensives, non-obese hypertensives and non-obese non hypertensives.

The mean HDL-C value for Group I was 42.33 ± 9.76 mg/dL, 39.01 ± 10.44 mg/dL for Group II, 38.17 ± 10.18 mg/dL for Group III and 37.12 ± 7.41 mg/dL in Group IV. The highest value was for obese non-hypertensives, followed by obese hypertensives, non-obese, no hypertensives and non obese hypertensives, however, the difference was non significant.

Mean cholesterol values were 183.7 ± 34.92, 190.56 ± 48.65, 167.70 ± 28.78 and 169.69 ± 28.94 mg/dL for groups I, II, III and IV respectively, the difference was significant. The highest value of cholesterol was for obese hypertensive, then obese non-hypertensives, non-obese hypertensives and non-obese non-hypertensives.

The mean triglyceride levels for groups I, II, III and IV were 162.03 ± 30.2, 171.85 ± 35.8, 166.23 ± 31.5, 144 ± 32.01 mg/dL, respectively. The highest value was in obese hypertensive group, then in non-obese non-hypertensives, obese non-hypertensives and non-obese hypertensives, the difference was, however, non significant.

Various parameters in subjects using saturated and unsaturated fats

The subjects using saturated fats had a mean BMI of 31.94 ± 5.22 versus 30.27 ± 5.79 for subjects using unsaturated fats. The mean SBP of subjects using saturated fats was 142.9 ± 18.8 mm Hg whereas it was 138.5 ± 17.9 mm Hg in subjects using unsaturated fats. The subjects using saturated fats showed a mean DBP value of 93.0 ± 12.3 mm Hg as compared to 89.2 ± 12.3 mm Hg for the subjects using unsaturated fats. Mean LDL-C value for the subjects using saturated fats was 114.6 ± 37.9 mg/dL versus 104.4 ± 31.8 mg/dL for the subjects using unsaturated fats. The subjects consuming saturated fats in their diets had a mean HDL-C value of 38.02 ± 9.53 mg/dL as compared to 40.47 ± 9.54 mg/dL for the subjects consuming unsaturated fats. The mean cholesterol level for the subjects using saturated fats was 181.2 ± 41.2 mg/dL and for subject consuming unsaturated fats it was 171.4 ± 36.3 mg/dL. The mean triglyceride value for the subjects on saturated fats was 167.7 ± 73.5 mg/dL and for subjects on unsaturated fats it was 166.9 ± 75.2 mg/dL. However, the differences in various parameters among individuals using two types of fatty acids were statistically non-significant.

DISCUSSION

The mean BMI for females was higher ($p<0.05$) than males. This observation suggested that obesity was more prevalent in females than in males. This might be due to the habit of nibbling between meals for some housewives, who are also fond of eating during cooking (2). Also the women included in the present study had given birth to 5 children on the average which suggested that repeated pregnancies might have contributed towards the obesity. Further, hormonal changes occurring during pregnancy or at menopause might have contributed to obesity (2).

Mean SBP showed a greater value in females than in males. However, the difference between the two means was statistically non-significant as of DBP. These results are in contrast with those of Richard *et al.* (12), who observed that males had significantly higher systolic and diastolic blood pressure than females. The difference might be due to local conditions, specially variation in diet patterns prevalent in Sialkot.

Mean HDL-C was higher in females than in males. The difference between the two means was significant. The characteristic male lipid profile (HDL-C high LDL-C) was observed during a previous study (13). Mean cholesterol level was also higher in females than in males but the difference between two means was non-significant. Same was true for triglycerides. This may be due to repeated pregnancies resulting in fat deposition leading to higher levels of cholesterol and triglycerides in females. Also females included in the study were mostly housewives doing less physical work (14).

For the obese subjects, total cholesterol showed non-significant but positive correlation with both DBP and SBP. This explains that DBP and SBP rise with the increase in serum cholesterol level but the change was statistically non-significant (15).

A significant negative correlation was found between HDL-C and DBP in obese subjects i.e. with the increase in HDL-C, the DBP decreased significantly. Similar results were also reported by Reaven (16) and Shich *et al.* (17).

The correlation of HDL-C with SBP was, however, negatively, non-significant, revealing that there was a decrease in SBP with an increase in HDL-C and vice versa. A positive but non-significant correlation was observed between LDL-C and blood pressure. There was an increasing trend in blood pressure with increase in LDL-C in obese subjects (15). Triglyceride levels were also positively correlated with both systolic and diastolic blood pressures in obese subjects (18) but the correlation was statistically non-significant in both obese males and females.

The mean SBP of all the four groups were significantly different from each other. Obese hypertensive and non-obese hypertensive persons showed approximately equal values which were greater than those of obese non-hypertensives. Overall, the obese group, however, showed somewhat higher mean SBP values than their non obese equivalents. This explains that obesity affects the blood pressure values. There appeared to be a significant increasing trend in the proportion of cases of hypertension observed according to different grades of nutrition i.e. underweight or normal, overweight and obese (19).

Mean DBP was highest in obese hypertensive group, followed by non-obese hypertensives. The obese non-hypertensive group and non-obese non-hypertensive group showed approximately same results. Balsamo *et al.* (20) also reported that obese subjects had significantly higher DBP and SBP values than non-obese subjects.

The highest mean LDL-C was noticed in obese hypertensives, followed by obese non-hypertensives. Lowest value was observed for the non-obese non-hypertensive group. Similar results were also reported by Srinivan *et al.* (21).

The obese group showed better HDL-C levels as compared to non-obese groups. This may be due to ample fruit and vegetables intake during their weight reducing programmes. Because fruits and vegetables contain antioxidants which improve the HDL-C; (21), the HDL-C of obese subjects may be increased as compared to non-obese subjects.

Highest mean cholesterol levels were observed in obese hypertensive group followed by that of obese non-hypertensive group. The mean cholesterol levels of both non-obese groups did not show any significant difference among themselves. This shows that obesity is related to levels of cholesterol (22).

Saturated and unsaturated fats

The mean BMI was higher in subjects consuming saturated fats as compared to those using unsaturated fats. This reveals that BMI increased by the use of saturated fats in diet but the difference was non-significant (23). Similarly, the means SBP and DBP were also higher in subjects consuming saturated fats (24). Mean LDL-C showed a higher value for individuals using saturated fats than those consuming unsaturated ones but the difference was non-significant. Same was true for HDL-C, TC and TG. There may be some reasons for the non-significant difference between the diet consumption of both groups; the information given by the subjects related to their diet consumption may be false, or the obese subjects might have been consuming lesser amounts of diet in order to reduce their weight.

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