Original Article

Dyslipidemia, C-Reactive Protein and Leptin levels in Non Diabetic Obese subjects

Sowbhagya Lakshmi[1], D. M. Ravichand[2]
[1]Depatment of Biochemitry,Bangalore Medical College and Research Institue, Bangalore,
[2]Depatment of Pharmacology, Osmania Medical College, Koti, Hyderabad, India

Abstract

Introduction: The objective of the study is to find the relationship of obesity with dyslipidemia and Leptin levels. **Material and Methods:** The study was carried out in the Department of clinical Biochemistry, Bangalore Medical College. Cases and controls were chosen from the subjects attending the out patient department of Victoria hospital for their routine check up.The protocol of the study was to study and compare the linear relationship of obesity, dyslipidemia, CRP and Leptin levels is Non Diabetic obese persons to Non Diabetic persons with normal weight. The protocol was based on inclusion and exclusion criteria and is approved by local ethical committee Serum samples were stored at -200C for estimation of Leptin and CRP levels. The samples were thawed on one stretch for the estimation. Leptin was analyzed by DRG Leptin sand witch ELISA method by using kit from DRG Company. **Results:** About 8.0% of patients had elevated Total cholesterol in normal subjects when compared to 84.0% in Obese subjects, indicates that patients with obesity are 60.37 times more likely to have elevated Total cholesterol (>200 mg/dl) when compared to Normal. Patients with obesity (98.0%) are 46.23 times more likely to have elevated Triglycerides when compared to normal subjects (52.0%). Subjects in Obese groups, 76.0% had decreased HDL when compared to only 12.0% on Normal group, which 8.14 times more likely in obsess group. Subjects with obesity (80.0%) are 29.33 times more likely to have elevated LDL (>150 mg/dl) when compared to Normal subjects (12.0%). The elevated VLDL is 21.0 times more likely in obese subjects (84.0%) when compared to normal subjects (20.0%). Subjects in obese are 46.58 times more likely to have elevated LP (a) when compared to normal subjects. **Conclusions:** Present study has shown a strong link between obesity, dislipidemia and cardiovascular disease in accordance with other studies. The role of Leptin associated with cardiovascular disease is not well established, so prospective study should be carried out to elucidate the role of Leptin in cardio vascular disease and Diabetes to establish its role as, whether it is causative, additive risk factor or a protective factor. Leptin may play a role to prevent metabolic syndrome by its interaction with neuroendocrine systems to maintain metabolic homeostasis, similar to the role played by Insulin in homeostasis of blood sugar level.

Introduction

Obesity, a common nutritional disorder, is the burning Global problem. It is raising concern because of its potential impact on health. It reflects multigenic predisposition to store excess of calories as fat in adipocytes in conjunction with excess of food intake and low physical activity.Increase in weight is strongly associated with dyslipedemia and hyper Leptinemia. Lipid Triad is-increase in Triglycerides (Tgl), increase in Total Cholesterol (TC) and decrease in High Density Lipoprotein (HDL). Lipid Triad was usually found in obese people. It is a strong predictor of endothelial dysfunction and cardio vascular diseases[1-3].

Various studies in diverse and ethnic groups have shown strong association between obesity and Lipid Triad [4,5]. There are strong links between Obesity, Thrombosis, Vascular changes and Atherosclerosis[1]. APO A, the protein fraction of lipoproteins exists on the surface of HDL, known to activate LCAT .It plays an important role in HDL solubilization. APO B is a major structural protein of Chylomicron, VLDL and LDL.

It is a strong factor for atherogenisis. Plasma Lipid and apolipoprotein ratio that include both an atherogenic and an atherogenic protective lipid component like Tgl /HDL, TC/HDL, LDL/HDL, APOB/APO A has been found to be strongly associated with obesity and predictors of Coronary heart disease[6].

The optimum TC/HDL ratio is 3. If the ratio is more than 5; it appears to be a predictor of CVD[7]. Increased ratio is observed in 25% of Industrial and 32% of urban female population in India[8]. One unit raise in TC/HDL and LDL/HDL ratio is associated with 49% and 75% increased risk of MI respectively[9]. If LDL/HDL ratio is more than 2.5 it is deleterious. The most reliable index is the ratio of APO B/APO A (0.2-0.5). The ratio of 0.4 is very good. The ratio of more than one shows the highest risk. Lp (a) con-

tains a unique protein (apo a), highly glycosylated and structurally different from other apoprotiens. Its lipid composition and structure is similar to that of LDL. It is linked to APO B through a simple disulphide bond. It has many properties in common with LDL including in its clearance rates. Lp (a) synthesized in liver is normally present in low concentration in plasma. Raised Lp (a) more than 30 mg/dl is seen in obese subjects and in patients with coronary heart diseases (CHD), serves in stratifying patients with increased risk of CVD[10,11]. Lp (a) inhibits fibronolysis. Increased Lp (a) associated with increased LDL, raises the risk of CVD by six times. Hyperlipidemia promotes functional abnormalities and structural vascular wall injury.

CRP is a normal alpha globulin, which increases in inflammatory process. Higher CRP levels indicates a low-grade systemic inflammation[11,12] CRP levels are elevated in response to inflammation, acute infections and M.I. Systemic inflammation is associated with increased serum Leptin concentration[13]. It is becoming clear that adipocytes is not merely an inert organ for storage of energy but it also secretes a host of factors that interact with each other to have an effect on various metabolic activities.

Leptin is a protein with 167 amino acids, a member of cytokine family coded by ob gene[14] primarily secreted by adipocytes directly proportional to adipocytes mass and BMI[15]. Its levels are rich in hypothalamus[16] known to regulate body weight. It plays important role in appetite metabolism and energy balance[17,18]. Leptin is known to stimulate the sympathetic nervous system for a peripheral signal linking adiposity and central neural networks[19] by receptor signal through Tyrosine kinase leading to phosphorylation of members of signal transducer pathway and activator of Transcription protein.

One set of oroxogenic neurons produce appetite stimulating neurotransmitter (NPY), second set of anorexogenic neurons produce appetite suppressing neuropeptide (∝MSH)[20].

Leptin is known to reduce the expression of NPY and stimulates the expression of ∝MSH, suppressing the anabolic pathway and/ or activating catabolic pathway[16] Leptin has effect on he key organs of metabolism including brain, liver, fat and pancreas[21]. It regulates neuroendocrine function and its secretion, pulsatile with TSH secretion which potentiall increases thermogenesis, by increasing BMR through T3 and T4 levels leading to weight loss. It has a permissive role in the onset of puberty and ovulation[22]. Hyper Leptinemia or Leptin resistance is often associated with dyslipidemia and central obesity[23]. Remarkable linear relationship exists between rise in BMI and Leptin[23] to promote angiogenesis[24], platelet aggregation[25],and Thrombosis[26].

Experiments on mice by Pellymounter has shown that, Leptin to have anti Diabetic activities[27], highly efficacious as an anti Diabetic agent and in weight reduction. In Leptin deficient rodents, 1 to 7 kgs of weight reduction was seen in rodents by giving low dose of recombinant Leptin in Leptin deficient Rodents. Hyper Leptinemia prevents lipotropic cardiomyopathy in mice[28]. Rodents and Humans with genetic deficiencies in the Leptin system become morbidly obese supports the importance of Leptin in regulation of energy balance[29]. Leptin deficiency is corrected by the administration of Leptin at doses that raise serum concentration 20-30 times the normal concentration of the animal or human fat mass[28].

Materials and Methods

The study was carried out in the Department of clinical Biochemistry, Bangalore Medical College. Cases and controls were chosen from the subjects attending the out patient department of Victoria hospital for their routine check up.The protocol of the study was to study and compare the linear relationship of obesity, dyslipidemia, CRP and Leptin levels is Non Diabetic obese persons to Non Diabetic persons with normal weight. The protocol was based on inclusion and exclusion criteria and is approved by local ethical committee.

Control

N=20 age and sex matched healthy individuals with normal weight (BMI 20-25) without clinical evidence of any disease.

Cases

Non-Diabetic obese persons with BMI>30 without clinical evidence of any disease. . They were non alcoholic and non smokers.

Exclusion criteria

Subjects with hypertension and elevated blood sugar levels, infection and inflammation were excluded from the study.

Detailed history of subjects regarding their socioeconomic status, dietary habits, family history for metabolic disorders, their physical activity were taken. Most of them had no family history of Diabetic Mellitus and Hypertension. They were on sedentary life style with overeating tendencies.

Venous blood was collected on overnight fasting at morning 9AM. Blood samples were allowed to clot and serum was separated by centrifugation.

Following parameters were estimated in both cases and controls on the same day of blood collection in auto analyzer- ERBA 600 by using standard kits. Baseline evaluation included determination of Blood sugar, urea and creatinine levels to rule out metabolic disease and organ dysfunction. Leptin levels was estimayed by ELISA method. Serum samples were stored at -20^{0}C for estimation of Leptin and CRP levels. The samples were thawed on one stretch for the estimation. Leptin was analyzed by DRG Leptin sand witch ELISA method by using kit from DRG Company. Standard curve was drawn by using various standards of increase in concentration provided in the kit. Controls were run to ascertain reliability of values.Serum samples were diluted 1:10 and the Leptin levels were found out by using the standard curve.

Study Design

A Case-Control study consisting of 50 Non-diabetic cases subjects (With BMI >30) and 25 non-diabetics with normal weight (BMI 20-25) is undertaken to study the effect of obesity on Lipid parameters, Leptin and CRP.

The Blood sugar levels in Normal and Obese groups are statistically comparable, and are clinically within the Normal group to support the non-diabetic population.

The Total cholesterol (mg/dl) is 184.12 (SD:45.21) and in obese it was 271.66(SD:40.03), the cholesterol level is significantly increased in non-diabetic group with P<0.001** and effect of obesity on total cholesterol is very large (d=2.07). Total cholesterol is also clinically significant apart from statistical significant.

Triglycerides in Normal group was 144.91(SD: 47.86) and in Obese it was 277.98 (SD: 79.76), Triglycerides is significantly and clinically elevated in Obese group with very large effect (d=2.09, P<.001). HDL in the normal subjects was 41.72(SD: 9.54) and in obese subjects it was 30.88(SD: 4.85), the HDL is statistically and clinically decreased in obese subjects with very large effect (d=1.59, P<0.001). VLDL was observed in normal subjects was 38.40(SD:35.57) and it was 58.34 (SD: 24.69) in Obese group , the VLDL is statistically and clinically elevated in obese subjects with moderate effect (d=0.69, P=0.006).LDL in Normal subject was 108.48S(SD: 34.44) and in case it was 178.62(SD: 33.63), the elevation of LDL in obese is statistically and clinically significant with very large effect (d=2.05, P<0.001).

APO-A in Normal subjects was, 129.04(SD: 12.70) and in obese it was 115.40(SD: 23.36), the decrease in APO-A in obese is statistically significant with moderate effect (d=0.66, P=0.008). APO-B, in Normal subjects was 74.72(SD: 19.40) and in obese group it was 140.82 (SD:29.17), the APO-B is significantly elevated in obese with very large effect (d=2.48, P<0.001).LP(a) is significantly increased in obese subjects (37.48±13.67) and it is 18.00±17.53 in normal subjects, LP(a) is significantly increased in obese subjects when compared to Normal subjects with very large effect (d=1.28, P<0.001)

About 8.0% of patients had elevated Total cholesterol in normal subjects when compared to 84.0% in Obese subjects, indicates that patients with obesity are 60.37 times more likely to have elevated Total cholesterol (>200 mg/dl) when compared to Normal. Patients with obesity (98.0%) are 46.23 times more likely to have elevated Triglycerides when compared to normal subjects (52.0%). Subjects in Obese groups, 76.0% had decreased HDL when compared to only 12.0% on Normal group, which 8.14 times more likely in obsess group. Subjects with obesity (80.0%) are 29.33 times more likely to have elevated LDL (>150 mg/dl) when compared to Normal subjects (12.0%). The elevated VLDL is 21.0 times more likely in obese subjects (84.0%) when compared to normal subjects (20.0%). Subjects in obese are 46.58 times more likely to have elevated LP (a) when compared to normal subjects.

Discussion

Present study shows association of dyslipidemia, raised CRP and increased Leptin levels in Non Diabetic obese cases (BMI>30) as compared to Non Diabetic normal weight subjects.Obesity has an unusually adverse effect on metabolic profile. Many underlying mechanism in addition to adiposity are likely to play a role in causing dyslipedema and its associated effects on health. The study showed elevated levels of Tgl (p<0.001) with a large effects of d=2.09, Total cholesterol (p<0.001), VLDL(p< 0.006), LDL (p<0.001), APO B (p<0.001). Lp (a) (p<0.001), decreased levels of APO A (p<0.05), HDL (p<0.001). The study shows raised CRP (p<0.05), and Leptin levels (p<0.001) in cases as compare to controls. Similar finding has been reported by Daneesh etal12 showing strong inverse relationship between atherogenic and atherogenic protective factors in linking obesity and dyslipidemia.

APO A, the chief protein of HDL is an activator of LCAT, which esterifies cholesterol, thus helps in lowering cholesterol level by reverse transport mechanism. It has an important role in regulating LDL metabolism and in APO (B) degradation.

APO B is the apoprotein of LDL. Triglyceride is the major component of LDL and VLDL. Decrease in atherogenic protective factor- APO A and HDL accounts for the increased

LDL ,VLDL, Tgl and Cholesterol levels asserting the role of HDL as good Cholesterol in clearing cholesterol level and in lowering LDL fraction. Predominance of small dense LDL significantly increases Triglyceride concentration.

There is significant increase in Lp(a) ($p<0001$)in cases as compared to controls . Lp(a) has cholesterol rich cores similar to LDL. It could promote cholesterol delivery in to the artery wall known to stimulate smooth muscle proliferation. Increase in CRP ($p<0.05$) concentration in cases as compared to cases indicates a low grade systemic inflammation[12,30].

HDL Cholesterol has antioxidant, antithrombotic and anti-inflammatory action[31,32] relationship between decreased HDL, APO A with increased CRP levels indicates the role of CRP in anti inflammatory action[33]. Dyslypidemia with poor physical activity may show anti oxidant activity with proinflammatory state[34].

The study shows the ratios of atherogenic and atherogenic protective factors. TC /HDL ratio is more than five in obese subjects as compared to controls.LDL/HDL ratio is more than five in cases, Tgl/HDL ratio is 9.7 as compared to 5.3 in controls. APO B/APO A ratio is more than one showing the levels being deleterious .Most obese subjects have high serum leptin levels and presumed to have leptin resistence[35].

Tgl/HDL ratio suggests a metabolic interaction between Triglyceride and cholesterol rich lipoprotein in increasing the risk of MI. Higher Leptin level in obese subject is in agreement with other studies[15,20]. Hyper Leptinemia is strongly associated with obesity and dislipidemia substantiating the statement that “Fat talks to brain”. Adipocytes are signaling the brain to stimulate the central mechanism to regulate food intake and energy expenditure[36]. Pellymounter[27] indicated Leptin as an anti Diabetic agent and weight reducing substance. Many animal experiments have shown hyper Leptinemia to prevent lipotropic cardiomyopathy[28,37]. Lipotoxic cardiomyopathy was completely prevented by elevating plasma Leptin levels in mice and rodents[28].

Conclusion

Present study has shown a strong link between obesity, dislipidemia and cardiovascular disease in accordance with other studies. The role of Leptin associated with cardiovascular disease is not well established, so prospective study should be carried out to elucidate the role of Leptin in cardio vascular disease and Diabetes to establish its role as, whether it is causative, additive risk factor or a protective factor. Leptin may play a role to prevent metabolic syndrome by its interaction with neuroendocrine systems to maintain metabolic homeostasis, similar to the role played by Insulin in homeostasis of blood sugar level. Complete knowledge of intricate mechanism of adipocytes and its metabolic role along with hormonal, neuronal interactions is essential to understand the action of Leptin in weight reduction. It is also crucial to know the Pharmokinetic and Pharmodynamic profile of Leptin, for its utilization as a therapeutic agent in clinical diagnosis and treatment of obesity and its associated disorders.

Epidemiological study and further research has to be carried out to elucidate the ultra molecular mechanisms in underlying the hormonal regulations of Leptin production and its strong link to Endocrine syndrome, which helps to solve the global problem of obesity and its associated disorders.

Acknowledgement

The project was sponsored by Rajiv Gandhi University of Health Sciences, Bangalore, Karnataka.Statistical analysis was done by K. P. Suresh, Scientist (Biostatistics Institute of Animal Nutrition & Physiology, Bangalore-560030.

References

1. Austin MA. Plasma Triglyceride and coronary artery disease. Arteriosclerosis 1991;11:12-14.
2. Denke.MA. Sepos CT, Grundy SM. Excess body weight, an under recognized contributer to dyslipidiemia in white American women Arch-Intern Med 1994;154:401-410.
3. Sterfled B, Sidney S, Jocobs D.Jr, et al . Seven year changes in physical fitness, physical activity and lipid profile in the cardia study coronary artery risk development in young adults. Ann. Epidemiol 1999;9 (1):25-35.
4. Folsom. AR, Burke. GL , Ballow.C, Jocob Dr.Jr.et al. Relation of body fatness and its distribution to cardiovascular risk factors in young block and white. The role of insulin. Am.J.Epidiol 1989;130: 911-924
5. Barbara. V Howard, Bogardus. C, Ravussin E, Foley. JE et al. Stuies of the etiology of obesity in Pima Indians. Am.J.Clin.Nutr1991; 53.1577-1585.
6. Daniel J, Rader, Machael, Davidson, H, Richard J, Caplan John S Pears(2003). Lipid and Apocipoprotien Ratios. Association with coronary artery disease and effects of Resovastatin compared with Astrovastatin Pravastatin and Simvastatins. AMJ.cardiology 2003;91(5A):20-24
7. Ladeia A.M, Guimaraies. AC, and Lima. J.C (1994). The Lipid profile in coronery artery disease. Am. Brez. Cardiol 1994;63(2): 101-106
8. Enas A, Enas A, Senthilkumar, Vijaya Juturu and Gupta Rajeev 2001. Coronary Artery Disease in women, India.Heart Jan 2001;53:282-292.

9. Michael Gaziano.J, Charles H, Hennekens, Christopher, O'Donnell, John Breslow and Jublie E, Burring 1997. Fasting Triglycerides HDL and the risk of Myocardial infarction.Circulation 1997; 96:2520-2525

10. Lars Berglund, Rajashekar Ramakrishnan . Atheroclerosis thrombosis vascular Bio 2004;24:2219-2226.

11. Danesh.J, Wheeler. JG, Hirchfield. GM, Edas et al C. reactive protein and other circulating markers of inflammation in the preduction of C.A, D. New Eng J Med 2004;350 (140): 1387-1397

12. Berg,A>H;Scherer,P.E. Adipose tissue, inflammation and cardio vascular disease. Circ.Res 2005; 96:336-349.

13. Hernandez.C, Simo R ,Chacon.P, Sabin P et al. .Influence of surgical stress and parenteral nutrition on Serum Leptin concentration.

14. Freidmann.JM. The functions of Leptin in nutrition weight and physiology. Nutrition Reviews 2002; 11 suppl: 1-14.

15. Haluzik. M, Fiedler .J, Nedvidkova. J, Ceska. R. Sirum Leptin concentration in patients with combined hyperlipedimia relationship to syrum lipid and hyperprotiens. Physiol. Res 1999;48:363-368

16. Elias.CF, Aschkenasi.C Lee.C Kelly . J et al . leptin differentially regulates NPY and POMC neurons projecting to the lateral hypothalamic area. Neuran 1999; 23:775- 786

17. Van Dijk. G 2001. The role of Leptin in the regulation of energy balance and Adiposity. J neuroendocrinol 2001: 9132-9132

18. Robert.V Considine, Madhur K. Sinha, Mark.L.Heiman, Aidas Kriauciunas. Et al. Serum immuno reactiveLeptin concentration in normal weight and obese humans. N.E.J.M 1996;334 Feb(1): 292-295

19. Campfield LA, Smith FJ, Guisez.Y, Devos.R, Burn. P. Recombinant mouse OB protein-evidence for a peripheral signal linking adiposity and central neural networks. Science 1995; 269: 546-549.

20. Harvey. J, Ashford M.L.J leptin in CnS much more than a satiety sign. Neuro Pharmacology 2003;44:845-854

21. Alif Arioglu oral, Vinaya Simha, Elaine Ruiz, Alexa Andewelf et al. leptin replacement therapy for lipodystrophy.

22. Farroqi. IS, Jebb.SA, Langmack. G. et al. Effects of recombinant leptin therapy in a child with congenital Leptin deficiency. NEJM 1999; 341:879-884.

23. Peelman F, Waelout W, Iserentant H, et al. Leptin: Linking adipocyte metabolism with CV and autoimmune disease Prog.Lip.Res 2004; 43 July(4): 283-301

24. Sierra-Honigmann M.R, Nath AK, Murakami C. et al. Biological action of Leptin as an angiogenic factor Science 1998;281: 1683-6

25. Nakata M, Yada T, Soejma,N, Maruyama I. Leptin promotes aggregation of human platelets via the long form of its receptor Diabetes 1999 ; 48: 426-9

26. Bodary PF, Westrick RJ, Wickonheiser KJ, Shan YC, Eitzmon DT. Effect of Leptin on artificial thrombosis following vascular injury in mice.JAMA 2002; 24:112-117

27. Pelleymounter MA et al. Effects of the obese gene product on body weight regular in ob/ob mice. Science 1995; 269 July (5253): 540-3

28. Lee.Y, Naseem. R.H,Duplomb,L,Park,B.H.etal. Hyperleptinemia prevents lipotoxic cardiomyopathy in acyl CoA synthase transgenic mice Proc.Natl.Acad.Sci. USA 101:13624-13629.

29. Mantague. CT, Farooqi IS, Whitehead JP Soos . MA et al Congenital leptin dificiancy is associated with severe early answer obesity in humans. Nature 1977; 387: 903-908.

30. Rowley K, Walker K Z, Cohen J, Jenkins A J.etal. Inflamation and vascular endothelial activation in an Aboriginal population. Relationship to coronary disease risk factorsand nutritional markers. Med .J AUST 2003;178(10): 495-500.

31. Barter P.J ,Nicholls S,Rye K A , Anantharamaiah G M et al Anti inflamatary properties of HDL Cir Res 2004 ; 95(8) 764-772

32. Shemesh.T, Rowley. KG, Jenkins. A, Brimblecombe. J. et al . Serum leptin in normal weight and obese humans. New Eng J Med 1996;334:15442-15445

33. Greenberg. AS, Obin. MS. Obesity and the role of adipose tissue in inflammation and metabolism. Am J Clin Nutri 2006;83: 461-465

34. Yudkan. JS, Stehower. CD, Emeis. J J, Coppack. SW. C. Reactive protein in healthy subject association with obesity, insulin resistance and endothelial dysfunction. A potential role for cytokines originating from adipose tissue. Arterioscler. Thromb Vas Biol 1999;19: 972-978.

35. Mantzoros. CS, Flier.JS. Leptin as a therapeutic agent Trials and Tribulations. J Clin Endocrinol Met 2000;85:4000-4002

36. Schwartz M.W Central nervous system regulation of food intake Obesity 2006; 14:1-8

37. Unger.R.H. Hyperleptinemia protecting the heart from lipid overload. Hypertention 2005;45:1031-1036

Table 1. Age distribution

Age distribution in years	Normal		Obese		Total	
	No	%	No	%	No	%
20-30	5	20.0	6	12.0	11	14.7
31-40	7	28.0	12	24.0	19	25.3
41-50	4	16.0	21	42.0	25	33.3
51-60	6	24.0	5	10.0	11	14.7
61-70	3	12.0	4	8.0	7	9.3
>70	-	-	2	4.0	2	2.7
Total	25	100.0	50	100.0	75	100.0
Mean ± SD	43.88±14.46		45.10±12.34		44.69±12.99	
	(20-70)		(22-75)		(20-75)	

Age in Normal group was 43.88 years with SD 14.46 and in the Obese group 45.10 years and SD 12.99 years and the difference in age between the two groups is statistically matched with P=0.704.

Table 2. Blood Sugar levels in Normal and Obese subjects

Blood sugar levels (mg/dl)	Normal (n=25)	Obese (n=50)
Range	71-140	57-171
Mean ± SD	90.40 ± 16.81	90.82 ± 24.49
Inference	Sugar values are comparable statistically with P=0.939	

Table 3. Levels of Lipid parameters between Normal and Obese subjects Results are presented in Mean ± SD (Min-Max)

Lipid parameters	Normal	Obese	P value	Effect size (d)
Total cholesterol (mg/dl)	184.12 ± 45.21 (105-318)	271.66 ± 40.03 (196-386)	<0.001**	2.07(VL)
Triglycerides (mg/dl)	144.91 ± 47.86 (76-235)	277.98 ± 79.76 (162-519.0)	0.006**	2.09 (VL)
HDL (mg/dl)	41.72 ± 9.54 (28-61)	30.88 ± 4.85 (21-44)	<0.001**	1.59 (VL)
VLDL (mg/dl)	38.40 ± 35.57 (15-180)	58.34 ± 24.69 (32-190)	0.006**	0.69 (M)
LDL (mg/dl)	108.48 ± 34.44 (37-155)	178.62 ± 33.63 (102-259)	<0.001**	2.05 (VL)
APO-A	129.04 ± 12.70 (93-168)	115.40 ± 23.36 (40-176)	0.008**	0.66 (M)
APO-B	74.72 ± 19.40 (29-101)	140.82 ± 29.17 (68-211)	<0.001**	2.48 (VL)
LP(a)	18.00 ± 17.53 (9-99)	37.48 ± 13.67 (8-68)	<0.001**	1.28 (VL)

S: Small Effect; M: Moderate Effect; L: Large effect and VL: Very Large effect

Table 4. Levels of ratio of Lipid parameters between Normal and Obese subjects Results are presented in Mean ± SD (Min-max)

Lipid parameters Ratio	Normal	Obese	P value
Cholesterol/HDL	4.62 ± 1.72 (3.02-10.97)	8.86 ± 2.19 (0.77-13.31)	<0.001**
LDL/HDL	2.69 ± 1.04 (1.32-5.10)	5.96 ± 1.61(3.32-10.43)	<0.001**
Triglycerides/HDL	5.30 ± 6.26 (1.64-31.03)	9.70 ± 4.56 (4.41-32.76)	0.001**
LDL/APO-B	1.36 ± 0.39 (0.80-2.78)	1.33 ± 0.43 (0.60-2.85)	0.773
HDL/APO-A	0.33 ± 0.07 (0.22-0.68)	0.28 ± 0.09 (0.18-0.78)	0.039*
APO-B/APO-A	0.58 ± 0.15(0.22-0.81)	1.29 ± 0.51(0.62-3.55)	<0.001**

LDL/APO-B ratio is not statistically significant between the group

Table 5. Levels of CRP and Leptin between Normal and Obese Results are presented in Mean ± SD (Min-Max)

CRP and Leptin	Normal	Obese	P value	Effect size
CRP(mg/l)	0.41 ± 0.46 (0-1.91)	0.87 ± 0.82 (0-3.38)	0.013*	0.63 (M)
Leptin(ng/ml)	4.74 ± 2.64 (1.00-12.00)	38.52 ± 23.01 (10.0-96.0)	<0.001**	1.77 (VL)

CRP in Obese subjects is significantly increased (0.87±0.82) when compared to Normal subjects (0.41±0.46) with moderate effect (d=0.63, P=0.013)

Leptin is significantly increased in obese subjects (38.52±23.01) when compared to Normal subjects (4.74±2.64), with very large effect (d=1.77, P<0.001).

Table 6. Number and percentage of subjects having elevated Lipids in Normal and Obese groups Results are presented in Number (%)

Lipid Parameters	Normal (n=25)	Obese (n=50)	P value	OR(95% CI)
Total cholesterol (>230 mg/dl)	2 (8.0%)	42 (84.0%)	<0.001**	60.37 (11.82-308.38)
Triglycerides (>150 mg/dl)	11(44.0%)	49 (98.0%)	<0.001**	46.23 (6.37-381.36)
HDL (<35 mg/dl)	7 (28.0%)	38 (76.0%)	<0.001**	8.14(2.74-24.17)
LDL (>150 mg/dl)	3 (12.0%)	40 (80.0%)	<0.001**	29.33 (7.29-117.29)
VLDL (>40 mg/dl)	5 (20.0%)	42 (84.0%)	<0.001**	21.00 (6.09-72.40)
Lp(a) (>30 mg/dl)	1 (4.0%)	33 (66.0%)	<0.001**	46.58 (5.79-374.48)

Table 7. Number and percentage of subjects having elevated CRP and Leptin in Normal and Obese groups. Results are presented in Number (%)

CRP and Leptin	Normal (n=25)	Obese (n=50)	P value	OR (95%CI)
CRP (>1.0mg/l)	2 (8.0%)	13 (26.0%)	0.066+	4.04 (0.83-19.55)
Leptin (Male: 2-5 ng/ml) (Female: 4-11 ng/ml)	4 (16.0%)	49 (98.0%)	<0.001	257.20

Elevated CRP)>1.0 mg/l) is significantly more (4.04 times more) in obese group when compared to normal subjects with P=0.066, while the Leptin is 257.20 times more likely to be elevated in obese groups (98.0%) when compared to normal subjects (16.0%) with p<0.001**.

Figure 1. Levels of blood Sugar distribution

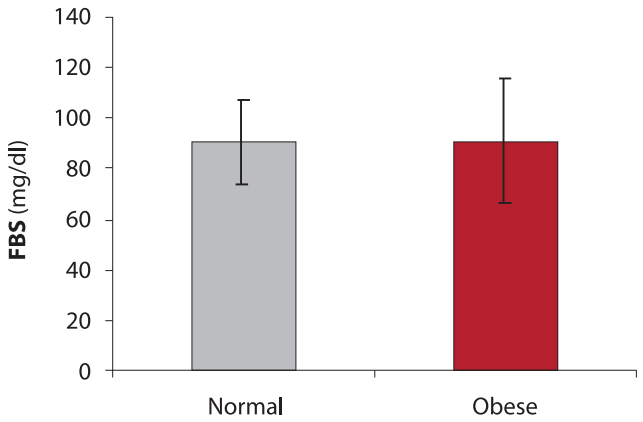

Figure 2a. Total cholesterol

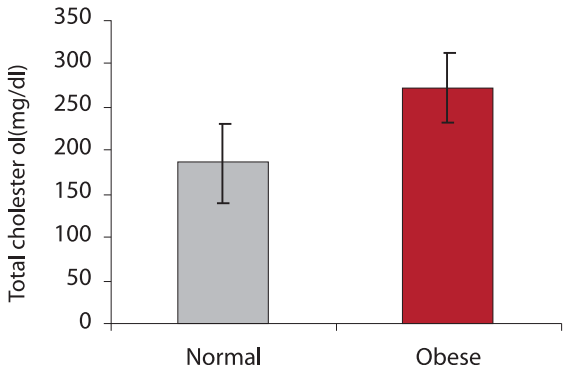

Figure 2b. Triglycerides

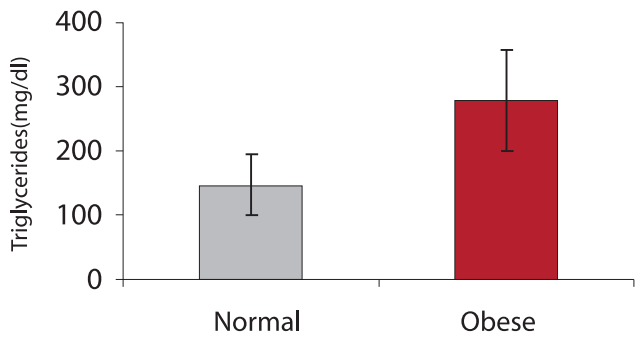

Figure 2c. HDL

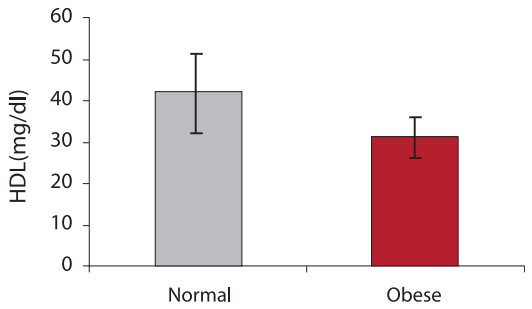

Figure 2d. VLDL

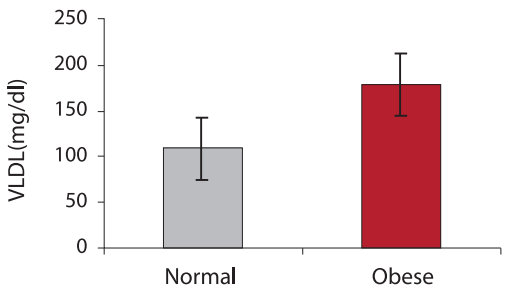

Figure 2e. APO-A

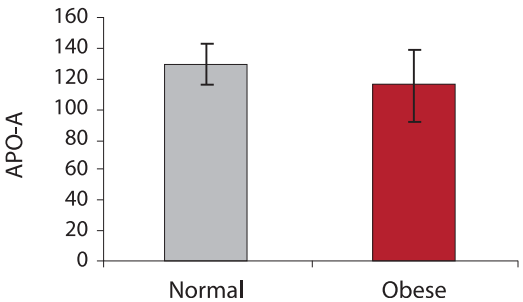

Figure 2f. APO-B

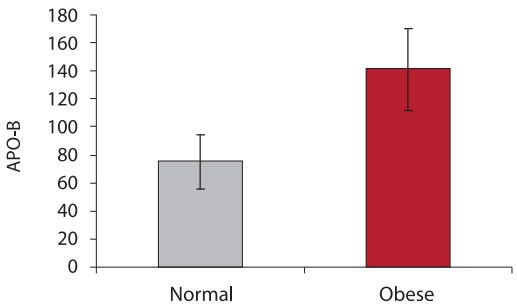

Figure 2g. LP(a)

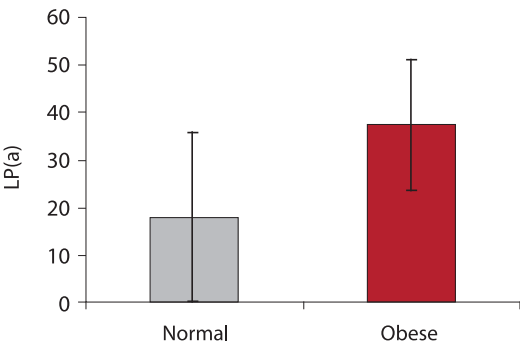

Figure 3. Comparison of Percentage of patients having elevated levels of Lipid parameters

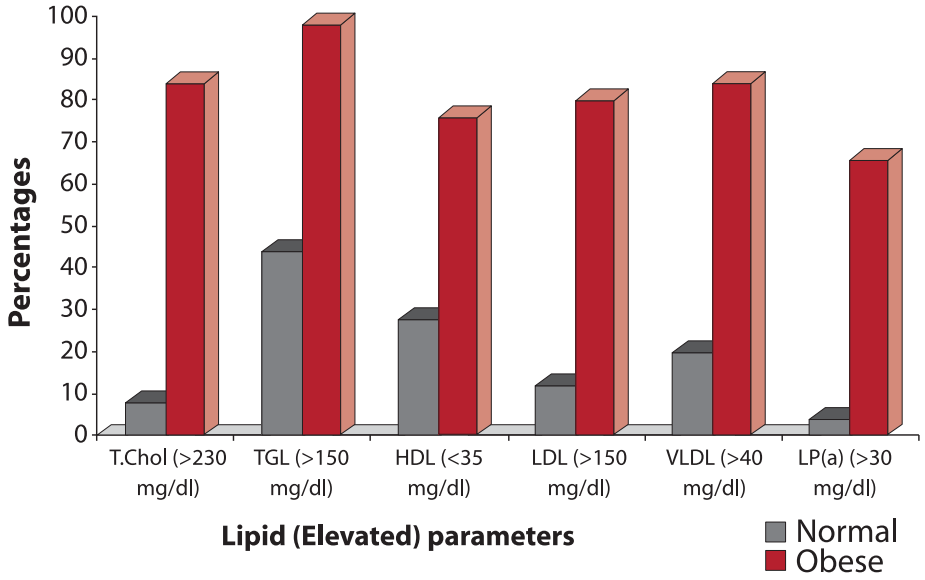

Figure 4. Percentage of subjects having elevated CRP and Leptin in Normal and Obese groups