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Study of serum lipid profile in obese prediabetics

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Abstract
Prediabetes is well-known to be a significant risk factor for type 2diabetes as well as heart disease and other chronic conditions. The pattern of multi-system involvement in prediabetes is similar to that of diabetic neuropathy. The purpose of this study was to determine the trend in fasting lipids in obese prediabetics who were obese at baseline.
Objective of the study: To study the serum lipid profile in prediabetic patients who are obese.
Materials and Methods: This study is a prospective case control study including 100 cases and 100 controls admitted to Shadan Institute of Medical Sciences, Hyderabad over a period of 18 months meeting the selection criteria. The relevant data was collected and the variables were analyzed using t test and chi square tests.
Results: The study evaluated 100 cases and 100 controls meeting the selection criteria. The mean age among the control group was 43 years, and it was 47.27 years in the case/study group. The body mass index (BMI) had a mean value of 29.4kg/m^2 in the control group and averaged 28.09kg/m^2 in the case group. The fasting blood sugar averaged 93 in the control group and had a mean value of 111.68 in the case group. The p value was <0.001 and was significant. The HbA1c used for defining patients of interest had a mean of 5.26 in the control group as against 6.06 among the case group, p value being significant at <0.001.Among 100 controls, 58 were females and 42 were males. In comparison, there were 46 females and 54 males in the case group. There were 44 subjects below the age of 45(inclusive) and 56 subjects who were above 45 years among the cases while the control group had 60 individuals who were more than 45 years of age and 40 individuals aged 45 years or less. Analysis did not show any statistically significant elevation in lipid parameters as far as age and gender delineation was concerned. It was also observed that HbA1c by itself was not an adequate tool for identifying dyslipidemia when compared to FBS.
Conclusion: This study concluded that serum lipid parameters are significantly elevated in prediabetic obese individuals barring HDL-c which is decreased. These prediabetic obese individuals because of their dyslipidemic status are at a higher risk for developing cardiovascular disease.

Keywords: Obese, Prediabetes, Lipid Profile, Dyslipidemia

Introduction
Diabetes Mellitus is a global epidemic emerging as a major burden on health care systems. Three hundred and forty-seven million people worldwide have diabetes. The complications of Diabetes and its impact on quality of life has been extensively studied. The effects of raised blood glucose on other metabolic parameters and pathways are being actively researched [1, 2]. Its precursor Prediabetes is close behind and needs to be extensively evaluated for its associations with other co-morbidities. The global prevalence of prediabetes has been increasing progressively in the past few decades. There is a school of thought that the incidence of prediabetes is higher than that of type 2 diabetes mellitus. It has been established that prediabetes is a strong risk factor for overt DM and cardiovascular disease. As expected, prediabetes also follows a similar pattern concerning multi-system involvement [3]. We tend to focus on the impact of high normal sugars in obese individuals, particularly on the fasting lipid profile. Our observations are aimed at deriving a relationship between prediabetes sugars and lipid parameters in obese individuals and hence conclude the cumulative effect of these three risk factors in cardiovascular diseases.

Objectives
1) To study the serum lipid profile in prediabetic individuals who are obese.

Methodology

Source of data: The study included both outpatients and inpatients of Shadan Institute of Medical Sciences.

Method of collection of data

Study Design

A prospective case control study spanning a period of 18 months beginning January 2019 to June 2020 involving a sample size of a minimum of 100 cases and 100 controls with age and sex match.

Study Protocol

A fasting blood glucose or glycated hemoglobin was done for obese patients on both outpatient and inpatient basis followed by a fasting lipid profile. Analysis of the lipid profile derangements in subjects participating in the study was carried out.

Inclusion Criteria

1. Patients in the age group of 18-65.
2. Patients with a BMI of 25kg/m^2 or more.
3. Patients with a fasting blood glucose between 100 and 125 (both included) and an HbA1C of 5.7 to 6.4 (both included).

Exclusion Criteria

Patients with

1. Diabetes mellitus on insulin or oral hypoglycemics.
2. Liver diseases with deranged liver function tests.
3. Chronic kidney disease.
4. Alcohol dependence.
5. Pregnancy.
6. Drug therapy on
   - Lipid lowering agents.
   -Oral contraceptive agents
   -steroids
   -thiazides
   -anticoagulants

Data Analysis

Data collected was analyzed by frequency, percentage, mean, standard deviation (S.D), 't' test and 'çhi square' test.

Results

Table 1: Comparison of the means of different Variables using students T Test

	Group	N	Mean	Std. Deviation	T	DF	P Value
Age	Control	100	44	11.999	-1.917	99	0.059
	Cases	100	47.27	10.157			
Height	Control	100	162.37	8.505	0.212	98	0.834
	Cases	100	161.8	12.873			
Weight	Control	100	78.15	15.025	1.304	99	0.197
	Cases	100	74.8	9.14			
BMI	Control	100	29.5	3.767	2.138	99	0.035
	Cases	100	28.08	2.098			
FBS	Control	100	94	5.69283	-13.14	86	<0.001
	Cases	100	111.6758	7.58308			
HBA1C	Control	100	5.265	0.3213	-11.83	84	<0.001
	Cases	100	6.0572	0.27896			
TC	Control	100	179.25	35.84694	-3.888	99	<0.001
	Cases	100	208.27	38.75397			
TG	Control	100	156.85	85.89538	-1.953	98	0.05
	Cases	100	190.45	86.13704			
LDL	Control	100	118.68	26.25498	-4.385	91.26	<0.001
	Cases	100	145.66	34.69553			
HDL	Control	100	40.35	12.98133	1.866	99	0.065
	Cases	100	35.69	11.98885			
VLDL	Control	100	31.357	17.84955	0.165	99	0.88
	Cases	100	30.8	15.91046			
TC/HDL	Control	100	4.8452	1.59116	-3.913	98	<0.001
	Cases	100	6.1827	1.81868			

The mean age among the control group was 43±11.999 years and it was 47.26±10.157 years in the case group. Data was not significant with a p value of 0.058.

The mean height for the control group was 162.37±8.503 cms and for the case group it was 161.8±12.873cms. The p value was 0.834 and was not significant.

The mean weight among the control group was 78.15±15.025 kg and it was 74.9±9.14kg among the case group. The p value was 0.196 and was not significant.

The mean BMI among the control group was 29.4±3.767 kg/m^2. It was 28.09±2.0978kg/m^2

The mean value of FBS among the control group was 93±5.693 mg/dl and 111.675±7.59 mg/dl among the case group. The p value was <0.001 and hence was significant.

HbA1c values as expected were higher among the case group as against the control group. The mean HbA1c was 5.265±0.33 among the control group and 6.06±0.28 among.

The above figure shows that the mean values of various lipid parameters were higher in the case group as compared to the control group, barring HDL cholesterol for which the control group portrayed higher values. VLDL did not show any significant difference between both study groups.

The mean total cholesterol was 179.25 in the control group whereas in the case group it was 208.27. The p value was significant (<0.001).

The mean triglyceride level among the case group was significantly higher than the control group (190.45 vs. 156.85), p value being 0.05.

The mean LDL among the control group was 118.67 and it was 145.67 among the case group. The p value was <0.001 and significant.

HDL cholesterol had a higher mean among the control group as compared to the case group. (40.35 vs 35.69) with a p value of 0.065.

VLDL values among case and controls were 30.9 and 31.36 respectively. The p value was 0.

Of the 50 controls, 36 had a total cholesterol in the normal range while 14 had abnormal Total Cholesterol (TC) values. Among the case group 29 had abnormal TC values while 21 had TC values within normal limits.

Among 50 controls, 28 had triglycerides (TG) in the normal range whereas 22 individuals had TG in the abnormal range. On the other hand 34 case had TG in the abnormal range and 16 in the normal range.

Of the 50 controls, 40 had low density lipoprotein (LDL) in the abnormal range while 46 individuals had LDL above the normal value.

As far as high density lipoprotein (HDL) was concerned, 21 individuals had higher HDL levels in the case group. Among the control group, 26 subjects had HDL values in the higher range.

As far as very low density lipoproteins (VLDL) were concerned 38 individuals in the case group had a VLDL in the abnormal range with 62 individuals in the normal range. Sixteen subjects in the control group had VLDL values in the higher range and 68 subjects had normal values.

Table 2: Age wise distribution of variables in case and control group

		Age	N	Mean	Std. Deviation	T	DF	P Value
Control	Height	<=45 years	60	162.24	9.135	-0.129	49	0.899
		>45 years	40	162.56	7.689			
	Weight	<=45 years	60	78.3	17.116	0.035	49	0.974
		>45 years	40	78.06	11.618			
	BMI	<=45 years	60	29.5	4.424	0.009	49	0.994
		>45 years	40	29.39	2.591			
	FBS	<=45 years	60	92.38	5.54	-0.963	48	0.341
		>45 years	40	93.96	5.943			
	HBA1C	<=45 years	60	5.2568	0.26352	-0.197	48	0.846
		>45 years	40	5.276	0.39985			
	TC	<=45 years	60	176.4334	28.75424	-0.674	48	0.503
		>45 years	40	183.46	44.95434			
	TG	<=45 years	60	166.1668	93.34589	0.939	48	0.352
		>45 years	40	142.86	73.38024			
	LDL	<=45 years	60	113.0334	23.88258	-1.912	48	0.062
		>45 years	40	127.16	27.9517			
	HDL	<=45 years	60	36.5668	11.27916	-2.67	49	0.01
		>45 years	40	47	13.57243			
	VLDL	<=45 years	60	32.5	19.9649	0.503	48	0.618
		>45 years	40	29.79	14.45639			
	TC/HDL	<=45 years	60	5.192	1.67347	1.934	48	0.059
		>45 years	40	4.3265	1.33527			
Cases	Height	<=45 years	46	161.82	15.723	-0.040	47	0.969
		>45 years	54	161.97	10.305			
	Weight	<=45 years	44	76.18	9.022	0.878	48	0.384
		>45 years	56	73.89	9.251			
	BMI	<=45 years	44	28.22	2.319	0.354	48	0.725
		>45 years	56	28	1.943			
	FBS	<=45 years	38	109.05	7.699	-2.285	35	0.028
		>45 years	36	114.44	6.573			
	HBA1C	<=45 years	30	6	0.33381	-1.051	33	0.301
		>45 years	40	6.1	0.22942			
	TC	<=45 years	44	207.4546	45.14815	-0.129	48	0.898
		>45 years	56	208.8929	33.75329			
	TG	<=45 years	44	185.4091	79.81686	-0.363	48	0.718
		>45 years	56	194.3929	92.05086			
	LDL	<=45 years	44	149.2273	36.74355	0.641	48	0.525
		>45 years	56	142.8571	33.40739			
	HDL	<=45 years	44	36.0909	8.46793	0.213	48	0.832
		>45 years	56	35.3571	14.31192			
	VLDL	<=45 years	44	33.9091	17.61469	1.231	48	0.224
		>45 years	56	28.3571	14.28342			
	TC/HDL	<=45 years	44	6.2336	1.35433	0.184	46.144	0.855
		>45 years	56	6.1425	2.13828			

Among the control group, 29 were females and there were 21 males correspondingly, there were 46females and 54 males in the study group.

When HbA1c was considered as the inclusion criteria, the cases comprised of 16 females and 19 males respectively.
On the other hand, when FBS was the inclusion criteria, the cases included 32 females and 42 males.

Table 3: Gender wise distribution of variables in case and control group

		Sex	N	Mean	Std. Deviation	T	DF	P Value
Control	Height	M	42	169.39	5.978	6.978	49	<0.001
		F	58	157.28	6.107			
	Weight	M	42	88.62	15.725	5.18	48	<0.001
		F	58	70.55	8.742			
	BMI	M	42	30.82	4.774	2.164	27.538	0.039
		F	58	28.36	2.434			
	FBS	M	42	92.9	6.083	-0.2	48	0.921
		F	58	93.07	5.504			
	HBA1C	M	42	5.2524	0.40203	-0.202	31.428	0.842
		F	58	5.2724	0.25482			
	TC	M	42	175.0952	37.82316	-0.693	49	0.492
		F	58	182.2414	34.70865			
	TG	M	42	176.2857	82.78476	1.376	49	0.176
		F	58	142.7586	86.7603			
	LDL	M	42	118.8571	22.88513	0.05	49	0.968
		F	58	118.5517	28.84762			
	HDL	M	42	37	14.17746	-1.572	49	0.123
		F	58	42.7586	11.7007			
	VLDL	M	42	36.5238	17.50035	1.79	49	0.081
		F	58	27.6138	17.44328			
	TC/HDL	M	42	5.3471	1.85928	1.953	49	0.057
		F	58	4.4817	1.2786			
Cases	Height	M	52	169.35	7.049	5.45	48	<0.001
		F	46	153.48	12.858			
	Weight	M	54	79.44	7.346	4.502	49	<0.001
		F	46	69.57	8.174			
	BMI	M	54	27.68	2.099	-1.545	49	0.129
		F	46	28.58	2.033			
	FBS	M	42	112.57	8.042	0.818	36	0.418
		F	32	110.5	7.015			
	HBA1C	M	38	6.1	0.24722	0.98	34	0.329
		F	32	6.0063	0.31299			
	TC	M	54	215.5556	40.38597	1.458	49	0.151
		F	46	199.6957	35.71407			
	TG	M	54	192.6296	79.64014	0.194	49	0.848
		F	46	187.8696	94.95756			
	LDL	M	54	152.6667	31.14358	1.58	49	0.123
		F	46	137.4348	37.46857			
	HDL	M	54	34.7778	7.77736	-0.546	31.014	0.59
		F	46	36.7391	15.6996			
	VLDL	M	54	30.2593	14.09745	-0.259	49	0.798
		F	46	31.4348	18.11536			
	TC/HDL	M	54	6.4504	1.41028	1.132	49	0.264
		F	46	5.8683	2.1967			

The table on the previous page depicts the trend of lipid parameters when HbA1c and FBS were taken as inclusion criteria separately.
It is evident that when FBS was the inclusion criteria, four out of five lipid variables were of statistically significant values. Out of these, total cholesterol, triglycerides and low density lipoprotein showed a significantly higher mean among the study group, whereas HDL cholesterol showed a statistically significant lower value among the study group.
On the other hand when HbA1c was the inclusion criteria, only two out of five lipid variables were significant. Among these, TC and LDL were significantly higher among the study group compared to controls.

Statistical Analysis
Statistical analysis was done using Microsoft Excel 2010 and IBM SPSS version 20. Independent student T test was used to compare cases vs. controls. Case vs. control and categorical variables were compared using Chi square test.

Discussion
The study evaluated 100 cases and 100 controls meeting the selection criteria. The mean age among the control group was 43 years, and it was 47.27 years in the case/study group. The body mass index (BMI) had a mean value of 29.4kg/m^2 in the control group and averaged 28.09kg/m^2 in the case group.

The fasting blood sugar averaged 93 in the control group and had a mean value of 111.68 in the case group. The p value was <0.001 and was significant. The HbA1c used for defining patients of interest had a mean of 5.26 in the control group as against 6.06 among the case group, p value being significant at <0.001.

Among 100 controls, 58 were females and 42 were males. In comparison, there were 46 females and 54 males in the case group.

There were 44 subjects below the age of 45(inclusive) and 56 subjects who were above 45 years among the cases while the control group had 60 individuals who were more than 45 years of age and 40 individuals aged 45 years or less.

Analysis did not show any statistically significant elevation in lipid parameters as far as age and gender delineation was concerned.

Evaluation of the serum lipid parameters showed an elevation of total cholesterol, LDL cholesterol and serum triglycerides above normal limits even in the control group which comprised of obese normo-glycemic individuals. This lends weightage to studies carried out by Franssen R, *et al.* [4] and Wang H, *et al.* [5]. Who studied the impact of obesity on triglycerides and concluded that there is a positive correlation between these entities.

Total cholesterol

The mean total cholesterol in the control group was 179.24 whereas it was higher in the case group and averaged 208.26. The p value was <0.001 and was statistically significant.

Triglycerides

Triglycerides also showed significant increase in the case group compared to the controls. The mean triglycerides in the control group comprising of obese euglycaemic individuals was 156.84mg/dl Hile it averaged 190.44mg/dl among obese prediabetics. Miyazaki, *et al.* [6] also observed higher triglyceride levels in prediabetic subjects. Studies carried out by Barzi, *et al.*, Gaziano, *et al.* and Boizel, *et al.* [7-9] concluded that serum triglycerides were significantly higher in pre-diabetic individuals as compared to their normo-glycemic peers. Our observation of hypertrigly-ceridemia among the control group is in accordance with earlier studies done by Franssen R, *et al.* and Wang H, *et al.*, which they explained based on the impact of obesity on triglyceride levels.

Low density lipoproteins

The present study observed a significantly higher LDL level among the obese prediabetics as compared to normal glycemic obese individuals. While the LDL averaged 118.68mg/dl in the latter it was 145.66mg/dl in individuals who had prediabetes. These findings were in accordance with earlier studies [5, 6].

High density lipoprotein

This study revealed a higher HDL cholesterol of 40.34mg/dl among the control group as against 35.68mg/dl among the case group. The data was not significant with a p value of 0.065. Our observations were similar to those made by Shin et al and Miyazaki et al. who concluded that high density lipoprotein- cholesterol was lower in prediabetic individual.

Very low density lipoprotein

This study did not reveal a significant difference in the levels of VLDL. A mean VLDL of 31.357mg/dl was observed among the control group. Obese prediabetics revealed a VLDL of 30.8mg/dl.

TC/HDL

The ratio of total cholesterol and high density lipoprotein was found to be elevated in prediabetic obese individuals as compared to the control group comprising of obese euglycemic subjects. This is in accordance with the above quoted studies. TC/HDL ratio was significantly elevated at 6.183 in the case group as compared to 4.8453 among the control group. The p value was significant at <0.001.

It was further also observed that HbA1c by itself was not an adequate tool for identifying dyslipidemia in the subjects studied when compared to FBS. This observation lends support to studies by Shimodaira M et al and Wu S et al, who concluded that HbA1c was an inadequate tool for identifying prediabetics. Also, Li J et al had suggested that increasing the HbA1c threshold in prediabetic individuals remarkably improved the agreement between A1C and oral glucose tolerance test criteria in the obese population.

Conclusion

This study concludes that serum lipid parameters are significantly elevated in prediabetic obese individuals barring HDL-c which is decreased. These prediabetic obese individuals because of their dyslipidemic status are at a higher risk for developing cardiovascular disease.

Screening for prediabetes and weight control hence is warranted for the well- being of the individual and more importantly for minimizing the risk of cardiovascular disease.

Lifestyle modification or pharmacotherapy, thus becomes a pre-requisite and part of initial management of such individuals.

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