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The Relation between Overweight, Obesity and Plasma Lipids in Saudi Adults with Type 2 Diabetes

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Abstract

Background: Worldwide epidemic exists with respect to diabetes mellitus, primarily because of increased rates of obesity. Lipoprotein abnormalities are common in overweight and obese patients with diabetes and contribute significantly to its complications.

Methods: A cross sectional study was conducted at the Primary Health Care Clinics at King Fahad Armed Forces Hospital, Jeddah, Saudi Arabia. A total of 2519 Saudi diabetic and non-diabetic patients were randomly selected to assess the association of dyslipidemia and overweight and obesity in type-2 diabetic patients and non-diabetic controls. Patients were subjected to investigations of glycosylated hemoglobin (HbA1c) and fasting serum lipids.

Results: A total of 2519 patients attending the Primary Health Care Clinics were included in this study (45.9% men, 54.1% women). The diabetic group comprised of 50.8% (1280) and non-diabetic group comprised of 49.2% (1239) of the sample. The mean ± SD ages of diabetic and non-diabetic patients were 37.1 ± 7.7 and 32.1 ± 8.1 respectively. The diabetic patients were older, had higher BMI, Serum triglyceride and HbA1c values were significantly higher when compared to non-diabetic subjects. Whereas, total cholesterol, LDL and HDL were significantly lower in diabetics. 19% of men and 27% of women with diabetes mellitus had increased total plasma cholesterol levels did not differ significantly (p=0.2) from the rates in non diabetic men and women (21% of men and 34% of women). The prevalence of high LDL cholesterol levels in men and women with diabetes mellitus (23% and 31%, respectively) did not differ significantly (p=0.4) from the rates in non diabetic men and women (18% and 28%, respectively). The prevalence of high HDL cholesterol levels in men and women with diabetes mellitus (25% and 27%, respectively) did not differ significantly (p=0.7) from the rates in non diabetic men and women (23% and 25%, respectively). By contrast, the prevalence of high plasma triglyceride levels in individuals with diabetes mellitus (30% in men and 32% in women) was significantly higher than in those without diabetes mellitus (21% of men and 16% of women), p=0.02

Conclusion: The study has documented several lipid abnormalities in type 2 diabetic patients and has pointed to the significance of diabetic management in the control of lipid abnormalities where the control of overweight and obesity is of importance. The study revealed that obesity and dyslipidemia were high among diabetic patients and required special attention. This can be done through health education at the primary care level and the diabetic clinics.

Keywords

Diabetes, Dyslipidemia, Obesity

Introduction

Diabetes mellitus is the third greatest cause of death all over the world and is responsible for many complications affecting various organs in the body. The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030 [1-3]. The prevalence of diabetes mellitus among adults in Saudi Arabia is 30% [4]. Worldwide and nationally epidemic exists with respect to diabetes mellitus, primarily because of increased rates of obesity. Obesity has become widespread in developed countries along with a corresponding increase in the prevalence of diabetes [5]. In Saudi Arabia, obesity and diabetes became major causes of morbidity in big cities in the last 2 decades [6]. The frequency of abnormality of lipids, lipoproteins and apolipoproteins varies in different populations [7]. Lipoprotein abnormalities often precede the onset of diabetes mellitus by many years and persist despite achievement of euglycemia, particularly in type 2 diabetes. Lipoprotein abnormalities are common in diabetes and contribute significantly to its complications. The most typical lipoprotein pattern in diabetes, also known as diabetic dyslipidemia or atherogenic dyslipidemia, consists of moderate elevation in triglyceride levels, low HDL cholesterol values, and small dense LDL particles [8]. Studies in Saudi Arabia showed high prevalence of dyslipidemia in type 2 diabetes mellitus Saudi patients [9-12]. This study was conducted to examine the lipids profile in type 2 diabetic and control patients in relation to overweight and obesity.

Methods

This cross sectional study was conducted at Primary Health Care Clinics at King Fahad Armed Forces Hospital. A total of 2519 Saudi diabetic and non diabetic patients were randomly selected between January 2008 and June 2009. The demographic data and medical history were documented. The Body mass index (BMI) was considered normal if it was below 25kg/m^2, 25-29.9kg/m^2 overweight and 30kg/m^2 or greater was obese [13]. Glycosylated hemoglobin (HbA1c) and lipid profile were obtained. Fasting serum lipids were done on a sample of blood after fasting for 14 hours. The method used for determining the cholesterol and trigylcerides levels in the laboratory was the enzymatic method. Dyslipidemia was defined according to the American association of clinical endocrinologists' guidelines [14]. The study was approved by the ethical board of King Fahad Armed Forces Hospital.

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Statistical Analysis

Univariate analysis of baseline and follow up demography and clinical laboratory endpoints were accomplished using unpaired t-test. Chi square(X^2) test were used for categorical data comparison. Pearson's correlations between continuous variables were used as a measure of association. The data were analyzed by one-way analysis of variance (ANOVA), to estimate the significance of different between groups. Logistic regression model was used to determine the influence of several risk factors in describing the changes in the prevalence of dyslipidemia. All statistical analyses were performed using SPSS Version 16.0. All P values were based on two-sided tests. P<0.05 was considered significant.

Results

The essential physical data of the total cohort and difference between the diabetic patients and controls are listed in table 1. A total of 2519 patients attending the Primary Health Care Clinics were included in this study (45.9% men, 54.1% women). The diabetic group comprised of 50.8% (1280) and non-diabetic group comprised of 49.2% (1239) of the sample. The diabetic patients were older, had higher BMI, Serum triglyceride and HbA1c values were significantly higher when compared to non-diabetic subjects. Whereas, total cholesterol, LDL and HDL were significantly lower in patients with diabetes.

Table 2 shows a comparison between both diabetic and non-diabetic groups in relation to BMI subgroups. The diabetic patients with BMI <25 were older and the LDL and HDL values were significantly different when compared to diabetic patients with BMI ≥25 whereas the total cholesterol and serum triglyceride values were non-significantly different when compared to diabetic patients with BMI ≥25.

Table 1: Demographic patients' parameters and Comparison of features between diabetics and non-diabetics

Parameters		Total	Diabetes presents		P value
			Yes	NO	
Gender	Male	1156 (45.9)	567 (49.0)	589 (51,0)	0.1
	Female	1363 (54.1)	713 (52.3)	650 (47.7)	
Age(years)		34.6 ± 8.3	37.1 ± 7.7	32.1 ± 8.1	<0.005
Body mass index(kg/m^2)		30.3 ± 5.9	30.9 ± 6.1	29.6 ± 5.9	<0.005
Total cholesterol		5.3 ± 1.0	5.2 ± 1.1	5.3 ± 0.9	<0.005
Low density lipoprotein		3.3 ± 0.9	3.2 ± 0.9	3.5 ± 0.8	<0.005
High density lipoprotein		1.2 ± 0.3	1.2 ± 0.3	1.3 ± 0.3	<0.005
Triglyceride		1.7 ± 1.1	1.9 ± 1.3	1.5 ± 0.9	<0.005
HbA1c		7.9 ± 2.4	8.5 ± 2.3	5.7 ± 0.6	<0.005

Table 3 shows that comparing serum Low density lipoprotein of the BMI <25 group in patients with diabetes to 25-29.9 group in patients with diabetes, p value=0.01 and to ≥30 group in patients with diabetes, p value=0.001 and comparing serum High density lipoprotein of the BMI <25 in patients with diabetes to 25-29.9 group in patients with diabetes, p value=0.04. Comparing serum triglyceride of the BMI <25 group in patients with diabetes to 25-29.9 groups in patients with diabetes, p value= 0.05.

Table 4 shows the percentage of dyslipidaemia in diabetics patients in relation to gender according to the recommendation of the American Diabetes Association (2014). Female patients had significant higher prevalence HDL as compared to male patients where as male patients had significant higher mean and percentage of triglyceride.

Table 5 shows the percentage of dyslipidaemia in diabetics in relation to body mass index according to the recommendation of the American Diabetes Association (2014). Patients with BMI <25 had significant lower LDL and higher HDL as compared to patients with BMI ≥25. The correlation between HbA1c concentration and total cholesterol, LDL, triglyceride and HDL were 0.1 (P<0.005), 0.08 (P=0.01), 0.08 (P=0.01) and – 0.008(P=0.8) subsequently; higher HbA1c concentration were associated significantly with higher total cholesterol, LDL, triglyceride and non significantly lower HDL. Logistic regression model was used to determine the influence of several risk factors in describing the changes in the prevalence of dyslipidemia. BMI was the only significant variable in affecting LDL prevalence. Gender and HbA1c were the only significant variable in affecting total cholesterol and triglyceride prevalence and BMI and gender was the only significant variable in affecting HDL prevalence.

Discussion

This study highlights the importance of overweight and obesity in lipids Saudi population with diabetes. An important observation was that females presented with poor lipid compared to males. Patients with type 2 diabetes have increased risk of cardiovascular disease associated with atherogenic dyslipidemia [15]. This signifies individuals having diabetes associated obesity are more prone to develop cardiovascular disease than obese non-diabetic individuals. It has been well documented that high levels of cholesterol and LDL play a significant role in the development of arteriosclerosis and hence coronary artery disease [16,17].

Dyslipidemia is very common in type 2 diabetes and the reported prevalence of dyslipidaemia varied from 25 to 60% [18]. In our study, 19% of men and 27% of women with diabetes mellitus had increased total plasma cholesterol levels did not differ significantly (p=0.2) from

Table 2: Comparison of features between diabetics and non-diabetics in relation to BMI

Parameters		Diabetes presents				P value
		Yes		No		
		Body mass index(kg/m^2)		Body mass index(kg/m^2)		
		<25	≥25	<25	≥25	
Gender	Male	112(51.4)	455(48.5)	106(48.6)	483(51.5)	0.007
	Female	90(38.6)	623(55.1)	143(61.4)	507(44.9)	
Age(years)		38.7 ± 7.3	36.8 ± 7.8	32.6± 9.6	32.0 ± 7.7	<0.005
Body mass index(kg/m^2)		22.7 ± 2.7	32.5 ± 5.3	22.2 ± 2.2	31.4± 4.7	<0.005
Total cholesterol		5.1 ± 1.2 Ʉ	5.2 ± 1.0	5.2 ± 1.0	5.3 ± 1.0	<0.005
Low density lipoprotein		3.0 ± 1.1 £	3.2 ± 0.8	3.3 ± 0.9	3.6 ± 0.8	<0.005
High density lipoprotein		1.2 ± 0.3 §	1.2 ± 0.3	1.3 ± 0.4	1.2 ± 0.3	<0.005
Triglyceride		1.8 ± 1.2 ¥	1.9 ± 1.3	1.4 ± 1.1	1.6 ± 0.9	<0.005
HbA1c		9.2 ± 2.7	8.4 ± 2.2	5.7 ± 0.5	5.7 ± 0.7	<0.005

Ʉ=Comparing serum total cholesterol of the BMI <25 in patients with diabetes to ≥25 group in patients without diabetes, p value=0.002.

£=Comparing serum low density lipoprotein of the BMI <25 in patients with diabetes to ≥25 group in patients with diabetes, p value=0.008, Comparing serum low density lipoprotein of the BMI <25 in patients with diabetes to <25 group in patients without diabetes, p value=0.001, Comparing serum low density lipoprotein of the BMI <25 in patients with diabetes to ≥25 group in patients without diabetes, p value=<0.005.

§=Comparing serum high density lipoprotein of the BMI <25 in patients with diabetes to ≥25 group in patients with diabetes, p value=0.01, Comparing serum high density lipoprotein of the BMI <25 in patients with diabetes to <25group in patients without diabetes, p value=0.001.

¥=Comparing serum triglyceride of the BMI <25 in patients with diabetes to <25 group in patients without diabetes, p value=0.001 and the BMI <25 in patients with diabetes to ≥25 group in patients without diabetes, p value=0.02.

Table 3: Comparison of lipids features in diabetics in relation to BMI

Parameters		Diabetes presents						
		Yes				No		
		Body mass index(kg/m²)				Body mass index(kg/m²)		
		<25	25-29.9	≥30	P value	<25	25-29.9	≥30
Gender	Male	111(9.6)	217(18.8)	239(20.7)	<0.005	105(9.1)	254(22.0)	229(19.8)
	Female	89(6.5)	182(13.4)	442(32.4)		144(10.6)	197(14.5)	309(22.7)
Age(years)		38.7 ± 7.4	37.0 ± 7.7	36.7 ± 7.8	0.003	32.5± 9.6	31.6 ± 8.0	32.3 ± 7.5
Body mass index(kg/m²)		22.6 ± 2.1	27.7 ± 1.4	35.3 ± 4.7	<0.005	22.3 ± 2.3	27.5 ± 1.4	34.7 ± 4.0
Total cholesterol		5.1 ± 1.2	5.2 ± 1.0	5.1 ± 1.0	0.4	5.2 ± 1.0	5.2 ± 0.9	5.5 ± 0.9
Low density lipoprotein		3.0 ± 1.1 £	3.2 ± 0.9	3.2 ± 0.8	0.03	3.3 ± 0.9	3.4 ± 0.8	3.7 ± 0.8
High density lipoprotein		1.2 ± 0.4 §	1.1 ± 0.3	1.2 ± 0.3	0.005	1.3 ± 0.4	1.2 ± 0.3	1.2 ± 0.3
Triglyceride		1.8 ± 1.2 ¥	2.0 ± 1.2	1.9 ± 1.3	0.09	1.4 ± 1.1	1.5 ± 0.8	1.6 ± 0.9
HbA1c		9.2 ± 2.7	8.6 ± 2.2	8.3 ± 2.2	<0.005	5.7 ± 0.5	5.6 ± 0.5	5.7 ± 0.7

Data are numbers (%) and mean ± Standard deviation.

£=Comparing serum Low density lipoprotein of the BMI <25 group in patients with diabetes to 25-29.9 group in patients with diabetes, p value = 0.01 and to ≥30 group in patients with diabetes, p value=0.02.

§=Comparing serum High density lipoprotein of the BMI <25 in patients with diabetes to 25-29.9 group in patients with diabetes, p value = 0.001 and to ≥30 group in patients with diabetes, p value=0.04.

¥=Comparing serum triglyceride of the BMI <25 group in patients with diabetes to 25-29.9 groups in patients with diabetes, p value=0.05.

Table 4: Mean ± SD and the percentage of dyslipidaemia in diabetics in relation to gender

Parameters	Gender					
	Mean ± SD		P value	No.(%)		P value
	Male	Female		Male	Female	
Age(years)	38.2 ± 7.9	36.2 ± 7.4	<0.005			
Body mass index(kg/m²)	29.4 ± 5.2	32.2 ± 6.4	<0.005			
HbA1c	8.8 ± 2.4	8.3 ± 2.3	<0.005			
Total cholesterol	5.1 ± 1.1	5.3 ± 1.1	0.001	242(19)	340(27)	0.07
Low density lipoprotein	3.1 ± 0.9	3.2 ± 0.8	0.01	354(32)	494(45)	0.2
Triglyceride	2.0 ± 1.5	1.8 ± 1.0	<0.005	284(22)	304(24)	0.01
High density lipoprotein	1.1 ± 0.2	1.3 ± 0.3	<0.005	247(22)	265(23)	0.002

Table 5: Percentage of dyslipidaemia in diabetics in relation to body mass index and gender

Parameters	Gender								
	Total N0. (%)			Male N0. (%)			Female N0. (%)		
	Body mass index(kg/m²)								
	<25	25-29.9	≥30	<25	25-29.9	≥30	<25	25-29.9	≥30
Total cholesterol	87(7)	190(15)	305(24)	40(3)	100(8)	102(8)	47(3)	90(7)	203(16)
P value	0.5			0.2			0.4		
Low density lipoprotein	113(10)	268(24)	467(42)	62(6)	142(13)	150(14)	51(5)	126(11)	317(29)
P value	<0.005			0.02			0.002		
Triglyceride	83(7)	191(15)	314(25)	46(4)	108(9)	130(10)	37(3)	83(7)	184(14)
P value	0.3			0.08			0.6		
High density lipoprotein	101(9)	157(14)	254(22)	56(5)	89(8)	102(9)	45(4)	68(6)	152(16)
P value	0.004			0.3			0.02		

the rates in non diabetic men and women (21% of men and 34% of women). The prevalence of high LDL cholesterol levels in men and women with diabetes mellitus (23% and 31%, respectively) did not differ significantly(p=0.4) from the rates in non diabetic men and women (18% and 28%, respectively). The prevalence of high HDL cholesterol levels in men and women with diabetes mellitus (25% and 27%, respectively) did not differ significantly (p=0.7) from the rates in non diabetic men and women (23% and 25%, respectively). By contrast, the prevalence of high plasma triglyceride levels in individuals with diabetes mellitus (30% in men and 32% in women) was significantly higher than in those without diabetes mellitus (21% of men and 16% of women), p=0.02. Thus, both men and women with diabetes had an increased prevalence of hyper trigyceridemia levels, but their total cholesterol and LDL cholesterol and low HDL cholesterol levels did not differ from those in non-diabetic counterparts. A similar pattern of altered plasma lipid profiles with exception of low HDL was observed in the Framingham Heart Study and the UK Prospective Diabetes Study (UKPDS) [19,20]. An important caveat in relation to observations made in these pivotal epidemiologic studies is that the data were collected before the cut-off point for fasting plasma glucose that indicates a diagnosis of diabetes mellitus was lowered to 6.94mmol/L and the wide variation could be attributed to the studied population and the degree of glycogenic control as well as to the variation in the definition of the "cut off" values for lipid profile parameters. The prevalence of dyslipidaemia was increased with increasing BMI levels in both sexes which is consistent with our study.

Dyslipidemia in patients with diabetes is characterized by hypertriglyceridemia and low levels of HDL-C [21]. Hypertriglyceridemia predisposes the patients to life threatening complications like diabetic ketoacidosis, coronary artery disease and lipaemia retanalis [22]. It is more common in diabetics as compared to non-diabetics due to four fold increase in VLDL triglyceride [23]. Obesity and type 2 diabetes mellitus are associated with increased deposition of triglycerides in non-adipose tissue, such as the heart, liver, pancreas, and skeletal muscle. Obesity, i.e. fat accumulation in the subcutaneous abdominal and visceral depots, is most strongly associated with the risk of metabolic and cardiovascular complications [24]. As in our study, the studies of Santen et al. and Peret et al. observed mean serum triglyceride levels higher in obese diabetics in comparison to obese control subject [25,26].

In an early study by Bacchus in 1982, the cholesterol levels among healthy subjects, in Saudi Arabia, were reported as 4.27mmol/L

among males and 4.23mmol/L among females [27]. In 1991, Inam reported a level of 5.25mmol/L among males and 5.49mmol/L among females [28]. However, in 1985 the cholesterol level among diabetics in this country was reported as 5.2mmol/L among non-insulin dependent diabetes mellitus (NIDDM) [29]. In Al-Ghamdi et al. the mean cholesterol level among all the diabetic males was found to be 5.49mmol/L and 5.71mmol/L among diabetic females [9]. These figures are very close to the levels reported by Khandekar (i.e., 5.52mmol/L for males and 5.97mmol/L for females) [30]. Our figures were within the reported figures by others. In contrary to our study, other studies observed increase in the levels of total cholesterol, in diabetic subjects as compared to normal controls [31-35].

In obesity, the low plasma HDL-C levels have been attributed to increased fractional clearance of HDL secondary to depletion of its cholesterol [36]. Many key enzymes involved in HDL metabolism are altered in obese people with insulin resistance. Some of these changes are further developed in type 2 diabetes where in addition to insulin resistance, relative or absolute insulin deficiency. The observation of higher level of HDL among females than males is found in our study and it is another evidence of the positive effect of estrogen, as previously documented [37].

In conclusion the study has documented several lipid abnormalities in type 2 diabetic Patients and has pointed to the significance of diabetic management in the control of lipid abnormalities where the control of overweight and obesity is of importance. The study revealed that obesity and dyslipidemia were high among diabetic patients and required special attention. This can be done through health education at the primary care level and the diabetic clinics.

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