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Original Research Article

Relationship between glycosylated hemoglobin with FBS, blood pressure, serum lipid profiles and body fat distribution in staff of Ahvaz Jundishapur University of Medical Sciences

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Abstract: The aim of this study was to investigate the relationship between serum levels of HbA1C and blood pressure, lipid disorders, disorders of glucose, body fat percentage in staff Ahvaz University of Medical Sciences. In this method cross-sectional study, after obtaining inform consent, proper questionnaire filled up. Biochemical tests, including FBS, TG, Chol, HDL, LDL, VLDL and HbA1C blood were taken. Independent t-test and analysis of variance (ANOVA) were used to compare means. The relationship between quantitative and qualitative variables was tested by Pearson and Chi-square. In results the 183 participants, 99 men (54.4%) and 83 females (45.6%). BMI, abdominal circumference, waist circumference, systolic and diastolic blood pressure FBS, triglyceride, total cholesterol and HbA1c were significantly higher in men than in women. Body fat percentage and HDL were significantly higher in women than men (P= 0.0001). HbA1c>6.5 fasting blood glucose and triglycerides, VLDL and Homa_IR were significantly different from the other level of HbA1c. HbA1C was significantly associated with systolic blood pressure and age, r =0.15 P=0.04, r =0.36, P=0.0001 respectively. HbA1C with fasting blood glucose (P= 0.0001), cholesterol (P = 0.006) and LDL (P= 0.002) had a direct and significant correlation but with triglycerides. Body fat percentage with triglycerides (P=0.005) and VLDL (P=0.012) had a direct and significant correlation but with HDL (P =0.001) negative significant correlation. The conclusion in this study, in non-diabetics with 6/5 <HbA1c, fasting blood sugar, triglycerides, VLDL and Homa IR were higher than others.

Keywords: Glycosylated Hemoglobin, Fasting Blood Sugar, lipid profiles, Serum Insulin

INTRODUCTION:

Studies conducted in recent years have shown the relationship between metabolic disorders, Atherosclerosis and type 2 diabetes mellitus [1-3]. Type 2 diabetes is characterized by impaired secretion of insulin, and defect in target tissue's reaction to insulin when glucose molecule enters cell [4-5]. People with type 2 diabetes are generally more obese than other non-diabetics [6]. Obesity is the key risk factor in resistance to insulin which this in turn is the main symptom of type 2 diabetes mellitus [7-8]. Obesity comprises two types; general and visceral. BMI is a symptom of general obesity, and WHR is a symptom of visceral obesity [6]. The increase in fat tissue in abdomen is a serious danger of type 2 diabetes [9]; and visceral fat in fact causes impaired hepatic glucose uptake and extraction and its metabolism [9]. Although obesity is the most crucial risk factor in type 2 diabetes [4], risk factors such as hypertension, impaired glucose metabolism and serum lipids [1,10], and also an increase in HbA_1C [11] exacerbate diabetes. The increase in HbA_1C is considered as a dangerous key factor in type 2 diabetes, and is believed that people with glycosylated hemoglobin levels above normal are more prone to type 2 diabetes [11] in a way that the disease can be more easily diagnosed in the early stages [12]; and the early diagnosis can prevent many of microvascular complications of diabetes [12]. It was seen that with a decrease of only 1% in HbA_1C, microvascular complications of diabetes decreased by 35% [13-14]. Glycosylated hemoglobin molecule is made through the combination of hemoglobin and glucose molecules in the serum; with an increase in blood glucose, the level of glycosylated hemoglobin in

serum increases. Patients with type 2 diabetes who do not properly and precisely control their blood sugar levels are generally observed with an increase in the level of glycosylated hemoglobin in serum through which the level of blood glucose is measured during a period of 2-3 months. Long-term increase in the level of glucose in serum causes irreversible microvascular complications. Some retrospective studies have affirmed the relation between increased glycosylated hemoglobin and increased events and mortality rates from cardio-vascular diseases among diabetic patients. But recently the relation between glycosylated hemoglobin and increased danger of cardio-vascular diseases in non-diabetics [18] and people with natural tolerance for glucose [14] has been reported. Due to increasing rate of diabetes in the world, researchers intend to provide a solution for diagnosing people with type 2 diabetes in the early stages of the disease; and the increase in glycosylated hemoglobin not only stands as a meaningful symptoms of the disease but is also considered as one of the dangerous and deciding factors in cardio-vascular diseases [14, 18]. Thus, the decrease in levels of glycosylated hemoglobin and symptoms of cardio-vascular diseases must be seriously taken into account. Therefore, we intend to study the relation between HbA1C in serum and hypertension, lipid abnormalities, glucose abnormalities, and the percentage of body fat among the personnel of Medical Sciences University of Ahvaz through the article.

MATERIALS & METHODS:

In this analytic-descriptive study, an invitation was sent to the personnel through the Office Automation Service, and they were also notified through advertisement papers on the University's boards. Each volunteer registered through Office Automation System or telephone calls made by the center for diabetes studies in which case volunteers would go to the center's laboratory on a given date after being notified by secretaries about required qualifications –they would be required to have a low-calorie and brief meal and fast for 12 hours. Then at the laboratory, they would receive a consent form, and then they would be asked to fill out questionnaires by 2 college students majoring in Nutrition. Then, a 10 CC blood sample would be taken from each volunteer's right hand. The questionnaires comprised 1- general questions including each volunteer's full name, address, telephone number, gender, age, level of education, employment status –employee and worker –and 2- specific questions including each volunteer's or their family's history of disease –diabetes, hyperlipidemia, heart disease, hypertension –activity level –low, average, high –and smoking. Then, variables including weight, height, waist and hip circumference, hypertension, the percentage of body fat would be measured by a girl and a boy college students majoring in Nutrition.

Hypertension would be measured by a mercury device observing requirements which included sitting for 20 minutes, not taking tea or coffee before going to the laboratory, keeping arms on heart, putting stethoscope on the pulse of brachial. Cuff would be filled up to 20 mm Hg higher than the pulse number, then it would be emptied at a speed of 2 mm Hg/s until the Kvrtkvf first sound would be heard or the first radial pulse would be felt. The number would show systolic blood pressure, and the point at which Kvrtkvf sound would be mute was considered diastolic number.

After centrifugation, filtration and separation of serum, biochemical tests FBS, TG, Chol, HDL, LDL; VLDL would be performed by Auto analyzer BT3000 on samples. HbA1C would be measured by Nicocard device. Each volunteer's percentage of body fat would also be checked by body fat Monitor model BF306.

The information and data would be assessed by statistical software SPSS version 17. In order to compare average numbers, T test and analysis of variance (ANOVA) and Tukey test were used. Pearson's correlation coefficient was used to investigate the relationship between quantitative variables, and Chi-square test was used to investigate the relationship between qualitative variables.

RESULTS

183 people participated in the study out of which 99 people were men (54.4%) and 83 people were women (45.6%); 36 people (11 men and 25 women) aged an average of 36 ± 8.8 years old. Men's average age was different meaningfully from women's which were 38.3 ± 8.8 and 33.82 ± 8.19 (p=.0001), respectively. Variables waist and hip circumference, systolic and diastolic blood pressures were higher meaningfully in men than women (Table 1). The percentage of body fat was higher meaningfully in women than men (Table 1). FBS, triglyceride, total cholesterol and HbA1c were meaningfully higher in men than women (Table 1). 31 participants were workers (17%) and 151 participants (83%) were employees; 41.8% had a diploma or lower education levels, and the rest (56.6%) had a Bachelor or higher academic degrees. 7 people were rated an FBS of equal to or higher than 126. In non-diabetics, based on various levels of HbA1C, there was a meaningful difference between age, weight and body mass index, and at HbA1C > 6.5, fasting blood glucose and tri-glyceride and VLDL were meaningfully different from other levels of HbA1C. HomaIR was meaningfully different in various levels of HbA1C (Table 2).

Table 1: Comparison of different variable according to gender

Variable	Male N=99		Female N=83		P value
	Mean	SD	Mean	SD	
Age	38.31	8.748	33.82	8.195	0.0001
BMI	27.4808	3.88108	25.8561	4.55854	0.010
Tummy.size	93.146	15.3224	87.524	11.2762	0.005
waist	90.152	10.1555	78.994	10.2137	0.0001
bp1	11.944	1.5318	10.880	1.2459	0.0001
bp2	7.63	1.069	6.94	0.915	0.0001
Body.fat	27.9306	6.16067	36.7317	6.19924	0.0001
FBS	94.8788	29.82201	88.0964	19.25668	0.0001
TG	217.8384	140.91774	131.4819	81.96420	0.0001
Chol	187.6263	42.50944	176.6265	31.46803	0.047
HDL	46.9697	7.63244	55.1928	10.27839	0.0001
LDL	101.4239	34.20727	96.0488	23.36606	0.224
VLDL	37.4846	16.20605	24.6585	10.58559	0.0001
HbA1c	6.1010	1.09285	5.7627	0.56885	0.012
HomaIR	1.9631	0.87500	1.9013	0.89931	0.666

P<0.05 significant

Table 2: Basic characteristic of non diabetic patients for three different level of HbA1c

Parameters	HbA1c Category			P value
	(1) <5.5% (N=33) (mean±SD)	(2) 5.5-6.5% (N=126) (mean±SD)	(3) >6.5% (N=15) (mean±SD)	
Age	31.70±7.02	36.06±8.41	46.27±6.11	.000*
Weight	70.70±14.67	72.96±14.05	90.83±18.49	.000†
BMI	25.70±3.98	26.54±4.04	31.21±4.91	.000†
Tummy.size	88.95±10.77	90.21±12.77	96.83±25.79	.174
BP1	11.14±1.08	11.49±1.55	11.67±1.54	.387
BP2	7.18±0.92	7.31±1.09	7.47±1.06	.670
Body.fat	31.95±9.50	31.86±7.21	33.55±7.90	.725
FBS	81.15±8.43	87.56±8.25	101.87±13.50	.000†
TG	153.48±71.47	172.54±129.09	277.33±160.79	.004†
Chol	168.06±31.36	183.05±38.17	210.47±40.17	.002†
HDL	50.15±11.69	51.73±9.67	47.27±8.10	.223
LDL	2.29±1.31	99.68±30.29	119.92±31.40	.131
VLDL	30.57±14.35	29.90±15.03	44.31±13.53	.004†
Insulin	9.14±3.99	8.44±2.93	8.38±2.45	.192
HomaIR	1.96±1.11	1.91±1.14	3.77±6.13	.008†

*PostHoc Test TukeyHSD (1) vs (2)p<.016, (3)vs(1)and(2)p<.000

† PostHoc Test TukeyHSD (3)vs(1)and(2)p<.000

The relationship between fasting blood glucose and HbA1C (r=.82, p=.0001), cholesterol (r=.20, p=.006) and LDL (r=.23, p=.002), was meaningful and direct, but it was not meaningful with tri-glyceride, HDL, VLDL. There were not a meaningful relationship between HbA1C and BMI, waist circumference, hip circumference and body fat percentage and diastolic blood pressure. A meaningful relationship was observed between HbA1C, systolic blood pressure and age; r= .15, p= .04, r=.36, p= .0001, respectively (Diagram 1). Average HbA1C in people with or without a history of family diseases including hyperlipidemia, heart disease, diabetes, hypertension and obesity was compared which did not show a meaningful difference. 157 people did not have a history of diseases and 23 people had the history out of which 6 people with diabetes, 9 people with hyperlipidemia, 4 people with heart disease and 4 others with hypertension.

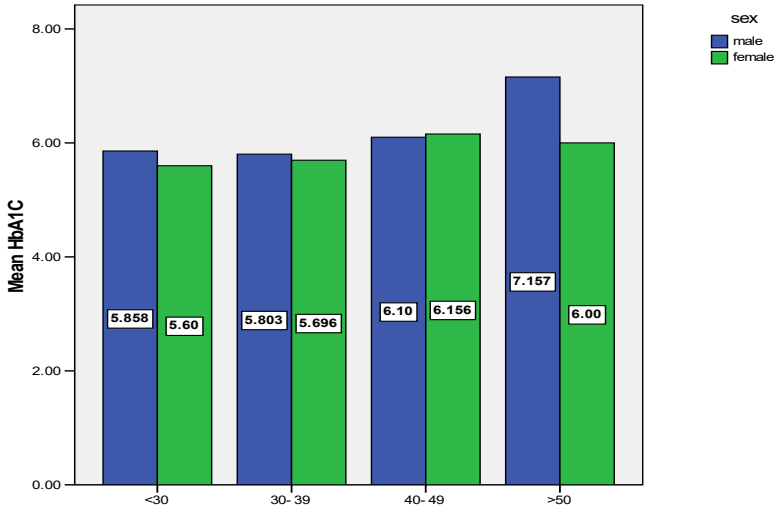

Fig-1: Relation between age and HBA1c

The comparison of average HbA1C with variables such as gender, marital status, employment status, smoking and activity level was assessed through T test; and the variables gender and marital status were meaningfully different from average HbA1C, but it was not meaningfully different from variables employment status, smoking and activity level. Also, analysis of variance showed a meaningful difference in average HbA1C in various age groups. The separation test Tukey was utilized for the difference between HbA1C and age groups over 50 and other age groups which showed a meaningful difference (Table 3). There was not a meaningful relationship between percentage of body fat and age, systolic and diastolic blood pressure. The relationship between body fat and BMI, and waist circumference was direct and meaningful (Table 4).

Table 3: Comparison between HbA1C and Different variables

Variable	N	HbA1c Mean ±SD	P Value
Sex			0.012
Male	98	1.09±6.1	
Female	83	0.56±5.76	
Married Status			0.021
Single	35	0.37±5.62	
Married	146	0.97±6.02	
Occupation			0.071
Worker	30	0.48±6.0	
Employee	150	0.97±5.93	
Age			0.0001
30<	54	0.63±5.69	
30-39	61	0.43±5.75	
40-49	47	0.67±6.11	
50≥	19	1.98±6.58	
Smoking			0.59
Yes	11	0.59±6.09	
No	168	0.92±5.93	
Activity			0.46
Low	121	0.09±6.0	
Moderate	47	0.06±5.8	
High	12	0.08±5.8	

There was not a meaningful relationship between age, systolic and diastolic blood pressure and percentage of body fat, but the relationship between BMI and waist circumference and percentage of body was direct and meaningful (Table 4). Percentage of body fat had a direct and meaningful relationship with tri-glyceride (r= -.20, p= .005) and VLDL (r= -.19, p= .012), and a meaningful and inverse relationship with

HDL (r= .25, p= .001). Percentage of body fat did not have a meaningful relationship with cholesterol, IDL and fasting blood glucose (Table 5).

Table 4: Comparison of different variable with body fat different level in both genders

Parameters	Body fat% Category (1) (N=9)	(2) (N=89)	(3) (N=9)	(4) (N=73)	P value
Age	34.78±9.67	38.73±8.66	27.67±4.00	34.71±8.23	.000*
BMI	21.68±1.29	28.08±3.58	19.74±1.65	26.61±4.22	.000†
Tummy.size	79.72±6.94	94.57±15.37	75.06±6.93	89.34±10.53	.000†
BP1	11.78±0.83	11.96±1.59	10.39±1.32	10.94±1.24	.000†
BP2	7.67±0.50	7.63±1.12	6.56±0.88	6.99±0.92	.000†
FBS	85.89±8.74	96.07±31.09	84.89±8.05	88.64±20.29	.200
TG	204.00±175.47	220.07±138.67	98.89±40.11	136.25±85.30	.000†
Chol	156.22±20.28	191.12±43.04	148.78±24.23	180.62±30.44	.001†
HDL	48.67±7.14	46.72±7.70	56.89±6.31	55.09±10.70	.000†
LDL	73.12±8.84	104.38±34.64	74.33±19.10	99.08±22.48	.001†
VLDL	31.62±22.69	38.22±15.52	17.55±6.80	25.68±10.67	.000†
HbA1c	5.90±0.49	6.13±1.14	5.73±0.28	5.77±0.60	.074
Insulin	9.02±2.28	8.56±3.46	7.29±1.96	8.69±2.26	.704
HomaIR	1.92±0.55	2.36±2.82	1.46±0.37	1.95±0.93	.573

1=Sex male body fat <20(normal)
2= Sex male body fat >20
3= Sex female body fat <30(normal)
4= Sex female body fat >30
*2vs3, †2vs3and4

Table 5: Relation between body fat and clinical & biochemical variable

متغیرها	r	P value
Age	0.06	0.38
Waist	0.139	0.06
BMI	0.41	0.0001
Tummy.size	0.16	0.03
Sys.BP	-0.1	0.17
Dys.BP	-0.12	0.1
FBS	-0.003	0.96
TG	-0.20	0.005
Chol	0.14	0.053
HDL	0.25	0.001
LDL	-0.07	0.32
VLDL	-0.19	0.012

To draw a comparison with average body fat based on age and activity level, variance analysis and T test were utilized to compare variables gender, marital status, job, and smoking among which a meaningful difference was only observed for job and gender, and not for others.

T test was utilized to draw a comparison with percentage of body fat in people with or without a history of family diseases including diabetes, hyperlipidemia, hypertension and cardio-vascular diseases; and the percentage of body fat in the people did not show a meaningful difference, and a meaningful difference was observed only for percentage of body fat in people with or without a history of family disease of hyperlipidemia.

DISCUSSION:

In the current study, the relationship between HbA1C and HOMA-IR was meaningful (p= .15). In the study, the relationship between HbA1C and age, systolic blood pressure, fasting blood glucose and cholesterol was meaningful, but the correlation between TG and HDL and LDL and VLDL was not meaningful. There was not a meaningful relationship between HbA1C, systolic blood pressure and age. HbA1C showed a meaningful difference with age and marital status. There was a meaningful difference between HbA1C and age group over 50 years old.

TG and VLDL showed an inverse relationship with percentage of body fat, and a direct one with HDL. The relationship between BMI and waist circumference and percentage of body fat was direct and meaningful. Percentage of body fat based on age and activity level showed a meaningful difference with job and gender. Percentage of body fat in people with or without a history of family disease of hyperlipidemia showed a meaningful difference.

In the current study, there were meaningful correlation and relationship between HbA1C and FBS and chol. In the study, there was not any relationship between TG and HDL and LDL and VLDL. Also, there was a meaningful relationship between HbA1C and systolic blood pressure and aging. TG and VLDL showed a meaningful and inverse relationship with percentage of body fat, and a direct and meaningful relationship with HDL. BMI and waist circumference showed a direct and meaningful relationship with percentage of body fat. Percentage of body fat based on age, activity level, job and gender showed a meaningful difference. Also, it showed a meaningful difference in people with or without a history of family disease of hyperlipidemia.

In the study, there was a meaningful relationship between HbA1C and HOMA-IR. In a study conducted in China, it was found that there was a meaningful relationship between distribution of adipose tissue and FBS and the glucose tolerance test and HbA1C and TG and LDL and HDL. In our study, percentage of body fat had a relationship with SBP, and a direct one with HDL; and a meaningful and inverse relationship with TG and VLDL.

Slevin *et al.;* found a strong relationship between FBS and HbA1C [18] which correspond to the results of our study. In Slevin's study [18], HbA1C did not show any relationship with gender; but in our study the relationship existed. People with HbA1C over 6% are prone to type 2 diabetes. Also, HbA1C is a marker for cardio-vascular diseases. In non-diabetics, HbA1C has a relationship with cardio-vascular diseases [18].

HbA1C can be utilized as a diagnosing factor for coronary artery disease, stroke, and death before the diagnosis of diabetes [18]. In the study conducted by Sung *et al;* in 2007, a meaningful relationship was shown between HbA1C and HOMA-IR, the same as in our study [20].

In a study conducted in the USA in 2003, a weak relationship was found between serum insulin and resistance to insulin and hypertension and non-diabetics prone to type 2 diabetes [21]. In a study conducted by Dilley et al. in 2007, there was a strong relationship between HbA1C and fasting serum insulin and resistance to insulin regardless of age and gender [14] which corresponds to our achieved results in our own study. Also, in the currents study, a strong relationship between HbA1C and High-density lipoprotein was observed, but no relationship was observed with serum tri-glyceride. HbA1C did not have any relationship with none of them in our study.

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Conflict of interests

The author declared no competing interests.

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