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Body Mass Index and Hemoglobin A1c Levels in Diabetic Adults

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ABSTRACT

Objective: Studies have shown that an increase in body mass index (BMI) increases the risk of developing diabetes and that there exist a strong relationship between hemoglobin A1c (HbA1c) and BMI. The aim of this studywas to interpret the relationship between BMI and HbA1c levels in adults.

Methods: Three hundred seven adult individuals in the patient group aged 18 years and older who presented to the internal medicine outpatient clinic and were diagnosed with type 2 diabetes and 99 healthy volunteers in the control group were evaluated within the scope of our study. Body mass index values and biochemical blood test results of diabetic and healthy individuals participating in our study were obtained prospectively from hospital records.

Results: The mean BMI of the patients was 31.2 ± 6.0 kg/m^2, glucose values were 164.7 ± 91.4 mg/dL, and HbA1c values were 8.3 ± 2.0%. The mean BMI value of all individuals with an HbA1c value of 6.5% and above was found to be above normal.

Conclusion: Diabetes and obesity are chronic and progressive diseases that are among the important public health problems today. The results of this research show the importance of HbA1c, BMI measurements, and cholesterol level measurements in health institutions applied for the improvement of public health.

Keywords: Body mass index, glucose, hemoglobin A1c, type 2 diabetes

INTRODUCTION

Obesity, according to the definition of the World Health Organization (WHO), is a chronic disease that carries the risk of increased morbidity and mortality, resulting from the interaction of genetic and environmental factors as well as factors affecting lifestyle. Although obesity is a common disease, it was determined that 1.9 billion adults aged 18 and over were overweight in 2016, and 650 million of these adults were obese.[1] The WHO recommends the use of body mass index (BMI) in adult obesity classification.[2]

Body weight gain has been shown to be associated with an increased risk of type 2 diabetes.[3] Diabetes is a metabolic disorder characterized by high blood glucose levels. Uncontrolled diabetes can lead to many adverse conditions, including renal failure, retinopathies that may even result in blindness, cardiovascular diseases, and diabetic wounds in the future.[4]

The hemoglobin A1c (HbA1c) test, which is used in the diagnosis and follow-up of diabetes, is a marker that shows the average blood glucose levels over a 3-month period. According to the American Diabetes Association, the plasma HbA1c level must be above 6.5% in order to be diagnosed with diabetes.[5]

The aim of this study was to evaluate the relationship between BMI and HbA1c levels in patients with type 2 diabetes and healthy controls without type 2 diabetes.

METHODS

Our research was carried out in two research hospitals (Erzurum Regional Training and Research Hospital and Erzurum Mareşal Çakmak State Hospital) between September 2022 and February 2023. This prospective study was carried out with the data of 307 patients aged 18 and over and 99 healthy individuals whose HbA1c measurements were made between September 2022 and February 2023. Patients and healthy individuals who accepted to participate in the study read the consent form of the study and accepted the research conditions and were included in the study. Pregnant women were not included in the study. The study was approved by the Clinical Resarch Ethics Committee of Erzurum Regional Training and Research Hospital (November 24, 2022, 2022/18-178).

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Biochemical data were obtained from the hospital automation system. After obtaining the consent of all participants, the age, gender, body weight, height, and biochemical analysis results of all individuals were obtained from the records of the automation system. As biochemical parameters, serum glucose, triglyceride, high-density lipoprotein (HDL) cholesterol (HDL-Chol), low-density lipoprotein (LDL) cholesterol (LDL-Chol), total cholesterol, uric acid, and plasma HbA1c values were evaluated.

Body mass index levels of all individuals participating in the study were calculated using the formula body weight (kg)/height^2 (m^2). Those with a BMI between 18.50 and 24.99 kg/m^2 were in normal weight; those between 25.00 and 29.99 kg/m^2 were considered overweight; and those over ≥30.0 kg/m^2 were considered obese.[2] The HbA1c value of 260 of the patients was 6.5% and above, and the HbA1c value of 47 of the patients was 6.5% and below. The entire patient group had a known diagnosis of type 2 diabetes.

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows 25 package program (SPPS Inc., Chicago, Ill, USA). The normality of the data was evaluated with the Kolmogorov–Smirnov test. Descriptive statistical methods (mean, SD) were used. The *t*-test was used to compare independent groups. *P* values less than .05 at the 95% CI were considered significant.

RESULTS

Comparisons of patient and control groups with demographic and biochemical parameters are presented in Table 1.

Patients were divided into 2 groups: those with an HbA1c value below 6.5 and those with a HbA1c value above 6.5. The mean HbA1c value (%) of patients with an HbA1c value below 6.5 was found to be 5.8 ± 0.7, and the mean HbA1c value (%) of patients with an HbA1c value above 6.5 was 8.7 ± 1.8. There was a statistically significant difference in HgA1c levels between the 2 groups (*P* < .01).

The biochemical parameters and subgroup comparisons of the 2 subgroups according to this subclassification in the patient groups are presented in Table 2.

Comparisons of the demographic characteristics and biochemical values of male and female patients are presented in Table 3.

As a result of comparing the demographic characteristics and biochemical values of male and female patients with the *t*-test in independent groups, it was determined that age, glucose and HgA1c, triglyceride, LDL-Chol, and total cholesterol values did not show a statistically significant difference between male and female patients (*P* > .05 for all parameters) (Table 2). Body mass index, HDL-Chol, and uric acid values were found to differ statistically between male and female patients (*P* < .01, *P* < .01, and *P* = .002, respectively).

Table 1. Comparisons of Patient and Control Groups with Demographic and Biochemical Parameters

	Patient Group (n=307)	Control Group (n=99)	*P*
Age (years)	59.5 ± 10.9	46.1 ± 15.4	<.01**
BMI (kg/m^2)	31.2 ± 6.0	26.9 ± 5.0	<.01**
Glucose (mg/dL)	164.7 ± 91.4	90.6 ± 11.2	<.01**
HbA1c (%)	8.3 ± 2.0	5.0 ± 0.5	<.01**
Triglyceride (mg/dL)	195.7 ± 98.9	135.9 ± 28.1	< .01**
HDL-Chol (mg/dL)	42.2 ± 11.4	49.1 ± 6.5	<**
LDL-Chol (mg/dL)	132.1 ± 36.3	138.8 ± 14.1	.074
T cholesterol (mg/dL)	179.9 ± 46.1	180.8 ± 18.3	.849
Uric acid (mg/dL)	4.8 ± 1.5	4.0 ± 1.4	<.01**

Results are presented as mean ± SD. BMI, body mass index; HbA1c, hemoglobin A1c; HDL-Chol, high-density lipoprotein cholesterol; LDL-Chol, low-density lipoprotein cholesterol; T-cholesterol, Total Cholesterol; *P*, test statistics *P* value of independent samples *t*-test; T cholesterol, total cholesterol.**Significance at *P* < .01 level.

Table 2. Demographic, Biochemical Parameters, and Comparisons of Patients with HbA1c < 6.5 and HbA1c ≥ 6.5

	Patients with HbA1c < 6.5 (n=47)	Patients with HbA1c ≥ 6.5 (n=260)	*P*
Age (years)	58.4 ± 8.7	59.6 ± 11.3	.486
BMI (kg/m^2)	29.6 ± 4.2	31.5 ± 6.3	.048*
Glucose (mg/dL)	127.2 ± 133.9	171.5 ± 79.9	.002**
HbA1c (%)	5.8 ± 0.7	8.7 ± 1.8	< .01**
Triglyceride (mg/dL)	169.7 ± 74.2	200.4 ± 102.1	.050*
HDL-Chol (mg/dL)	42.6 ± 8.9	42.2 ± 11.8	.799
LDL-Chol (mg/dL)	126.0 ± 31.2	133.2 ± 37.1	.214
T cholesterol (mg/dL)	177.7 ± 35.0	180.3 ± 47.9	.722
Uric acid (mg/dL)	5.3 ± 1.4	4.7 ± 1.5	.005**

Results are presented as mean ± SD. BMI, body mass index; HbA1c, hemoglobin A1c; HDL-Chol, high-density lipoprotein cholesterol; LDL-Chol, low-density lipoprotein cholesterol; T-cholesterol, Total Cholesterol; *P*, test statistics *P* value of independent samples *t*-test; T cholesterol, total cholesterol.**Significance at *P*< .01 level.

Table 3. Comparisons of the Demographic Characteristics and Biochemical Values of Male and Female Patients

	Female (N=180, 58.6%)	Male (N=127, 41.4%)	*P*
Age (years)	59.3 ± 10.9	59.7 ± 10.9	.766
BMI (kg/m^2)	32.4 ± 5.9	29.4 ± 5.8	<.01**
Glucose (mg/dL)	163.5 ± 94.3	166.5 ± 87.5	.778
HbA1c (%)	8.2 ± 1.9	8.4 ± 2.1	.338
Triglyceride (mg/dL)	190.3 ± 91.6	203.4 ± 108.2	.252
HDL-Chol (mg/dL)	44.0 ± 12.1	39.7 ± 9.8	< .01**
LDL-Chol (mg/dL)	131.9 ± 33.5	132.4 ± 40.1	.911
T cholesterol (mg/dL)	179.9 ± 48.0	179.9 ± 43.5	.997
Uric acid (mg/dL)	4.5 ± 1.4	5.1 ± 1.5	.002**

Results are presented as mean ± SD.BMI, body mass index; HbA1c, hemoglobin A1c; HDL-Chol, high-density lipoprotein cholesterol; LDL-Chol, low-density lipoprotein cholesterol; T-cholesterol, Total Cholesterol; *P*, test statistics *P* value of independent samples *t*-test; T Cholesterol, total cholesterol.**Significance at *P* < .01 level.

DISCUSSION

Obesity and diabetes, which are common diseases today, are related to each other. The WHO recommends the calculation of BMI for defining obesity in adults.[2] In addition to fasting glucose measurement, HbA1c measurement is also commonly preferred for the diagnosis of diabetes.[6] Since obesity and diabetes are important public health problems, measurements of BMI, glucose, and HbA1c values are important for individuals (7). The aim of this study to examine the relationship between random glucose and HbA1c measurements and BMI levels of individuals who presented to the internal medicine outpatient clinics of 2 state hospitals (Erzurum Regional Training and Research Hospital and Erzurum Mareşal Çakmak State Hospital).

The mean age of the patients participating in the study was 59.5 ± 10.9 years, the mean BMI values were 31.2 ± 6.0 kg/m^2, serum glucose values were 164.7 ± 91.4 mg/dL, and the HbA1c values were 8.3 ± 2.0%. In a meta-analysis examining the prevalence of obesity in Turkey, the mean BMI value of individuals was found to be 27.4 kg/m^2.[8] It is seen that the data of our research are higher than the BMI data across the country.

The UK Prospective Diabetes Study described plasma HbA1c measurement as the most valuable data in assessing the risk of developing diabetic complications as well as providing glycemic control.[7]

Hyperglycemia causes body weight gain due to lipid biosynthesis formation.[9] In studies examining the relationship between BMI

and fasting blood glucose levels, a positive and significant relationship was found.[9] The fact that individuals have high BMI and glucose values is due to the fact that hyperglycemia increases the body fat ratio. The best way to prevent possible complications for diabetic patients is to lose weight.[6]

In conclusion, BMI values, serum glucose values, plasma HbA1c levels, and plasma cholesterol levels were found to be higher in the patient group compared to the control group. As energy consumption increases, BMI levels increase, and so blood glucose and HbA1c levels also increase. Since obesity and diabetes are chronic diseases with increasing importance, it is very important to detect obesity, if any, and to monitor the HbA1c values of diabetes patients in health institutions applied to reduce its prevalence. In addition, diabetic patients with obesity should be provided with professional help to change their lifestyle and eating habits.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Clinical Resarch Ethics Committee of Erzurum Regional Training and Research Hospital (Date: November 24, 2022, Number: 2022/18-178).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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