Research Article / Araştırma Makalesi

Predicting Cardiovascular Risk in Prediabetes Status: The Role of Atherogenic Plasma Index in Individuals with Impaired Fasting Glucose

Prediyabet Durumunda Kardiyovasküler Riskin Öngörülmesi: Bozulmuş Açlık Glukozu olan Bireylerde Aterojenik Plazma İndeksinin Rolü

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Abstract: Atherogenic plasma index (API) is a relatively new index used in the general population for predicting the risk of cardiovascular disease. High fasting plasma glucose (FPG) levels have been shown to be associated with diabetes mellitus and metabolic syndrome, and API. However, no study has been conducted on the relationship between impaired fasting glucose identified using fasting and 2-hour plasma glucose in the oral glucose tolerance test, hemoglobin A1c (HbA1c) levels, and API. API was calculated using the logarithm of the molar ratio of triglycerides to high-density lipoprotein cholesterol. The relationship between glucose metabolism parameters with diabetes status and API was analyzed. The frequency of prediabetes and diabetes in the study participants was 35.3% (n=58) and 25.3% (n=40), respectively. 40 individuals were identified as Type 2 diabetes (fasting glucose >125 mg/dl, OGTT 2nd hour >200 mg/dl), 58 as impaired fasting glucose (IFG) prediabetes (fasting glucose: 100-125 mg/dl, OGTT 2nd hour <140mg/dl), and 66 individuals as a non-diabetic control group (glucose <100 mg/dL). 28.1% of participants were in the low-risk group (API<0.11), 18.2% were in the medium-risk group (API 0.11-0.21), and 53.6% were in the high-risk group (API>0.21). High API (high-risk group) was found to be significantly associated with prediabetes and diabetes status. API was also significantly associated with HbA1c, FPG, and 2-hour plasma glucose levels in the OGTT. AIP was significantly associated with the param¬eters of diabetes and prediabetes. Simple calculations made from fasting lipid panel results can be provide more information in assessing the risk of cardiovascular disease with IFG patients in prediabetes status.
Keywords: Atherogenic Plasma Index, Prediabetes, Diabetes Mellitus, Dyslipidemia

Özet: Aterojenik plazma indeksi (API), kardiyovasküler hastalık riskini tahmin etmek için kullanılan nispeten yeni bir indekstir. API'nin metabolik sendrom, yüksek açlık plazma glukoz (FPG) ve diabetes mellitus ile ilişkili olduğu gösterilmiştir. Bununla birlikte, açlık plazma glukozu oral glukoz tolerans testi (OGTT) 2. saat plazma glukozu ve hemoglobin A1c (HbA1c) kombinasyon testleri kullanılarak API ile bozulmuş açlık glukozu arasındaki ilişkiyi araştıran bir çalışma yapılmamıştır. API, trigliseritin yüksek yoğunluklu lipoprotein kolesterole molar oranının logaritmasını içeren formül kullanılarak hesaplandı. Glikoz metabolizması parametreleri ve saptanan diyabet durumları ile API arasındaki ilişki analiz edildi.: Çalışma katılımcıları arasında prediyabet ve diyabet sıklığı sırasıyla %35,3 (n=58) ve %25,3 (n=40) idi. Katılımcıların %28,1'i düşük risk grubunda (API<0,11), %18,2'si orta risk grubunda (API 0,11-0,21) ve %53,6'sı yüksek risk grubunda (API>0,21) idi. Yüksek AIP (yüksek risk grubu), prediyabet ve diyabet ile önemli ölçüde ilişkiliydi. HbA1c, FPG ve OGTT 2.saat plazma glukoz seviyeleri ile API önemli ölçüde ilişkiliydi. AIP, bozulmuş açlık glukozu ve metabolik sendrom parametreleri ile önemli ölçüde ilişkiliydi. API gibi lipid panelli basit hesaplamalar, prediyabet ve diyabetli hastalarda kardiyovasküler hastalık riskini değerlendirmek için bilgi sağlayabilir.
Anahtar Kelimeler: Aterojenik Plazma İndexi, Prediyabet, Diabetes Mellitus, Dislipidemi

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1. Introduction

Prediabetes is a metabolic condition characterized by blood glucose levels that are higher than normal but not yet high enough to be classified as diabetes. It has been shown that prediabetes is associated with increased cardiovascular risk and mortality (1,2). In prediabetic patients, the rate of developing diabetes is stated to be 70% in some publications. Therefore, early diagnosis increases the clinical importance of the disease by preventing the development of diabetes and diabetes-related clinical complications. The American Diabetes Association (ADA) has defined impaired fasting glucose (IFG) and impaired glucose tolerance (IGT). Since 2005, ADA has been using the term prediabetes for IFG and IGT (3,4). At the time of type 2 diabetes diagnosis, 10-20% of patients have complications. This situation should lead us to think that prediabetes is not a silent stage but harbors the health risks carried by diabetes. This period leads to a series of problems for the development of both microvascular and macrovascular diseases.

Atherogenic Plasma Index (API) is defined as an indicator used to assess low-density lipoprotein (LDL) particles and plasma atherogenicity, calculated with the formula of the base-10 logarithm of the ratio of plasma triglycerides (TG) to high-density lipoprotein (HDL). Current studies have shown that API not only reflects the real relationship between protective and atherogenic lipoproteins but also has emerged as a strong indicator of atherosclerosis and cardiovascular disease (CVD) (5,6). Looking at the current literature, it is emphasized that API is a strong and reliable biomarker for predicting CVD risk for individuals with metabolic syndrome, hypertension and DM. API is therefore indicated as an indicator of LDL particle size not determined by the normal lipid profile (7-9). According to our extensive literature review, no study has been conducted evaluating the relationship between individuals with impaired fasting glucose identified by fasting plasma glucose, oral glucose tolerance test (OGTT), and HbA1c, and API. We aimed to evaluate the relationship between API and those with impaired fasting glucose among prediabetic individuals.

2. Materials and Methods

The study was conducted after obtaining ethical approval from Tokat Gaziosmanpasa University Clinical Researches Ethics Committee (Date: 08.06.2023, Decision No: 23-KAEK-192). All study procedures were conducted complying with the ethical guidelines and principles stated in the Declaration of Helsinki. Patients who presented to our internal medicine outpatient clinic with new diagnosed of T2DM and IFG between 01.01.2023 and 01.07.2023, who were screened on FPG, 75 gr OGTT and Hba1c levels evaluated retrospectively.

Participants were categorized into three groups with fasting plasma glucose, 75g oral glucose tolerance test (OGTT) 2-hour plasma glucose values and Hba1c levels based on the American Diabetes Association diagnostic criteria for diabetes, prediabetes and non-diabetic status. İndividuals aged 18-77 years, who had not used antidiabetic treatment before were included in the study. Among the groups, 40 individuals had Type 2 diabetes (fasting plasma glucose >125 mg/dL, OGTT 2-hour >200 mg/dL), 58 individuals had impaired fasting plasma glucose (IFG) (fasting plasma glucose: 100-125 mg/dL, OGTT 2-hour <140 mg/dL) indicating prediabetes, and 66 individuals without diabetes were designated as the non-diabetic control group (glucose <100 mg/dL). The medical histories of all participants were collected, and systemic physical examinations were performed. Individuals with heart failure, acute and chronic kidney disease, chronic liver disease, hypothyroidism, hyperthyroidism, use of antihyperlipidemic drugs, steroids, omega-3, vitamin D, vitamin E, and acute infectious diseases were excluded from the study. Blood samples were taken from the antecubital vein after an 8-10 hour fasting period to determine biochemical and hemogram levels. 75 g OGTT was applied to individuals whose fasting plasma glucose measurement was found to be above 100mg/dl. The OGTT was conducted using a

solution prepared by dissolving 75 grams of glucose in 200 ml of water after an 8-12 hour fasting period. İndividuals were instructed to remain as still as possible and refrain from eating, drinking, and smoking during the test. The test was concluded by collecting a venous plasma sample for glucose measurement at the 2-hour mark after ingestion of the solution. According to AIP results and regarding previous literature reports subjects were grouped into three groups: low (<0.11), intermediate (0.11-0.21) and increased (>0.21) risk (7-9). Atherogenic plasma index (API) and body mass index were calculated with the formulas given below:

BMI: weight (kg) divided by the square of height (m^2)

API: Log_{10} [TG/HDL-C]

Statistical Analysis

Statistical analysis was conducted using IBM SPSS (Statistical Package for the Social Sciences) version 25.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics including mean (μ), standard deviation (SD), median, and lower quartile values were calculated for continuous variables. In cases of non-homogeneous distribution, median values were considered to account for the potential impact of distribution skewness. Categorical data were presented as percentages. Non-parametric analysis methods were employed for tests of significance involving continuous variables, considering sample sizes and distribution characteristics. Specifically, for comparing independent groups, the Mann-Whitney U test was utilized for groups of two, while the Kruskal-Wallis analysis of variance was applied for groups with more than two categories. Pearson and Spearman tests were chosen appropriately for significance testing of categorical variables. For normally distributed variables, Student's t-test was employed for pairwise comparisons, while for variables with non-normal distribution, the Mann-Whitney U test was used. The chi-square test was used to assess statistical significant differences between categorical variables. The obtained results were subjected to statistical evaluation at a 95% confidence interval with a significance level of $p < 0.05$.

3. Results

A total of 164 individuals with screened diabetes status, 127 (77.4%) female and 37 (22.6%) male, with an overall mean age of 41.01 (SD ±12.21, ranging from 18-77) years were enrolled in the study. The study was conducted on three groups: 40 (24.3%) newly diagnosed Type 2 diabetes, 58 (35.3%) prediabetes with IFG and 66 (40.2%) nondiabetic control group evaluated at the Internal Medicine Clinic of Tokat Gaziosmanpasa University Hospital between January 1 and July 1 2023. When focusing on the main subject of the study the Atherogenic Plasma Index (API), the minimum, maximum and mean values were found to be -0.41, 1.11 and 0.33±0.33 mmol/L respectively for all participants.

Comparing clinical and biochemical findings among the three study groups (diabetes, prediabetes, and nondiabetic control), statistically significant differences ($p<0.01$) were observed in terms of BMI, API, total cholesterol, triglycerides, HDL-C, LDL-C, fasting plasma glucose, HbA1c, creatinine and GFR (Glomerular Filtration Rate) values. Specifically in the diabetes group, the highest values were observed for BMI, API, total cholesterol, triglycerides, LDL-C, glucose, HbA1c and creatinine, while the non-diabetic healthy control group had the lowest averages for these parameters. Conversely, the mean HDL and GFR values were lowest in the diabetes group and highest in the control group. No significant differences were observed in AST, ALT and hemoglobin values across the three study groups. When evaluating only the diabetic and prediabetic groups (Table 2), significant differences ($p<0.01$) were noted for API, TG, LDL-C, fasting plasma glucose, OGTT 2nd hour plasma glucose and HbA1c, which were higher in the diabetic group. Total cholesterol and creatinine values were also significantly ($p<0.05$) higher in the diabetic group, while GFR values were significantly lower. In Table 3, participants were categorized into risk groups based on API, irrespective of diabetes

status. The distribution showed that 28.1% (n=47) were in the low-risk group (API <0.11), 18.2% (n=30) intermediate-risk group (API=0.11 – 0.21), and 53.6% (n=88) were in the high-risk group (API >0.21). Significant differences (p<0.01) were observed among API risk groups concerning age, BMI, API, total cholesterol, triglycerides, LDL-C, HDL-C, fasting plasma glucose, HbA1c, creatinine and GFR values. A significant difference (p<0.05) was observed in ALT values. The means of age, BMI, API, total cholesterol, triglycerides, LDL-C, fasting plasma glucose, HbA1c, creatinine and AST values were highest in the high-risk group, while HDL values were lowest in the high-risk group.

Table 4 presents diabetes status and rates according to API risk groups. High API risk status (API >0.21) was significantly associated with diabetic individuals (p<0.001). The likelihood of prediabetic individuals being in the high API risk group was higher compared to nondiabetic individuals (32.7% vs. 22.8%, p<0.04). Similarly, diabetic individuals had a higher likelihood of being in the high API risk group compared to prediabetic individuals (57.4% vs. 32.7%, p=0.002). As shown in Table 5, API was significantly correlated with HbA1c levels, fasting plasma glucose, and OGTT 2nd hour plasma glucose levels. According to the diagnostic diabetes test parameters, API was positively strong correlated with HbA1c. Compared to Hba1c, fasting plasma glucose and OGTT 2nd hour plasma glucose were statistically significant smaller positively correlated with API.

Table 1. Comparison of clinical and biochemical findings of the diabetic, prediabetic and non-diabetic control group

	Mean±SD			
	Diabetic (n=40)	**Prediabetic (IFG) (n=58)**	**Non-diabetic (Control) (n=66)**	**p**
Age (Years)	50.98±10.24	42.03±11.62	34.06±9.03	0.0001**
BMI (kg/m2)	30.80±4.63	31.6±7.56	25.64±5.86	0.0001**
API (mmol/L)	0.63±0.28	0.40±0.30	0.09±0.20	0.0001*
Total Cholesterol (mg/dL)	209.75±42.74	189.55±43.30	171.62±36.81	0.0001*
Triglycerides (mg/dL)	228.83±130.48	143.66±92.80	75.18±29.79	0.0001**
HDL-C (mg/dL)	46.93±9.05	49.05±12.18	57.13±11.07	0.0001*
LDL-C (mg/dL)	132.30±28.56	112.93±29.25	98.27±27.90	0.0001*
FPG (mg/dL)	162.63±66.84	106.00±6.59	90.79±4.49	0.0001**
HbA1c (%)	8.15±2.03	5.78±0.41	5.31±0.33	0.0001**
Creatinine (mg/dL)	0.76±0.34	0.66±0.16	0.70±0.17	0.090**
GFR (ml/dk)	98.85±25.77	109.96±16.66	121.19±11.49	0.0001**
AST (IU/L)	20.70±7.09	19.21±5.94	18.29±5.69	0.150**
ALT (IU/L)	21.65±12.11	19.31±8.31	17.68±10.52	0.157**
Hemoglobin (g/dL)	13.35±1.46	13.37±1.40	12.78±1.74	0.072*

** Student's t-Test*
*** Mann Whitney U test*
BMI: Body Mass İndex HbA1c: Glycated Hemoglobin FPG: Fasting Plasma Glucose IFG: Impaired Fasting Glucose LDL-C: Low-density lipoprotein cholesterol HDL-C: High-density lipoprotein cholesterol ALT: Alanine aminotransferase AST: Aspartate transaminase BMI: Body Mass Index API: Atherogenic Plasma Index GFR: Glomeruler Filtration Rate

Table 2. Comparison of clinical and biochemical findings of the diabetic and prediabetic group

	Mean±Sd		
	Diabetic (n=40)	**Prediabetic (IFG) (n=58)**	**P**
Age (Years)	50.98±10.24	42.03±11.62	0.0001**
BMI (kg/m2)	30.80±4.63	31.6±7.56	0.543**
API(mmol/L)	0.63±0.28	0.40±0.30	0.0001*
Total Cholesterol (mg/dL)	209.75±42.74	189.55±43.30	0.025*
Triglycerides (mg/dL)	228.83±130.48	143.66±92.80	0.0001**
HDL-C (mg/dL)	46.93±9.05	49.05±12.18	0.351*
LDL-C (mg/dL)	132.30±28.56	112.93±29.25	0.002*
FPG (mg/dL)	162.63±66.84	106.00±6.59	0.0001**
OGTT 2nd Hour PG (mg/dl)	216.56±71.42	132.34±7.13	0.001**
HbA1c (%)	8.15±2.03	5.78±0.41	0.0001**
Creatinine (mg/dL)	0.76±0.34	0.66±0.16	0.060**
GFR (ml/dk)	98.85±25.77	109.96±16.66	0.011**
AST (IU/L)	20.70±7.09	19.21±5.94	0.262**
ALT (IU/L)	21.65±12.11	19.31±8.31	0.259**
Hemoglobin (g/dL)	13.35±1.46	13.37±1.40	0.948*

** Student's t-Test*
*** Mann Whitney U test*
BMI: Body Mass İndex HbA1c: Glycated Hemoglobin LDL-C: Low-density lipoprotein cholesterol HDL-C: High-density lipoprotein cholesterol FPG: Fasting Plasma Glucose IFG: Impaired Fasting Glucose OGTT 2nd Hour PG: Oral Glucose Tolerans Test 2nd Hour Plasma Glucose ALT: Alanine aminotransferase AST: Aspartate transaminase BMI: Body Mass Index API: Atherogenic Plasma Index GFR: Glomeruler Filtration Rate

Table 3. Comparison of clinical and biochemical findings according to atherogenic plasma index risk groups

	Mean±Sd			
	Low Risk (API < 0,11) (n=46)	**İntermediate Risk (API=0,11-0,21) (n=30)**	**High Risk (API > 0,21) (n=88)**	**p**
Age (Years)	34.57±1.44	39.00±2.65	45.06±1.16	0.0001*
BMI (kg/m2)	25.42±0.84	27.41±0.96	31.44±0.73	0.0001**
API(mmol/L)	-0.02±0.01	0.15±0.02	0.58±0.02	0.0001**
Total Cholesterol (mg/dL)	169.67±5.29	169.20±6.86	202.61±4.55	0.0001*
Triglycerides (mg/dL)	59.24±2.12	77.77±3.25	197.60±11.87	0.0001*
HDL-C (mg/dL)	61.94±1.50	53.52±1.90	45.89±0.96	0.0001*
LDL -C(mg/dL)	97.30±4.02	97.77±5.20	124.08±3.11	0.0001*
FPG (mg/dL)	99.30±3.61	103.28±7.96	124.03±4.40	0.004**
HbA1c (%)	5.58±0.12	5.62±0.21	6.66±0.17	0.0001**
Creatinine (mg/dL)	0.66±0.18	0.63±0.08	0.73±0.24	0.017**
GFR (ml/dk)	120.49±1.88	114.86±2.63	106.15±2.37	0.0001**
AST (IU/L)	17.67±0.69	19.90±1.64	19.76±0.59	0.141**
ALT (IU/L)	16.13±1.04	19.20±2.67	20.85±1.02	0.041**
Hemoglobin (g/dL)	12.84±0.23	12.84±0.22	13.38±0.17	0.093*

** Student's t-Test*
*** Mann Whitney U test*
BMI: Body Mass İndex HbA1c: Glycated Hemoglobin FPG: Fasting Plasma Glucose LDL-C: Low-density lipoprotein cholesterol HDL-C: High-density lipoprotein cholesterol ALT: Alanine aminotransferase AST: Aspartate transaminase BMI: Body Mass Index API: Atherogenic Plasma Index GFR: Glomeruler Filtration Rate

Table 4. Distribution of groups according to diabetes status and API risk groups

Parameters	Low Risk (API<0.11) (n=46)	Intermediate Risk (API=0.11-0.21) (n=30)	High Risk (API >0.21) (n=88)
Non-diabetic Group (n=66) n(%)	43 (65.1%)	8 (12.1%)	15 (22.8%)
Prediabetic Group (n=58) n(%)	28 (48.3%)	11 (18.0%)	19 (32.7%)
Diabetic Group (n=40) n(%)	12 (32.6%)	5 (13.0%)	23 (57.4%)

Chi-Square test (p<0.001),

API: Atherogenic Plasma Index

Table 5. Bivariate correlation results between API and diagnostic diabetes test parameters in all participants

Parameters	Correlation Coefficient	p
HbA1c (%)	0.320	<0.001*
FPG (mg/dL)	0.249	<0.001*
OGTT 2nd hour PG (mg/dL)	0.236	<0.001**

** Pearson correlation*
***Spearman's rho*
HbA1c: Glycated Hemoglobin FPG: Fasting Plasma GlucoseOGTT 2nd Hour PG: Oral Glucose Tolerans Test 2nd Hour Plasma Glucose

4. Discussion

Exposure to chronic hyperglycemia in diabetic patients may result in macrovascular complications, but data on the risk of prediabetic levels of hyperglycemia and the possibility of macrovascular disease are limited. Since high blood glucose has been identified as a direct or indirect cause of atherosclerosis or clinical cardiovascular disease, prediabetes may also be a risk factor for macrovascular disease.Diabetic dyslipidemia is one of the most important associated metabolic features of diabetes that is closely related to macrovascular complications.(10) Diabetic dyslipidemia is typically characterized by elevated plasma triglyceride and low-density lipoprotein levels and low plasma high-density lipoprotein levels.(11) The reason for including patients with IFG in our study is that IFG has an isolated first phase insulin secretion defect (early phase), whereas IGT (Impaired Glucose Tolerance) is associated with both first (late phase) and second phase secretion defects. We aimed to investigate the relationship between PAI and the identification of individuals with IFG, a prediabetic condition in which only early phase insulin secretion is impaired.

According to the National Diabetes Statistics Report published by the Diabetes Collaboration Society in 2014, 37% of the US population is prediabetic.(12) According to the 2005-2006 data of the North American Cohort (NHANES), 34.62% of the population is prediabetic, 19.4% has impaired fasting glucose (IPG), 5.4% has impaired glucose tolerance (IGT) and 9.8% has a combination of these two statuses.(13) In the TURDEP 2 study conducted in our country, the prevalence of prediabetes increased to 30.4% when APG and OGTT were analyzed together.(14,15) The reason we selected patients with IFG in our study is that IFG is the earliest diagnosed, first recognized and increasingly prevalent prediabetic condition. Currently, the diagnostic methods used to determine prediabetes have a diagnostic accuracy of around 50%. (16) In one study, combined tests were evaluated in order to

improve the diagnosticity of the used tests and from lowest to highest diagnosticity, OGTT-FPG, OGTT A1C, FPG-A1C and FPG-OGTT-A1C combinations were ranked.(17) In our study, we used a combination of OGTT and A1C in addition to FPG for diagnostic sensitivity to detect prediabetic with impaired fasting glucose. When we evaluated the plasma atherogenic index according to risk groups in our study, FPG, OGTT 2nd hour PG, HbA1C values were found to be statistically significantly lower in the low-risk group compared to the intermediate and high risk groups. The main outcome of the study was firstly that higher API values were significantly associated with abnormal glucose metabolism parameters such as higher HbA1c, FPG and OGTT 2nd hour plasma glucose levels. The main outcome of the study was firstly that higher API values were significantly associated with abnormal glucose metabolism parameters such as higher HbA1c, FPG and OGTT 2nd hour plasma glucose levels. Consistently, API was significantly associated with diabetes status in our study. The mean PAI values of both IFG and diabetic patients were in the high-risk group. We observed an increasing pattern of mean API values from non-diabetics to diabetics. Diabetics were statistically more likely to be in the API high-risk group compared between those with IFG.(57.4% vs. 32.7%, p=0.002). Those with IFG were also more likely to be in the API high-risk group compared to non-diabetics (32.7% vs. 22.8%, $p<0.04$) According to the our study's analysis we found that the API had a significant linear positive correlation with prediabetes and diabetes status. According to the diagnostic tests for diabetes, the strongest positive significant correlation between API and HbA1c level. And also there was a slight but statistically significant positive correlation between API with FPG and OGTT 2nd hour PG.

In cross-sectional studies, mild and moderate hyperglycemia in the range lower than the diabetic limit has been shown to increase the frequency of coronary disease.(18) A systematic review by Ford et al. investigated the association between prediabetes and cardiovascular risk factors. (19) In this meta-analysis, in 18 studies analyzed on the basis of impaired fasting glucose (FPG>110 mg/dl), the risk value for cardiovascular disease ranged between 0.65-2.5, with a mean risk increase of 1.2. In 8 studies with an FPG cut-off of 100 mg/dL, the increased risk for cardiovascular disease ranged from 0.87-1.40, with a mean risk increase of 1.18. In a study by Jing Liu and colleagues, the risk of cardiovascular disease was 1.29 times higher, the risk of coronary heart disease was 1.42 times higher, and the risk of ischemic stroke was 1.39 times higher in those with IFG (100-125 mg/dl) compared to those with normal fasting glucose.

With our current data, patients with IFG were statistically in the high-risk group for cardiovascular disease risk in terms of API (32.7% vs. 22.8%). It has been suggested that this moderate increase in cardiovascular disease risk (approximately 20%) observed in prediabetic patients cannot be explained only by the direct effect of the high blood glucose level in the prediabetic range. Metabolic syndrome components such as obesity, dyslipidemia, hypertension, proinflammatory and prothrombotic status, which are often associated with prediabetes, may also contribute to the increase in cardiovascular disease risk (21).

Therefore, the effect of these risk factors should be taken into account when investigating the relationship between blood glucose levels and API. In terms of metabolic syndrome and dyslipidemia, high TG, low HDL and increased LDL profile were found in the diabetic and prediabetic group with IFG compared to the control group in our study. In relation to BMI, the prediabetic group with IFG had a statistically higher BMI, compared to the diabetic and control group.

In conclusion, API was significantly associated with diabetes and metabolic syndrome parameters. In this perspective, higher API may be a sign of prediabetes, diabetes, metabolic syndrome, more atherogenic lipid profile and possible existing CAD.

While this index may help to more accurately assess cardiovascular risk in diabetic patients, It may also be helpful in assessing cardiovascular risk in prediabetics with IFG who are easy to detect early. In addition, screening for prediabetes or even diabetes can be considered in individuals with highed API levels. Larger series of prospective and multicenter studies will be needed to provide more insight into the relationship between API and prediabetic conditions.

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Ethics

Ethics Committee Approval: The study was approved by Tokat Gaziosmanpaşa University Clinical Research Ethical Committee (Decision no: 23-KAEK-192, Date: 08.06.2023).

Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.

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