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Investigation of the Effectiveness of the ADA Prediabetes Risk Test in Identifying Prediabetic Turkish Patients and Determination of the Frequency of Retinopathy in Prediabetic Patients

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Abstract: In this study, the Turkish version of the American Diabetes Association (ADA) prediabetes risk test and the 75-g oral glucose tolerance test (OGTT) were administered to patients to determine the rate of prediabetic patients in our geographical region and investigate its consistency with the ADA risk test. In addition, the presence of retinopathy in prediabetic patients was examined. The study included a total of 342 patients with a fasting plasma glucose value of 100-125 mg/dl. The OGTT and risk test results were compared. According to the ADA prediabetes risk test, the patients were classified into those at risk for type 2 diabetes mellitus (DM) and those diagnosed with prediabetes. Prediabetes diagnosis determined by OGTT and HbA1C. When the OGTT results of the patients with negative ADA prediabetes risk test scores were compared, the sensitivity was determined as 54 % and the specificity as 63 % ($p<0.05$). When the patients with positive ADA prediabetes risk test scores were compared with those diagnosed with prediabetes and type 2 DM, the sensitivity and specificity values were calculated as 58 % and 54 %, respectively ($p>0.05$). There was no retinopathy finding in the eye examination of 262 of the 342 patients included in the study ($p>0.05$). In this study, we found that a positive ADA prediabetes risk score was effective in predicting prediabetes, but it was not sufficient. However, prediabetes diagnosed according to OGTT was found to be higher in the patients with negative test scores. © 2023 NTMS.

Keywords: Prediabetes; Type-2 Diabetes; ADA Risk Test; OGTT; Retinopathy.

1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disease in which the organism cannot adequately benefit from carbohydrates, fats, and proteins due to insulin deficiency or defects in the effect of insulin and requires continuous medical care and treatment [1].

Prediabetes is an intermediate state of hyperglycemia with a high risk for type 2 DM. The process between a normal glucose metabolism and overt diabetes is called the 'prediabetic period' [2]. There are three conditions in prediabetes patients: isolated impaired fasting glucose

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(IFG), isolated impaired glucose tolerance (IGT), and combined IFG+IGT. If these three conditions are left untreated, they progress to overt diabetes.

According to some publications, the rate of progression to diabetes in prediabetic patients is 70 %. Therefore, the early diagnosis and prevention of DM development and related clinical complications increase the clinical importance of the disease [3]. Observational studies have reported that prediabetes is associated with nephropathy, small fiber neuropathy, retinopathy, chronic kidney disease, and increased risk of cerebrovascular and cardiovascular diseases. The main purpose of treatment in prediabetes is to prevent the development of diabetes. An easy, practical, and cost-effective way to identify individuals at risk for prediabetes and diabetes is the American Diabetes Association (ADA) prediabetes risk test.

Diabetic retinopathy is the most common preventable or treatable chronic microvascular complication of DM. In other words, it constitutes the most common cause of preventable and/or treatable blindness in adults aged 20-74 years [4]. However, data on the development of retinopathy in prediabetes are very limited, and therefore the relationship between prediabetes and retinopathy needs further investigation. Treatment methods to be applied in retinopathy detected in the early period can prevent the development of advanced retinopathy, maculopathy, and blindness.

This study aimed to determine the rate of prediabetic cases among the patients that presented to the internal medicine outpatient clinic with a suspected risk of prediabetes, evaluate their ADA risk test scores, and investigate the relationship between prediabetes and retinopathy in these patients.

2. Material and Methods

This study was conducted prospectively at the Endocrinology and Metabolic Diseases Outpatients Clinic and Internal Medicine Outpatient Clinic of Erzurum Regional Training and Research Hospital between June 2016 and December 2017. The study was commenced after receiving approval from the local ethics committee (ethics committee date: 19.02.2018, number: 37732058-514.10). A total of 342 patients with a fasting plasma glucose (FPG) value of 100-125 mg/dl and 75-g oral glucose tolerance test (OGTT) results were included in the study. The patients were informed, and their consent was obtained. The ADA prediabetes risk test was administered to the patients, and the related data were noted. Height, weight, and waist circumference measurements were made. The laboratory results of the patients were accessed and noted through the hospital's automation system. Patients with known eye diseases, such as glaucoma and a history of eye surgery were not included in the study.

The laboratory procedures of the study were carried out in the biochemistry laboratory of the hospital. Venous blood was drawn from the antecubital vein after the patients fasted for 12 hours. The patients' gender, age, diagnosis, FPG value at the time of diagnosis, 75-g OGTT result, HbA1C, uric acid, total cholesterol, triglyceride, high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, and basic biochemical tests were recorded from the hospital automation system and patient files.

Among the anthropometric measurements of the patients, body weight was determined with the patient wearing the thinnest clothes possible and barefoot. Height was measured with the patient standing bare feet and his/her feet positioned together, while leaning perpendicular to the height measurement ruler. Waist circumference was measured with a tape from the midpoint of the distance between the lowest rib and the iliac crest. Body mass index (BMI) was calculated by dividing the body weight (kg) by the square of the height in meters (kg/m^2).

The ADA prediabetes risk test includes seven simple and easy-to-understand questions about age, gender, history of gestational diabetes, family history of DM, high blood pressure, physical activity, and height-weight. Scores of 5 and above in this test are accepted as positive and indicate risk for type 2 DM.

After 10-12 hours of fasting, 75-g OGTT was performed on the patients, and their HbA1C levels were measured. Before the test, FPG was evaluated, and plasma glucose (PG) was measured in the second hour after the patients ingested 75 g of oral glucose solution. Patients with an FPG value 100-125 mg/dl and second-hour PG of <140 mg/dl were evaluated as having IFG, those with an FPG of <100 mg/dl and second-hour PG of 140-199 mg/dl as having IGT, those with an FPG of 100-125 mg/dl and second-hour PG of 140-199 mg/dl as having combined IFG+IGT, those with a second-hour PG of >200mg/dl as diabetic, and those with an FPG of <100 mg/dl and second-hour PG of <140 mg/dl as having normal values.

According to these results, the patients who met one of the following criteria were considered prediabetic.

1.HBA1C of 5.7-6.4 %

2.FPG of 100-125 mg/dl

3.Second-hour PG of 140-199 mg/dl in OGTT.

2.1. Retinopathy assessment

Each patient underwent a complete ophthalmologic examination, including visual acuity, intraocular pressure measurement (Goldmann applanation), anterior segment and fundus examinations, and central foveal thickness (CFT) and mean foveal thickness (MFT) measurements. CFT and MFT measurements were undertaken using spectral-domain optical coherence tomography (SD-OCT) (Optovue Inc., Fremont, CA, USA) in a dim room by instilling a 0.5 % drop following tropicamide mydriasis. All the SD-OCT evaluations were performed by a single ophthalmologist. The mean outcome measures, CFT, and MFT were automatically calculated by SD-OCT.

2.2. Statistical Analysis

Data were presented as mean ± standard deviation, percentage, and number. The analysis of the research data was undertaken using the Statistical Package for the Social Sciences (SPSS) for Windows, v. 17.0. The normality of the distribution of continuous variables was evaluated with the Kolmogorov-Smirnov test and histograms. In the comparisons between two independent groups, the independent-samples t-test was used when the normal distribution condition was met. Comparisons between categorical variables were made with the chi-square and Fisher's exact tests. In the comparison of two continuous variables, the Pearson test was conducted if the normal distribution condition was met and the Spearman correlation test otherwise. The receiver operating characteristics (ROC) analysis was performed to determine whether the continuous variable could be used in the diagnosis. The results were evaluated at the 95 % confidence interval by taking the statistical significance level as $p<0.05$.

3. Results

The study included a total of 342 patients, of whom 34.2 % (n=117) were male and 65.8 % (n=225) were female. The mean age of the patients was 53.1 [standard deviation (sd): 12.5] years. The lowest patient age was 18 years and the highest was 85 years. The mean age of the male patients was 55.1 years, and that of the female patients was 52.1 years. Other demographic and laboratory parameters of the patients are detailed in Table 1.

The prediabetes diagnosis of the patients included in the study was made based on the OGTT and HbA1C results. Accordingly, 95.2 % of the patients whose FPG value was 100 mg/dl and above were diagnosed with prediabetes. In the remaining 4.8 % of the patients, both the OGTT and HbA1C results were found to be normal. According to the ADA prediabetes risk test, the rate of patients with type 2 DM risk was 72.5 % in the group diagnosed with prediabetes and 37.5 % in the group without prediabetes. Accordingly, among the patients with prediabetes, the risk of type 2 DM was found to be significantly higher than in those without prediabetes (p=0.001) (Table 2).

When the patients were examined according to the diagnosis of prediabetes, it was found that 16 did not have prediabetes. When these 16 patients were further examined according to their scores in the prediabetes risk test, 53.3 % (n=8) had 4 points, 33.3 % (n=5) had 5 points and the remaining 6.66 % (n=1) had 2 points, i.e., the majority of those without prediabetes scored 4 or 5.

The patients with a score of 5 and above in the prediabetes risk test were considered to be at risk for type 2 DM. When examined from this perspective, it was determined that 70.8 % of the patients were at risk. There was no significant difference between the male and female patients in terms of prediabetes risk ($p>0.05$). The mean scores of the patients in the prediabetes risk test was 5.35 (sd: 1.59). It was observed that 79.6 % of the patients had a score between 4 and 7 points.

The OGTT results were normal in only 41 (46.6 %) of the 88 patients who had a prediabetes risk test score of 4 and below, i.e., who did not have type 2 DM risk according to the test. Of these cases, 16 (18.2 %) were classified as IFG, nine (10.2 %) as IGT, 15 (17 %) as combined IFG+IGT, and seven (8 %) as DM. Detailed data are given in Table 3.

According to the OGTT results of the 223 patients with a prediabetes risk test score of 5 and above, i.e., those with type 2 DM risk according to the test, 72 (32.3 %) were evaluated as having normal values, 45 (20.2 %) as having IFG, 24 (10.8 %) as having IGT, 43 (19.3 %) as having combined IFG+IGT, and 39 (17.5 %) as having DM. There was no significant difference between the groups ($p>0.05$) (Table 4).

In the prediabetes risk test, the patients were analyzed in detail according to whether they were at risk of type 2 DM. In the examination made in terms of age, the mean age of those with type 2 DM risk was determined to be significantly higher (p=0.001). The mean age of the patients at risk for type 2 DM was 57.8 years, while the mean age of those without this risk 42 years. The detailed data of the patients with and without type 2 DM risk are given in Table 5.

When the relationship between the HbA1C results and the prediabetes risk test scores was examined, there was an increase in the HbA1C value as the prediabetes risk test score increased. The patients who had a score of 5 and above in the prediabetes risk test, i.e., those that were considered to be at risk for type 2 DM, were found to have a mean HbA1C value above 6 %, while the mean HbA1C value of those with a score of 4 or less in the test was determined to be below 6 % (Table 6).

The patients were divided into two groups according to whether their OGTT results were normal or abnormal. The sensitivity of the prediabetes risk test score in predicting the OGTT outcome was tested using the ROC analysis. In this analysis, the area under the curve was calculated as 0.593, sensitivity as 54 %, and specificity as 63 % ($p =0.001$), suggesting that the ADA prediabetes risk test could be used to identify patients without prediabetes or type 2 DM risk at a statistically significant level (Figure 1).

There was no evidence of retinopathy in the eye examination of 262 of the 342 patients included in the study. The rate of retinopathy in the prediabetic patients was not statistically significant when compared to the diabetic patients ($p>0.05$).

4. Discussion

In this study, the Turkish version of the ADA type 2 prediabetes risk test scores and the 75-g OGTT results were compared. The ADA risk test is a short and easy-to-understand tool that includes seven questions which can be answered by patients themselves. Despite being such a simple and inexpensive test, it is very effective in detecting prediabetes.

Table 1: Demographic and laboratory parameters of the patients by gender.

	Male (n=117, 34.2 %)	Female (n=225, 65.8 %)	Total (n=342, 100 %)
Age	55.10±12.28	52.13±12.53	53.14±12.50
Body Mass Index (kg/m^2)	28.32±4.66	33.04±6.53	31.39±6.35
Creatinine (mg/dl)	0.90±0.16	0.73±0.11	0.79±0.15
Uric acid (mg/dl)	6.04±1.44	5.07±1.27	5.40±1.40
Total cholesterol (mg/dl)	200.26±41.64	206.29±39.52	204.36±40.24
LDL (mg/dl)	127.25±34.25	129.44±31.32	128.68±32.34
HDL (mg/dl)	43.62±10.71	49.04±10.62	47.30±10.93
Triglyceride (mg/dl)	169.27±89.61	153.04±75.69	158.72±81.08
Presence of HT	27.6 % (n=32)	45.2 % (n=98)	38 % (n=130)
Presence of type 2 DM according to the ADA risk test (score 5 and above)	75 % (n=87)	68.5 % (n=148)	70.8 % (n=235)
Mean score in ADA prediabetes risk test (points)	5.50±1.59	5.26±1.59	5.35±1.59
HbA1C (%)	6.03±0.42	6.10±0.40	6.07±0.41

sd: standard deviation, HDL: high density lipoprotein, LDL: low density lipoprotein, HT: Hypertension, DM: Diyabets Mellitus.

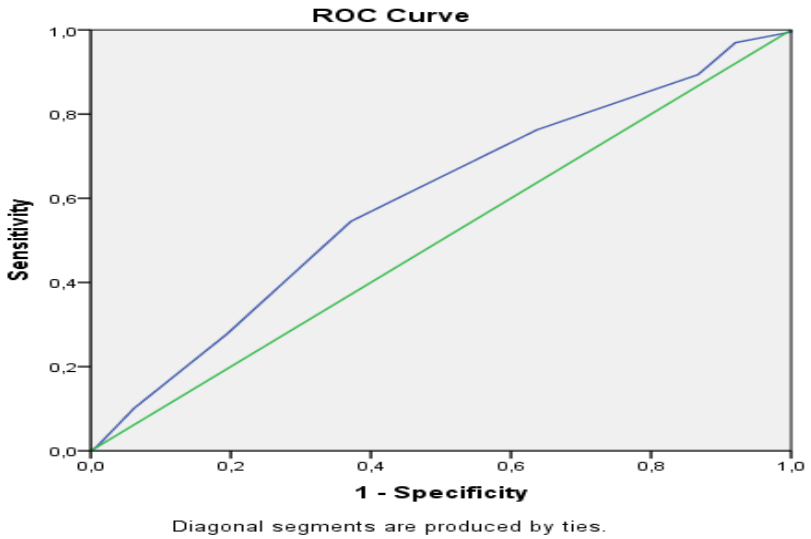

Figure 1: Ability of the ADA prediabetes risk test score to predict normal and abnormal OGTT results in patients.

Table 2: Comparison of the patients with and non-prediabetic.

	Prediabetic (n=316, 95.2 %)	Non-prediabetic (n=16, 4.8 %)	p* value
Age	53.90±11.88	44.25±17.09	**0.001**
Presence of type 2 DM risk	72.5 % (n: 229)	37.5 % (n: 6)	**0.001**

*: Chi-square test, sd: standart sapma, DM: Diyabets Mellitus.

Table 1: OGTT results of the patients with a prediabetes risk score of 4 and below according to the ADA risk test.

	Normal	IFG	IGT	IFG + IGT	DM	Total
1 point	0 (0 %)	1 (100 %)	0 (0 %)	0 (0 %)	0 (0%)	1 (100 %)
2 points	9 (64.3 %)	0 (0 %)	2 (14.3 %)	0 (0 %)	3 (21.4 %)	14 (100 %)
3 points	6 (28.6 %)	5 (23.8 %)	5 (23.8 %)	5 (23.8%)	0 (0 %)	21 (100 %)
4 points	26 (50 %)	10 (19.2 %)	2 (3.8 %)	10 (19.2 %)	4 (7.7 %)	52 (100 %)
Total	41 (46.6 %)	16 (18.2 %)	9 (10.2 %)	15 (17 %)	7 (8 %)	88 (100 %)

Table 4: OGTT results of the patients with a prediabetes risk score of 5 and above according to the ADA risk test.

	Normal	IFG	IGT	IFG + IGT	DM	Total
5 points	30 (41.1 %)	13 (0 %) 17.8	7 (9.6 %)	11 (15.1 %)	12 (16.4 %)	73 (100 %)
6 points	20 (27.4 %)	18 (24.7 %)	9 (12.3 %)	12 (16.4 %)	14 (19.2 %)	73 (100 %)
7 points	15 (30 %)	10 (20 %)	6 (12 %)	11 (22 %)	8 (16 %)	50 (100 %)
8 points	6 (25 %)	2 (8.3 %)	2 (8.3 %)	9 (37.5 %)	5 (20.8 %)	24 (100 %)
9 points	1 (33.3 %)	2 (66.7 %)	0 (0 %)	0 (0 %)	0 (0 %)	3 (100 %)
Total	72 (32.3 %)	45 (20.2 %)	24 (10.8 %)	43 (19.3 %)	39 (17.5 %)	223 (100 %)

Table 5: Mean values of variables and analysis results of groups with and without type 2 DM risk according to the ADA risk test.

	Patients with type 2 DM risk	Patients without type 2 DM risk	p value
Age	57.84±10.44	42.00±9.99	**0.001***
BMI (kg/m^2)	32.52±6.37	28.66±5.42	**0.001***
Creatinine (mg/dl)	0.81±0.15	0.76±0.14	**0.001***
Uric acid (mg/dl)	5.56±1.43	4.99±1.27	**0.001***
HbA1C (%)	6.12±0.39	5.92±0.38	**0.001***
Presence of HT	51.1 % (n=120)	9.3 % (n=9)	**0.001****
Presence of overt DM	35.1 % (n=39)	14.6 % (n=7)	**0.001****

*: Independent-samples t-test, **: Chi-square test BMI: Body Mass Index, HT: Hypertension, DM: Diyabets Mellitus.

Table 6: Comparison of the HbA1C results and ADA prediabetes risk test scores.

Score	Number	Mean HbA1C	Standard deviation
1 point	1	5.90	-
2 points	14	5.90	0.26
3 points	21	5.90	0.39
4 points	53	5.93	0.41
5 points	76	6.01	0.33
6 points	74	6.21	0.52
7 points	53	6.13	0.30
8 points	23	6.19	0.18
9 points	4	6.17	0.20
Total	319	6.07	0.40

This study is one of the few studies using the ADA risk test and OGTT to identify patients at risk of prediabetes and the first research conducted with a Turkish population. We determined that a positive ADA risk score was effective in predicting prediabetes, but it was not sufficient. However, among the patients with negative risk scores, prediabetes was found at higher rates based on the OGTT results. Therefore, the risk test was not effective in predicting prediabetes in those with negative risk scores.

In our study, when the patients' type 2 DM risk in the ADA prediabetes risk test was examined according to their age, it was determined that the mean age of those with type 2 DM risk was 57.8 years, and the mean age of those without this risk was 42 years, indicating a statistically significantly higher value for the former. This finding is consistent with the literature data reporting that the prevalence of diabetes increases with age. According to the IDF 2017 data, the prevalence of prediabetes was the lowest in the youngest patient group and the highest in the oldest patient group [5].

We also investigated whether being at risk for type 2 DM according to the ADA risk test resulted in a significant difference in HbA1C values. The mean HbA1C value was determined as 5.92 % (sd: 0.38) for the patients without type 2 diabetes risk and 6.12 % (sd: 0.39) for those with this risk. The difference between the two groups was statistically significant, and those with type 2 diabetes risk had higher HbA1C values. When the relationship between the HbA1C value and the prediabetes risk test score was examined using the correlation analysis, it was observed that as the prediabetes risk test score increased, the HbA1C value also increased, and there was a statistically significant positive correlation. The patients with a prediabetes test score of 5 and above, i.e., those considered to be at risk

for type 2 DM, were found to have a mean HbA1C value above 6%, while the patients that scored 4 and below in the prediabetes risk test had a mean HbA1C value below 6 %.

There was also a statistically significant difference between the OGTT groups in relation to the HbA1C values. In the subgroup analysis, differences were at significant levels in the pairwise comparisons of the normal and combined IFG+IGT groups, normal and DM groups, IFG and combined IFG+IGT) groups, IFG and DM groups, IGT and DM groups, and DM and combined IFG+IGT groups. The mean HbA1C value of the DM group was found to be statistically significantly higher compared to the remaining groups. In addition, the mean HbA1C value of the combined IFG+IGT group was statistically significantly higher compared to the normal and IGT groups.

Türkiye Diyabetes, Obesity and Hypertension Epidemiology 2 and various studies have revealed that the high-risk group determined by HbA1C includes people with more severe glucose metabolism disorders than those with isolated IFG and isolated IGT and close to those with IFG+IGT [6]. It has been reported that individuals that are determined to be at high risk of diabetes according to the A1C test performed with a standard method are more likely to develop this disease, and therefore they should be included in diabetes prevention studies [1].

In another study examining the data obtained from seven studies investigating HbA1C in diabetic cases, the incidence of diabetes over a five-year follow-up was reported to be <5 % for the HbA1C range of 5.0-5.5 %, 9-25 % for the HbA1C range of 5.5-6.0 %, and 25-50 % for the HbA1C range of 6.0 and 6.5 % [7]. Similarly, in our study, the risk of developing diabetes was found to be higher as the HbA1C level increased.

In the current study, according to the OGTT results of the 223 patients with a prediabetes risk test score of 5 and above, i.e., those with type 2 DM risk, 72 (32.3 %) had normal values, 45 (20.2 %) had IFG, 24 (10.8 %) had IGT, 43 (19.3 %) had combined IFG+IGT, and 39 (17.5 %) had DM. There was no significant difference between the groups.

Only 41 (46.6 %) of the 88 patients with a prediabetes risk test score of 4 and below, i.e., those without type 2 DM risk, had normal OGTT results. Sixteen (18.2 %) of these cases were classified as IFG, nine (10.2 %) as IGT, 15 (17 %) as combined IFG+IGT, and seven (8 %) as DM based on the OGTT results. According to OGTT, we also evaluated the patients in two groups as normal and abnormal results. We performed the ROC analysis between the OGTT results of the patients with negative scores in the prediabetes risk test and the prediabetes risk scores. In the ROC analysis, the AUC, sensitivity, and specificity values were determined to be 0.593, 54 %, and 63 %, respectively, suggesting that the ADA prediabetes risk test could be used to identify patients without prediabetes and type 2 DM risk at a statistically significant level. We also observed that the patients with positive risk scores had normal OGTT results. Therefore, the use of the ADA risk test is helpful but needs confirmation by another test.

The Finnish Diabetes Risk Score (FINDRISC) is another scoring system developed to identify individuals at risk for diabetes through simple and easy-to-understand questions scored in a similar manner to the ADA test. Among the studies in the literature using this scoring system, Vandersmissen et al., reported that FINDRISC was useful in identifying patients at risk of diabetes [8]. In a study by Kutlu et al., including 479 patients from the Turkish population, a correlation was found between the FINDRISC survey results and FBG levels [9]. Martin et al. compared the HbA1C, FINDRISC, and OGTT results to investigate diabetes risk in healthy individuals and determined that the FINDRISC test was an inexpensive, reproducible, and reliable method for this purpose [10].

In the literature, there are many similar studies using FINDRISC, but there is no large-scale study for the Turkish population. In our review of the literature on the ADA risk test, a scoring system similar to FINDRISC, we did not find satisfactory results. In a study by Tentolouris et al., random capillary glucose, ADA diabetes risk test, and skin fluorescence spectroscope results were compared. On completion of the study, the authors observed that the ADA risk test was significant in identifying both prediabetic and diabetic patients diagnosed based on their HbA1C values [11]. When all the literature findings are considered together, it can be concluded that there are not a sufficient number of studies on the ADA risk test. Our study is one of the few conducted to evaluate the effectiveness of the ADA risk test in identifying patients at risk of diabetes with respect to OGTT results, and it is also the first study undertaken with a Turkish population.

Of patients diagnosed with type 2 DM, 10-40% have complications at the time of diagnosis. Therefore, it should be considered that prediabetes is not a silent stage but contains the health risks of diabetes. This period may cause a series of problems in terms of the development of not only microvascular and macrovascular diseases but also other health risks [12].

Diabetic retinopathy is the most common preventable or treatable chronic microvascular complication of diabetes. In other words, it is the most common cause of preventable and/or treatable blindness in adults aged 20-74 years [4]. However, data on the development of retinopathy in prediabetes are very limited. There is still no large-scale study in the literature investigating the relationship between prediabetes and retinopathy in Turkey [12]. Almost all cases of diabetic retinopathy among prediabetic patients have been reported to be mild non-proliferative diabetic retinopathy [12]. To our knowledge, our study is the first to investigate retinopathy in prediabetic patients in the Turkish population.

In the DPP study, in which 878 prediabetic patients were followed up for three years, diabetic retinopathy was detected by fundus photography in 12.6 % of the

594 patients with diabetes and 7.9 % of those without diabetes [13]. In a meta-analysis covering 12 studies on retinopathy, the data of 44.623 patients were evaluated, and the prevalence of total retinopathy was determined as 6.7 %, and the prevalence of DM-specific retinopathy was 1.5 %. Furthermore, the prevalence of diabetic retinopathy was 9.4 % in individuals with known DM, 1 % in the presence of newly diagnosed DM, 0.1 % in the presence of IGT, and 0.1 % in the presence of IFG [14-15]. In our study, however, retinopathy was not detected in the presence of prediabetes. Although retinopathy was found in 0.1 % of prediabetic cases in the meta-analysis, the relationship between prediabetes and retinopathy can be revealed more clearly by increasing the number of patients in our study. In studies included in the meta-analysis, diabetic retinopathy was classified according to the retinal photographing method. We consider that if we had used retinal photographing method in our study, we could have found a significant relationship between prediabetes and retinopathy.

5. Conclusion

In this study, it was determined that a positive ADA risk test score was effective in predicting prediabetes, but it was not sufficient. The diagnosis of prediabetes based on the OGTT results was found to be higher in patients with negative ADA risk scores. However, prediabetes diagnosed according to OGTT was found to be higher in the patients with negative scores. Therefore, the prediabetes risk test was not effective in predicting prediabetes among the patients with negative scores.

Limitations of the Study

The major limitation of our study is that it only included patients who presented to the outpatient clinic of a single center, which reduces the generalizability of the findings to the whole Turkish population.

Acknowledgement

None.

Conflict of Interests

The authors declare no conflict of interest.

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Author Contributions

FC contributed to the writing-original draft preparation of the manuscript, writing-review & editing, methodology, visualization, and investigation. AVŞ contributed to conceptualization, writing-review & editing, and data curation. İB contributed to formal analysis, resources, and visualization. DNB contributed to investigation, software, and resources. Final approval was given by FC, AVŞ, İB, and DNB.

Ethical Approval

The study was commenced after receiving approval from the local ethics committee (ethics committee date: 19.02.2018, number: 37732058-514.10).

Data sharing statement

None.

Consent to participate

Informed consent was obtained from the patients.

Informed Consent

The study complies with the principles of the Declaration of Helsinki. The consent of all the patients was obtained before commencing the study.

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