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The Validity of the American Diabetes Association's Diabetes Risk Test in A Sample of Egyptian Population

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ABSTRACT

Background: In order to identify community members at high risk for developing diabetes and to bring attention to the importance of good lifestyle choices and reducing risk factors. The American Diabetes Association created the diabetes risk test.

Objectives: This study aimed to determine whether the American Diabetes Association (ADA) risk test is accurate in predicting who among Egyptian population would develop pre-diabetes or diabetes & how sensitive & specific it is in doing it.

Patients and Methods: This cross-sectional study performed on 580 cases aged 18 years or older attending different hospitals in Benha City, Egypt,

According toADA risk test subjects of score <4have no risk to develop prediabetes or type2DM,those of score=4 risky .to develop prediabetes and those of score>=5 are risky to be diabetic

T.he persons in this study are divided into 2 groups:euglycemic and diabetic group that complete the score

Results: T. his study found that in the euglycemic group, 184 people (51.1%) had no risk of developing either prediabetes or diabetes, 44 people (12.2%) had a risk of developing prediabetes, and 132 people (36.7%) had a potential for progressing type 2 DM. Between our studied population, ADA ≥ 4 was found in 93.6% of DM subjects, and ADA ≥ 5 was found in 88.2% of DM subjects, suggesting significant agreement of the ADA score to predict DM. Older age > 50 years, obesity, gestational diabetes mellitus (GDM), hypertension, and poor physical activity were significantly correlated with an enhanced probability of DM. at scores ≥ 4, ADA had 93.6% sensitivity and 63.3% specificity to detect DM. At scores ≥ 5, ADA had 88.2% sensitivity and 62.3% specificity to detect DM.

Conclusion: Screening for prediabetes & type 2 DM risk factors in Egyptian population sample using the American Diabetes Association's prediabetic risk assessment test was valid, reliable, & authentic.

Key words: Diabetes risk test, American diabetes association, Egyptian population, Diabetes mellitus.

INTRODUCTION

The cardiovascular mortality rate increases due to the microvascular & macrovascular problems caused by type 2 diabetes mellitus, a condition that worsens over time [(1)]. Thus, DM2 poses a significant threat to global public health. The incidence of DM2 is approximately 11.6% in countries like China & USA. The prevalence of type 2 diabetes is 9.7% in Egypt [(2)]. This is why pre-diabetes & diabetes detection should be the primary goals of public health initiatives [(3)]. So, Having a primary care facilities don't necessarily have access to laboratory tests [(4)]. This is why it is critical to develop a quick, easy, & lab-free detection approach immediately [(5)]. One of the tools available is the ADA (Risk TestADA TestADA Test Risk Score) [(6)].

The ADA test has seven questions and a possible score between zero and eleven. The original intent was to identify people who were at high risk of developing type 2 diabetes. Patients have indicated a rejected DM2 test [(6)] if their score was higher than five. Although the cut-off points for prediabetes screening vary per study, this test has demonstrated good screening values in previous research [(7)]. For the sake of making the best possible clinical decisions, it is not advised to apply these findings to the Egyptian population [(8)].

So, this study intended to assess the ADA test's diagnostic validity as a screening tool for prediabetes & diabetes in a group of Egyptian employees, beginning with a group that is exposed to risk factors as age, stress, & unhealthy eating habits [(9)]. The researchers in this study set out to determine how well the ADA risk test could detect cases of prediabetes & diabetes in a population sample from Egypt, considering the test's sensitivity, specificity, & validity.

PATIENTS AND METHODS

This was a cross-sectional study conducted on 580 cases over the age of eighteen who visited different hospitals in Benha City, Egypt through the period from December 2022 to June 2023, using the American Diabetes Association Risk Test questionnaire.

The inclusion criteria: Any patient over the age of eighteen who visited different hospitals in Benha City, Egypt.

The exclusion criteria: Pregnant and lactating women, patients below 18 years of age, and patients who did not need follow-up tests have Type 1DM.

The sample size: A power of eighty-five percent & a sampling error of five percent were used to generate the estimated sample size. The screening tool was estimated to have a sensitivity of seventy-two percent & an estimated diabetes prevalence of 14.4%. 4 patients were

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added to the required sample size of 176 to cover the possibility of dropouts.

Methods: We used the American Diabetes Association risk test questionnaire.
The study was conducted on apparently healthy people (non-diabetic) who completed the score, and lab investigations were done on fasting blood glucose, 2h post-prandial blood glucose, & HbA1c. Through a retrospective study, the diabetic patients completed the score to determine the sensitivity and specificity of ADA in a sample of the Egyptian population.
A thorough history was taken with stress on the following: sex, age, history of antihypertension medications or history of, hypertension history of gestational diabetes, family history of DM2, & history of performance in physical activity.
A thorough clinical examination was performed with stress on the following: ABP, anthropometric measures (height, weight, and body mass index), laboratory investigations (2 hours postprandial blood glucose & fasting blood glucose), & HbA1c.

Fasting glucose test: The severity of DM is inversely related to fasting glucose.

Postprandial plasma glucose test: Diabetes mellitus is more readily detected when carbohydrate metabolic capacity is tested.

Glycated hemoglobin (HbA1c): In DM, glycosylation produces a small hemoglobin derivative known as HbA1c. One of the best ways to keep an eye on diabetes is to measure glycated hemoglobin. They aren't sensitive enough to catch cases with borderline diabetic mellitus. There is a direct correlation between plasma glucose levels and the amount of glycosylation on serum albumin. Because of its relatively short half-life of fifteen days, albumin is an excellent indicator of blood plasma glucose levels in the short term.

Ethical considerations: In order to be included in the study, participants had to give written informed consents, they filled out the questionnaire themselves during their doctor's appointments. At all times, the study adhered to the highest ethical standards, as it was approved by Benha Faculty of Medicine Review Board & its Ethics Committee. The study adhered to the Declaration of Helsinki through the study conduct.

Statistical methods

The data was analyzed using IBM SPSS statistics for Windows, version 24.0 (IBM Corp., Armonk, New York). We employed the Chi-square test & area under the curve (AUC) to evaluate the occurrence rate of prediabetes. We utilized Youden's test to evaluate the sensitivity & specificity of the questionnaire.

RESULTS

The current study included 580 subjects, and regarding age, 27.9% were < 40 years old, 24.1% were 40 to 49 years old, 24.5% were 50 to 59 years old, & 23.4% were up to sixty years old. BMI was normal in 9.3%, overweight in 43.8%, obese in 33.1%, and morbidly obese in 13.8% [Table 1].

Table (1): Demographic data distribution of the studied population

	Total (n =580)
Age	
<40 years	162 (27.9%)
40-49 years	140 (24.1%)
50-59 years	142 (24.5%)
> 60 years	136 (23.4%)
BMI	
Normal weight	54 (9.3%)
Over weight	254 (43.8%)
Obesity	192 (33.1%)
Morbid obesity	80 (13.8%)

Among our studied population, 358 (61.7%) were males and 222 (38.3%) were females. 1.4% of the included females have a history of GDM, 46.9% have a history of HTN, 51.4% have a family history of GDM, and 15.9% did not perform physical activity [Table 2].

Table (2): clinical characteristics of the studied population

	Total (n = 580)
Sex	
Male	358 (61.7%)
Female	222 (38.3%)
History of GDM in females (n=222)	
NO	214 (98.6%)
Yes	8 (1.4%)
History of HTN	
NO	308 (53.1%)
Yes	272 (46.9%)
Family history of DM	
No	282 (48.6%)
Yes	398 (51.4%)
Perform physical activity	
NO	92 (15.9%)
Yes	488 (84.1%)

Among our studied population, ADA ≥ 5 was discovered in 88.2% of DM subjects & 36.7% of non-

DM subjects, suggesting significant agreement of the ADA score to predict DM. Older age > 50 years, obesity, GDM, family history of DM, and poor physical activity were significantly correlated with an increased probability of DM [Table 3].

Table (3): DM risk data of the studied groups

	No DM (n=360)	**DM (n-220)**	**P-value**
ADA category			
<4 score	184 (51.1%)	0 (0%)	<0.0001
=4 score	44 (12.2%)	26 (21.8%)	
≥ 5 score	132 (36.7%)	194 (88.2%)	
Age			
<40 year	128 (35.5%)	24 (10.9%)	<0.0001
40-49 year	90 (25%)	50 (22.7%)	
50-59 year	65 (18%)	70 (31.8%)	
>60 year	42 (11.7%)	66 (34.5%)	
Sex			
Male	226 (62.8%)	132 (60%)	0.504
Female	134 (37.2%)	88 (40%)	
BMI			
Normal weight	36 (10%)	18 (8.2%)	<0.0001
Over weight	186 (51.7%)	68 (30.9%)	
Obesity	116 (32.2%)	76 (34.5%)	
Morbid obesity	22 (6.1%)	58 (26.4%)	
History of GDM in females			0.049
NO	130 (97%)	80 (98.6%)	
Yes	4 (3%)	8 (1.4%)	
History of HTN			
NO	210 (58.3%)	96 (43.6%)	0.641
Yes	150 (39.7%)	124 (56.4%)	
Family history of DM			
No	210 (58.3%)	70 (31.8%)	<0.0001
Yes	150 (39.7%)	150 (68.2%)	
Poor physical activity			
NO	84 (23.3%)	8 (3.6%)	<0.0001
Yes	276 (76.7%)	212 (96.4%)	

This table showed that at scores ≥ 5, ADA has 88.2% sensitivity and 62.3% specificity to detect DM [Table 4].

Table (4): Sensitivity and specificity of ADA score ≥ 5 for diagnosis of DM

Cut off point	Area under curve	Std. Error[a]	Sensitivity%	Specificity%	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
Score ≥ 5	0.745	0.029	88.2%	62.3%	0.687	0.802

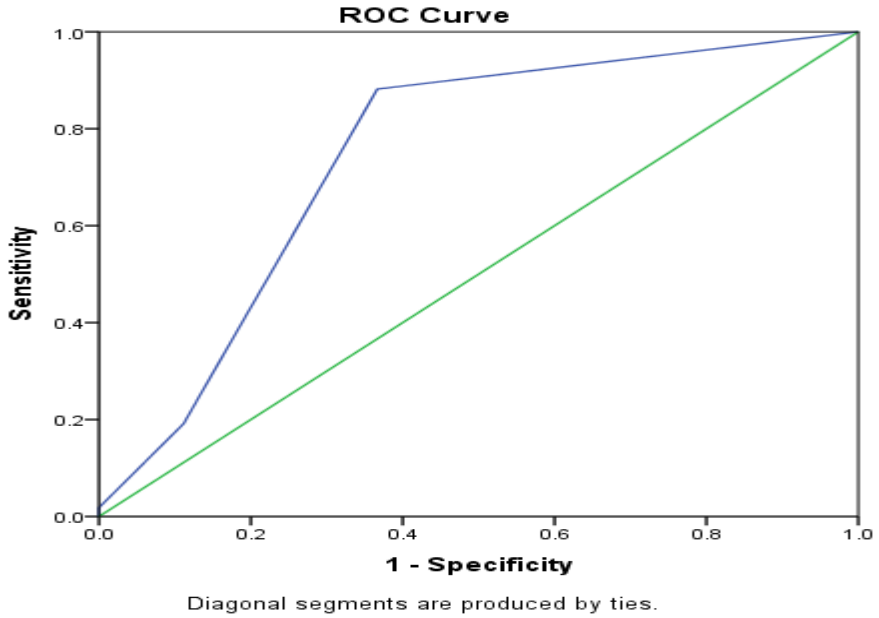

Figure (1): Roc curve of ADA score ≥ 5 for diagnosis of DM.

This table showed that at score ≥ 4, ADA has 93.6% sensitivity and 63.3% specificity to detect DM **[Table 5]**.

Table (5): Sensitivity and specificity of ADA score ≥4for diagnosis of DM

Cut off point	Area under curve	Std. Error[a]	Sensitivity%	Specificity%	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
Score >4	0.719	0.030	93.6%	63.3%	0.661	0.777

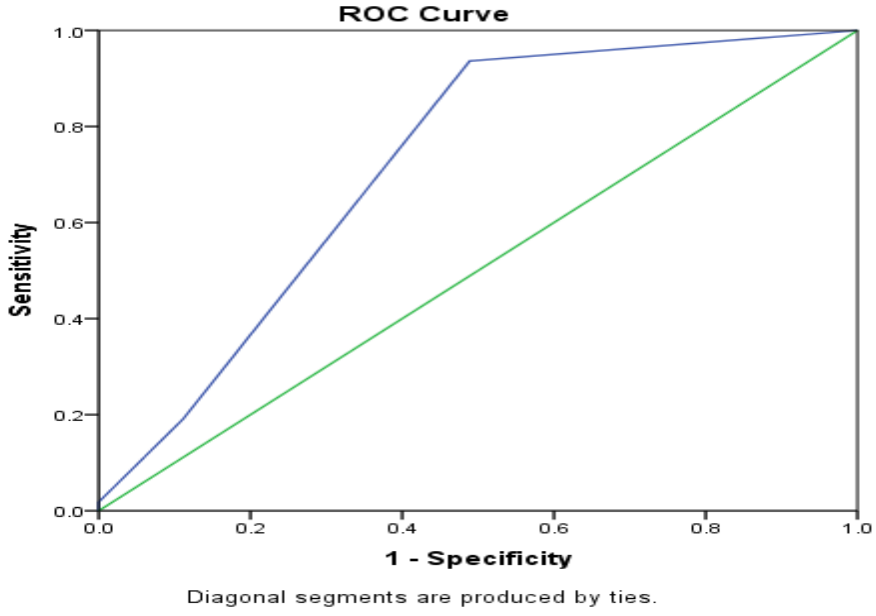

Figure (2): Roc curve of ADA score≥4 for diagnosis of DM

DISCUSSION

The current study showed that among the studied group, the prevalence of prediabetes was 60/580 (10.3%) and diabetes was 220/580 (37.9%), and the rest had normal diabetes according to the HbA1c test based on ADA standards. However, **Farag *et al.*** [10] in a cross-sectional study from Egypt revealed that the occurrence of diabetes mellitus & pre-diabetes (pre-DM) was 5% & 21.7% respectively, among a group of 719 persons aged eighteen or older. The difference in prevalence may be due to differences in sample size, mean age, physical activity, and other environmental factors.

The ADA diabetes risk test scoring included older age as a potential determinant of risk for the improvement of diabetes [11]**.** The current study assessed the risk of DM and pre-DM revealed that age older than 50 years was significantly correlated with a raised probability of DM. In concordance with the current study, **Abdel-Hamid *et al.*** [12] in a case-control study from Egypt revealed that older age was associated as a significant potential determinant of risk for prediabetes.

The ADA diabetes risk test scoring included male sex as a potential determinant of the onset of diabetes. [11]. However, the current study showed that a patient's sex has no significant relationship with the probability of DM. In concordance with the current study, **Abdel-Hamid *et al.*** [12] discovered that there wasn't significant correlation among sex and the probability of DM.

The ADA diabetes risk test scoring included higher BMI as a risk factor for the enhancement of diabetes [11]**.** The present research showed that obesity was significantly correlated with an enhanced chance of DM. In agreement with the current study, **Abdel-Hamid *et al.*** [12] revealed that a higher BMI of ≥ 29.7 and obesity were significantly correlated with an enhanced chance of diabetes. Individuals who are obese are 4.9 times more likely to show signs of prediabetes. Those who are classified as obese are assigned a score of 16 points.

The scoring of the ADA diabetes risk test considers the presence of gestational diabetes in one's medical history as a risk factor for the onset of diabetes [11]**.** The current investigation unveiled a strong correlation between gestational diabetes and an elevated susceptibility to DM. This is consistent with the findings of **Aldayel *et al.*** [13] who demonstrated that women with a previous history of gestational diabetes are at a greater risk of acquiring type 2 diabetes compared to those without such a history, particularly if they don't make beneficial changes to their diet & lifestyle.

The ADA diabetes risk test score incorporates hypertension as a risk factor for the onset of diabetes [11]. The present investigation demonstrated a substantial association between hypertension & an elevated risk of DM. This is Consistent with the findings of the investigation of **Abdel-Hamid *et al.*** [12] who demonstrated a strong correlation between elevated blood pressure & an elevated risk of developing diabetes.

Having a family history of T2D is a substantial risk factor for having the disease. Individuals with a family history are more susceptible to develop T2D compared to those without such a history [14]. Genetic diversity is also a significant factor, with type 2 diabetes believed to have a heritability rate ranging from thirty percent to seventy percent [15]. A multitude of genetic variations associated with the risk of type 2 diabetes have been discovered in recent genome-wide association studies [16]**.** The various genetic variations can be consolidated into a polygenic risk score, which quantifies an individual's inherent susceptibility to type 2 diabetes [17]. The scoring of the ADA diabetes risk test considers the existence of a familial history of diabetes as a risk factor for the onset of diabetes [11]. The present investigation demonstrated a strong correlation between a familial history of diabetes & an elevated susceptibility to DM. In line with the present research, **Farag *et al.*** [10] demonstrated a noteworthy relationship among aberrant glycemic levels and a positive familial predisposition to DM ($p< 0.001$).

The ADA diabetes risk test score incorporates physical inactivity as a contributing factor for the onset of diabetes [11]. The present investigation demonstrated a substantial correlation between low levels of physical exercise & an elevated risk of developing DM. The findings of our study emphasize that engaging in physical exercise can lower the likelihood of acquiring prediabetes & type 2 diabetes, while a lack of physical activity is linked to an increased risk of developing the condition. Engaging in physical activity boosts metabolism & lowers glucose levels. Consistent with the findings of the present investigation, **Farag *et al.*** [10] showed by multivariate analysis that a lack of physical activity was a significant indicator of having an abnormal glucose level. Our study of many variables revealed that the absence of moderate physical activity was the most influential risk factor for predicting prediabetes (OR = 2.6; 95% CI: 1.12–6.19; p = 0.027). In addition, **Aldayel *et al.*** [13] asserted that individuals who engage in regular physical activity and have lower ADA scores have a reduced likelihood of developing prediabetes compared to individuals who are less physically active & have higher ADA scores. A study revealed that 66.6% of individuals who do not partake in any physical activity remain free from T2D, but 73.4% of individuals who engage in a moderate level of physical exercise also avoid developing T2D. This suggests that physical activity plays a beneficial role in preventing T2D. Among our studied population, ADA ≥ 5 was discovered in 88.2% of DM subjects & 36.7% of non-DM subjects, suggesting significant agreement of the ADA score to predict DM.

In non-diabetic subjects, the ADA score ranged between 1 and 8, with a median value of 3. 51.1% had an ADA score < 4, 12.2% had a score of 4, and 36.7% had a score > 4. 39.7% had a family history of DM, 76.7% had poor physical activity, 51.7% are overweight, 32.2% are obese, and 6.1% have morbid obesity. However, in DM subjects, the ADA score

ranged between 1 and 10, with a median value of 6. 93.6% had an ADA score > 4. 68.2% had a family history of DM, 96.4% had poor physical activity, 30.9% were overweight, 34.5% were obese, and 26.4% were morbidly obese. 9% of the included females had a history of GDM.

To test the validity of the ADA test to predict diabetes, ROC curve analysis was performed and revealed that at a score cutoff of ≥ 5, ADA had 88.2% sensitivity and 62.3% specificity to detect DM. And at a score cutoff of ≥ 4, ADA had 93.6% sensitivity and 63.3% specificity to detect DM. Our results suggested that the ADA cutoff point cutoff of ≥ 4 was more sensitive and specific than the cutoff of ≥ 5 in the detection of DM. In line with the present investigation, **Aldayel *et al*. [(13)]** demonstrated that individuals with elevated ADA scores exhibit a greater propensity for elevated HbA1c levels and thus have a higher likelihood of developing T2D compared to those with low ADA scores. At the ADA cutoff of ≥ 5, ADA had 78.9% sensitivity and 82% specificity to detect DM. And at a score cutoff of ≥ 4, ADA had 81.7% sensitivity and 70% specificity to detect DM. Supporting the superiority of the cutoff point 4 over 5 of the ADA to detect diabetes.

The population's HbA1c test showed that 25.8% of the individuals in the sample had either prediabetes or diabetes. At the designated threshold for ADADRT (i.e., a score of five or higher), the following measures were observed: The percentage of individuals at high risk was 47.7%. The sensitivity was 74.4%, indicating the ability to correctly identify positive cases. The specificity was 61.6% indicating the ability to correctly identify negative cases. The positive predictive value was 40.3%, indicating the probability of a positive test result being accurate. The negative predictive value was 87.3%, indicating the probability of a negative test result being accurate. In a Peruvian study conducted by **Vera-Ponce *et al*. [(2)],** the ADA test demonstrated an AUC of 0.868, a sensitivity of 94.8%, & a specificity of 51.8% with a lower cutoff point of ≥ three points. For this particular scenario, the PPV was 44.5% & the NPV was 96.1%.

CONCLUSION

Finally, this study confirmed in a sample of Egyptians that the American Diabetes Association's prediabetic risk assessment test is valid, reliable, & authentic for screening for prediabetes & type 2 DM indicators. The spread of type 2 diabetes can be averted with the right amount of education & public understanding of the condition. The current study found that the risk of diabetes was higher among older adults, those who were overweight, had a history of hypertension, had a close relative with diabetes, & engaged in insufficient physical activity.

DECLARATIONS

- **Consent for publication:** Every author gave their consent to submit the work.
- **Availability of data and material:** Available.
- **Competing interests:** None
- **Funding:** No fund.
- **Conflicts of interest:** No competing interests.

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