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# The use of risk score test of American Diabetes Association in the prediction of diabetes risk in Iraq

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## ABSTRACT

The objective of this study was to evaluate the risk of developing diabetes mellitus (DM) in a sample of 900 non-diabetic volunteers who were randomly selected from various cities and towns in Baghdad and Babylon Governorates. These volunteers underwent a risk assessment test developed by the American Diabetic Association (ADA). The researchers completed the test forms based on the subjects' responses to assess the likelihood of developing type 2 diabetes mellitus. The findings indicated that approximately 20.56% of all participants in the study exhibited a high risk of developing DM. Additionally, the results demonstrated a strong and statistically significant inverse relationship between age and the risk of DM. The findings also indicated a higher prevalence of high-risk scores in males compared to females. However, women with a previous diagnosis of gestational diabetes have an elevated risk of developing diabetes. Additionally, the study demonstrated a significant correlation between the occurrence of hypertension and a family history of diabetes mellitus with the risk of developing diabetes. Physical activity shown a substantial correlation with the risk of DM, as seen by the significant association between weight status and DM risk. This suggests that all the aforementioned factors influence the risk of DM.

**Keywords:** American Diabetes Association, diabetes mellitus, risk score test

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## INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a diverse disease that encompasses intricate metabolic, behavioral, and genetic elements. Prospective research has enhanced the comprehension of modifiable risk factors associated with T2DM. Nevertheless, the way individuals respond to behavioral and lifestyle risk factors differs, possibly due to several factors such as variations in physiology, adherence to interventions, and the potential for intricate gene-environment interactions that are not fully comprehended[1]. The prevalence of diabetes has significantly increased in both developing and wealthy countries over the past few decades, making it a major global health concern[2]. Around 463 million persons between the ages of 20 and 79 are affected by diabetes[3]. This number is projected to increase to 700 million by the year 2045. Hence, there is an urgent requirement for an evaluation instrument that can assist healthcare practitioners in monitoring the easily identifiable risk factors for diabetes in a convenient, effective, and non-intrusive manner. This can be achieved by utilizing data gathered during routine medical visits, including details such as gender, age, body mass index (BMI), family medical history, smoking history, and the usage of steroidal and anti-hypertensive medications[4]. Utilizing a generic risk calculator for population-wide diabetes screening is preferable to employing intrusive tests such as blood glucose or HbA1c[5].

The diabetes risk test, created by the American Diabetes Association (ADA), serves as a screening tool to accurately identify persons in the community who are at a heightened risk for developing diabetes. The primary objective is to enhance consciousness of alterable risk factors and advocate for a health-conscious way of living. The ADA diabetes risk test is scored based on seven questions that cover gender, age, gestational diabetes mellitus (GDM), family history of diabetes, blood pressure, physical activity, and obesity (measured using BMI and a weight-height chart). The total score ranges from 0 to 11. Individuals who obtain scores of 5 or above are categorized as being at a heightened risk of developing diabetes. Studies have shown that the probability of acquiring diabetes increases in direct relation to the progression of age[6]. The occurrence of diabetes is more prevalent among older individuals due to the simultaneous rise in insulin resistance associated with obesity and sedentary lifestyle[7]. Prior research has also indicated that males have a greater susceptibility to developing diabetes compared to females, as evidenced by a higher incidence rate among men under the age of 55 for both heart disease and diabetes[8].

Studies have shown that women with a history of GDM are at a higher risk of developing diabetes and cardiovascular diseases in the future than those with

a normal blood sugar level during pregnancy. In fact, they have a risk of developing T2DM that is more than seven times higher. Multiple population-based studies have established a strong correlation between a family history of diabetes and the likelihood of developing diabetes. The most prominent indicators of diabetes are being overweight or obese. Research undertaken in several nations has revealed a more robust correlation between anthropometric indicators and the incidence of T2DM. Significantly, individuals with hypertension (HTN) were found to have a 50% higher likelihood of acquiring T2DM [3].

## METHODOLOGY

In this screening study 900 person (584 females and 316 males) were subjected to a risk test designed by ADA as illustrated the Figure 1. The subjects recruited randomly from several cities and towns in Baghdad and Babylon Governorates and the forms were filled by the researchers according to the subjects' answers to estimate the risk of T2DM. Age of subjects ranged from 22 - 68 years old and categorized according to gender, age, family history, health status, physical activity and weight status. According to the risk test established by the ADA, the summation of ≥ 5 means that the subject is at a high risk to get T2DM.

### ADA diabetes risk test

The ADA diabetes risk test (Figure 1) is a risk assessment tool that utilizes seven parameters to estimate the likelihood of developing diabetes. These criteria include gender, age, BMI, physical activity level, history of GDM, family history of diabetes, history of HTN. Participants were obligated to respond affirmatively or negatively to all inquiries, with the exception of BMI and age which are scored with range of 0 to 3. The scoring system for age is as follows: individuals aged 39 years or below are assigned a score of 0, those aged 40-49 are assigned a score of 1, those aged 50-59 are assigned a score of 2, and those aged 60 years or above are assigned a score of 3. Regarding BMI, a score of 0 was assigned to individuals with a normal or underweight status (BMI ≤ 25), a score of 1 to those who were overweight (BMI > 25), a score of 2 to individuals classified as obese class I (BMI > 30), and a score of 3 to those classified as obese class II (BMI > 35). The scoring system assigned a value of 1 to males and 0 to females for gender. A score of 1 was assigned to a negative answer, while a score of 0 was assigned to a positive response for the physical activity level. Regarding the remaining parameters, a negative reaction was assigned a score of 0, while a positive response was assigned a score of 1. The overall ADA diabetes risk test score was calculated by adding together the scores from all seven questions. Individuals who had a score of five or higher were classified as being at a high risk of getting diabetes[3].

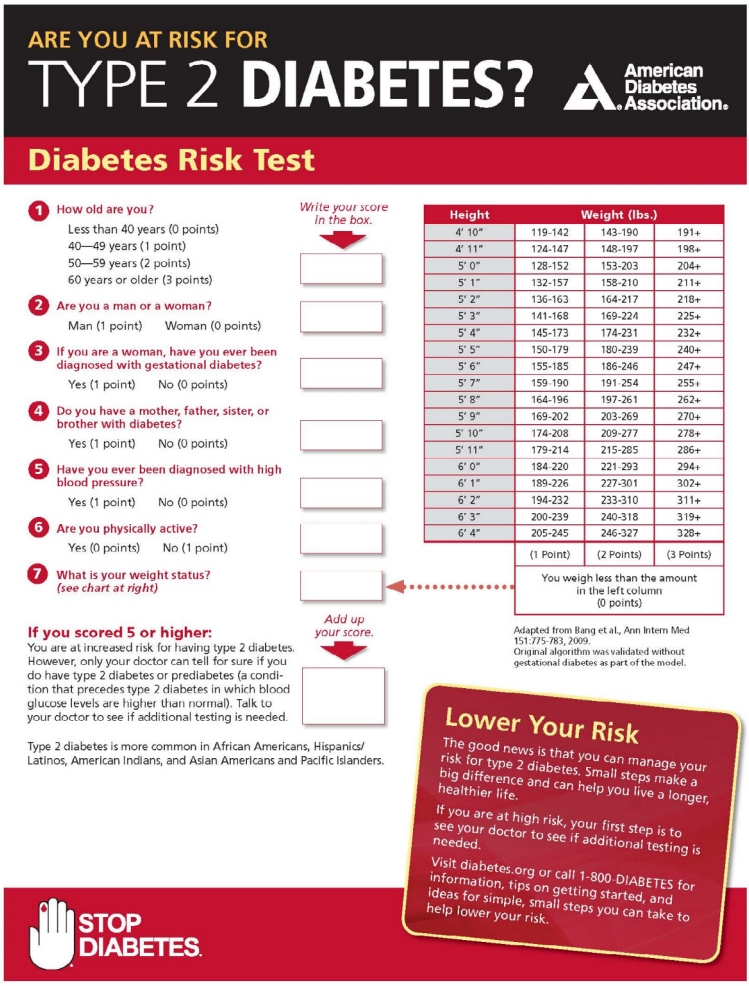


**Figure 1.** ADA diabetes risk test form[3]

## Statistical analysis

The study's data were analyzed utilizing the SPSS program version 20. The categorical variables were quantified and examined by cross tabulation to determine the frequency and percentage of each variable within the groups being researched. Chi square ($Chi^2$) test was conducted to examine the correlation between all parameters. A significance level of $P \leq 0.05$ was used to determine statistical significance. The strength of the association was measured using Phi, which is a chi square-based measure. Values ranging from 0 to 0.5 were considered indicative of weak association, while values above 0.5 were considered indicative of strong association.

## RESULTS and DISCUSSION

Results obtained in the current study revealed that 185 subjects out of 900 volunteers subjected to this study showed a high risk of getting DM which is representing about 20.56% of all subjects. This finding is nearly consistent with previous studies conducted in Iraq which showed that Approximately 1.4 million Iraqis are afflicted with diabetes. The reported prevalence of T2DM in Iraq varies from 8.5% (adjusted for age according to the International Diabetes Federation) and 13.9%[9]. A recent study conducted in Basrah, Southern Iraq, including around 5400 participants. The study found that the age-adjusted prevalence of diabetes in individuals aged 19 to 94 years was 19.7%[9,10].

Results illustrated in Table 1 showed that risk of DM increased with age and the results also revealed a highly significant negative correlation between the age and the risk of DM ($p<0.001$) which is in agreement with previous studies which demonstrated that the risk of diabetes increases with age[6,11]. Diabetes is more prevalent in elderly individuals due to the simultaneous increment in insulin resistance which is associated with obesity and a lifestyle which is devoid of physical activity[7].

**Table 1.** Cross tabulation of age versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Age (year) | Less than 40 | No. of cases | 55 | 614 | 669 |
| | | % | 8.22% | 91.78% | 100.0% |
| | 40-49 | No. of cases | 93 | 87 | 180 |
| | | % | 51.67% | 48.33% | 100.0% |
| | 50-59 | No. of cases | 26 | 14 | 40 |
| | | % | 65% | 35% | 100.0% |
| | 60 and more | No. of cases | 11 | 0 | 11 |
| | | % | 100.0% | 0.0% | 100.0% |
| Total | | Count | 185 | 715 | 900 |
| | | % Within Age | 20.56% | 79.44% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.554 | | |

Results illustrated in Table 2 showed that the gender was correlated weakly (Phi = 0.096) but significantly with the risk of DM (p=0.042) in that the percentage of male subjects with high risk (27.85%) was more than the percentage of high risk female subjects (17.47%) which is compatible with the previous results which reported that Men exhibit a higher susceptibility to developing diabetes compared to women[12,13].

**Table 2.** Cross tabulation of gender versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Gender | Female | No. of cases | 102 | 482 | 584 |
| | | % | 17.47% | 82.53% | 100.0% |
| | Male | No. of cases | 88 | 228 | 316 |
| | | % | 27.85% | 73.15% | 100.0% |
| Total | | Count | 184 | 716 | 900 |
| | | % Within Gender | 20.44% | 79.56% | 100.0% |
| $Chi^2$ | | p-value | 0.042 | | |
| | | Phi | 0.096 | | |

Table 3 showed that 54.8% of female subjects were strongly (0.627) and significantly (p<0.001) associated with previous GDM were at high risk for DM whereas only 11.6% of females who didn't experience GDM were at high risk of DM. Studies have shown that women with a history of GDM are at a higher risk of developing diabetes and cardiovascular diseases in the future than those with a normal blood sugar level during pregnancy. The risk of developing T2DM is more than seven times higher for these women[14,15].

**Table 3.** Cross tabulation of previous history of GDM versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Previous GDM | No | No. Of cases | 94 | 654 | 748 |
| | | % | 12.57% | 87.43% | 100.0% |
| | Yes | No. Of cases | 85 | 67 | 152 |
| | | % | 55.92% | 44.08% | 100.0% |
| Total | | Count | 179 | 721 | 900 |
| | | % Within Previous GDM | 19.89% | 80.11% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.627 | | |

Data listed in Table 4 showed a weak (Phi = 0.177) but significant ($p<0.001$) correlation between the family history of DM and the risk of DM which is owned to that 26.5% of subjects with a family history showed a high risk of DM whereas only 11.8% of subjects without family history were at high risk of DM and this result aligns with multiple population-based studies that have indicated a strong correlation between a family history of diabetes and the onset of diabetes[16,17].

**Table 4.** Cross tabulation of family history of DM versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Family History | No | No. Of cases | 21 | 157 | 178 |
| | | % | 11.8% | 88.2% | 100.0% |
| | Yes | No. Of cases | 72 | 200 | 272 |
| | | % | 26.5% | 73.5% | 100.0% |
| Total | | Count | 183 | 717 | 900 |
| | | % Within Family History | 20.7% | 79.3% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.177 | | |

Another factor that may be affect the risk of DM is the HTN and the results of the current research showed that 47.5% of subjects with HTN are at high risk of DM whereas only 12.9% of normotensive subjects were at high risk of DM which is obviated by the significant correlation between the incidence of HTN and the risk of DM (Table 5) which is compatible with the previous epidemiologic studies which demonstrated that the prevalence of HTN in individuals with diabetes is nearly twice as high as in those without diabetes that prove the strong correlation between DM an HTN[18,19,20].

**Table 5.** Cross tabulation of HTN incidence versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| HTN | No | No. of cases | 45 | 304 | 349 |
| | | % | 12.9% | 87.1% | 100.0% |
| | Yes | No. of cases | 48 | 53 | 101 |
| | | % | 47.5% | 52.5% | 100.0% |
| Total | | Count | No. Of cases | 357 | 450 |
| | | % Within HTN | 20.7% | 79.3% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.357 | | |

Table 6 revealed that the physical activity can be considered as a protective factor against DM that reduce its incidence in a population which is clarified by the significant correlation between physical activity and the risk of DM in that only 8.5% of physically active subjects showed a high DM risk while 30.4% of physically inactive subjects faced a high risk of getting T2DM. Studies reported that the sedentary behaviors with low physical activity are a risk factor for T2DM which defined as insufficient physical activity to meet the World Health Organization 2010 recommendations[21], that reported to be is responsible for 7% of the burden of T2DM[22].

**Table 6.** Cross tabulation of physical activity versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Physical Activity | Yes | No. Of cases | 17 | 183 | 200 |
| | | % | 8.5% | 91.5% | 100.0% |
| | No | No. Of cases | 76 | 174 | 250 |
| | | % | 30.4% | 69.6% | 100.0% |
| Total | | Count | 93 | 357 | 450 |
| | | % Within Physical Activity | 20.7% | 79.3% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.269 | | |

Finally, the data obtained in the present research revealed that the weight status was significantly associated with the risk of DM in that the ratio of subjects with high risk for DM increased with the increase in the weight status to reach 85.7% in subject that showed weight status of 3 as illustrated in Table 7. Many researches demonstrated that the obesity is considered as one of the major risk factors for DM. The risk of developing diabetes due to excessive body fat, as assessed by BMI or anthropometric indicators like skinfold thickness or waist circumference, increases in a continual manner. The clinical risk categories for BMI, which include normal weight (18.5–24.9 $kg/m^2$), overweight (25–29.9 $kg/m^2$), and obesity (≥ 30 $kg/m^2$), are linked to a gradual rise in the chance of developing diabetes[23]. Individuals who are overweight or obese have a higher susceptibility to developing T2DM, particularly if they carry excess weight in their abdominal region. Abdominal obesity triggers the release of 'proinflammatory' substances by fat cells, which can reduce the body's sensitivity to insulin. This interference affects the function of insulin-responsive cells and their capacity to properly respond to insulin. This condition is known as insulin resistance[24].

**Table 7.** Cross tabulation of weight status versus the risk of DM

| | | | Risk of DM | | Total |
|---|---|---|---|---|---|
| | | | At High Risk | At low risk | |
| Weight status | 0.00 | No. Of cases | 1 | 98 | 99 |
| | | % | 1.0% | 99.0% | 100.0% |
| | 1.00 | No. Of cases | 26 | 212 | 238 |
| | | % | 10.9% | 89.1% | 100.0% |
| | 2.00 | No. Of cases | 60 | 46 | 106 |
| | | % | 56.6% | 43.4% | 100.0% |
| | 3.00 | No. Of cases | 6 | 1 | 7 |
| | | % | 85.7% | 14.3% | 100.0% |
| Total | | Count | 93 | 357 | 450 |
| | | % Within Weight status | 20.7% | 79.3% | 100.0% |
| $Chi^2$ | | p-value | <0.001 | | |
| | | Phi | 0.555 | | |

According to risk test designed by American Diabetic Association (ADA), there is significant correlations between the age, gender, family history, GDM, HTN, physical activity and weight status with the risk of DM.

## STATEMENT OF ETHICS

The study was approved by the "Scientific Committee at the Baghdad College of Medical Sciences" (Approval number: 8S, date: 15th November 2023).

## CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest.

## AUTHOR CONTRIBUTIONS

Design – Alrubaye YSJ, Albadri HMB, Yousif OA; Acquisition of data – Alrubaye YSJ, Albadri HMB; Analysis of data – Albadri HMB, Yousif OA; Drafting of the manuscript – Alrubaye YSJ; Critical revision of the manuscript – Albadri HMB, Yousif OA; Statistical analysis – Albadri HMB; Technical or financial support – Yousif OA; Supervision – Alrubaye YSJ, Albadri HMB, Yousif OA.

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