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Estimation of type 2 diabetes risk score using diabetes risk test in Neishabour-Iran

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Abstract:

BACKGROUND: Preventing diabetes and identifying patients who are at risk for it is very important. This study was conducted to estimate the risk score of type 2 diabetes among adults living in Neishabour city in 2020.

MATERIALS AND METHODS: This descriptive-analytical study was performed on 1000 people aged 25 years and older living in Neishabour (Iran) using a multi-stage sampling method. The data collection instrument included the American Diabetes Association Diabetes Risk Test (DRT), which is a screening instrument to assess the risk of type 2 diabetes. Data analysis was carried out using SPSS ver. 18, using independent *t*-test, Chi-squared, Fisher's Exact test, Mann-Whitney, path analysis, and regression of generalized estimating equation model at 95% confidence interval.

RESULTS: The mean age of the subjects was 43.87 years (SD = 0.419) and 50.7% (n = 507) were female and the rest were male (n = 493). The risk of developing type 2 diabetes was high in 18.4% (n = 184) of the subjects. And the average risk of diabetes in people was 2.76 (SD = 0.057) out of 10 points. There was no significant relationship between gender and gestational diabetes with the risk of diabetes, but there was a significant relationship between age over 40 years, history of hypertension, family history of diabetes, lack of physical activity, and being overweight with the risk of type 2 diabetes.

CONCLUSION: Approximately, one-fifth of the subjects had a high risk of developing type 2 diabetes. Therefore, the use of a simple and practical instrument such as DRT can be suitable for screening and early detection of Prediabetic state and type 2 diabetes.

Keywords:

Diabetes mellitus, prevalence, type 2

Introduction

Diabetes mellitus (DM) is a chronic metabolic disease with a world prevalence of 8.4%.[1] Diabetes has become a global concern at present, Among which type 2 diabetes mellitus (T2DM) accounts for approximately 90%–95% of patients.T2DM is a type of metabolic disorder syndrome that results from a genetic defect, and it is based on insulin resistance and an insulin secretion disorder.[2] High blood sugar levels generally cause vascular damage in the heart, eyes, kidneys, and nerves, resulting in a variety of complications.[3] Globally, the number of people with diabetes mellitus has quadrupled in the past three decades. Mortality from diabetes and its complications increased to 5.5 million in 2015, which is equivalent to one death every six seconds. Asia is the main region of diabetes as a global rapidly spreading pandemic.[4] Diabetes will be the seventh leading cause of death by 2030.[5] Approximately, 12% of global health expenditures were spent on the treatment of type 2 diabetes and its complications in 2015.[6] According to the latest results of a nationwide study in 2011, approximately

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11.4% of Iranian adults suffer from diabetes, and the prevalence of diabetes mellitus has increased by 35% compared to 2005. It is predicted that the number of diabetic patients in Iran will probably reach ten million by 2030.[7] The prevalence rate of diabetes mellitus among Iranian adult citizens (25–64 years) was estimated at 7.7% in 2005 (2 million individuals) by The "National Survey of Risk Factors for Non-Communicable Diseases of Iran".[8] Considering that diabetes and pre-diabetes follow a significant increasing pattern among the urban population of Iran. This finding emphasizes the importance of the need to improve prevention and screening strategies in the urban population of Iran.[9] Effective prevention strategies are important to reduce the incidence of diabetes and its associated burden.[10] From a clinical perspective, earlier identification during the asymptomatic stage is important to permit earlier initiation of treatment to prevent or delay the development of micro- and macrovascular complications.[11] None of the laboratory methods are accurate during acute hospitalization because the stress response can affect glucose levels.[12] The use of random capillary glucose (RCG) is also questioned due to changes in carbohydrate intake due to the time of the last meal.[13] Fasting-blood sugar measurement is an invasive, costly, and time-consuming method. There are unexplained changes in blood glucose levels and only provides information about a person's current glycemic status. Primary prevention is possible when people at high risk for diabetes are identified when they person is still normoglycemic using interventions that prevent them from developing prediabetes and diabetes. Interventions to prevent type 2 diabetes should be directed at high-risk people.[6] The American Diabetes Association (ADA) recently approved A1c as a diagnostic test for diabetes mellitus. Many studies suggest a high A1c may predict diabetes mellitus, while A1C is more expensive and invasive than medical history or the use of the Diabetes Risk Test (DRT). DRT can be used to diagnose patients at high risk for developing diabetes mellitus (DM), as recommended by the ADA. DRT is rapid, simple, and easy to obtain, and is cheaper and less invasive than using A1c to identify patients with DM.[12] In a cohort study of 4,435 people aged 35–64 in the United States, Lindström and Tuomilehto developed a diabetes risk questionnaire from 1992 for 10 years in three stages. They reported sensitivity, specificity, negative predictive value, and positive predictive value of 78–81%, 76–77%, 98–99%, and 0.05–0.13%, respectively.[6] Literature review showed that there was a study on screening of the population aged 25–65 years in Zahedan in terms of the risk of developing type 2 diabetes in 2016 using the Finnish Diabetes Risk Score (FINDRISC) form. The results showed that, in general, participants had a moderate to high risk of developing diabetes in 15.3% of cases.[14] However, to the best of the researcher's knowledge, no study has used this instrument (DRT) with a high sample size (n = 1000) in Iran to assess the risk of type 2 diabetes. Therefore, considering the importance of screening patients with a high risk of type 2 diabetes, to provide preventive interventions, the researcher decided to use this questionnaire to estimate the type 2 diabetes risk score based on diabetes risk factors among adults living in Neishabour in 2020.

Materials and Methods

Study design and setting

In this cross-sectional descriptive study, data were collected using the American Diabetes Association (DRT) Diabetes Risk Questionnaire. The study was conducted between January 2020 and May 2021.

Study participants and sampling

About 1000 adults (25 years and above) with electronic health records were selected by simple random sampling and subjected to statistical analysis. In this research, the formula for determining the sample size based on Cochran's standard deviation was used. Multi-stratified sampling was performed. To this end, the city of Neishabour was first divided into 5 regions (categories) north, south, east, west and center. Then, out of 16 health centers (clusters), eight centers were randomly selected. In the last stage, simple random sampling was performed from each center and patients' health records were considered as a source of data collection.

Data collection tool and technique

In the present study, ADA's DRT was used, which includes seven risk predictors for diabetes mellitus. It is a seven-item questionnaire that includes questions on demographic information (age, sex, height, and weight), gestational diabetes, hypertension, family history of diabetes, and physical activity. The possible score range is 0–10 so a score of 5 and above 5 indicates a high risk of developing type 2 diabetes. A questionnaire was completed using the (electronic) health record information of each person. Inclusion criteria included individuals aged 25 years and older, no pregnancy, no history of diabetes or prediabetes.

Statistical analysis

Data analysis was carried out using Chi-square, Fisher, Shapiro-Wilk, Kolmogorov–Smirnov, Pearson, tables, graphs, and various central statistical indices (mean, median, mode) and dispersion (range, variance, standard deviation, coefficient of variation) in SPSS ver. 18. Also, to estimate the average risk score in the target population, the methods of estimating the ratio and average (inferential statistics) were used at 95% confidence interval.

Ethical considerations

Before the study, the researcher obtained relevant permissions from the Ethics Committee (ethics code IR.MEDSAB.REC.1399.135) of Sabzevar University of Medical Sciences and presented the university's written letter of introduction to the officials of Neishabour Health Network.

Results

The mean age of the subjects was 43.87 years (SD = 0.419) and 50.7% of them were women [Table 1].

The results showed that 18.4% (n = 184) of the subjects had a high risk of developing diabetes (risk score = 5 and above), and 81.6% (n = 816) had a low risk of developing diabetes (risk score = less than 4) [Table 2]. Also, the mean overall score of diabetes risk in the subjects was 2.76 (SD = 0.057).

The results showed that older people were at higher risk of type 2 diabetes. There was also a significant relationship between a history of hypertension, a family history of diabetes, physical activity, and overweight risk of diabetes. But there was no significant relationship between gender and gestational diabetes with the risk of diabetes [Table 3].

Discussion

Data analysis showed that the mean risk of diabetes was 2.76 (SD = 0.057) out of a score of 10, which indicates a low level of risk of diabetes. The results show that 18.4% of the subjects had a score of 5 or higher, which makes them more likely to develop diabetes.

In a nearly similar study on 1,000 people in Zahedan, Jahantigh *et al*. used the Finnish Diabetes Risk Score (FINDRISC) form. The overall score range of the above form was 0–26. The score results showed that the overall score of the majority of the subjects (54%) was less than 7 (lower risk of developing diabetes) and also the lowest number of them (0.2%) had a risk score greater than 20 (high risk of developing diabetes).[14] Jahantigh *et al*. reported that their questionnaire has a low sensitivity (77%) and specificity (66%) compared to DRT[5] and lacks standard and accurate measurement criteria (measurement of abdomen and waist circumference according to anatomical location). Body weight and height measurement is a more accurate method than waist circumference, which is strongly influenced by the anatomical location of the measurement.[15]

In their study, Scanlan *et al*. (2018) assessed the risk of diabetes in 214 Hispanic American women in Latin America to assess the effectiveness of the Diabetes Risk Test (DRT) for diagnosing diabetes based on a community-based sample. They used data from the US National Institutes of Health and Nutrition. Data were collected using an ADA risk questionnaire and A1C assessment. The mean risk of ADA and A1C was 5.6 ± 1.6 and 5.6 ± 0.4, respectively. The mean ADA risk score for diabetes was 5.6 ± 1.6. People with prediabetes were older, had higher blood pressure, and had a higher risk of ADA than non-prediabetic ones. Risk score 5 is the same as the risk threshold set by the ADA. People with a score of ≥4 were evaluated for A1C and their glycemic status was determined.[16]

In their study, Woo *et al*. used DRT to identify diabetic people (cut-off point) and compared it to the HbA1C test. They found that a score of 5 was desirable and the instrument had good accuracy, which was the same as the score recommended by the ADA. There was a need to measure sugar levels for 60.7% of the subjects using screening criteria, but if DRT was accepted as a screening tool, this figure was reduced to 45.7%. This study showed that the ADA recommendations are effective in screening for undiagnosed diabetes cases in the population. DRT seems to be a non-invasive and widely used tool in the

Table 1: Demographic characteristics of the subjects

	Descriptive indicators	Number	Average	Standard deviation
Age (years)	Age <40 years	478 47.8%	43.87	0.419
	Age ≥40 years	522 52.2%		
Gender	Female	507 50.7%	-	-
	Male	493 49.3%		
Hypertension	Present	108 10.8%	-	-
	Absent	892 89.2%		
History of family diabetes	Present	62 6.2%	-	-
	Absent	938 93.8%		
History of gestational diabetes	Present	1 0.1%	-	-
	Absent	999 99.9%		
Physical activity	Present	734 73.4%	-	-
	Absent	266 26.6%		
BMI kg/m^2	-	1000	26.4747	0.13837
Height (cm)	-	1000	165.65	0.319
Weight (kg)	-	1000	72.67	0.429
Risk score (0–10)	-	1000	2.76	0.057

Chinese population because this approach has a high NPV, so, it is very important because diabetes can be ruled out with high confidence, and the number needed to test for blood glucose levels to diagnose one case of diabetes (NNT) is low (The number of people screened for diabetes based on a blood sugar test was 11 versus 18).[17]

The present study showed a significant relationship between age and the risk of diabetes so older people were at higher risk for type 2 diabetes. Jahantigh *et al*. also showed a significant relationship between age and the risk of diabetes so older individuals had a higher diabetes score than younger ones.[14]

Since diabetes prevalence is very different in various societies, factors such as race, age distribution, eating habits, physical activity, etc., are among the factors that specifically affect specific genotypes and cause different prevalences of diabetes in societies. T-test, in the study by Jahantigh *et al*., showed a significant difference between men and women in terms of diabetes prevalence.[14] While the results of the present study showed no statistically significant relationship between gender and the risk of diabetes. This discrepancy can be due to the above-mentioned reasons.

Mostafavi *et al*. also reported that the odds ratio (OR) of diabetes in people under 45 years of age was 2.41 times higher than those aged 45 years and older and the same

Table 2: Frequency of high and low risk of diabetes in participants

	Absolute frequency	Percentage
Low risk of diabetes (risk score <4)	816	81.6
High risk of diabetes (risk score ≥4)	184	18.4
Total	1000	100

Table 3: Frequency distribution of diabetes risk in the subjects

	Risk category	Low-risk category for diabetes (risk score <4)	High-risk category for diabetes (risk score ≥5)	Total	*P*
Age					
Age <40 years	Number	476	2	478 (47.8%)	
	%	99.6	0.4	100	*P*<0.001
Age ≥40 years	Number	340	182	522 (52.2%)	
	%	65	35	100	
Gender					
Female	Number	416	91	507 (50.7%)	
	%	82	18	100	*P*=0.709
Male	Number	400	93	493 (49.3%)	
	%	81	19	100	
History of gestational diabetes					
History of gestational diabetes	Number	1	0	1 (0.1%)	
	%	100	0.00	100	*P*=0.635
No history of gestational diabetes	Number	815	184	999 (99.9%)	
	%	81.6	18.4	100	
Family history of diabetes					
History of family diabetes	Number	41	21	62 (%6.2)	
	%	66.1	33.9	100	*P*=0.001
No history of familial diabetes	Number	775	163	938 (93.8%)	
	%	82.6	17.4	100	
History of hypertension					
A history of hypertension	Number	18	90	108 (10.8%)	
	%	16.7	83.3	100	*P*<0.001
No history of hypertension	Number	798	94	892 (89.2%)	
	%	89.5	10.5	100	
History of physical activity					
Physical activity	Number	675	59	734 (%73.4)	
	%	92	8	100	*P*<0.001
Lack of Physical activity	Number	141	125	266 (26.6%)	
	%	53	47	100	
Body mass index status					
Normal (<26)	Number	453	44	497 (49.7%)	*P*<0.001
	%	91.1	8.9	100	
Overweight (over 26)	Number	363	140	503 (50.3%)	
	%	72.2	27.8	100	

OR in men was 1.26 times higher than that of women. Both ORs are statistically significant, which can be due to following high-calorie and low-fiber diets and low physical activity, which are all factors contributing to weight gain, which itself is a risk factor for type 2 diabetes.[18]

Different studies followed up on cases of postpartum gestational diabetes, and results showed that the prevalence of type 2 postpartum diabetes differed depending on the study place, diagnostic tests, and follow-up time.[19] According to a study by Casagrande *et al*. The prevalence of GDM in the U.S. was 7.6%, with 19.7% of these women having a subsequent diabetes diagnosis.[20] However, the present study showed no statistically significant relationship between gestational diabetes and the risk of diabetes.

Izadi *et al*. also found that more than 50% of diabetic patients have a family history of diabetes.[21] A similar study in Tehran also reported a family history of diabetes in diabetic patients, which was higher among first-degree relatives, especially siblings and then father-daughter among other relatives.[22] Najafipour *et al*.[23] In the case of type 2 diabetes development in one member of a family, the incidence of diabetes in other family members would increase by up to 50%. Kikha *et al*. also reported that type 2 diabetes, metabolic syndrome, and IGT are more prevalent among relatives of patients with type 2 diabetes compared to the general population. They also found that the risk increases with increasing age and obesity,[24] and all these results are consistent with the results of the present study, which showed a significant relationship between a family history of diabetes and the risk of diabetes.

The present study showed a significant relationship between a history of hypertension and the risk of diabetes. Jahantigh *et al*. also stated that the mean score of hypertensive people was higher than that of non-hypertensive ones and the *t*-test showed a significant difference.[14]

According to a study by Kriska, *et al*. physical activity was inversely related to incident diabetes in the entire cohort across the study, with cross-sectional accelerometry results supporting these findings. This highlights the importance of physical activity within lifestyle intervention efforts designed to prevent diabetes and urges healthcare providers to consider both physical activity and weight when counseling high-risk patients.[25] The present study revealed a significant relationship between the history of physical activity and the risk of diabetes. However, Dehghan *et al*. reported no significant relationship between the prevalence of diabetes in campus staff at Gonabad University of Medical Sciences with gender, marriage, level of education, employment status, place of residence, family history, and physical activity. However, this study was performed on a small sample size (n = 91 people) and was limited to a specific center, therefore, the results could not be generalized to the whole population.[26]

Shakeri *et al*. showed that anthropometric indices such as body mass index, and waist and hip circumference can affect the risk of diabetes, in other words, the more obese a person is, that is, the higher the above indices, the higher the risk of diabetes may be.[15] The present study showed a significant relationship between being overweight and the risk of diabetes ($P < 0.001$).

So far, no study in Iran has used this tool (DRT) with a large sample size (1000 people) to assess the risk of type 2 diabetes. This simple, safe and inexpensive screening tool (DRT) greatly reduces the invasive glucose testing required in the screening phase and is a specialized and inexpensive method to identify individuals at high risk of diabetes medication use in the community. It can be easily used in primary care and also by the people themselves and available to the public. In this research, information was collected in emergency conditions due to the COVID-19 epidemic, which provided access to subjects' information due to the use of electronic files of individuals and the necessity of the researcher's presence in health centers, and the simultaneous use of the electronic system by health experts. And overcrowding was a problem, and on the other hand, the epidemic was a confounding factor in the whole study.

Limitation and recommendation

This study was conducted cross-sectionally and was limited to one region (city). To achieve better and more accurate results, it is recommended to conduct this study on a larger scale and in a cohort and longitudinal manner. It is also recommended that the study in the population is more comprehensive and not limited to health centers, and it is better to conduct a study to check the predictive validity of the DRT tool to predict type 2 diabetes.

Conclusion

Overall, the results showed that the mean risk of diabetes was 2.76 (SD = 0.057) out of a score of 10, which indicates a low level of risk of diabetes in the subjects. The results also showed that the percentage of high-risk people in Neishabour was 18.4% of the total study population.

The present study showed that many people are unaware of the OR of developing diabetes or their diabetes. Moreover, if there is a high OR of developing diabetes after using tools such as the DRT questionnaire, they can follow the process of diagnosis and treatment in

a new way by using diagnostic tests (blood tests) and referring to a specialist. Most studies also use invasive procedures and costs to identify cases of diabetes or prediabetes, which can be very financially burdensome for people. As in many cases, these tests are not necessary and these exorbitant costs can be avoided through an initial examination and evaluation of risk factors (even by the individual himself using a DRT questionnaire). On the other hand, early identification of people at risk of diabetes can lead to a significant reduction in financial costs for the health system and much less time and cost expenditures, and mental and physical stress for individuals. Overall, the results showed that considering the acceptable sensitivity and specificity of this questionnaire and other characteristics such as being quick and easy to complete and being free, the study population should be screened and identified early to receive clinical and paraclinical services for diabetes and prediabetes. Therefore, health policymakers are advised to use this tool as a non-invasive and cost-effective tool for general use and to identify people at risk of type 2 diabetes, as well as in health centers to identify adults' risk of diabetes.

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Conflicts of interest

There are no conflicts of interest.

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