Research Article

Screening of Occurrence of Type ٢ Diabetes Mellitus Among El-Minia University Employees

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Abstract
Background: Finding effective means to prevent type ٢ diabetes (T٢D) is a critical public health priority. Most current screening modalities to identify high risk individuals are invasive and time consuming, and not really suitable for the population-based screening. Thus, identifying people at high risk of developing T٢D through a simple method with accepted accuracy to assess their risk profile may contribute to preventive efforts of public health magnitude. This study was conducted to identify risk for T٢D development during the next ten years and to assess the performance of the Finnish Diabetes Risk Score as a screening tool for undetected T٢D and dysglycemia among El-Minia University employees. **Methods:** In a cross-sectional study a total of ٢٤٠ employees at El-Minia University were randomly selected to fill out the Finnish T٢D Risk Score (FINDRISC) questionnaire. Random fingerpick blood glucose level was determined by using One Touch "Bionime Gs٣٠٠". The accuracy of Diabetes Risk Score for screening diabetes was assessed using ROC curve. **Results:** About two thirds (٣٥٪) of the study sample categorized as at low risk, ٢٦.٢٪ at slightly elevated risk, ١٦.٣٪ at moderate risk, ٢٠.٨٪ were categorized as at high risk and ١.٧٪ at very high risk of developing diabetes within the next ١٠ years of life. The females had higher risk scores than males. In both men and women, there was marked increase in the prevalence of dysglycemia with increasing value of the risk score. ROC curve showed that the AUC of FINDRISC questionnaire in predicting diabetes and dysglycemia among the studied employees was ٠.٦٨ and ٠.٧٧ respectively. Diabetes risk score ١١ is the best cut-point that gave the sensitivity of ٧٤٪ and specificity of ٦٤.٦٪. **Conclusion:** About quarter of the studied employees were categorized as at high risk of developing diabetes within the next ١٠ years of life. ROC curve showed that FINDRISC questionnaire is an accepted screening test in predicting dysglycemia among the studied employees. **Recommendation:** All individuals at high risk of developing T٢D should be identified through opportunistic screening. FINDRISC questionnaire should be easily implemented into the medical office routine in primary health care units. Creating healthy public policy in workplaces and facilitating physical activity at work sites..
Key words: Type ٢ Diabetes, Risk score, FINDRISC questionnaire, employees, El-Minia

Introduction
Diabetes is a chronic disease associated with multiple morbidities and reduced life expectancy. Type ٢ diabetes (T٢D) is the predominant form of diabetes worldwide, accounting for ٩٠٪ of cases. It has become a global public health crisis that threatens the economies of all nations, particularly developing countries.[١] According to the International Diabetes Federation (IDF) diabetes affects at least ٣٦٦ million people worldwide in ٢٠١١, and that number is expected to reach ٥٥٢ million by the year ٢٠٣٠, with two-thirds of all diabetes cases occurring in low- to middle-income countries. IDF also estimates that as many as ١٨٣ million people are unaware that they have diabetes. The number of adults with impaired glucose tolerance (IGT) will rise from ٢٨٠ million in ٢٠١١ to an estimated ٣٩٨ million by ٢٠٣٠.[٢] According to the Diabetes Atlas survey, the incidence of diabetes in Egypt in ٢٠١٠ was ١٠.٤٪ and estimated to increase by ٢٠٣٠ to ١٢.٨٪. The prevalence estimate of IGT in ٢٠١٠ was ٤.٨٪ and expected to reach ٥.٣٪ in ٢٠٣٠.[٣]

Around half of all subjects with T٢D are undiagnosed[٤]. Unsurprisingly, at the time of diagnosis, many people already suffer from diabetic related complication, especially vascular complications[٥]. Recent intervention studies have clearly shown that diabetes could be reduced among high-risk individuals[٦-٨]. Nonetheless, most current screening modalities to identify high risk individuals are invasive (fasting or random plasma glucose) and time consuming (oral glucose tolerance test), and not really suitable for the population-based screening[٩]. Thus, identifying people at high risk of developing T٢D through a simple method that could be used by individuals themselves to assess their risk profile may contribute to preventive efforts of public health magnitude[١٠].

Such an approach has been evaluated in a number of populations with encouraging results[١٠-١٤], but it has been also realized that it may not be universally applicable among all ethnic groups and populations[١٥,١٦]. To our knowledge the applicability to use such an approach among Egyptian was not tested.

Thus in this study, we aimed to identify risk for T٢D development during the next ten years and assess the performance of the FINDRISC questionnaire as a screening tool for undetected T٢D and dysglycemia among El-Minia University employees.

Subjects and methods

This cross-sectional study was conducted in El Mania University, El-Minia governorate, Egypt, during the period from September, ٢٠١٠ to March, ٢٠١١. El-Minia University is composed of ١٦ faculties from which eight faculties were chosen by a systematic random sample namely faculties of medicine, nursing, agriculture, art, science, education, pharmacy and tourism. An introductory visit was made to the vice president of the university and Deans of the eight chosen faculties to explain the study purposes and to seek their acceptance and support.

The required sample size was estimated based on the following conditions: expected proportion of the population with diabetes mellitus in Egypt (P) = ١٠٪; tolerated error/margin of error (d) = ٠.٠٥; confidence interval (CI) = ٩٥٪. The following formula was used [n= p* (١-p)* (Zα/d) ٢][١٧]. The value for Z is found in statistical tables which contain the area under the normal curve. Accordingly, the sample size was estimated to be ٢١٠ and an additio
nal ١٥٪ of the calculated sample was added to guard against drop-out and non-respondent‘s rate. Finally, a total ٢٤٠ employees were included in the study.

Criteria of inclusion:
The employees of El-Minia University aged ≥٤٥ years old

Criteria of exclusion:
Persons with previously diagnosed DM, age less than ٤٥ years, pregnant females, history of sever psychic trauma or recent surgery and chronic use of several medications, including high-dose glucocorticoids, some chemotherapy agents, as well as some of the antipsychotics and mood stabilizers (especially phenothiazines and some atypical antipsychotics).

Employees were chosen randomly from the eight faculties and all participated give written consent. Data were collected by a designed well-structured questionnaire every person was interviewed and the aim of the study was explained. The questionnaire included demographic data and the dependent variable, diabetes was assessed by using special questionnaire “(FINDRISC)” it is one-page questionnaire containing eight questions, with categorized answers, about age, body mass index (measured), waist circumference (measured), physical activity, daily consumption of fruits, berries or vegetables, use of antihypertensive medication, history of elevated blood glucose and family history of diabetes. Each of the answers to the questions in the form was weighted, corresponding to the risk increase associated with the respective variable. The total risk score is a simple sum of the individual weights, and values range from ٠ to ٢٦. (FINDRISC) is designed to measure a person’s probability of developing T٢D over the following ١٠ years.

The risk of developing T٢D scored as the following:

- Lower than ٧ = Low: estimated ١ in ١٠٠ will develop disease
- ٧–١١ = slightly elevated: estimated ١ in ٢٥ will develop disease
- ١٢–١٤ = Moderate: estimated ١ in ٦ will develop disease
- ١٥–٢٠ = High: estimated ١ in ٣ will develop disease

Higher than ٢٠ Very high: estimated ١ in ٢ will develop disease[١٨].

Anthropometric measurement

Waist circumference (in centimeters): It was measured By using non stretchable measuring tape at the smallest horizontal circumference between the ١٢th rib and the iliac crest, the person stand with abdomen relaxed, arms at sides, and feet together. Standing height and weight measurements were completed with the subjects wearing lightweight clothing and no shoes. Height was measured to the nearest cm and weight was measured to the nearest half kilogram (kg). Body mass index (BMI) was calculated the use of the following equation: BMI = weight (kg) / height (m^2)[١٩].

Diabetes Screening Protocol:

After completing the questionnaire and the anthropometric measurement, random fingerpick blood glucose level was determined by using One Touch "Bionime Gs٣٠٠". Those with random plasma glucose levels equal to or more than ١٤٠ mg/dl were considered as abnormal. The next morning fasting plasma glucose (FPG) was measured. Fasting is defined as no caloric intake for at least ٨ hours. New DM diagnosis was based on FPG equal or more than ١٢٦ mg/dl.

* Individuals with a FPG < ١١٠ mg/dl: are considered to be normoglycemic
* Individuals ≥ ١١٠ mg/dl but < ١٢٦ mg/dl are considered to have impaired glucose tolerance
* Individuals ≥ ١٢٦ mg/dl are considered to be diabetic[٢٠].

Then the accuracy of Diabetes Risk Score for screening diabetes was assessed against the FPG as a standard using ROC curve.

Ethical consideration:

The study was approved by the ethical committee of the Faculty of Medicine, El-Minia University. Prior to data collection, informed consents were obtained from all participants after supplying comprehensive information about the nature of the study and the procedural details of the blood sugar investigations.

Statistical analysis:

The Statistical Program SPSS for Windows (Version ١٩.٠, SPSS Inc., Chicago, Ill., USA) was used for data entry and analysis and the Excel Microsoft office ٢٠١٠ program was used for graphics. Quantitative data were presented by mean and standard deviation, while qualitative data were presented by frequency distribution. Chi square test and Z test were used to compare between proportions. Student t-test was used to compare between two means. A statistically significant level was considered when p value was less than ٠.٠٥

The accuracy of Diabetes Risk Score for screening diabetes was assessed using ROC curve, which plot the sensitivity (true-positive rate) to the false-positive rate (١ – specificity) using MedCalc statistical software program version ١٢.١.٤.

Results

This study included ٢٤٠ employees; whose ages ranged from ٤٥ to ٦٠ years with a mean of (٥٠.٧±٤.٦). The mean age of males was ٥١.٦±٤.٧ and the mean age of females was ٥٠.٠٢±٤.٣ (p=٠.٠٠٨). In all, ٥٧.٥٪ were females and ٦٥.٨٪ were urban inhabitants. Random blood glucose was ≥ ١٤٠mg/dl in ٥٠ persons (١٠ diabetic and ٤٠ pre-diabetic). Fasting blood glucose was done for those ٥٠ persons and the results were equivalent to the results of their random blood glucose.

The risk factors of developing diabetes among the studied employees according to gender were reported in (Table ١). Mean of

BMI was significantly higher in females (٣٢.٣±٦.٨١) than males (٢٨±٤.٨٥). Waist circumferences were significantly higher (>٨٨cm for females; >١٠٢cm for males) in females (٥٥.١٪) than in males (١٧.٦٪).

Nearly two thirds (٦٦.٧٪) of males were physically active, ٣٣.٣٪ of them were physically inactive compared to ٤١.٣٪ and ٥٨.٧٪ of females respectively, and this difference was statistically significant (p = ٠.٠٠٠١). No statistical significant differences between males and females regarding eating vegetables or fruits and history of previous episode of high blood glucose.

About tow thirds (٣٥٪) of the study sample had score less than ٧ out of ٢٦ and categorized as at low risk, ٢٦.٢٪ at slightly elevated risk, ١٦.٣٪ at moderate risk, ٢٠.٨٪ were categorized as at high risk and ١.٧٪ at very high risk of developing diabetes within the next ١٠ years of life (Table ٢).

About ٢٢٪ of females were categorized as at moderate risk and ٢٩٪ at high risk of developing diabetes within the next ١٠ years of life. These figures were more than that found for males (٨.٨٪) and (٩.٨٪) respectively, and these differences were statistically significant (p= ٠.٠٠٠٣ for moderate risk and p= ٠.٠٠٠١ for high risk), while ٥٢.٩٪ of males were categorized as low risk compared to ٢١.٧٪ of females and the difference was statistically significant (p= ٠.٠٠٠٢) (Table٣).

ROC curve was plotted to describe the sensitivity and specificity of different cut-off points. The best point lies at the elbow of the curve (its highest points to the left). The AUC represents the diagnostic (or predictive) ability of the test. ROC curve showing the performance of diabetes risk score in predicting diabetes among the studied employees, the AUC was ٠.٦٨ (٩٥٪ confidence interval [CI] ٠.٦١-٠.٧٤). Diabetes risk score ١٦ (white marker) was the best cut-point that gave the sensitivity of ٥٠٪ and specificity of ٨٥.٢٪e (Figure ١ and table ٤).

The performance of diabetes risk score in predicting dysglycemia (diabetes+ pre-diabetes) among the studied employees was calculated by using ROC curve, the AUC was ٠.٧٧ (٩٥٪ confidence interval [CI] ٠.٧١-٠.٨٢). The optimal cut point (high sensitivity with comparable high specificity) for the FINDRISC was ١١. Sensitivity was ٧٤٪, specificity was ٦٤.٦٪, positive predictive value was ٣٥.٦٪ and negative predictive value was ٩٠.٤٪ (Figure ٢ and Table ٥).

Table ١: Risk factors of developing diabetes among El-Minia University employees according to gender, ٢٠١١

Risk factors	Males (n=١٠٢)	Female (n=١٣٨)	The test	P value
Age (years)*	٥١.٥٩±٤.٧٥	٥٠.٠٢±٤.٣١	٢.٦*	٠.٠٠٨
BMI*	٢٨.٠٠±٤.٨٥	٣٢.٣٠±٦.٨١	٥.٤*	٠.٠٠٠١
Waist circumference**				
≤٨٨cm for females/≤١٠٢cm for males	٨٤ (٨٢.٤٪)	٦٢ (٤٤.٩٪)	٣٢.٩**	٠.٠٠٠١
>٨٨cm for females/>١٠٢cm for males	١٨ (١٧.٦٪)	٧٦ (٥٥.١٪)		
Physical activity**				
≥٣٠ minutes/day	٦٨ (٦٦.٧٪)	٥٧ (٤١.٣٪)	١٤.١**	٠.٠٠٠١
<٣٠ minutes/day	٣٤ (٣٣.٣٪)	٨١ (٥٨.٧٪)		
Daily eating of vegetables, fruit**				
Every day	٥٧ (٥٥.٩٪)	٧٩ (٥٧.٢٪)	٠.٠٤**	٠.٨
Not every day	٤٥ (٤٤.١٪)	٥٩ (٤٢.٨٪)		
Taking antihypertensive drugs**				
Yes	١٦ (١٥.٧٪)	٤٣ (٣١.٢٪)	٧.٥**	٠.٠٠٦
No	٨٦ (٨٤.٣٪)	٩٥ (٦٨.٨٪)		
History of previous episode high blood glucose**				
Yes	٩ (٨.٨٪)	١٧ (١٢.٣٪)	٠.٢٤**	٠.٤
No	٩٣ (٩١.٢٪)	١٢١ (٨٧.٧٪)		
Family history of diabetes**				
No	٦٨ (٦٦.٧٪)	٦٣ (٤٥.٧٪)	٩.٦**	٠.٠٠١
Yes (١st and ٢nd degree relatives)	٣٤ (٣٣.٣٪)	٧٥ (٥٤.٣٪)		

N.B. *Quantitative data are expressed as mean±SD and compared by t test; **qualitative data are expressed as number (%) and compared by Qui square test.

Table ٢: Frequency distribution of the studied employees of El-Minia University according to Finnish Diabetes Risk Score, ٢٠١١

Risk category	Number	Percent
Low risk (< ٧)	٨٤	٣٥
Slightly elevated risk (٧-١١)	٦٣	٢٦.٥
Moderate risk (١٢-١٤)	٣٩	١٦.٣
High risk (١٥-٢٠)	٥٠	٢٠.٨
Very high risk (>٢٠)	٤	١.٧
Total	٢٤٠	١٠٠

Table ٣: Relation between sex and diabetes risk score among El-Minia University employees, ٢٠١١

Finnish Diabetes Risk Score	Sex		Z	P
	Males No (%) (n= ١٠٢)	Females No(%) (n= ١٣٨)		
Low risk (< ٧)	٥٤ (٥٢.٩٪)	٣٠ (٢١.٧٪)	٥.٠١	٠.٠٠٠٢
Slightly elevated risk (٧-١١)	٢٨ (٢٧.٥٪)	٣٥ (٢٥.٤٪)	٠.٣٦	٠.٣
Moderate risk (١٢-١٤)	٩ (٨.٨)	٣٠ (٢١.٧٪)	٢.٦٨	٠.٠٠٠٣
High risk (١٥-٢٠)	١٠ (٩.٨٪)	٤٠ (٢٩٪)	٣.٦٢	٠.٠٠٠١
Very high risk (>٢٠)	١ (١٪)	٣ (٢.٢٪)	٠.٧١	٠.٢

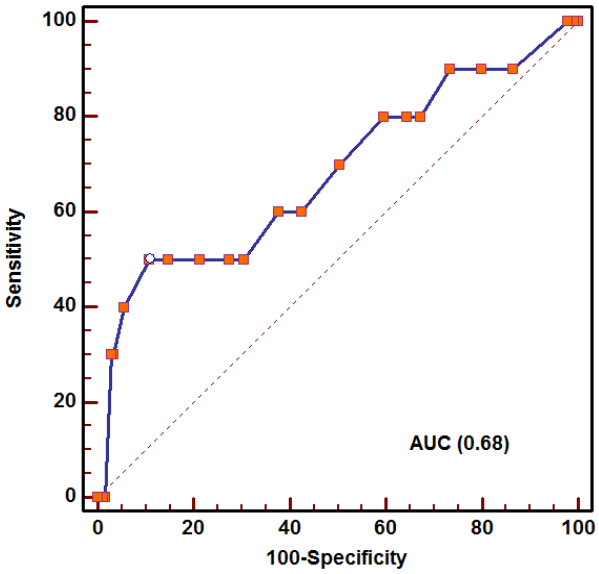

Figure ١: Receiver operating characteristic (ROC) curve analysis of the FINDRISC score values for screen-detected diabetes mellitus among the studied employees of El-Minia University, ٢٠١١

Table ٤: Characteristics of FINDRISC using different cutoff values for screen-detected diabetes mellitus among El-Minia University employees, ٢٠١١.

Cutoff values	Sensitivity %	Specificity %	Positive predictive Value %	Negative predictive value %
١١	٦٠	٦٢.١٧	٦.٥	٩٧.٣
١٣	٥٠	٧٢.٦١	٧.٤	٩٧.١
١٦*	٥٠	٨٩.١٣	١٦.٧	٩٧.٦

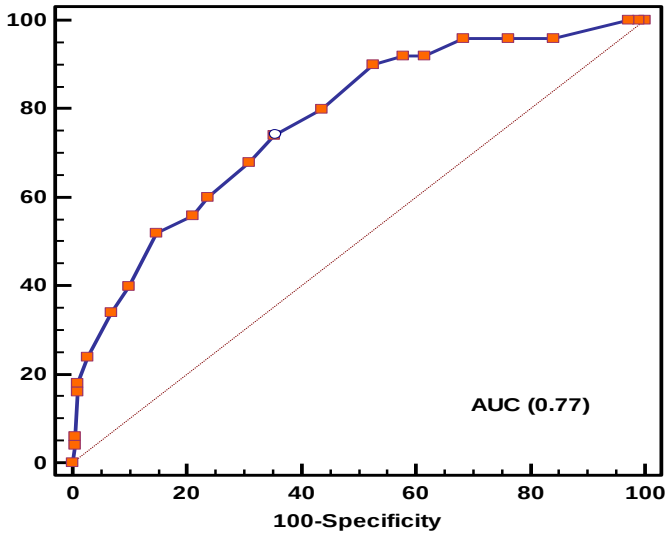

Figure ٢: Receiver operating characteristic (ROC) curve analysis of the FINDRISC score values for dysglycemia among El-Minia University employees, ٢٠١١

Table ٥: Characteristics of FINDRISC using different cutoff values for detecting dysglycemia among El-Minia University employees, ٢٠١١

Cutoff values	Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %
١١	٧٤	٦٤.٦	٣٥.٦	٩٠.٤
١٣	٦٠	٧٦.٣	٤٠	٨٧.٩
١٥	٥٢	٨٥.٢	٤٨.١	٨٧.١

Discussion

The FINDRISC was originally developed in a prospective setting to identify persons at high risk for development of T٢D. The aim of the present study was to analyze the score's performance in a cross-sectional setting as a screening tool for detection of previously undiagnosed T٢D and dysglycemia and to identify individuals at increased risk for T٢D among El-Minia University employees.

Regarding physical activity, the current study showed that there was statistical significant difference between males and females, males were more physically active than females (٦٦.٧٪ versus ٤١.٣٪) (Table ١). This is in accordance with Azevedo et al., ٢٠٠٧ who studied gender differences in leisure-time physical activity in a population-based sample of adults living in Brazil by using International Physical Activity Questionnaire and found that marked differences between males and females on the prevalence of inactivity, regardless of the criteria used men were more likely to be considered active[٢١]. Explained by during leisure time, men are clearly more active than women due to more activity at work outside the household and participation in competitive sports. These results are contrary to Oanh et al., (٢٠٠٨) who studied the prevalence and correlates of physical inactivity among adults in Ho Chi Minh City, Vietnam and found that women were more active than men and continued to be more active with increasing age[٢٢].

The current study found that BMI was higher in females than males. Obesity among Egyptian women is particularly high, often attributed to women tend to spend a large part of their time indoors, with limited

access to active leisure time activities, while indoor activities (such as TV watching) and socializing frequently involve eating and snacking. In a review of ٣٩ surveys from ٢٨ developing countries to determine obesity among women, Martorell et al., (٢٠٠٠) reported that women in Egypt and Turkey have the highest proportion of overweight (٣١.٧٪ for both), as well as the highest proportion of obesity (٢٠.١٪ for Egypt and ١٨.٦٪ for Turkey)[٢٣].

The current study found that ٢٠.٨٪ were categorized as at high risk and ١.٧٪ at very high risk of developing diabetes within the next ١٠ years of life (Table ٢); this was higher than found by Abduelkarem et al., (٢٠٠٩) who reported that ١٢.٣٪ were categorized as at high and very high risk[٢٤]. This difference may be attributed to the higher percentages of some important risk factors in the current study such as obesity, central adiposity and previous episode of high blood glucose.

In this study females were more at risk of developing diabetes than males (Table ٣); this is nearly the same as reported in previous study[٢٤]. The higher risk of getting DM in females than males may be due to higher BMI in females, they were more physically inactive, had history of previous episodes of hyperglycemia and positive family history of diabetes more than males.

In the current study the performance of FINDRISC score in predicting diabetes and dyglycemia (diabetes + pre-diabetes) was evaluated by the AUC with a value ٠.٦٨ and ٠.٧٧ (Figure ١ and ٢) respectively, which is comparable to the performance of other risk scores developed to detect undiagnosed T٢D[١٠,١١,٢٥]. The findings in this study was different from what found by Makrilakis et al., (٢٠١١) who conducted a study to validate the FINDRISC questionnaire for its ability to predict the presence of any glucose homoeostasis abnormalities in the Greek population and found that AUC for detecting unknown diabetes was ٠.٧٢٤, for any dysglycaemia, the AUC was ٠.٧١٦[٢٦]. This difference could be explained by, the efficiency of risk scores may vary between populations with different ethnic back grounds[٢٧,٢٨].

The current study showed that using the risk score cutoff value of ١١ to identify dysglycemia (diabetes+ pre-diabetes) resulted in a sensitivity of ٧٤٪, specificity was ٦٤.٦٪, positive predictive value was ٣٥.٦٪ and negative predictive value was ٩٠.٤٪ (table ٤). This is in accordance with Saaristo et al., ٢٠٠٥ who conducted a cross-sectional study to evaluate the FINDRISC score as a to tool to identify undetected T٢D in Finland and found that the sensitivity of FINDRISC score at cutoff value ١١ was ٦٦٪ and ٧٠٪; specificity was ٦٩٪ and ٦١٪ in males and in females respectively[١٣].

In conclusion, FINDRISC questionnaire may be useful as noninvasive test at first stage to determine whether a sequence of testing should be performed.

Recommendations: All individuals at high risk of developing T٢D should be identified through opportunistic screening. FINDRISC questionnaire should be easily implemented into the medical office routine in primary health care units. Creating healthy public policy in workplaces and facilitating physical activity at work sites.

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