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Finnish Diabetes Risk Score to predict type 2 diabetes in the Isfahan diabetes prevention study

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ABSTRACT

Aim: The strong association between the Finnish Diabetes Risk Score (FINDRISC) and risk of diabetes reported in European populations cannot necessarily be generalized to other populations. The aim of this study was to evaluate the ability of FINDRISC to predict progression to diabetes in an Iranian population without diabetes.

Methods: A total of 1537 first-degree relatives (FDR) without diabetes of consecutive people with type 2 diabetes 30–70 years old (376 men and 1161 women) were examined and followed for a mean (SD) of 7.8 (1.7) years for diabetes incidence. We examined the incidence of diabetes across quartiles of FINDRISC and plotted a receiver operating characteristic (ROC) curve to assess discrimination. At baseline and through follow-up, participants underwent a standard 75-g 2-h oral glucose tolerance test. Data for the FINDRISC were available from each participant.

Results: During 12,046 person-years of follow-up, 41 men and 154 women developed diabetes. The incidence of type 2 diabetes was 14.0 per 1000 person-years in men and 16.9 in women. Those in the top quartile of FINDRISC were 21.7 times more likely to develop diabetes than those in the bottom quartile (relative risk 21.7; 95% CI 9.90, 47.39). The area under the ROC was 75.1% (95% CI 71.3, 78.8).

Conclusions: The results of this study show that FINDRISC is a robust predictor of type 2 diabetes in high-risk individuals in Iran.

1. Introduction

Type 2 diabetes is an important and growing public health problem worldwide [1]. Its prevalence in low- and middle-income countries, where 80% of people with diabetes and 85% of people with undiagnosed diabetes live [1], is already high and expected to rise more rapidly than elsewhere. Thus, with a strong evidence base for lifestyle interventions to prevent diabetes [2,3], there is great interest in identifying individuals at high risk of developing diabetes. Population screening for diabetes, using blood glucose tests, would not be practicable or cost-effective, especially in low-income countries. A simple, non-invasive, effective tool using readily available clinical information to rapidly identify asymptomatic individuals in whom glucose tolerance tests should be measured to rule out type 2 diabetes would be practical for use by the general public and in primary health care. During the past two decades, many attempts have been made to develop such screening tools to identify persons at high risk for the future development of type 2 diabetes [4–6]. Among these tools, the Finnish Diabetes Risk

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Score (FINDRISC) has been successfully implemented as a practical screening instrument to assess diabetes risk and to detect undiagnosed type 2 diabetes [7–9]. It have been tested in a number of European populations with encouraging results [10–24], but it may not be universally applicable among all ethnic groups and populations [15,17,25,26]. Recent reports [25,26] highlighted the lack of studies on diabetes risk scores for low- and middle-income countries. No study to date has examined diabetes incidence with FINDRISC in Iran.

The objective of this study was to evaluate the ability of FINDRISC to predict incident type 2 diabetes in first-degree relatives (FDR) of people with type 2 diabetes in an Iranian population without diabetes.

2. Patients and methods

2.1. *Data collection*

The recruitment methods and examination procedures of the Isfahan Diabetes Prevention Study (IDPS) have been described before [27]. Briefly, IDPS is an ongoing cohort in central Iran to assess the various potential risk factors for diabetes in FDR of people with type 2 diabetes (one of the main risk factors for diabetes). Our study sample comprised 3409 (895 men and 2514 women) FDR of consecutive people with type 2 diabetes. All subjects were attendees at clinics at Isfahan Endocrine and Metabolism Research Center, which is affiliated to Isfahan University of Medical Sciences, Iran. The study was conducted between the years 2003 and 2005. All participants were from Isfahan city and adjoining areas. They completed laboratory tests including a standard 75-g 2-h oral glucose tolerance test (OGTT), a questionnaire on their health status and on various potential risk factors for diabetes, and the FINDRISC questionnaire. Participants received follow-up tests according to Standards of Medical Care in Diabetes [28] to update information on demographic, anthropometric and lifestyle factors and on newly diagnosed diabetes. Accordingly, if the OGTT was normal at baseline, repeat testing was carried out at least at 3-year intervals. Otherwise, repeat testing was usually carried out annually. Tenets of the current version of the Declaration of Helsinki were followed, institutional ethical committee approval was granted, and an informed consent form was signed by each participant.

2.2. *Follow-up and ascertainment of diabetes*

Cases of diabetes were identified from baseline and follow-up OGTT according to American Diabetes Association criteria [29]. Pregnant women and people with type 1 diabetes were excluded. Among 3409 persons who participated at baseline, 308 were excluded because of a diagnosis of diabetes at baseline and 1564 had no follow-up, leaving 1537 participants with a mean age 43.1 (6.6) (range 30–70) years for the present analysis, all of whom had at least one subsequent review during a mean (standard deviation [SD]) follow-up period of 7.8 (1.7) (range 3–10) years. Attendees at the follow-up visit did not differ significantly from non-attendees regarding most baseline characteristics: age, height, weight, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR) and levels of HbA1c, cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides, systolic and diastolic blood pressure (BP) and obesity. However, non-attendees had slightly lower fasting plasma glucose (FPG) (94.6 mg/dl versus 95.7 mg/dl, $P < 0.05$) and plasma glucose (PG) at 30 min (138.5 mg/dl versus 145.5 mg/dl ($P < 0.001$), 60 min (140.9 mg/dl versus 150.9 mg/dl, $P < 0.001$), 120 min (111.1 mg/dl versus 120.6 mg/dl, $P < 0.001$) and a slightly lower FINDRISC (11.8 versus 12.8, $P < 0.001$), but higher levels of high-density lipoprotein (HDL) cholesterol (46.4 mg/dl versus 45.0 mg/dl, $P < 0.0$).

2.3. *Procedures*

Information on age, gender, body size, HbA1c, cholesterol, LDL cholesterol, HDL cholesterol, triglycerides and BP, family and personal medical history was collected at baseline and through follow-up. The same methodology was used for baseline and follow-up studies. The participants included siblings and children. Participants reported to clinics in the morning after an overnight fast. They were asked to abstain from vigorous exercise in the evening, and in the morning of the investigations. Smokers were encouraged to abstain from smoking in the morning of their visit. First, on arrival at the clinic, the information provided by the participants in the questionnaire on family history was verified. Then, with the subjects in light clothing and without shoes, height, weight, WC and HC were measured using standard apparatus. Weight was measured to the nearest 0.1 kg on a calibrated beam scale. Height, WC and HC were measured to the nearest 0.5 cm with a measuring tape. The waist was measured midway between the lower rib margin and the iliac crest at the end of gentle expiration. Hip circumference was measured over the greater trochanters directly over the underwear. Resting BP was measured after the participant had been seated for 10 min with a mercury sphygmomanometer and appropriately sized cuffs, using standard techniques. FPG was measured with the glucose oxidase method. Participants with FPG $\geq$ 200 mg/dl or pharmacological treatment were considered to have diabetes. If FPG was $\geq$126 mg/dl and <200 mg/dl, a second FPG was measured on another day. If the second FPG was also $\geq$126 mg/dl, participants were considered have diabetes. Those with FPG <126 mg/dl underwent a standard OGTT (75 g glucose, 2 h) at baseline and follow-up visits. Venous blood was sampled 0, 30, 60, and 120 min after oral glucose administration. Plasma samples were centrifuged and analyzed the same day.

Glycated hemoglobin (HbA1c) (measured by ion-exchange chromatography), total cholesterol, triglycerides, HDL, LDL (calculated with the Friedewald equation [30] provided total triglycerides did not exceed 400 mg/dl) were recorded. All blood analysis procedures were performed in the central laboratory of the Isfahan Endocrine and Metabolism Research Center using enzyme-linked method.

2.4. *Definitions*

Based on the OGTT results, participants were categorized as having either normal glucose tolerance (NGT, FPG below 100 mg/dl and the 2-h plasma glucose (2hPG) <140 mg/dl), impaired fasting glucose (IFG, FPG in the range of 100–126 mg/dl and the 2hPG was <140 mg/dl), impaired glucose tolerance