Contents lists available at SciVerse ScienceDirect

Primary Care Diabetes

journal homepage: http://www.elsevier.com/locate/pcd

Original research

The development and validation of the Portuguese risk score for detecting type 2 diabetes and impaired fasting glucose

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ARTICLE INFO

Article history:
Received 24 September 2012
Received in revised form
3 January 2013
Accepted 4 January 2013
Available online 26 January 2013

Keywords:
Type 2 diabetes mellitus
Screening
Prevention
Risk score
Prediction

ABSTRACT

Aims: To develop and validate a non-invasive score for detecting undiagnosed impaired fasting glucose (IFG) and type 2 diabetes (T2DM) in a Portuguese population.
Methods: We used data from 3,374 individuals aged 18–94 years from a Portuguese cross-sectional study. We developed a logistic regression model for predicting IFG/T2DM (diagnosed using fasting glucose). We externally validated the score using data from two cohorts of the EPI-Porto study, cross-sectional ($n = 2{,}131$) and data from the 5 year follow-up ($n = 1{,}304$).
Results: The final model included age, sex, BMI and hypertension with an area under the ROC curve of 70.1 (95%CI 68.4, 71.7). Using a cut-point which classifies 50% of the EPI-Porto cross-sectional data as high-risk gave sensitivity 73.2% (95%CI 68.5%, 77.6%), specificity 55.5% (53.1%, 57.8%), positive predictive value (PPV) 27.0% (24.3%, 29.8%) and negative predictive value (NPV) 90.2% (88.3%, 92.0%) for IFG/T2DM. Using the same cut-point on the prospective data classified 45% as high-risk; sensitivity 69.1% (63.4%, 74.4%), specificity 63.3% (60.0%, 66.5%), PPV 38.0% (33.9%, 42.4%), and NPV 86.2% (83.3%, 88.8%).
Conclusion: The Portuguese risk score can be used to identify those at high risk of both prevalent undiagnosed and incident IFG/T2DM.

1. Introduction

Type 2 diabetes (T2DM) is a growing world-wide problem. It is estimated that 366 million people world-wide have diabetes raising to 522 million by 2030 [1] and that the death rates attributable to diabetes will double between 2005 and 2030 [2]. T2DM is usually preceded by the 'pre-diabetic' state called impaired glucose regulation (IGR), which includes impaired fasting glucose (IFG) and impaired glucose tolerance

Abbreviations: IGR, impaired glucose regulation; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; BMI, body mass index; ROC, receiver operator characteristic; PPV, positive predictive value; NPV, negative predictive value; LR+, likelihood ratios for a positive test; LR−, likelihood ratios for a negative test.

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http://dx.doi.org/10.1016/j.pcd.2013.01.003

(IGT). T2DM and IGR are associated with increased risk of cardiovascular disease [3,4]. Both IGR and T2DM are often asymptomatic, many cases remain undiagnosed and therefore, untreated. The International Diabetes Federation estimates that there are 183 million cases of undiagnosed diabetes world-wide [1].

The PREVDIAB study was the first population based diabetes prevalence study carried out in Portugal. The study reported a prevalence of diabetes of 11.7%, with 5.1% being previously undiagnosed [5]. The rates of IGR were much higher at 23.3% (10.6% IFG); this demonstrates a large population at risk of T2DM. Randomised controlled trials have shown that progression from IGT to diabetes can be prevented through lifestyle modification and that this is likely to be cost effective [6,7]. Although data regarding prevention in those with IFG is lacking, many bodies around the world are now recommending measuring fasting blood glucose alone as it is much less resource intensive than a full oral glucose tolerance test [8,9]. Additionally utilising a low cut point for IFG (5.6 mmol/l versus 6.0 mmol/l) has also been shown to have a high level of sensitivity (82%) for detecting IGT [10]. Early detection of those with elevated glucose levels gives a window of opportunity for the prevention of T2DM and the reduction of potential micro and macro-vascular complications.

Population based screening offers an opportunity for early case detection, but is expensive and impractical. Targeted screening to high risk groups has been shown to be more efficient, and results in a higher positive diagnostic yield than testing the whole population [11–13]. One method of risk stratifying a population is the use of risk scores. Self-assessment scores are simple questionnaire based risk scores which allow members of the public to calculate and interpret their own risk of disease. Many self-assessment risk scores have been developed world-wide [14–16], but validation studies show that scores developed for a particular population often do not perform well when used elsewhere [15].

The aim of this study was to develop and validate a simple score which can be completed by a lay person for detecting previously undiagnosed IFG and T2DM for use in a Portuguese population.

2. Methods

2.1. Development data set

The data used to develop the risk score was taken from the PORMETS cross-sectional study which was designed to establish the prevalence of the metabolic syndrome in mainland Portugal [17]. Two primary health care centres from each of the 18 Portuguese mainland districts were included, one from the district's capital and another representative of the non-urban area (apart from Setubal where only one centre was included). In each centre 120 participants were selected at random for inclusion. A total of 4,105 participants were included between February 2007 and July 2009. A structured questionnaire was given to each participant, collecting information on personal medical history, socio-demographic and behavioural characteristics.

Participants were considered current smokers if they smoked daily or occasionally and an ex-smoker if they had stopped smoking for at least 6 months. Regarding alcohol intake, participants were categorised as an occasional drinker if they had less than a drink per day, a daily drinker if they have at least a drink per day and non-drinker if they did not consume any type of alcoholic beverages. Participants were categorised as engaging in regular physical exercise if they took part in a leisure time physical activity preformed on a repeated basis, spending at least 30 min a week.

Anthropometrics measures were taken, namely weight, height, and waist circumferences. Body weight was measured to the nearest 0.1 kg using a digital scale, and height to the nearest centimetre in the standing position using a wall stadiometer. Waist circumference was measured midway between the lower limit of the rib cage and the iliac crest. A fasting venous blood sample was collected by trained nurse. Participants were classified as having IFG if their fasting glucose was $\geq$5.6 mmol/l and T2DM was defined as a fasting glucose result of $\geq$7.0 mmol/l [9].

Those with previously diagnosed diabetes or having reported taking anti diabetic medication or insulin were excluded from the development data set. We also excluded those without a fasting glucose measurement.

2.2. Variables considered

Only variables which can be self-completed by a lay person without intervention from a health care professional or the results of medical tests were considered for inclusion. These variables included age, sex, medical history of stroke or myocardial infarction, level of physical activity, waist circumference, statin therapy, current hypertension, BMI and current smoking status. The development data set has 388 events (IFG or T2DM), which gives around 38 events per variable being assessed which is above the general rule of thumb of 10 to 20 events per variable [18]; hence the sample size is adequate for this analysis. The pool of potential variables assessed covers the majority of those included in previously developed screening tools, although data on family history of diabetes were not recorded [3,14].

2.3. Modelling

All modelling was carried out in Stata (version 10) using logistic regression with a composite of screen detected IFG/T2DM as the dependent variable. A non-automated approach was taken for variable selection; initially each variable was modelled to see if it independently predicted the outcome. Sets of predictors shown to be independently related were then considered. At each step the area under the receiver operator characteristic (ROC) curve was used to compare models in addition to the p value for the covariate of interest (with significance levels set at $p \geq 0.05$). All measured variables were initially considered for inclusion in their original continuous form. Once a final model was chosen we then tested various categorisations to see which best fitted the data. Although collapsing continuous variables into groups is not best practice, this score is to be completed by hand by the public and