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Validation of the Finnish Diabetes Risk Score (FINDRISC) questionnaire for undiagnosed type 2 diabetes screening in the Slovenian working population

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ABSTRACT

We performed a cross-sectional population-based study on 632 participants, aged 20–65, who were screened using the Finnish Diabetes Risk Score (FINDRISC) questionnaire. Optimal results for men were achieved at FINDRISC ⩾ 7 (100.0% sensitivity and 0.78 AUC) and for women at FINDRISC ⩾ 13 (60.0% sensitivity and 0.78 AUC).

1. Introduction

In 2015, there were around 415 million people (8.8%) with diabetes in the world and this number is expected to rise to 640 million (10.4%) by the year 2040 [1,2]. A considerable proportion of this burden is made up of people with undiagnosed diabetes [1,3]. In Slovenia, the number of people with diabetes has increased from 120,000 (8.0%) in 2000 [4] to 170,000 (10.7%) in 2015, and more than 60,000 people are expected to have undiagnosed diabetes [1].

National diabetes screening guidelines in Slovenia [5] follow guidelines similar to those used in many other European countries [6] by setting the Finnish Diabetes Risk Score (FINDRISC) cut-off to select an individual for further examinations at ⩾15. The predictive performance of FINDRISC was previously demonstrated in detecting type 2 DM, impaired

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glucose tolerance, and the metabolic syndrome in Finland and Greece [7–9]. This study focused on validation of the FINDRISC questionnaire in the Slovenian working-age population and the identification of optimum cut-off values.

2. Methods

A cross-sectional population-based study was performed on a sample of 632 individuals in two healthcare institutions between April and December 2015. The FINDRISC questionnaire was fully completed by 551 participants, aged 20–65 years, who were screened from the healthy working population living in the south-eastern region of Slovenia. Individuals who scored ⩾15 were informed that they were, based on existing guidance [5,9], at increased risk of developing type 2 DM. Based on their fasting plasma glucose (FPG) levels, participants were categorised in the diabetes (FPG ⩾ 7,0 mmol/l) group. The diabetes group (n = 12) was compared to a group of participants with normal FPG levels (n = 470) together with participants where impaired fasting glucose was present

Table 1 – Summary of characteristics for patients with diabetes, impaired fasting glucose (IFG), and normal fasting plasma glucose levels.

	Diabetes	IFG	Normal
n (%)	12 (2.2)	57 (10.3)	482 (87.5)
Age (years)	50.3 ± 10.6	49.4 ± 10.0	43.6 ± 11.0
BMI (kg/m^2)	33.6 ± 6.1	29.9 ± 6.0	26.7 ± 5.3
Waist circumference (cm)	104.5 ± 17.7	96.6 ± 14.2	90.72 ± 12.9
Systolic BP (mmHg)	146.4 ± 10.5	137.1 ± 17.1	127.4 ± 14.3
Diastolic BP (mmHg)	96.6 ± 11.3	85.9 ± 9.6	80.0 ± 9.8
FPG (mmol/L)	8.4 ± 3.2	6.3 ± 2.1	5.2 ± 0.4

Data are presented as means ± standard deviation unless otherwise specified; BMI: body mass index; BP: blood pressure, FPG: fasting plasma glucose.

Table 2 – Characteristics of study participants based on FINDRISC variables (n = 551).

FINDRISC question	Male		Female		Difference
	Count (n = 260)	%	Count (n = 291)	%	(p-value)
Age group (years)					
<45	135	51.9%	137	47.1%	0.188
45–55	82	31.5%	88	30.2%	
56–65	43	16.5%	66	22.7%	
BMI (kg/m^2)					
<25	71	27.3%	141	48.5%	<0.001
25–30	119	45.8%	94	32.3%	
>30	70	26.9%	56	19.2%	
Waist circumference (cm)					
Male < 94, female < 80	116	44.6%	80	27.5%	<0.001
Male 94–102, female 80–88	76	29.2%	85	29.2%	
Male > 102, female > 88	68	26.2%	126	43.3%	
Physical activity					
Yes	224	86.2%	254	87.3%	0.696
No	36	13.8%	37	12.7%	
Fruit and vegetables daily					
Yes	196	75.4%	249	85.6%	0.002
No	64	24.6%	42	14.4%	
Hypertension medication					
Yes	77	29.6%	82	28.2%	0.710
No	183	70.4%	209	71.8%	
High blood glucose history					
Yes	32	12.3%	40	13.7%	0.617
No	228	87.7%	251	86.3%	
Family history of Type 2 diabetes					
No relatives with diabetes	193	74.2%	204	70.1%	0.547
Second-degree relatives	42	16.2%	56	19.2%	
First-degree relatives	25	9.6%	31	10.7%	

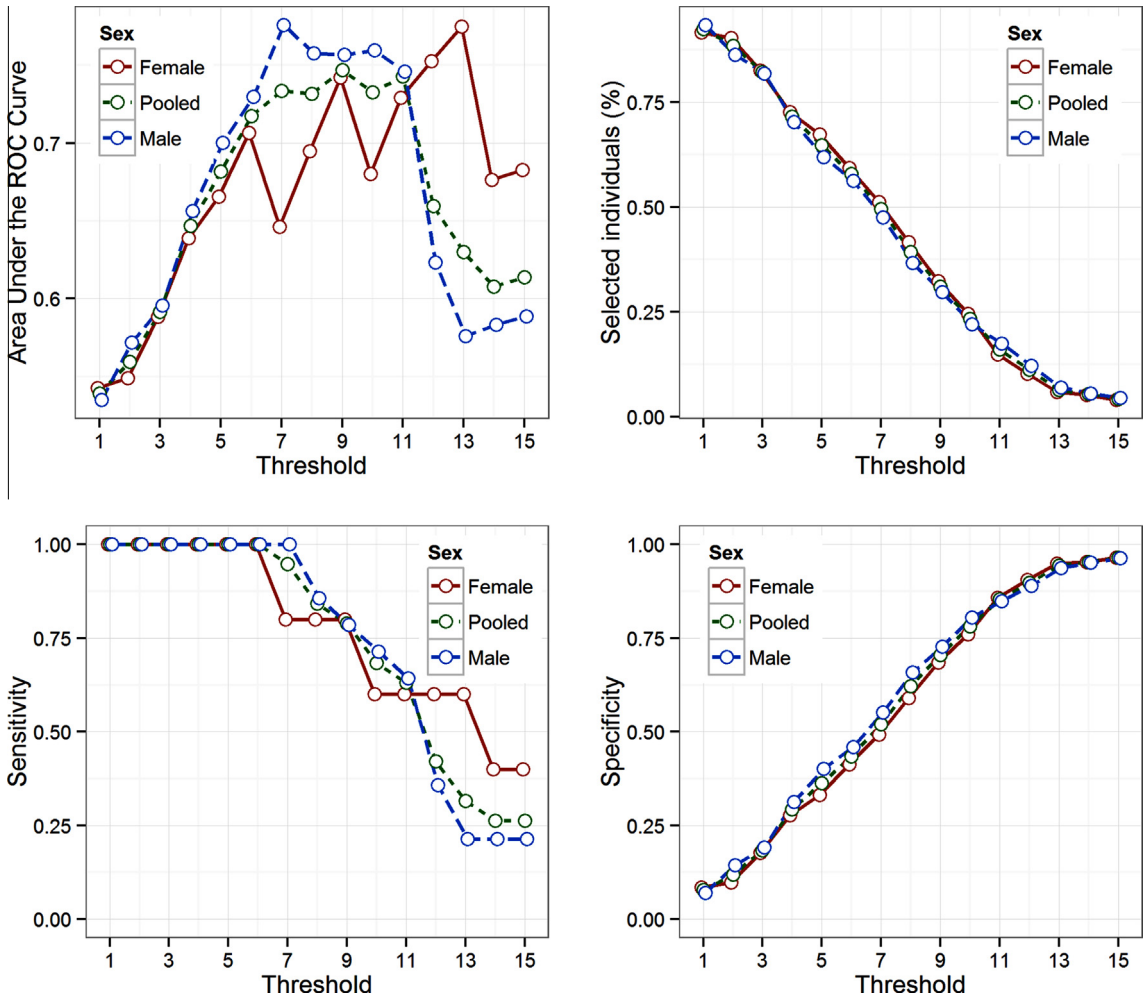

Fig. 1 – Predictive performance for detecting undiagnosed type 2 DM using different FINDRISC cut-off values.

($n = 69$). Table 1 summarizes key clinical parameters for all three groups. All participants with known diabetes were excluded from the study.

The significance of the difference between both sexes (Table 2) was calculated using Pearson's Chi-square test. The following six measures of performance were calculated for each cut-off value between 1 and 15 to observe the predictive performance for undiagnosed diabetes: accuracy, area under the ROC curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). The same performance metrics were calculated with pooled sample of all participants as well as with additional analysis by sex, due to different prevalence of type 2 DM in men and women.

3. Results

A descriptive overview of study participants in terms of FINDRISC questions is presented in Table 1. Fig. 1 demonstrates four different performance metrics including the AUC metric that reached maximal values in cases of optimal balance between sensitivity and specificity. With the currently used FINDRISC cut-off ($\geqslant$15), it was possible to achieve an AUC of 0.589 in the male and 0.683 in the female population. As it can be observed from Fig. 1, the optimal AUC was achieved at a cut-off value of 7 for men and 13 for women with their respective AUC values at 0.776 and 0.775. The sensitivities and specificities at the optimal cut-off values were 100.0% and 55.1% in men and 60.0% and 95.0% in women. The low cut-off value for men would result in 47.6% of participants being selected for further examinations. On the other hand, at a cut off value of 13 only 5.9% of women would be selected. At the currently used universal FINDRISC screening cut-off value of 15, 4.5% of men and 4.0% of women would be selected for further examinations, therefore we would face a significant increase in screening costs for men only. In case of a pooled analysis, an optimal AUC value of 0.747 was achieved at a FINDRISC cut-off value of 9. In this case, the proportion of participants selected for further examinations would amount to 31.1%.

4. Discussion

Our data indicate that lower values, especially in men, are needed in order to optimize the detection of undiagnosed type 2 DM. Introducing lower cut-off values would increase costs of the screening program due to additional OGTT and HbA1c tests. However, the additional screening costs that

amount to approximately 16 USD per person in Slovenia need to be weighed against the costs of treating people with diabetes estimated at 2300 USD per person with diabetes per year [1]. According to Zhuo et al. [10], it is possible to estimate the lifetime medical spending for people with diabetes at 124,600; 91,200; and 53,800 USD when diagnosed with diabetes at 40, 50, and 60 years of age, respectively. However, it is known that the general community often fails to take the impact of diabetes seriously [11].

Lower than currently valid FINDRISC cut-off values have been suggested before in studies from different countries. For example, Zhang et al. suggested an optimal FINDRISC cut-off value of 10 for men and 12 for women, with the respective AUC values of 0.74 and 0.78 [12]. In the study by Tankova et al. the optimal result (AUC of 0.70) was achieved at a FINDRISC cut-off value of 10 [8]. Vandersmissen and Godderis evaluated the FINDRISC score for diabetes screening in occupational healthcare, with their sample characteristics being very similar to the ones in our study. Although the authors did not use the AUC metric to define the optimal cut-off value, they suggested lowering the FINDRISC cut-off score to 12 [13].

Compared to other studies [7,8,12–14], a lower prevalence of diabetes and prediabetes can be noted in this study. This is most probably due to a younger age of our working population sample (46.0 ± 13.0 years). On the other hand, the study by Vandersmissen and Godderis with a similar average age of participants (44.7 ± 9.4 years) showed similar sample characteristics [15].

In the Slovenian working-age population, a more optimal use of the FINDRISC questionnaire in detecting people with undiagnosed diabetes can be attained if a lower than currently recommended FINDRISC cut-off score is employed. The discrepancy between the recommended and the optimal cut-off score was particularly prominent in men and we recommend that consideration be given to lower cut-off values despite higher screening costs as such changes are likely to prove cost-effective in the long run.

Conflict of interest statement

None declared.

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