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Risk prediction for type 2 diabetes in the German population with the updated German Diabetes Risk Score (GDRS).

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Summary

The GDRS was developed by the German Institute of Human Nutrition and enables the calculation of the 5-year risk for developing type 2 diabetes. Now, it was extended with the inclusion of family history information and with modifications regarding dietary risk factors (e.g. whole-grain cereals) and, with regard to experiences from the application, the GDRS was further improved in terms of practicability.

Keywords: diabetes mellitus type 2; diabetes risk prediction; prediction model; European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study

Introduction

Based on exclusively non-invasive risk factors the GDRS allows the prediction of the risk for developing type 2 diabetes within the next 5 years. It was derived from data of the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study in 2007 and validated in other studies [1]. For public use a web tool and a questionnaire version is available (http://drs.dife.de/). A study investigating the use of the web tool showed that especially people with a higher risk performed the test several times with varying answers of the modifiable risk factors [2]. Feedback from users of the test during the past years made it possible to identify areas which could lead to misunderstandings, although providing additional information. Critical aspects were

- the evaluation of alcohol consumption with non-drinkers having an increased diabetes risk;
- the evaluation of moderate smoking where former and current smokers with less than 20 cigarettes per day were valued similar to never smokers;
- the intake of whole-grain products which was limited to whole-grain bread, although also other whole-grain products (e.g. muesli) might be consumed – especially for breakfast.

In a recently published study it was shown that information regarding diabetes in the family, i.e. whether parents or siblings have or had diabetes, improved diabetes risk prediction. The GDRS was updated accordingly and validated in an independent population [3]. Based on the updated version, the aim of this study was to revise the modeling of varying risk factors in the GDRS with regard to an improved risk communication.

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Methods

Study population

Data from the prospective EPIC-Potsdam study were used for analysis. At baseline, information regarding lifestyle, nutrition, anthropometry and socio-demography were obtained [4]. For the identification of incident diabetes cases, routine follow-up assessments every 2 to 3 years were used [5]. The family history of diabetes was determined with data from the 5th follow-up [3]. After exclusion of prevalent diabetes cases, unverified cases, participants with missing follow-up data and missing or invalid covariate data, 21 845 participants remained for the analysis. During a mean follow-up time of 7 years, 727 participants (3.3 %) developed incident type 2 diabetes.

Statistical analysis

The 5-year diabetes risk was calculated using Cox-regression and discrimination was evaluated with the area under the receiver-operating-charac-

teristic curve (ROC-AUC) and corresponding 95 % confidence intervals (95-CIs) for cases until 5 years of follow-up (N=492) [6–8]. The score calculation was updated with the coefficients from Cox-regression and the absolute risk calculation was modified with regard to the updated baseline risk.

For the simplified paper questionnaire, categories of the risk factors were used and points assigned to these categories [9]. Absolute risk calculation was modified accordingly. The exact model and the simplified paper version were compared using ROC-AUC and correlation analysis.

Results

First, the added value of moderate alcohol consumption (10–40g per day) for risk prediction with the GDRS was evaluated. The discriminatory ability of the updated GDRS without the question of alcohol consumption (ROC-AUC [95 %-CI]: 0.856 [0.842–0.870]) was comparable to the original GDRS (ROC-AUC [95 %-CI]: 0.856 [0.842–0.871]).

Next, in addition to the intake of whole-grain bread the intake of muesli was included in the calculation of whole-grain consumption and the evaluation of smoking categories was based on the effect size (Table 1). These modifications resulted in a discrimination of 0.857 (0.843–0.871).

According to the revision of the GDRS, the paper version was revised also, which can be performed by persons without access to a computer or to the internet [8] (Tab. 2). For the paper version a comparable high discriminatory ability was achieved: 0.855 (0.841–0.870). The Spearman-correlation coefficient for the absolute risks or points of the exact model with the questionnaire was 0.981.

Risk factor	ß	Points	HR (95 %-CI)
Age (years)	0.051	5,1	1.05 (1.04–1.06)
Height (cm)	–0.027	–2,7	0.97 (0.96–0.98)
Waist circumference (cm)	0.076	7,6	1.08 (1.07–1.09)
Prevalent hypertension	0.473	47	1.61 (1.38–1.87)
Sports, biking and gardening (h/week)	–0.018	–2	0.98 (0.97–0.99)
Former smoking (<20 cig./day)	0.149	15	1.16 (0.96–1.41)
Former smoking (≥20 cig./day)	0.447	45	1.56 (1.26–1.94)
Current smoking (<20 cig./day)	0.226	23	1.25 (0.97–1.61)
Current smoking (≥20 cig./day)	0.772	77	2.16 (1.61–2.92)
Whole-grain consumption (rolls, bread, muesli) (per 50 g /day)	–0.074	–7	0.93 (0.86–1.00)
Coffee consumption (per 150 ml/day)	–0.047	–5	0.95 (0.92–0.99)
Intake of red meat (per 150 g/day)	0.551	55	1.74 (1.26–2.38)
One parent with diabetes	0.564	56	1.76 (1.49–2.07)
Both parents with diabetes	1.063	106	2.90 (2.09–4.02)
At least one sibling with diabetes	0.476	48	1.62 (1.28–2.04)

Absolute risk: P (Diabetes) = $1\text{-}0{,}99061^{\exp\left(\frac{\text{Scorepoints}-474{,}17096591}{100}\right)}$

Tab. 1: **Risk factors of the revised GDRS with regression coefficients, allocated points and hazard ratios (HR)**

Discussion

The GDRS is mainly used by private individuals, i.e. medical lay persons, and without medical dietary counseling. Hence, especially for the application of the questionnaire, the evaluation of moderate alcohol consumption led to misinterpretations by the applicants. To avoid such misunderstandings in the future, the question regarding moderate alcohol consumption was abandoned in the revised version of the GDRS. A substantial loss of information is not expected. Also for the evaluation of smoking, feedback came from applicants. In this case, the previous evaluation indicated that 'light' smoking (<20units/day) is not a risk factor. The new evaluation is now based on the actual observed risks and less on the statistical verification. This is in accordance with several studies, which identified smoking as an important risk factor for diabetes [10]. The addition of muesli to whole-grain bread roles and whole-grain bread extends the possible answers and represents as such the association of the whole intake of whole-grain products with a reduced diabetes risk in a better way [2, 11].

In sum, the GDRS was extended with helpful questions (see Table 1 and 2) and improved for the application in terms of understanding and meaning of single risk factors, without having influence on the prediction accuracy of the GDRS. The advantages of the

Risk factor	Points
Age (in years)	
< 35	0
35–39	1
40–44	4
45–49	7
50–54	10
55–59	13
60–64	16
65–69	19
70–74	22
> 74	25
Waist circumference (cm)	
< 75	0
75–78	4
80–84	8
85–89	12
90–94	16
95–99	20
100–104	24
105–109	28
110–114	32
115–119	36
≥ 120	40
Body height (cm)	
< 152	11
152–159	9
160–167	7
168–175	5
176–183	3
184–191	1
≥ 192	0
Prevalent hypertension	
No	0
Yes	5

Risk factor	Points
Smoking status	
Never	0
Former smoking < 20 cig./day	1
Former smoking ≥ 20 cig./day	5
Current smoking < 20 cig./day	2
Current smoking ≥ 20 cig./day	8
Physical activity	
<5 h/week	1
≥5 h/week	0
Coffee consumption	
0–1 cups/day	3
2–5 cups/day	2
>5 cups/day	0
Whole-grain intake (rolls, bread, muesli) (1 portion ≈ 1 slice or 3 tablespoons)	
0 portions/day	5
1 portions/day	4
2 portions/day	3
3 portions/day	2
4 portions/day	1
>4 portions/day	0
Meat intake	
Never or rarely	0
1–2 times/week	1
3–4 times/week	3
5–6 times/week	5
Daily	6
> 1 time a day	8
Family history	
No history of diabetes in the family	0
One parent with diabetes	6
Both parents with diabetes	11
At least one sibling with diabetes	5

Absolute risk: P (Diabetes) = $1\text{-}0{,}99061^{\exp\left(\frac{\text{POINTS}-38.4558938}{10}\right)}$

Tab. 2: **Risk factors and allocated points of the revised GDRS paper questionnaire**
New questions are marked

GDRS among the numerous published diabetes prediction models [12] are the simplicity assessing non-invasive risk factors and the precise prediction of the 5-year diabetes risk at the same time.

Nonetheless, with the application of risk scores in the population misunderstandings or misinterpretations might come up. Therefore, it is necessary to further evaluate the application of risk scores and revise questionnaires accordingly.

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Conflict of Interest
The authors declare no conflict of interest according to the guidelines of the International Committee of Medical Journal Editors.

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