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Predictors of undiagnosed prevalent type 2 diabetes – The Danish General Suburban Population Study

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ABSTRACT

Aims: To investigate how self-reported risk factors (including socioeconomic status) predict undiagnosed, prevalent type 2 diabetes mellitus (T2DM). To externally validate Leicester Risk Assessment Score (LRAS), Finnish Diabetes Risk Score (FINDRISC) and Danish Diabetes Risk Score (DDRS), and to investigate how these predict a European Heart SCORE ≥ 5% in a Danish population study.

Methods: We included 21,205 adults from the Danish General Suburban Population Study. We used relative importance calculations of self-reported variables in prediction of undiagnosed T2DM. We externally validated established prediction models reporting ROC-curves for undiagnosed T2DM, pre-diabetes and SCORE.

Results: More than 20% of people with T2DM were undiagnosed. The 7 most important self-rated predictors in sequential order were high BMI, antihypertensive-therapy, age, cardiovascular disease, waist-circumference, fitness compared to peers and family disposition for T2DM. The Area Under the Curve for prediction of undiagnosed T2DM was 77.1 for LRAS; 75.4 for DDRS and 67.9 for FINDRISC. AUCs for SCORE was 75.1 for LRAS; 62.3 for DDRS and 54.3 for FINDRISC.

Abbreviations: AUC, area under the curve; BMI, body mass index; BP, blood pressure; CCHS, Copenhagen City Heart Study; CGPS, Copenhagen General Population Study; CVD, cardio vascular disease; DDRS, Danish Diabetes Risk Score; DM, diabetes mellitus; FINDRISC, Finnish Diabetes Risk Score; GESUS, Danish General Suburban Population Study; HbA_{1c}, glycated hemoglobin; GP, general practitioner; OGTT, Oral Glucose Tolerance Test; Oral Pre-DM, pre-diabetes mellitus; SD, standard deviation; SES, socio economic status; T2DM, type 2 diabetes mellitus; ZRS, Zealand Risk Score.

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Conclusions: BMI and self-reported cardiovascular disease are important risk factors for undiagnosed T2DM. LRAS performed better than DDRS and FINDRISC in prediction of undiagnosed T2DM and SCORE ≥ 5%. SCORE performed best in predicting pre-diabetes.

1. Introduction

The number of patients with type 2 diabetes (T2DM) is increasing worldwide [1,2] and studies suggest that up to 50% of prevalent T2DM are undiagnosed dependent on regional differences and diagnostic methods [3–6]. Many newly diagnosed patients already have evidence of complications at diagnosis [7]. Pharmacological treatment and changes in lifestyle to prevent or postpone the onset of macro- and micro-vascular complications are important interventions [8]. As uncertainty persists concerning benefits of population-based screening for diabetes [6,9] – opportunistic, targeted screening to detect undiagnosed T2DM [3], has been the recommended strategy [6,10]. Several predictive risk-scoring tools are available, focusing on clinical observations and anamnestic information [11,12]. But in order to enhance detection of undiagnosed T2DM, by encouraging initial response rate and reduce the number needed to investigate, targeted screening for undiagnosed T2DM, using self-assessment tools (Apps or questionnaires), have been suggested [13]. These scores have been reported to be efficient in detection of undiagnosed diabetes [6,13,14]. Two Scandinavian models have previously been validated, The Danish Diabetes Risk Score (DDRS) [6,15,16] and the Finnish Diabetes Risk Score (FINDRISC) [11,17]. It has been argued, that moving to the Glycated Haemoglobin A1c (HbA_{1c}) based testing and diagnosis have reduced the proficiency of some scores (e.g. FINDRISC) in the prediction of glucose abnormalities [18].

Self-assessment scores and clinical tools have included known risk factors (e.g. anthropometric, family disposition, medication and lifestyle predictors) [19] some also using self-rated health variables (e.g. physical exercise), which has been argued helpful in risk prediction in patients with undiagnosed T2DM [11,15,20,21]. Studies have shown that ethnicity constitute a predictor for undiagnosed DM [22,23]. In addition it has been shown that low socio-economic status (SES) is associated with higher incidence and mortality of T2DM [24] and associated with undiagnosed T2DM [25–27]. Therefore, new self-assessment scores have suggested questions of ethnicity and SES for better detection of DM [23,28]. The "QD-Score" propose the inclusion of SES and ethnicity as risk factors for DM [23]. Unfortunately, the QD-Score is not directly applicable outside the UK, due to the use of the UK-based Townsend Deprivation Score. The Leicester Risk Assessment Score (LRAS) [28], which includes self-reported ethnicity, has only sparse validation outside the UK [29,30] and validation in different settings has been advocated [31].

Diabetes and cardiovascular disease share many common risk factors. The ADDITION Denmark study [32], showed that HbA1c ≥ 6.0% combined with an elevated cardiovascular disease (CVD) risk assessment (SCORE) [33] identifies 96.7% of patients from family practices in the age group 40–69 years old who would benefit from preventive antidiabetic lifestyle intervention and/or polypharmacy [32,34].

In this study, we aim to investigate which self-reported predicting factors from common risk scores [11,13,15,19,21,23,28] and which socio-economic factors (including ethnicity) are the most important to unveil undiagnosed prevalent T2DM. Second, externally validate established prediction models (DDRS, LRAS and FINDRISC). Third, compare DDRS, LRAS and FINDRISC in prediction of SCORE (≥5%), and the performance of SCORE for prediction of undiagnosed T2DM and pre-diabetes. We use the Danish General Suburban Population Study (GESUS) (N = 21,205).

2. Methods

2.1. Setting

The Danish health care system is intended to provide impartial health care service, being mainly tax financed and based on an egalitarian principle. In Denmark diagnosis and routine care for T2DM is usually provided by GPs who act as gatekeepers for specialist care.

2.2. Study population

This study was part of GESUS [35], a representative sample of the adult population in the Danish Naestved Municipality with a mix of urban and more rural areas. In brief, between January 2010 and October 2013, 49,115 individuals, all people over 30 years of age, and a computer-generated 25 percent random selection of people aged 20–30 years were invited by mail to participate in a health examination. If individuals did not respond, a reminder was sent with a new scheduled period. Total enrolment was 21,205 (43% of the invited) (Supplementary Table 1).

2.3. Variables considered

The health examination included anthropometric (BMI and waist-circumference) and blood-pressure (BP) measurements. Blood samples at enrolment were drawn in the non-fasting state. 2 ml whole blood was drawn for measurement of HbA_{1c} on Tosoh Automated Glycohemoglobin Analyzer HLC-723G8 (Tosoh Corporation) (an automated high-pressure liquid chromatography instrument). Total cholesterol was measured in lithium-heparin plasma on Cobas-6000 (Roche). For details of the study protocol see Bergholdt et al. [35]. A paper-based questionnaire was sent along with the invitation. The questionnaire was similar to the ones used for the Copenhagen City Heart Study (CCHS) and the Copenhagen General Population

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