## Original research

# Primary care screening for individuals with impaired glucose metabolism with focus on impaired glucose tolerance

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## ARTICLE INFO

## ABSTRACT

*Aim:* To evaluate the utility of three short questions (the Skövde Form) combined with a random plasma glucose, and HbA1c as alternative tools for detection of individuals with impaired glucose metabolism (IGM), and particularly impaired glucose tolerance (IGT).

*Methods:* Three questions concerning BMI $\geq 25\,\text{kg/m}^2$, heredity for type 2 diabetes, and known hypertension were asked in a random population of 573 individuals. All with two positive answers or one positive answer and a random plasma glucose >7.2 mmol/l were invited for an oral glucose tolerance test and an HbA1c examination. FINDRISC was completed for comparison.

*Results:* The positive predictive value (PPV) for IGM, using the Skövde Form, was 31% while sensitivity and specificity were 59% and 73%, respectively. Corresponding values for IGT were 11%, 50% and 69%. Using HbA1c $\geq 42\,\text{mmol/mol}$, the PPV for IGM was 64% while sensitivity and specificity were 28% and 97%, respectively. The corresponding values for IGT were 15%, 16% and 94%.

*Conclusion:* The Skövde Form combined with a random plasma glucose may be used as an alternative tool for detection of individuals with IGM and IGT in particular. HbA1c may be used to identify individuals with type 2 diabetes but fails to detect most individuals with prediabetes.

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## 1.     Background

Due to the increase of type 2 diabetes in the world today, screening instruments are urgently needed to identify both individuals with previously unknown manifest diabetes and individuals with impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) at high risk to develop type 2 diabetes. Previous studies have proved low insulin sensitivity to be predictive for cardiovascular disease even prior to the development of manifest type 2 diabetes [1]. It is well known that individuals with IGT are susceptible to lifestyle changes with diet and physical activity to limit progression to type 2 diabetes [2,3]. Unfortunately this is not the case for individuals with IFG, who show only minor effects of equivalent lifestyle changes [4]. Therefore, it is of particular interest to detect individuals with IGT, both for prevention with lifestyle changes and for studies concerning the early development of type 2 diabetes. Many researchers have had the discouraging experience of performing multiple oral glucose tolerance tests (OGTTs) only to detect a few individuals with IGT [5].

The method most frequently used to detect individuals with metabolic abnormalities is screening with a fasting plasma glucose in individuals at risk, an instrument also recommended by the American Diabetes Association (ADA) every third year after the age of 40 years [6]. Nevertheless, fasting plasma glucose is not an efficient way to detect individuals with IGT as only 16% of individuals with IGT were identified by IFG (fP-glucose $\geq 6.1 < 7.0$ mmol/l) [7]. Also, many screening questionnaires have been developed but few, if any, have particularly focused on individuals with IGT [8]. The most commonly used questionnaire is the FINDRISC questionnaire, developed in Finland for detection of abnormal glucose tolerance, and validated in several previous studies [8–13]. Recently, HbA1c was recommended as a diagnostic tool in Europe with a suggested cut-off of 48 mmol/mol for type 2 diabetes and a suggested cut-off of $\geq 42$ mmol/mol for pre-diabetes [14].

The aim of this study was to evaluate the utility of three short questions (the Skövde Form) combined with a random plasma glucose and HbA1c as an alternative tool for detection of individuals with impaired glucose metabolism (IGM = IGT, IFG or type 2 diabetes) and particularly those with IGT for recruitment to programs and studies with lifestyle interventions. The FINDRISC questionnaire was used as a comparison.

## 2.     Method

All participants signed informed consent forms, and the study was approved by the Regional Ethical Review Board in Gothenburg.

### 2.1.     The questionnaire

The Skövde Form. Based on a literature review, we composed a short questionnaire consisting of only three questions combined with a random plasma glucose [15–21] with the purpose to provide a simple additive tool to be used in advertising and at health care units. The three questions were; "(1). Do you have high blood pressure? (2). Do any of your first degree relatives have diabetes? (3). Are you overweight (BMI $\geq 25$ kg/m$^2$)?". Those with a positive answer to two of the questions or to one question combined with a random plasma glucose of >7.2 mmol/l were invited for an OGTT.

### 2.2.     Study populations

Three different study populations were used for validation:

(1) The follow-up of the Skaraborg Project, launched 2002–2005 in two communities in Sweden in the Skaraborg County, i.e. Vara and Skövde. A total of 2816 individuals (whereof 1849 in Vara and 967 in Skövde), aged 30–75 years old, participated yielding high participation rates, 81% and 70% in Vara and Skövde, respectively. Two thirds of the population were younger than 50 years. The procedure is described in detail in previous publications [22]. The ten year follow-up is now ongoing and full data for the Skövde cohort has been collected. All participants were examined by two specially trained nurses to obtain data on anthropometric measurements including body weight, height, waist and hip circumference, blood pressure and heart rate. Questionnaires concerning lifestyle, diet and the FINDRISC questionnaire were completed. In the ten-year follow-up, the participation rate in the Skövde subgroup was 66% ($n = 638$). All participants with missing data for the Skövde form or missing data for a random plasma glucose test ($n = 5$) were excluded as were all individuals with previously diagnosed diabetes ($n = 30$). In addition all those who had not completed the FINDRISC questionnaire were excluded ($n = 30$) resulting in 573 individuals for the current study.

(2) The three questions were presented in an advertisement that was published in the local newspaper on two occasions, including one Saturday. Individuals with at least one positive answer to the three questions were invited to contact the health care units for a random plasma glucose and were informed that, if fulfilling the criteria, they would be welcome to participate in a lifestyle intervention. A total of 68 individuals responded to the invitation in the advertisement, whereof 59 fulfilled the criteria for an OGTT. Of those, five individuals did not attend the examination and thus yielding a final sample of 54 who were examined with an OGTT.

(3) All patients, 50 years or older without a prior history of diabetes, visiting 2 different health care units, one in the main city of Gothenburg (population 500,000), and one in the middle-sized town Skövde (population 50,000) in Sweden, were offered the short questionnaire with the three questions, a random plasma glucose and an OGTT if criteria were fulfilled. At the health care unit, the Skövde Form was distributed at the reception, and 52 individuals fulfilled the criteria for an OGTT.

### 2.3.     Blood tests and diagnoses

All participants were examined with an OGTT performed by a nurse or a biomedical analyst, after an overnight fast by oral ingestion of 75 g glucose in 300 ml lemon-flavoured water. Venous plasma glucose was analysed at base-line and 120 min