

REVIEW

Development of the CANRISK questionnaire to screen for prediabetes and undiagnosed type 2 diabetes

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ABSTRACT

The prevalence of type 2 diabetes in Canada and worldwide has risen more quickly during the last 2 decades than originally forecast. Since 2005, the Public Health Agency of Canada (PHAC) has consulted with leading Canadian and international experts to develop and evaluate a strategy to address the pending diabetes epidemic. Emphasis has been placed on the prevention of type 2 diabetes among high-risk groups with impaired fasting glucose and/or impaired glucose tolerance (also referred to as prediabetes) as growing evidence demonstrates that type 2 diabetes can be prevented or delayed through lifestyle or pharmacological interventions. Before such preventive interventions can be widely applied in Canada, however, practical early detection strategies must be successfully implemented and evaluated. PHAC is developing a “made-in-Canada,” non laboratory-based screening questionnaire, validated against the diagnostic gold standard, to identify prediabetes and undiagnosed diabetes among middle-aged adults. This 2-stage screening approach is based on an effective Finnish model (the Finnish Diabetes Risk Score [FINDRISC]), which is being adapted to reflect Canada’s multi-ethnic population. Seven provincial pilots are currently underway to field test and validate this screening approach, while also assessing effectiveness and user satisfaction. This new implementation research will help inform Canadian efforts aimed at preventing type 2 diabetes.

KEYWORDS: diabetes, prediabetes, screening, self-administered questionnaire

RÉSUMÉ

La prévalence du diabète de type 2 au Canada et dans le monde a augmenté plus rapidement que prévu au cours des vingt dernières années. L’Agence de la santé publique du Canada (ASPC) consulte depuis 2005 d’éminents experts du Canada et d’autres pays pour élaborer et évaluer une stratégie visant à contrer l’épidémie de diabète qui nous guette. L’accent a été mis sur la prévention du diabète de type 2 dans les groupes à haut risque, soit les personnes chez qui il y a une anomalie de la glycémie à jeun et/ou une intolérance au glucose (aussi appelées prédiabète), car il semble de plus en plus probable qu’il soit possible de prévenir le diabète de type 2 ou d’en retarder la survenue par des modifications du mode de vie ou des traitements médicamenteux. Mais avant de pouvoir appliquer de telles mesures préventives partout au Canada, on doit mettre en place et évaluer des stratégies de dépistage précoce. L’ASPC est en train d’élaborer un questionnaire adapté au contexte canadien et validé au moyen du test diagnostique de référence qui permet de dépister le prédiabète et le diabète chez les adultes d’âge moyen autrement que par des épreuves de laboratoire. Ce questionnaire de dépistage en deux temps est fondé sur un modèle finlandais efficace (FINDRISC) qu’on est en train d’adapter à la population multiethnique canadienne. Sept projets pilotes sont actuellement en cours pour évaluer sur le terrain et valider cette méthode de dépistage, tout en déterminant son efficacité ainsi que la satisfaction des utilisateurs. Cette nouvelle analyse d’implantation contribuera aux efforts canadiens en matière de prévention du diabète de type 2.

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MOTS CLÉS : diabète, prédiabète, dépistage, questionnaire auto-administré

INTRODUCTION

Earlier predictions of the global epidemic nature of type 2 diabetes during the early 2000s are being surpassed at an alarming rate, based on emerging epidemiological data from both developed and developing countries, including Canada (1,2). Over the past 10 years, the prevalence of type 2 diabetes in Ontario has increased at a much faster rate than anticipated. For example, the age- and sex-adjusted prevalence of diagnosed diabetes increased from 5.2% in 1995 to 8.8% in 2005, already exceeding the global prevalence of type 2 diabetes of 6.4% projected for 2030 (1). The prevalence of undiagnosed diabetes in Canada is unknown, but data from the United States (US) National Health and Nutrition Examination Survey (NHANES) (3) suggest that it amounts to approximately a third to a half of the number of known cases. Recently, there has been increased interest in identifying population groups at high risk for the development of type 2 diabetes, particularly those with non-diabetic dysglycemia (i.e., impaired fasting glucose [IFG], impaired glucose tolerance [IGT] or both). Based on results from the Canadian Community Health Survey and NHANES III, the Public Health Agency of Canada (PHAC) estimates that non-diabetic dysglycemia affected approximately 5 million Canadian adults in 2004 (4). This includes approximately 3 million adults aged 40 to 74, and is predicted to increase to over 4.3 million by 2016 in this age group alone (4).

The specific causal mechanisms responsible for this alarming increase in the prevalence of type 2 diabetes and non-diabetic dysglycemia are complex and intertwined (5). These factors include rising incidence in type 2 diabetes; improved management of type 2 diabetes; increasing obesity rates (6,7); aging of the population (8); changes in lifestyle and diet due to increased affluence and Westernization; low socioeconomic status (9); and changing immigration patterns.

Diabetes is a common chronic disease that is costly in both health-related and economic terms. It is associated with many potential serious health complications, including premature death, cardiovascular disease (heart attack and stroke), blindness, kidney disease, lower-extremity amputation and erectile dysfunction. The World Health Organization (WHO) has estimated that 1 million deaths worldwide were caused by diabetes in 2002 (10). In addition, elevated blood glucose levels (from all forms of dysglycemia) are estimated to be responsible for 2.2 million cardiovascular deaths worldwide (1.5 million deaths from ischemic heart disease and 700 000 deaths from stroke) (11). This means that 1 in 5 deaths from ischemic heart disease and 1 in 8 from stroke worldwide are attributable to the long-term effects of elevated blood glucose levels. From

an economic perspective, the burden of diabetes alone was conservatively estimated at \$1.6 billion in 1998 in Canada [\$0.4 billion (25%) in direct costs and \$1.2 billion (75%) in indirect costs] (12). In 2007 in the US, when costs of other diabetes-associated illnesses were included, the total annual cost of diabetes was estimated at \$174 billion (13).

Prediabetes is a convenient term often used to refer to the intermediate metabolic states between normal and diabetic glucose homeostasis. It is comprised of IFG, IGT or both. IGT in particular is a strong risk factor for the progression from prediabetes to frank type 2 diabetes mellitus, as well as for cardiovascular disease. Depending on whether 1 or both glucose measures are impaired, it is estimated that 30 to 60% of people with prediabetes will develop type 2 diabetes in the next 8 to 10 years (14). It is important to note that even among individuals with elevated IFG or IGT, the risk of developing diabetes is not uniform: there is a 2- to 3-fold difference in risk depending on the presence or absence of additional risk factors (14). Therefore, risk-assessment questionnaires can play an important role in screening by supplying clinicians with additional risk information not conveyed by blood tests alone.

There is growing evidence that type 2 diabetes can be prevented or, at the very least, delayed by the implementation of effective lifestyle and/or pharmacological interventions (15). A recent systematic review of 21 trials and a meta-analysis of 17 trials concluded that both lifestyle and pharmacological interventions successfully reduced the rate of progression to type 2 diabetes in people with both IFG and IGT (16). Lifestyle interventions, though costly and challenging to implement, were generally more effective than drug treatments (16).

It is important to emphasize that the above international evidence supports the clinical efficacy of preventive interventions in individuals with known (diagnosed) IFG or IGT, but at present, the effectiveness of widespread community-based programs using these interventions has not been fully established. Furthermore, no practical implementation studies have been conducted among Canadians. As such, strategies to identify who may benefit most from such diabetes prevention programs in Canada must be developed and evaluated.

SCREENING FOR DIABETES AND PREDIABETES

Current screening recommendations

While diabetes professional associations advocate screening for type 2 diabetes, there is no consensus regarding the actual method and approach to use. The recommendations for screening for IFG and IGT are even more diverse. For example, the US Preventive Services Task Force recommends only selective screening for diabetes among adults with specific risk factors for type 2 diabetes (e.g., hypertension or hyperlipidemia), given the paucity of evidence for

population-based screening (17). In contrast, the American Diabetes Association recommends routine screening for type 2 diabetes, IFG and IGT among individuals who are ≥ 45 years of age, have a body mass index (BMI) ≥ 25 kg/m² and belong to a high-risk population (18). The Canadian Diabetes Association (CDA) recommends that all adults aged ≥ 40 years be screened for diabetes at 3-year intervals and that screening be considered at a younger age or more frequently among individuals with additional risk factors (19).

Diagnostic standards

At present, the diagnostic gold standard for dysglycemia is the 75-g oral glucose tolerance test (OGTT), which includes both a fasting plasma glucose (FPG) and a 2-hour glucose level following administration of 75 g of glucose (19). When used in a screening setting, the OGTT has sensitivity of ~93% (11.1 mmol/L cutoff) compared to ~56% for a single FPG (7.0 mmol/L venous cutoff) (20). Clinicians, however, rarely order the OGTT because patients dislike drinking the glucose-rich beverage and spending 2 hours in the laboratory to complete the test is inconvenient. In addition, the OGTT costs approximately \$35, roughly twice the cost of FPG testing. Given that an ideal screening test can be self-administered, has acceptable performance characteristics, is inexpensive and will either substantially reduce or eliminate the need for expensive blood tests for a majority of patients, the OGTT is often not recommended as a standalone screening test.

Diabetes screening questionnaire

Several different screening strategies can be considered for the early detection of individuals at risk of type 2 diabetes or prediabetes. One promising strategy is the use of a non laboratory-based Diabetes Screening Questionnaire as part of a comprehensive, educational, 2-stage screening approach. A 2-stage screening strategy consists of administering a low-cost, population-based, risk-assessment questionnaire, followed by laboratory testing of only those individuals who are identified as being at higher risk of type 2 diabetes. In addition, a Diabetes Screening Questionnaire would serve as a tool to increase both participants' and clinicians' awareness of risk factors for diabetes, thereby reinforcing effective prevention and early detection efforts. While several Diabetes Screening Questionnaires have been developed and validated in other countries, such as the Finnish Diabetes Risk Score (FINDRISC) in Finland, no Diabetes Screening Questionnaire has yet been validated in a multiethnic population such as Canada's. In addition, it is well-established that the risk of diabetes is higher in certain ethno-cultural groups, in particular, First Nations and South Asian populations. Given Canada's multiethnic, multicultural population, a Diabetes Screening Questionnaire validated in Canada is needed.

A recent systematic review and meta-analysis of the diagnostic test characteristics of Diabetes Screening Questionnaires concluded that their sensitivity is similar to that of the FPG when used in population screening for type 2 diabetes (21). In addition, Diabetes Screening Questionnaires are simple, inexpensive alternatives to laboratory tests for initial screening (21). The review identified 12 different non laboratory-based questionnaires. Common discriminative items across these Diabetes Screening Questionnaires included older age; high BMI; high waist circumference; treated hypertension or a history of hypertension; family history of diabetes in first- and second-degree relatives; and male sex. Item weightings, scoring formats and cutoffs varied between questionnaires, but these variations had little impact on the overall diagnostic accuracy (sensitivity 67% to 78%). Finally, Diabetes Screening Questionnaires that calculated a score using simple addition were as accurate as those that used complex mathematical calculations.

CANRISK: a made-in-Canada Diabetes Screening Questionnaire

The PHAC is currently developing and validating a "made-in-Canada," self-administered questionnaire with high diagnostic accuracy to detect prevalent undiagnosed type 2 diabetes, IFG and/or IGT. The CANRISK, shown in Appendix 1 (available at www.diabetes.ca), has been developed based on recommendations from an expert technical advisory group, the above systematic review of Diabetes Screening Questionnaires, and the existing FINDRISC questionnaire (22). This process has resulted in a modified (and translated) questionnaire based on the FINDRISC but expanded to include the following to better assess the Canadian population: ethnic origin of biological parents; smoking status; family history of diabetes; and in women only, a history of gestational diabetes (or giving birth to a baby weighing over 4.1 kg). Ethnicity was not included as part of the original Finnish FINDRISC development and validation (22) but has been added to the CANRISK questionnaire. In addition, level of schooling and self-reported health status were also added to better describe the demographics of the study population. The target population groups follow the 2008 CDA guidelines: adults aged 40 to 74 years, as well as younger individuals at increased risk of type 2 diabetes due to other established risk factors.

Under the direction of the PHAC, CANRISK is currently being implemented and validated in a series of pooled epidemiological studies across Canada (Prince Edward Island, Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan and British Columbia). Pilot sites have been specifically selected in order to ensure recruitment of an ethnoculturally diverse, urban and rural population. All individuals who consent to participate will complete both the CANRISK and an OGTT, regardless of their CANRISK score. The diagnostic

test characteristics of the CANRISK questionnaire will be assessed using the OGTT as the gold standard. Measures of diagnostic accuracy (with 95% CIs) will be calculated, including sensitivity, specificity, positive and negative predictive values, and likelihood ratios. In addition, receiver operator characteristic curve analysis using various CANRISK scoring cutoffs will be used to determine the optimal score to detect both diabetes and nondiabetic dysglycemia in the Canadian population. Furthermore, to ensure rigorous questionnaire development and implementation, data pertaining to the questionnaire's comprehensibility, content and ease of completion will also be collected and analyzed. Other practical issues related to questionnaire administration will also be evaluated, including patterns of responses and missing data, as well as the demographic characteristics of non-responders, partial-responders and completers.

Weaknesses and limitations of questionnaire-based screening

Tests for population screening are often selected for their ease of use and low cost of widespread implementation. Non laboratory-based Diabetes Screening Questionnaires such as CANRISK, while easier to implement, are less accurate than the gold standard OGTT. In addition, Diabetes Screening Questionnaires face particular challenges associated with the biases of self-selection, language barriers and recall of self-reported data. CANRISK has been translated into several languages to address the language issue. Also, in order to minimize other forms of selection bias, pilot studies are collecting relevant data to allow the examination of factors related to participation and questionnaire acceptability.

CONCLUSION

Simple, cost-effective early detection programs are an essential first step toward reducing the serious healthcare burden posed by the unprecedented rise in diabetes and prediabetes in Canada. New evidence from the 2-stage CANRISK approach will help inform new Canadian efforts aimed at preventing and addressing type 2 diabetes.

AUTHOR DUALITIES

No dualities of interest declared.

AUTHORS CONTRIBUTIONS

JK researched the article and drafted the manuscript. CR and KN edited and revised the manuscript. All authors read and approved the final manuscript.

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