Recommendations on screening for type 2 diabetes in adults

Canadian Task Force on Preventive Health Care

In 2008/09, an estimated 2.4 million Canadians (6.8%) had either type 1 or type 2 diabetes, and an additional 480 000 (1.4%) were unaware that they were affected.[1] The most recent Canadian data indicate that, from 1998/99 to 2008/09, the prevalence of diagnosed diabetes increased by 70% (Figure 1).[1] The greatest relative increase in prevalence was seen in the age groups 35–39 and 40–44 years, in which the proportion doubled. In 2008/09, almost 50% of people with newly diagnosed diabetes were 45–64 years old (Figure 2).[1] Substantial increases in prevalence are projected over the next decade.[1] Because type 1 diabetes is much less common than type 2 diabetes and is generally symptomatic, we focused on type 2 diabetes in these guidelines.

Laboratory values used to define the diagnosis of diabetes have become more inclusive over time[2–6] (Appendix 1). In 2002, a new diagnostic category (now commonly known as prediabetes) was created to describe patients at very high risk of diabetes. More recently, glycated hemoglobin (herein referred to as A1C), which reflects an individual's average plasma glucose level over the previous 2–3 months, has been accepted as an alternative diagnostic test for type 2 diabetes.[7,8]

Long-term consequences of type 2 diabetes include microvascular (retinopathy, nephropathy, neuropathy) and macrovascular (stroke, myocardial infarction) complications.[9] An estimated 65%–80% of people with diabetes will die of a cardiovascular event, many without prior signs or symptoms of cardiovascular disease.[10]

Type 2 diabetes is a prevalent and costly chronic illness that demands lifestyle interventions, effective monitoring and pharmacologic management.[11] Management of risk factors, including physical inactivity, blood pressure and blood lipid levels as well as blood glucose levels, is required to prevent long-term complications.[12]

Uncertainties remain about how best to prevent diabetes, the relative benefits of population screening and risk assessment, the ideal frequency of screening in high-risk populations and the potential harms of screening. This document updates the 2005 Canadian Task Force on Preventive Health Care recommendations on screening asymptomatic adults for type 2 diabetes. It does not apply to people with symptoms of diabetes or those who are at risk of type 1 diabetes.

Methods

The Canadian Task Force on Preventive Health Care is an independent panel of clinicians and methodologists that makes recommendations about clinical manoeuvres aimed at primary and secondary prevention (www.canadiantaskforce.ca). Work on each set of recommendations is led by a workgroup of 2 to 6 members of the task force. Each workgroup establishes the research questions and analytical framework for the guideline.

The current work was led by a workgroup of 6 members of the task force (listed at the end of the article). The research questions and analytical framework for this guideline are available in Appendix 2. The recommendations were revised and approved by the entire task force and underwent external review by experts in the field and by stakeholders. Details about the task force's methods can be found elsewhere.[13,14] The systematic review on which the recommendations are based was performed independently by the Evidence Review and Synthesis Centre (www.canadiantaskforce.ca/about_eng.html) and is available at http://canadiantaskforce.ca/recommendations/2012/diabetes.

Key points

- There is no evidence that screening for type 2 diabetes in adults who are at low to moderate risk of diabetes reduces the incidence, mortality or complications of diabetes.
- Low-quality evidence suggests that screening adults at high or very high risk of diabetes will reduce rates of myocardial infarction, microvascular complications and mortality.
- Use of a validated risk calculator, such as FINDRISC or CANRISK, is recommended to identify people at high or very high risk of diabetes.
- Validated risk calculators can be used to select patients for screening and may inform them about their risk factors.
- For adults who choose screening, low-quality evidence suggests that an interval of every 3–5 years is appropriate, except for people at very high risk of diabetes (determined with a validated risk calculator), for whom annual screening may maximize health benefits.

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The list of current members of the Canadian Task Force on Preventive Health Care is available at www.canadiantaskforce.ca/members_eng.html.

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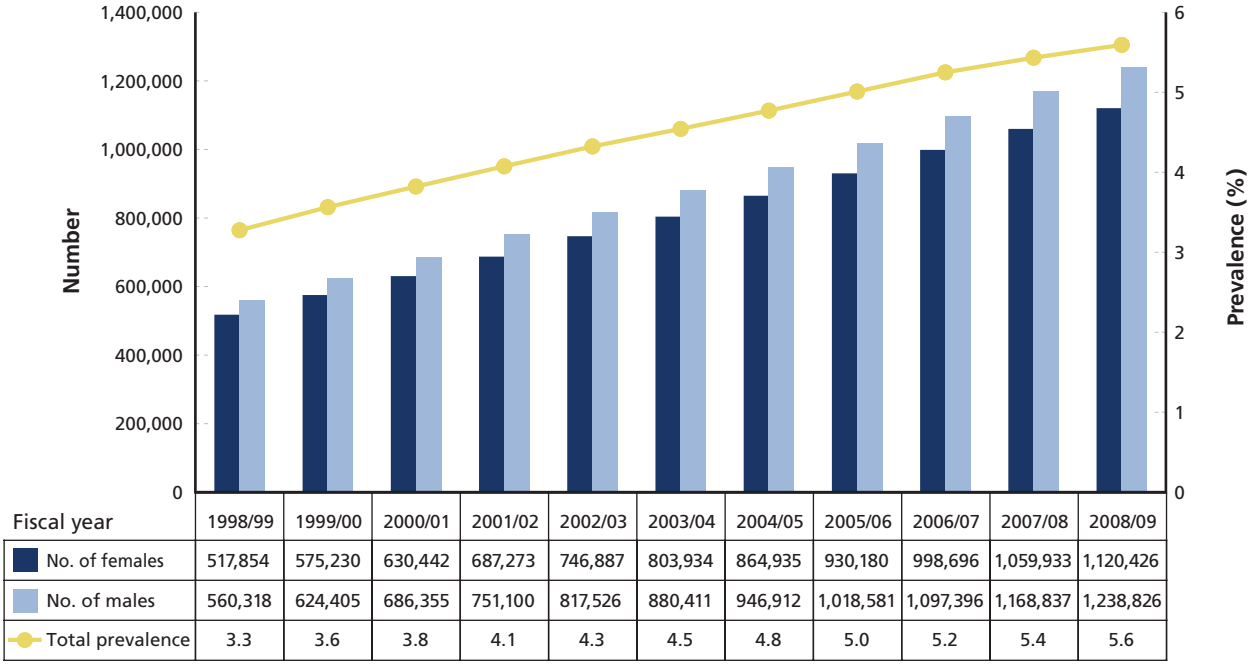
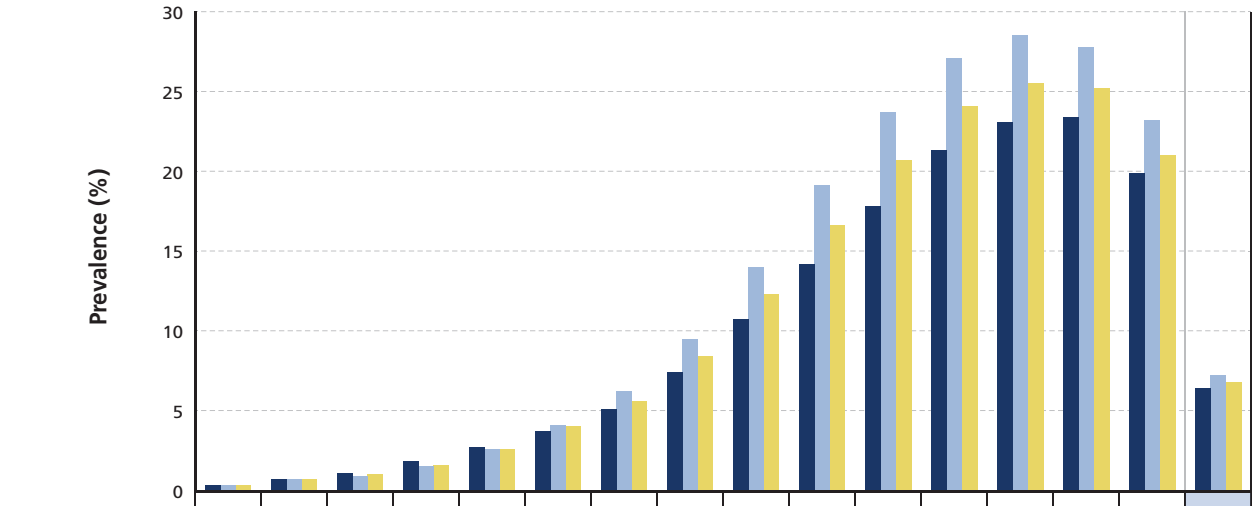


Fiscal year	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
No. of females	517,854	575,230	630,442	687,273	746,887	803,934	864,935	930,180	998,696	1,059,933	1,120,426
No. of males	560,318	624,405	686,355	751,100	817,526	880,411	946,912	1,018,581	1,097,396	1,168,837	1,238,826
Total prevalence	3.3	3.6	3.8	4.1	4.3	4.5	4.8	5.0	5.2	5.4	5.6

Figure 1: Age-standardized* prevalence and number of cases of diagnosed diabetes among individuals aged 1 year and older, Canada, 1998/99 to 2008/09. *Age-standardized to the 1991 Canadian population. Source: Canadian Chronic Disease Surveillance System, Public Health Agency of Canada, July 2011.



Age group (years)	1-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	≥85	Canada
Females	0.3	0.7	1.1	1.8	2.7	3.7	5.1	7.4	10.7	14.2	17.8	21.3	23.1	23.4	19.9	**6.4**
Males	0.3	0.7	0.9	1.5	2.6	4.1	6.2	9.5	14.0	19.1	23.7	27.1	28.5	27.8	23.2	**7.2**
Total	0.3	0.7	1.0	1.6	2.6	4.0	5.6	8.4	12.3	16.6	20.7	24.1	25.5	25.2	21.0	**6.8**

Figure 2: Prevalence of diagnosed diabetes among individuals aged 1 year and older, by age group and sex, Canada, 2008/09. Source: Canadian Chronic Disease Surveillance System, Public Health Agency of Canada, July 2011.

Recommendations

A summary of the recommendations for clinicians and policy-makers is shown in Box 1. The recommendations have been graded according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system, which is summarized in Box 2.[15]

Adults at low to moderate risk

For adults at low to moderate risk of diabetes (determined with the use of a validated risk calculator), we recommend not routinely screening for type 2 diabetes. (Weak recommendation; low-quality evidence.)

We found no randomized trials or observational studies showing that blood test screening for type 2 diabetes improved intermediate outcomes (differences in A1C, frequency of diagnosis) or final health outcomes (mortality and diabetes complications) among adults at low to moderate risk of type 2 diabetes (Appendix 3). Evidence from 2 modelling studies[16,17] suggests that screening adults starting between 30 and 45 years of age is cost-effective and maximizes health benefits (e.g., reducing mortality and microvascular complications), and results from 2 randomized controlled trials (RCTs)[18,19] suggest that the harms associated with screening for type 2 diabetes are minimal (Table 1, Appendix 4).

However, a large cluster-randomized controlled trial from the United Kingdom[20] recently showed that risk calculation plus one-time blood screening did not reduce all-cause or cardiovascular-related mortality over a median follow-up of 10 years in a population with a 3% baseline prevalence of diabetes, among whom an additional 3% was detected in the screened group. "High risk" or "very high risk" as defined by the task force implies a FINDRISC score (Finnish Diabetes Risk Score) of 15 points or higher, which is associated with prevalences of type 2 diabetes detected through screening that are several times higher than in the UK RCT, depending on the population.[21,22] Thus, we concluded that the findings of the UK RCT[20] are applicable to a population at low to moderate risk of diabetes, rather than to adults at high or very high risk.

In our judgment, the discrepant findings for mortality between the UK RCT and the modelling studies reduce confidence in the putative benefits for microvascular outcomes suggested by the latter. On balance, we conclude that available evidence warrants a weak recommendation against screening in adults who are at low or moderate risk of diabetes. Adults in this category who place a high value on uncertain benefits of screening and who are less concerned with the undesirable consequences of anxiety and the burden associated with a diagnosis of diabetes are likely to choose screening.

Adults at high risk

For adults at high risk of diabetes (determined with the use of a validated risk calculator), we

Box 1: Summary of recommendations for clinicians and policy-makers

Recommendations are presented for screening asymptomatic adults for type 2 diabetes. They do not apply to people with symptoms of diabetes or those at risk of type 1 diabetes.

- For adults at low to moderate risk of diabetes (determined with a validated risk calculator*†), we recommend not routinely screening for type 2 diabetes. (*Weak recommendation; low-quality evidence*)
- For adults at high risk of diabetes (determined with a validated risk calculator*†), we recommend routinely screening every 3–5 years with A1C.‡ (*Weak recommendation; low-quality evidence*)
- For adults at very high risk of diabetes (determined with a validated risk calculator*†), we recommend routine screening annually with A1C.‡ (*Weak recommendation; low-quality evidence*)

*Risk of diabetes developing within 10 years: low risk = 1/100–1/25 (1%–4%); moderate risk = 1/6 (17%); high risk = 1/3 (33%); very high risk = 1/2 (50%). For adults ≥ 18 years of age, we suggest risk calculation at least every 3–5 years.

†FINDRISC (the Finnish Diabetes Risk Score) has been selected as the preferred validated risk calculator, but CANRISK (the Canadian Diabetes Risk Assessment Questionnaire) is an acceptable alternative. Factors considered in FINDRISC and CANRISK are age, obesity, history of elevated glucose levels, history of hypertension, family history of diabetes, limited activity levels, and diet with limited intake of fruits and vegetables.

‡A1C has been selected as the preferred blood test, but fasting glucose measurement and the oral glucose tolerance test are acceptable alternatives. An A1C level of 6.5% or greater is recommended as the threshold for diagnosing diabetes, but values less than 6.5% do not exclude diabetes diagnosed using glucose tests. A1C should be measured using a standardized, validated assay.

Box 2: Grading of recommendations

- Recommendations are graded according to the Grading of Recommendations Assessment, Development and Evaluation system (GRADE).[15] GRADE offers two strengths of recommendation: strong and weak. The strength of recommendation is based on the quality of supporting evidence; the degree of uncertainty about the balance between desirable and undesirable effects; the degree of uncertainty or variability in values and preferences; and the degree of uncertainty about whether the intervention represents a wise use of resources.
- Strong recommendations are those for which we are confident that the desirable effects of an intervention outweigh its undesirable effects (strong recommendation for an intervention) or that the undesirable effects of an intervention outweigh its desirable effects (strong recommendation against an intervention). A strong recommendation implies that most people will be best served by the recommended course of action.
- Weak recommendations are those for which the desirable effects probably outweigh the undesirable effects (weak recommendation for an intervention) or undesirable effects probably outweigh the desirable effects (weak recommendation against an intervention) but appreciable uncertainty exists. A weak recommendation implies that most people would want the recommended course of action but that many would not. For clinicians, this means they must recognize that different choices will be appropriate for each person, and they must help each person arrive at a management decision consistent with his or her values and preferences. Policy-making will require substantial debate and involvement of various stakeholders. Weak recommendations result when the balance between desirable and undesirable effects is small, the quality of evidence is lower, and there is more variability in the values and preferences of patients.
- Evidence is graded as high, moderate, low or very low based on how likely further research is to change our confidence in the estimate of effect.

For more details, see the *GRADE Companion Document to Task Force Guidelines*, available at www.canadiantaskforce.ca/docs/grade_ENG.pdf.

recommend routinely screening every 3–5 years with the use of A1C. (Weak recommendation; low-quality evidence.)

We found 1 recent population-based cohort study that examined the impact of screening for type 2 diabetes and related cardiovascular risk factors on mortality in 2 cohorts of women and men aged 40–65 who were invited to undergo screening during 1990–1992 (first cohort) and 2000–2003 (second cohort).[23] Overall mortality did not differ significantly between the invited and noninvited cohorts when assessed after a median follow-up of 10 years (first cohort: hazard ratio 0.79, 95% confidence interval [CI] 0.63–1.00) and after a median of 8.1 years (second cohort: hazard ratio 1.18, 95% CI 0.93–1.51) (Table 2).[23]

In our judgment, the findings of the UK RCT[20] are not directly applicable to the screening of people at high or very high risk of diabetes. The 2 modelling studies described earlier[16,17]

Table 1: Summary of evidence of harms associated with screening for type 2 diabetes*

No. of studies	Outcome measure	Mean score ± SD: No invitation to screening	Mean score ± SD: Invitation to screening	Absolute effect (95% CI)†	GRADE quality of evidence
	Anxiety				
1 RCT[18] *n* = 355	Spielberger State Anxiety Inventory	6 wk after last contact‡ 34.1 ± 12.1 *n* = 168	37.6 ± 12.2 *n* = 77	Mean score 3.5 higher (0.22 to 6.78)	Moderate§¶**
1 RCT[19] *n* = 7380	**Anxiety** Spielberger State Anxiety Inventory	At baseline†† 32.7 ± 11.5 *n* = 199	32.7 ± 11.6 *n* = 2 468	Mean score 0.53 lower (–2.60 to 1.54)	Low¶**‡‡§§
		At 3–6 mo 31.8 ± 11.4 *n* = 358	33.5 ± 12.0 *n* = 2 504	Mean score 1.51 higher (–0.17 to 3.20)	
		At 12–15 mo 32.8 ± 11.8 *n* = 304	35.5 ± 12.2 *n* = 2 377	Mean score 0.57 higher (–1.11 to 2.24)	
	Hospital Anxiety and Depression Scale: Anxiety Subscale	At baseline†† 6.42 ± 4.39 *n* = 255	6.04 ± 3.79 *n* = 3 140	Mean score 0.46 lower (–0.99 to 0.07)	Low§¶**‡‡§§
		At 3–6 mo 5.97 ± 3.86 *n* = 442	5.91 ± 3.89 *n* = 3 159	Mean score 0.12 lower (–0.55 to 0.32)	
		At 12–15 mo 5.81 ± 3.87 *n* = 377	5.85 ± 3.87 *n* = 3 034	Mean score 0.01 lower (–0.47 to 0.45)	
	Depression				
	Hospital Anxiety and Depression Scale: Depression Subscale	At baseline†† 4.52 ± 3.48 *n* = 256	4.24 ± 3.31 *n* = 3 161	Mean score 0.37 lower (–0.93 to 0.18)	Low¶**‡‡§§
		At 3–6 mo 4.18 ± 3.38 *n* = 444	4.24 ± 3.40 *n* = 3 177	Mean score 0.01 higher (–0.51 to 0.54)	
		At 12–15 mo 4.03 ± 3.35 *n* = 378	4.28 ± 3.40 *n* = 3 049	Mean score 0.22 higher (–0.31 to 0.74)	

Note: CI = confidence interval, RCT = randomized controlled trial, SD = standard deviation.
*Our systematic review of harms associated with screening for type 2 diabetes in adults of any age identified 2 RCTs.
†Eborall et al.[19] used adjusted mean differences for age and comorbidity (use of antihypertensives) to compute absolute effect.
‡Questionnaire was sent 6 weeks after last contact (either test or invitation).
§Unclear allocation concealment.
¶No information regarding blinding.
**Quality rating is for a single study; thus, imprecision and publication bias criteria were rated as "no" and "unlikely."
††Questionnaire was given immediately after the initial blood test for those who attended screening, or after first contact for controls; data for those who attended screening were included in the analysis only if the questionnaire was completed and returned before the results of the test were received.
‡‡A nonrandomized sample of screening practices was used.
§§Large loss to follow-up (for the follow-up periods 3–6 and 12–15 mo).

Table 2: Summary of evidence of benefits associated with screening for type 2 diabetes*

No. of studies	Quality assessment: Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Summary of findings: Deaths: Screening, no. (%)	Control, no. (%)	Effect: Relative (95% CI)	Absolute (95% CI)	GRADE quality of evidence	Importance
Overall mortality												
1 cluster RCT[20]*												
2001–2011†	Randomized trial§	No serious risk of bias¶	No serious inconsistency**	No serious indirectness††	No serious imprecision‡‡	None§§	n = 1532 (9.5)¶¶	n = 377 (9.1)***	HR 1.06 (0.90 to 1.25)	5196 more per million (from 8726 fewer to 21454 more)	High	Critical
1 cohort study[23]*												
1990–1992 cohort‡	Observational study	No serious limitations†††	No serious inconsistency**	No serious indirectness	No serious imprecision	None**	*n* = 1705 116 (6.8)‡‡‡	*n* = 3231 229 (7.1)§§§	HR 0.79 (0.63 to 1)¶¶¶	14 455 fewer per million (from 25 619 fewer to 0 more)	Low	Critical
2000–2003 cohort‡	Observational study	No serious limitations†††	No serious inconsistency**	No serious indirectness	No serious imprecision	None**	*n* = 1577 165 (10.5)	*n* = 1425 126 (8.8)	HR 1.18 (0.93 to 1.51)****	15 065 more per million (from 5 927 fewer to 42 039 more)	Low	Critical
Cardiovascular mortality												
1 cluster RCT[20]*												
2001–2011†	Randomized trial§	No serious risk of bias¶	No serious inconsistency**	No serious indirectness††	No serious imprecision‡‡	None§§	n = 482 (3%)¶¶	n = 124 (3%)***	HR 1.02 (0.75 to 1.38)	590 more per million (from 7408 fewer to 11153 more)	High	Critical

Note: CI = confidence interval, GRADE = Grading of Recommendations Assessment, Development and Evaluation, HR = hazard ratio, RCT = randomized controlled trial.
*Our systematic review of benefits associated with screening for type 2 diabetes in adults of any age identified 1 cluster RCT and 1 cohort study, which looked at the effect of screening for type 2 diabetes and related cardiovascular risk factors on overall mortality; the RCT also looked at the effect on cardiovascular mortality. Evidence from modelling studies is available in Appendices 4 and 5.
†Follow-up was from November 2001 to November 2011 (median 9.6 years, interquartile range [IQR] 8.9–9.9 years; 184 057 person-years).
‡First cohort: follow-up was from 1991 to 1999 (median 10 years; 47 854 person-years of risk). Second cohort: follow-up was from 2000 to 2008 (median 8.1 years; 23 144 person-years of risk).
§Population-based cluster RCT. Study reported data from 32 general practices in eastern England randomized to 1 of 3 groups (screening plus intensive treatment for diagnosed diabetes [*n* = 14]; screening plus routine care for diabetes patients [*n* = 13]; no-screen control [*n* = 5]). Study population included 20 184 individuals 40–69 years of age (median 59 years IQR 53–65 years) at high risk of prevalent undiagnosed diabetes on the basis of previously validated risk score (minimum score of 0.17 – reflects top 25% of risk distribution in participating practices).
¶Cochrane Risk of Bias Tool was used to examine this study. The appraisal process was completed by 2 independent reviewers who agreed there was uncertainty regarding allocation concealment and that it was not possible to blind patients and their physicians to their screening status; however, this potential performance bias was unlikely to affect the outcome of interest (mortality). All other domains of bias covered in the Cochrane tool were determined to have a low risk of bias. On the basis of the overall assessment, the evidence was not downgraded for any serious concerns regarding study limitations.
**Single study.
††Study sample characteristics, risk-assessment variables and screening test were similar to the Canadian population and screening context of interest for this review.
‡‡Large sample and large event rate with narrow confidence interval around estimate of effect.
§§Single study; literature search indicated no other RCTs have been conducted or published for this particular comparison and outcome.
¶¶Unadjusted prevalence of diabetes in screening practices was 3.0% (standard deviation [SD] 1.0%). Characteristics of eligible participants in screening practices at baseline: mean age 58.2 (SD 7.7) years; 63.9% men (*n* = 10 260); mean body mass index (BMI) 30.5 (SD 4.6), median diabetes risk score 0.35 (IQR 0.24–0.52); 45.9% prescribed antihypertensive medication (*n* = 7372); 5.4% prescribed steroids (*n* = 866).
***Unadjusted prevalence of diabetes in control practices was 3.3% (SD 0.8%). Characteristics of eligible participants in control practices at baseline: mean age 57.9 (SD 7.8) years; 63.9% men (*n* = 2641); mean BMI 30.6 (SD 4.6), median diabetes risk score 0.34 (IQR 0.24–0.51); 44.8% prescribed antihypertensive medication (*n* = 1853); 3.7% prescribed steroids (*n* = 154).
†††The authors reported potential selection bias: "Despite random selection of participants into invitation groups, participants who were offered screening were older at baseline, lived in more deprived areas and included a smaller proportion of men." However, we did not downgrade this criterion, because in the analysis, the authors adjusted for age, sex and deprivation.
‡‡‡52 (45%) of the deaths were recorded as cancer-related, 41 (35%) were due to cardiovascular causes, and 23 (20%) were coded as "other."
§§§107 (47%) of the deaths were cancer related, 74 (32%) were due to cardiovascular causes, and 48 (21%) were coded as "other."
¶¶¶*p* = 0.05; adjusted for age, sex and deprivation. For 22 (6%) of those who died (1991–1999), diabetes was included as the underlying cause on the death certificate.
****$p = 0.05$; adjusted for age, sex and deprivation. For 22 (8%) of those who died (2000–2008), diabetes was included as the underlying cause on the death certificate.

were extended using a new effectiveness model that was performed at our request. The new analyses simulated the screening of individuals beginning at age 30, 45 and 60 years of age, at intervals of 1, 3 and 5 years. It also simulated the screening of people with hypertension, considered at higher risk of diabetes. The results of the new model suggest that clinically relevant benefits can be expected when screening individuals at higher risk of diabetes (Appendix 5).

Individuals at higher risk of diabetes generally have other risk factors for cardiovascular disease, such as obesity, inactivity, hypertension and dyslipidemia, all of which are potentially amenable to intervention. Using a validated risk calculator to guide the use of screening with blood tests offers an opportunity to identify and address these other risk factors as well as dysglycemia. In addition, there is evidence that the harms of screening for diabetes are small. In our judgment, these considerations warrant a weak recommendation for screening for type 2 diabetes in adults who are at high risk of diabetes.

No RCTs address the optimal frequency for blood test screening. Evidence from the modelling studies suggests that the health benefits associated with a screening interval of 5 years are similar to those with an interval of 3 years. Screening more frequently than every 3–5 years does not appear to increase benefits further in the general population, yet it leads to substantially increased costs and greater inconvenience to patients.

Data from these modelling studies also suggest that screening adults at high risk (e.g., those who are obese or hypertensive) every 3–5 years leads to reduced rates of myocardial infarction, microvascular complications and death, and preserves nearly all of the benefits of annual screening, but with reduced adverse effects, inconvenience and cost (Appendix 3).

Adults in this category who place a low value on the potential benefits of screening and who are more concerned with the undesirable consequences of unnecessary diagnostic testing and potential overdiagnosis are likely to decline screening.

Adults at very high risk

For adults at very high risk of diabetes (determined with the use of a validated risk calculator), we recommend routine screening annually with A1C. (Weak recommendation, low-quality evidence.)

Data from 2 modelling studies[16,17] (Appendix 4) suggest that there is value to screening patients at very high risk annually to decrease microvascular complications. The potential benefit of screening is magnified and the potential harm of false-positive results reduced among people at highest risk when screening is performed annually. Whether more frequent screening is economically attractive among people at very high risk is uncertain (Appendix 3).

Adults in this category who place a low value on the potential benefits of screening and who are more concerned with the undesirable consequences of unnecessary diagnostic testing and potential overdiagnosis are likely to decline screening.

Selection of risk calculator

Type 2 diabetes is caused by a combination of genetic, behavioural and environmental factors.[24–27] Because the causes cannot be explained by any single risk factor and the level of risk increases with the number of risk factors, there are a variety of approaches to estimating an individual's risk of diabetes.

A recent systematic review, rated as being of high methodologic quality, evaluated 94 risk prediction models and scores developed for estimating the risk of type 2 diabetes on the basis of multiple characteristics.[28] It identified 7 as being the most promising for adaptation and use in routine clinical practice: the Atherosclerosis Risk in Communities (ARIC) risk calculator, the Australian Diabetes Risk Assessment Tool (AusDrisk), the Cambridge Risk Score, FINDRISC, the Framingham Offspring Study risk score, the San Antonio Heart Study risk score and the QDScore. Preliminary results of a study that used FINDRISC to identify high-risk people showed a reduction in the incidence of type 2 diabetes after 12 months when combining the application of the risk calculator with an educational intervention.[29] Also, FINDRISC was found to have been validated in the most countries and studied in relation to patient-important outcomes.

More recently, a cross-sectional screening study[30] evaluated the accuracy and discrimination of the Canadian Diabetes Risk Assessment Questionnaire (CANRISK[31,32]) for detecting diabetes. CANRISK was not included in the systematic review; however, it was based on FINDRISC, and the authors state the tool may be suitable for assessing diabetes risk in Canada's multi-ethnic population.[33] Thus, we compared FINDRISC and CANRISK in terms of their accuracy and implications for patient-important outcomes (Appendix 6). For FINDRISC, there was evidence of internal and external validation,[22,34] prospective research, test accuracy similar to that of CANRISK and evidence of improved patient-important outcomes in randomized clinical trials.[29,35] Although CANRISK includes more items than FINDRISC, it has

been validated only in a cross-sectional convenience sample of patients[30,33] and has not yet been studied in clinical practice. Based on these factors, we selected FINDRISC as the preferred validated risk calculator and CANRISK as an acceptable alternative.

Selection of blood test for screening

Evidence from a high-quality systematic review[36] suggests that A1C and glucose measurement perform similarly in predicting type 2 diabetes and related microvascular complications such as retinopathy. We placed more value on the convenience for patients and the use of A1C in addressing variability in glucose levels, and less value on the small risk of interference of severe illness and hemoglobinopathies with A1C measurement in some assays (Appendix 7). An A1C value of 6.5% or greater is recommended as the threshold for diagnosing diabetes. There is insufficient evidence to make a recommendation about management of levels below 6.5.%.

Considerations for implementation

Calculating risk in practice

For the purposes of applying this guideline in practice, either FINDRISC or CANRISK may be used to assess the risk of type 2 diabetes in asymptomatic adults. There is no evidence to guide the optimal frequency of risk calculation. However, on the basis of the evidence for diabetes screening intervals, we suggest risk calculation at least every 3–5 years.

No evidence was found to suggest that recommendations on screening Aboriginal people, people in rural or remote areas, women and elderly people should differ from those for asymptomatic adults in the general population. However, practitioners should be aware that certain ethnic groups (Aboriginal, South Asian, Hispanic and black people) are at increased risk of diabetes and may be at increased risk of poor health outcomes related to diabetes.

Screening test in practice

Depending on the clinical context and patient preferences, clinicians may choose A1C, fasting glucose measurement or the oral glucose tolerance test for screening, recognizing that each test may detect a slightly different population of patients with diabetes.[37] An abnormal A1C or fasting glucose level may warrant repeat testing to confirm diagnosis of diabetes. Approximate costs are $6–$8 for A1C,[38] $6–$10 for a fasting blood glucose test[39] and $30 for an oral glucose tolerance test.[40]

Patient preference

Patients place a high value on clear communication about how screening is done, as well as the potential benefits, harms and consequences of screening, including the possibility of diabetes being diagnosed.[41–43] Regardless of the messaging style, patients accepted an invitation to screen if it was important to them. This suggests that patients who accept screening programs want physicians to identify diabetes and its risk factors (if present); to provide clear information about managing risk factors (if screening is negative); and to advise on how to prevent complications of diabetes (if screening is positive).[44–46] Risk calculators may provide an avenue to inform patients about risk factors and the importance of early lifestyle interventions for those at high and very high risk of diabetes.

Patients with prediabetes

Although the focus of this guideline is on the detection of diabetes to improve patient-important outcomes rather than on prediabetes, documented prediabetes (impaired fasting glucose or impaired glucose tolerance) is important for risk calculation. A diagnosis of prediabetes puts a patient in the category of very high risk of diabetes.

Role of other health professionals

The task force's work is aimed at family physicians. However, diabetes is one area in which other health professionals, such as registered nurses, pharmacists and dietitians, play an important role. The initial stage of screening — risk calculation using FINDRISC or CANRISK — does not result in a diagnosis of diabetes; rather, it identifies people at elevated risk in whom more intensive testing is appropriate. Risk calculation may be performed by other health professionals, in a range of settings. A summary of the guidelines has been prepared for use by family physicians and other health professionals (Appendix 8).

Management of other cardiovascular risk factors

Any benefits of screening for type 2 diabetes likely accrue through management of other cardiovascular risk factors as well as dysglycemia. Therefore, consideration should also be given to assessing and managing other cardiovascular risk factors such as obesity, physical inactivity, tobacco use, hypertension and dyslipidemia in individuals with diabetes detected through screening.

Potential harms of screening

Screening may lead to overdiagnosis, inappropriate investigation and treatment, avoidable adverse effects, and unnecessary psychosocial and eco-

nomic costs. However, no studies were found that specifically examined these issues in diabetes. Physical harm associated with diabetes screening may be considered negligible, but psychological and social harm could be more substantial.[47] Despite the absence of evidence, clinicians should remain aware of the potential harm resulting from a positive diagnosis of type 2 diabetes.

Suggested performance measures

We developed a set of performance measures to accompany the diabetes screening guideline for consideration by policy-makers and clinicians:

- The proportion of adults who are assessed for risk of diabetes using a risk calculator
- The proportion of adults who are screened for diabetes
- The proportion of adults who undergo blood test screening within the recommended interval (every 3–5 years for those at high risk; every year for those at very high risk).

Other guidelines

Differences between the current and previous task force recommendations can be attributed to new evidence and new methodology. The previous guidelines recommended screening using fasting glucose measurement among patients with hypertension or hyperlipidemia. The current

Table 3: Summary of available recommendations on screening for type 2 diabetes in adults

Organization	Risk assessment	Recommendation	Screening tests
Canadian Task Force on Preventive Health Care (current)	Use of FINDRISC or validated risk calculator (e.g., CANRISK) to calculate risk of diabetes at least every 3–5 years	• Recommend not routinely screening adults at low to moderate risk • Recommend routinely screening adults at high risk every 3–5 years • Recommend routine screening annually for adults at very high risk	A1C ≥ 6.5%
Canadian Task Force on Preventive Health Care (2005)[48]	No recommendation	• Evidence insufficient to recommend for or against routine screening of asymptomatic adults • Recommend screening adults with hypertension and hyperlipidemia	Fasting plasma glucose
Canadian Diabetes Association[4]	Annual assessment on the basis of demographic and clinical history	• Recommend routine screening every 3 years for adults starting at age 40 years • Recommend earlier screening or more frequent screening, or both, among people with additional risk factors for diabetes	• Fasting plasma glucose ≥ 7.0 mmol/L • Casual plasma glucose ≥ 11.1 mmol/L + symptoms of diabetes • 2-h plasma glucose in 75-g OGTT ≥ 11.1 mmol/L • A1C ≥ 6.5%
American Diabetes Association[49]	Measurement of BMI and ≥ 1 additional risk factor for diabetes	• Recommend routine screening every 3 years for adults starting at age 45 years • Recommend routine screening every 3 years for adults who are overweight or obese and have 1 or more additional risk factor for diabetes	• A1C ≥ 6.5% • Fasting plasma glucose ≥ 7.0 mmol/L • 2-h plasma glucose in 75-g OGTT ≥ 11.1 mmol/L
US Preventive Services Task Force[50]	Blood pressure measurement	• Evidence insufficient to recommend screening for asymptomatic adults with blood pressure of 135/80 mm Hg or lower • Recommend screening every 3 years for asymptomatic adults with sustained blood pressure (either treated or untreated) greater than 135/80 mm Hg	(Same as for American Diabetes Association)
UK National Institute for Health and Clinical Excellence[51]	Use of validated risk assessment tool or self-assessment questionnaire, or both; risk reassessed at least every 5 years if at low risk, at least every 3 years if at moderate risk, and at least every year if at high risk	• For adults at moderate to high risk or with possible diabetes, recommend blood test to confirm level of risk; choose either fasting plasma glucose or A1C	• Fasting plasma glucose ≥ 7.0 mmol/L • A1C ≥ 6.5%

Note: A1C = hemoglobin A_{1c}, BMI = body mass index, CANRISK = Canadian Diabetes Risk Assessment Questionnaire, FINDRISC = Finnish Diabetes Risk Score, OGTT = oral glucose tolerance test.

guidelines recommend starting with risk calculation to identify people at high or very high risk and screening with A1C.

The current recommendations are based on new evidence that supports the use of risk calculators and A1C; new evidence on the lack of benefit associated with screening in people at low or moderate risk; lack of evidence showing that screening reduces mortality in the general population; and new evidence suggesting that screening and treatment are likely to be most beneficial for people at high or very high risk of diabetes. The current recommendations also conclude that (except for people at very high risk) screening more frequently than every 3 years does not lead to further improvements in outcomes. Table 3 provides a comparison between the current and previous task force guidelines,[48] as well as recommendations from other groups.[4,49–51]

Gaps in knowledge

Only a single RCT evaluated the mortality benefit of screening asymptomatic adults at low to moderate risk of diabetes. No trials evaluated the effect on the incidence of microvascular and macrovascular complications in any population. No data from controlled studies were identified for people at high risk or very high risk of diabetes. Limited data on the potential harms of screening were identified, but no studies were found that specifically examined the effects of overdiagnosis, inappropriate investigation and treatment, avoidable adverse effects, and unnecessary psychosocial and economic costs in diabetes. Observational studies or clinical trials are needed to refine the optimal frequency and initial age for screening, the optimal laboratory test for screening in relation to patient outcomes, and the clinically relevant benefits and harms of treating prediabetes. Researchers conducting these studies should carefully evaluate whether their conclusions are likely to be influenced by the underlying risk of diabetes or preferences of the population studied.

Conclusion

A validated risk calculator should be used to assess the risk of diabetes and guide the use of screening. Our recommendations highlight the lack of evidence to support routine screening with a blood test for type 2 diabetes in adults at low to moderate risk of diabetes. Although annual screening with a blood test appears to be beneficial in adults at very high risk of diabetes, there is limited potential value for screening adults at high risk of diabetes with a blood test more often than every 3–5 years.

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