

Achievement of treatment targets among patients with type 2 diabetes in 2015 and 2020 in Canadian primary care

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Abstract

Background: An update on the degree to which patients with type 2 diabetes in Canada achieve treatment targets is needed to document progress and identify subgroups that need attention. We sought to estimate the frequency with which patients managed in primary care met treatment targets (i.e., HbA_{1c} ≤ 7.0%, blood pressure < 130/80 mmHg and low-density lipoprotein cholesterol [LDL-C] < 2.00 mmol/L), guideline-based use of statins and of angiotensin-converting-enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs), and the effects of patient age and sex.

Methods: We conducted a cross-sectional study of 32503 and 44930 adults with diabetes in Canada on June 30, 2015, and 2020, respectively, using electronic

medical record data from primary care practices across 5 provinces. We grouped achievement of diabetes targets by age and sex, and compared between groups using logistic regression with adjustment for cardiovascular comorbidities.

Results: In 2020, target HbA_{1c} levels were achieved for 63.8% of women and 58.9% of men. Blood pressure and LDL-C targets were achieved for 45.6% and 45.8% of women, and for 43.1% and 59.4% of men, respectively. All 3 treatment targets were achieved for 13.3% of women and 16.5% of men. Overall, 45.3% and 54.0% of women and men, respectively, used statins; 46.5% of women used ACE inhibitors or ARBs, compared with 51.9% of men. With the exception of blood

pressure and HbA_{1c} levels among women, target achievement was lower among younger patients. Achievement of the LDL-C target, statin use and ACE inhibitor or ARB use were lower among women at any age. From 2015 to 2020, target achievement increased for HbA_{1c}, remained consistent for LDL-C and declined for blood pressure; use of statins and of ACE inhibitors or ARBs also declined.

Interpretation: Target achievement for blood pressure and use of statins and of ACE inhibitors and ARBs declined between 2015 and 2020, and was suboptimal in all patient groups. Widespread quality improvement is needed to increase evidence-based therapy for people with diabetes.

Treatment targets for glycated hemoglobin (HbA_{1c}), blood pressure and low-density lipoprotein cholesterol (LDL-C), and prescription of statins and of angiotensin-converting-enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) for patients with diabetes mellitus are recommended to reduce the risks of cardiovascular and microvascular complications.¹⁻⁵ The achievement of targets in Canada in more than 1 province was last evaluated in 2013. At the time, HbA_{1c}, LDL-C and blood pressure targets were met for 50%, 57% and 36% of adults, respectively, with only 13% of adults meeting all 3 targets.^{6,7}

Women with diabetes have a disproportionately high relative increase in cardiovascular risk,⁸⁻¹² which may be partially

explained by lower use of medications that reduce the risk of cardiovascular disease.¹³⁻¹⁶ Few studies have tracked sex- and age-related differences in the achievement of diabetes targets. Updated information about sex- and age-related trends in target achievement in Canada will inform efforts to reduce cardiovascular risk among all eligible patients with diabetes. We aimed to describe the prevalence of diabetes measurements, and the frequency of target achievement and use of statins and ACE inhibitors or ARBs among adults with type 2 diabetes seen in primary care across 5 Canadian provinces in 2015 and 2020, and to evaluate the effect of age and sex on target achievement, adjusting for cardiovascular comorbidities.

Methods

Study design and data source

We conducted a cross-sectional study of people with type 2 diabetes in Canada in 2015 and 2020 using the National Diabetes Repository (NDR), which contains electronic medical record (EMR) data on individuals with diabetes from participating networks of the Canadian Primary Care Sentinel Surveillance Network (CPCSSN).¹⁷ The CPCSSN, the largest and only pan-Canadian EMR database, comprises provincial networks of full-service primary care clinics in academic (19%) and nonacademic (81%) settings.¹⁸ All individuals with diabetes were identified for NDR using a validated case definition (2 billings or 1 entry of health conditions with *International Classification of Diseases, Ninth Revision* [ICD-9] code 250; sensitivity 95.6%, specificity 97.1%).¹⁹ In the NDR, similar proportions of people live in rural regions as respondents to the 2011 Canadian Census, and medication prescribing patterns are similar to those estimated using large national surveys.²⁰ In addition to having physical measurements and laboratory values, the availability of prescriptions for adults younger than 65 years represents a distinct advantage over claims-based provincial data sets.

We chose 2015 and 2020 as the study years because they provide recent data after a similar Canadian study from 2013.⁶ We included all individuals in the NDR alive on June 30 of each study

year. We excluded those younger than 18 years and those 80 years or older, given the increased risks of overtreatment among older adults. We excluded people with codes specifically indicating type 1 diabetes (ICD-9 250.x1 or 250.1), and those with extreme outlier values for blood pressure, which likely represent data errors (Appendix 1, Supplemental Methods, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.220673/tab-related-content). We excluded those with no HbA_{1c}, serum creatinine (required to assess indications for statins and for ACE inhibitors or ARBs), LDL-C or blood pressure measurements within 2 years from the final data set.

Prevalence of diabetes measurements

We defined appropriate clinical measurement of diabetes as having each of HbA_{1c}, blood pressure, LDL-C and serum creatinine documented at least once within the previous 2 years. We compared patients missing 1 or more measurements with patients we included in the analysis of diabetes targets.

Diabetes targets

We used the thresholds published in the 2018 Diabetes Canada Clinical Practice Guidelines to assess HbA_{1c} (target $\leq 7.0\%$), blood pressure (target $\leq 130/80$ mm Hg) and LDL-C (target ≤ 2.0 mmol/L) (Table 1).^{1,3,5} Treatment parameters for use of statins and of ACE inhibitors or ARBs applied only to adults with specific guideline-based indications (Table 1).³

Table 1: Diabetes targets and their definitions

Target	Numerator	Denominator
HbA _{1c}	Adults with HbA _{1c} $\leq 7.0\%$	All included adults
Blood pressure	Adults with office systolic blood pressure ≤ 130 mm Hg and office diastolic blood pressure ≤ 80 mm Hg	All included adults
LDL-C	Adults with LDLc ≤ 2.0 mmol/L	All included adults
HbA _{1c} , blood pressure and LDL-C	Adults meeting criteria for targets 1, 2 and 3	All included adults
Statin use	Adults with a statin prescribed in the previous year	Included adults meeting any of the following criteria: <ul style="list-style-type: none"> • age ≥ 40 yr • previously diagnosed CAD, stroke or PAD • LDL-C ≥ 5.00 mmol/L • previous diagnosis of diabetic ophthalmopathy, neuropathy or CKD (eGFR ≤ 90 mL/min/1.73 m² or UACR ≥ 3 mg/mmol)
ACE inhibitor or ARB use	Adults with an ACE inhibitor or ARB prescribed in the previous year	Included adults meeting the following criteria: <ul style="list-style-type: none"> • CKD (eGFR ≤ 90 mL/min/1.73 m² or UACR ≥ 3 mg/mmol), hypertension, CAD, stroke or PAD • or adults age ≥ 55 yr and an additional cardiovascular risk factor:² <ul style="list-style-type: none"> • Documented current smoker • Systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 95 mm Hg or current antihypertensive use • BMI ≥ 30 • LDL-C > 3.4 mmol/L, HDL-C < 1.0 mmol/L (men) or < 1.3 mmol/L (women), or triglycerides > 2.3 mmol/L

Note: ACE = angiotensin-converting enzyme, ARB = angiotensin receptor blocker, BMI = body mass index, CAD = coronary artery disease, CKD = chronic kidney disease, eGFR = estimated glomerular filtration rate, HbA_{1c} = glycated hemoglobin, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, PAD = peripheral artery disease, UACR = urine albumin-to-creatinine ratio.

Measurements

We determined demographics, comorbidities, laboratory values and physical parameters from the most recent data at any time before June 30, 2015, or June 30, 2020. We used EMR-validated case definitions for hypertension and heart failure.^{19,21} We adapted administrative database-derived definitions for the other conditions.^{22,23} In a validation exercise, we found that the definition for coronary artery disease compared well to an EMR-validated definition available at a participating CPCSSN network.^{24,25} We defined current use of medications as having a prescription recorded any time in the previous year.^{20,26} Further details and explanation are provided in Appendix 1.

Statistical analysis

We estimated crude percentages of target achievement separately for men and women, across different age ranges. We compared achievement of targets in each sex and age group between 2020 and 2015 using a simple Z-test. We fitted logistic regression models to the data, with terms for time period (2020 v. 2015), and age categories crossed with sex, as well as coronary artery disease, stroke, heart failure, documented hypoglycemia, stage of chronic kidney disease and diabetes duration, which we chose a priori as important cardiovascular risk factors. We added interaction terms (sex × age group, time period × sex and time period × age group) to the models 1 at a time. We included statistically significant and clinically important interaction terms in the final model (see Appendix 1 for model specification). We fitted models using generalized estimating equations with robust sandwich estimators to account for the overlap of patients between 2015 and 2020. We performed the analysis with Stata 16.

Ethics approval

The study was approved by the research ethics board at the University of Alberta (Pro00111228).

Results

The NDR contained 93 784 individuals in 2020 and 65 943 in 2015. Of these, 44 930 (47.9%) and 32 503 (49.3%) adults were included in the 2020 and 2015 cohorts, respectively, including 17 395 patients who were in both cohorts (Figure 1 for 2020 cohort; Appendix 1, Figure S1 for 2015 cohort). Among patients included in the analysis, most were from Ontario (61.6%), Alberta (21.6%) and Manitoba (14.4%). Data for 2020 were collected from 211 practice sites. The average age of patients in 2020 was 62 years, and 47.6% were women (Table 2; Appendix 1, Table S3 for the 2015 sample). Compared with those aged 65–79 years, younger patients were more likely to be smokers and less likely to have comorbidities. Men had coronary artery disease more frequently than women and were more likely to be taking sodium-glucose cotransporter-2 inhibitors. Women younger than 40 years and those aged 40–65 years took glucagon-like peptide-1 receptor agonists more frequently than their male counterparts, though use of these agents was infrequent overall.

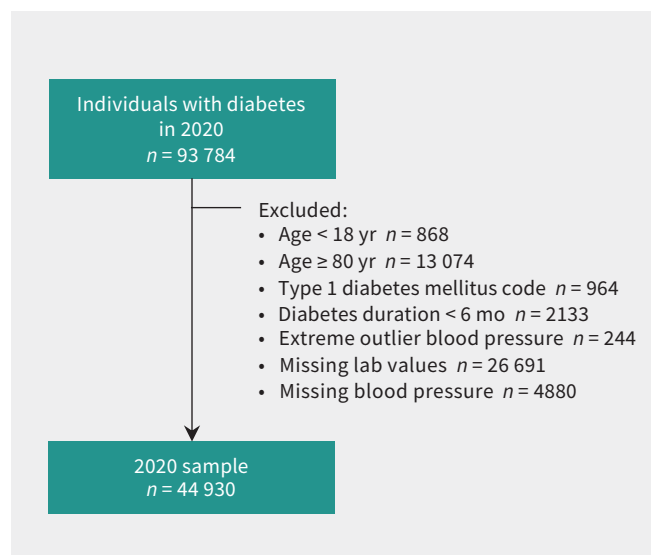


Figure 1: Study flowchart of individuals with diabetes in 2020. See Appendix 1, Figure S1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.220673/tab-related-content for the 2015 study flowchart.

The absence of 1 or more diabetes measurements in the preceding 2 years was the most common reason for exclusion. The prevalence of all diabetes measures, after accounting for all other exclusion criteria, was 61.8% (32 503 of 52 520 individuals included before assessment for missing parameters) in 2015, and 58.7% (44 930 of 76 501) in 2020. The probability of having complete diabetes measurements within 2 years ranged from 25% (women aged < 40 yr) to 65% (men aged 65–79 yr) in 2020 (Appendix 1, Table S1). Among patients younger than 65 years, fewer women had measurements within 2 years than men. Adults with missing measurements were younger (though they had only a slightly shorter duration of diabetes), were less likely to be on any class of diabetes medication and had fewer physician visits (Appendix 1, Table S2 compares those excluded for 1 or more missing measurements to those with complete measurements).

Target achievement

Across all age- and sex-based groups, HbA_{1c} target achievement in 2020 ranged from 51.5%–66.4% (Table 3 and Figure 2). Target achievement for blood pressure in 2020 ranged from 40.1% to 49.2%; LDL-C target achievement ranged from 26.8% to 68.8%. Achievement of all 3 targets ranged from 7.8% to 20.6%. Achievement of HbA_{1c}, LDL-C and all 3 of HbA_{1c}, LDL-C and blood pressure targets was higher among older adults, though the blood pressure target was achieved in a lower proportion of this subgroup than among younger adults (Table 3). Achieving the LDL-C target and being on a statin or ACE inhibitor or ARB was more likely among men, and women in the younger age groups appeared to have higher proportions of blood pressure and HbA_{1c} target achievement than men and older women. Overall, HbA_{1c} control improved from 2015 to 2020, though blood pressure control, ACE inhibitor or ARB use, and statin use declined, particularly among women.

Adjusted odds ratios (ORs), using older men (aged 65–79 yr) as the reference group, showed that HbA_{1c} target achievement was

Table 2: Patient characteristics of 2020 sample

Characteristic	No. (%) of patients* n = 44 930	No. (%) of men*			No. (%) of women*		
		< 40 yr n = 734	40–64 yr n = 11 174	65–79 yr n = 11 614	< 40 yr n = 1069	40–64 yr n = 10 387	65–79 yr n = 9952
Province							
Alberta	9723 (21.6)	129 (17.6)	2548 (22.8)	2604 (22.4)	241 (22.5)	2251 (21.7)	1950 (19.6)
Manitoba	6482 (14.4)	152 (20.7)	1763 (15.8)	1666 (14.3)	201 (18.8)	1462 (14.1)	1238 (12.4)
Ontario	27 687 (62)	440 (59.9)	6618 (59.2)	7065 (60.8)	603 (56.4)	6422 (61.8)	6539 (65.7)
Quebec	816 (1.8)	8 (1.1)	191 (1.7)	232 (2.0)	21 (2.0)	190 (1.8)	174 (1.7)
Newfoundland and Labrador	222 (0.5)	5 (0.7)	54 (0.5)	47 (0.4)	3 (0.3)	62 (0.6)	51 (0.5)
Age, yr, mean ± SD	62.3 ± 11.2	33.6 ± 5.1	55.8 ± 6.3	71.4 ± 4.1	32.9 ± 5.3	55.3 ± 6.5	71.5 ± 4.2
Diabetes duration, yr, mean ± SD	6.5 ± 5.3	4.6 ± 3.6	5.9 ± 4.6	7.1 ± 6.4	4.5 ± 3.2	6.0 ± 4.3	7.2 ± 5.5
Current smoker	1807 (20.1)	28 (20.7)	568 (25.9)	374 (15.9)	52 (24.0)	500 (23.9)	285 (14.1)
BMI, mean ± SD	32.3 ± 7.1	33.8 ± 8.5	32.4 ± 6.7	30.8 ± 5.7	35.6 ± 8.9	33.7 ± 7.8	31.8 ± 7.2
Comorbidities							
CAD	5613 (12.5)	6 (0.8)	1300 (11.6)	2683 (23.1)	7 (0.7)	496 (4.8)	1121 (11.3)
CHF	2223 (4.9)	2 (0.3)	392 (3.5)	884 (7.6)	11 (1.0)	273 (2.6)	661 (6.6)
Stroke	1565 (3.5)	2 (0.3)	278 (2.5)	570 (4.9)	18 (1.7)	286 (2.8)	411 (4.1)
PAD	161 (0.4)	0 (0.0)	32 (0.3)	78 (0.7)	1 (0.1)	18 (0.2)	32 (0.3)
Complications							
Neuropathy	1395 (3.1)	6 (0.8)	316 (2.8)	339 (2.9)	22 (2.1)	383 (3.7)	329 (3.3)
Retinopathy	1139 (2.5)	12 (1.6)	167 (1.5)	384 (3.3)	10 (0.9)	180 (1.7)	386 (3.9)
Hypoglycemia	233 (0.5)	0 (0.0)	66 (0.6)	63 (0.5)	2 (0.2)	67 (0.6)	35 (0.4)
eGFR, mean ± SD	83.2 ± 39.1	113.0 ± 48.7	90.3 ± 35.8	74.8 ± 43.6	108.3 ± 29.6	90.3 ± 33.8	72.6 ± 36.5
Proteinuria							
None (UACR < 3 mg/mmol)	19 449 (68.3)	313 (71.8)	5008 (69.4)	4972 (62.4)	372 (69.9)	4475 (74.3)	4309 (68.5)
Moderate (UACR 3–30 mg/mmol)	7226 (25.4)	103 (23.6)	1759 (24.4)	2333 (29.3)	132 (24.8)	1255 (20.8)	1644 (26.1)
Severe (UACR 31–220 mg/mmol)	1497 (5.3)	15 (3.4)	379 (5.3)	562 (7.1)	22 (4.1)	250 (4.2)	269 (4.3)
Nephrotic (UACR > 220 mg/mmol)	284 (1.0)	5 (1.1)	72 (1.0)	95 (1.2)	6 (1.1)	41 (0.7)	65 (1.0)
Medications							
Antihyperglycemic agent							
None	19 547 (43.5)	338 (46.0)	4492 (40.2)	4846 (41.7)	604 (56.5)	4717 (45.4)	4550 (45.7)
Oral only	20 523 (45.6)	292 (39.8)	5457 (48.8)	5447 (46.9)	346 (32.4)	4634 (44.6)	4347 (43.7)
Any insulin	4860 (10.8)	104 (14.2)	1225 (11.0)	1321 (11.4)	119 (11.1)	1036 (10.0)	1055 (10.6)
GLP-1RA	2396 (5.3)	25 (3.4)	634 (5.7)	492 (4.2)	65 (6.1)	773 (7.4)	407 (4.1)
SGLT2 inhibitor	6757 (15.0)	79 (10.8)	2087 (18.7)	1912 (16.5)	86 (8.0)	1482 (14.3)	1111 (11.2)
Metformin	20 073 (44.7)	278 (37.9)	5475 (49.0)	5459 (47.0)	338 (31.6)	4350 (41.9)	4173 (41.9)
Sulfonylurea	5566 (12.4)	61 (8.3)	1443 (12.9)	1711 (14.7)	59 (5.5)	1098 (10.6)	1194 (12.0)
AGI	34 (0.1)	0 (0.0)	11 (0.1)	6 (0.1)	0 (0.0)	5 (0.0)	12 (0.1)
Thiazolidinedione	62 (0.1)	0 (0.0)	19 (0.2)	18 (0.2)	1 (0.1)	12 (0.1)	12 (0.1)
DPP4i	8016 (17.8)	73 (9.9)	2091 (18.7)	2342 (20.2)	76 (7.1)	1636 (15.8)	1798 (18.1)
Meglitinide	256 (0.6)	1 (0.1)	60 (0.5)	92 (0.8)	0 (0.0)	38 (0.4)	65 (0.7)
Insulin							
Basal only	2699 (6.0)	39 (5.3)	721 (6.5)	772 (6.6)	49 (4.6)	573 (5.5)	545 (5.5)
Prandial (any)	2161 (4.8)	65 (8.9)	504 (4.5)	549 (4.7)	70 (6.5)	463 (4.5)	510 (5.1)
Diabetes clinical parameters, mean ± SD							
HbA _{1c} , %	7.1 ± 1.4	7.4 ± 1.9	7.2 ± 1.5	7.0 ± 1.2	6.9 ± 1.8	7.1 ± 1.5	6.9 ± 1.2
LDL-C, mmol/L	2.1 ± 1.0	2.5 ± 0.9	2.1 ± 0.9	1.8 ± 0.8	2.6 ± 0.9	2.4 ± 1.0	2.1 ± 0.9
Systolic blood pressure, mm Hg	130.6 ± 15.7	127.4 ± 13.6	130.5 ± 15.2	131.7 ± 15.9	123.6 ± 14.4	128.8 ± 15.3	132.4 ± 16.1
Diastolic blood pressure, mm Hg	77.0 ± 9.6	81.2 ± 9.2	80.0 ± 9.1	74.8 ± 9.4	79.7 ± 9.6	78.3 ± 9.3	74.0 ± 9.4

Note: AGI = α -glucosidase inhibitor, BMI = body mass index, CAD = coronary artery disease, CHF = congestive heart failure, DPP4i = dipeptidyl peptidase-4 inhibitor, eGFR = estimated glomerular filtration rate, GLP-1RA = glucagon-like peptide-1 agonist, HbA_{1c} = glycated hemoglobin, LDL-C = low-density lipoprotein cholesterol, PAD = peripheral arterial disease, SD = standard deviation, SGLT2 = sodium-glucose cotransporter-2, UACR = urine albumin-to-creatinine ratio.

*Unless indicated otherwise.

better for women (Table 4; see Appendix 1, Table S4 for crude ORs). Men younger than 65 years had lower HbA_{1c} target achievement than older men.

Women younger than 40 years had the highest frequency of blood pressure control, and men aged 40–64 years had the lowest. Achievement of the LDL-C target was highest in the reference group of older men, and lower among younger and middle-aged adults of both sexes, but particularly among women of any age. Use of statins and of ACE inhibitors or ARBs

had similar patterns by age group to those identified for LDL-C target achievement (Table 4).

The relative odds of HbA_{1c} control improved by 21%–27% across age categories ($p < 0.001$) between 2015 and 2020 (Table 4). Blood pressure control was lower in 2020 than in 2015 across all age categories. No clear temporal associations were identified in LDL-C target achievement, nor for triple target achievement. Use of statins and of ACE inhibitors or ARBs declined in all age categories, but particularly among people younger than 40 years.

Table 3: Diabetes target achievement by demographic subgroup in 2015 and 2020

Outcome	Men			Women		
	2015	2020	Difference (95% CI)*	2015	2020	Difference (95% CI)*
HbA_{1c} ≤ 7.0						
All	57.4	58.9	1.5 (0.5 to 2.5)†	61.7	63.8	2.1 (1.1 to 3.1)†
< 40 yr	45.5	51.5	6.0 (0.5 to 11.4)†	57.3	64.7	7.4 (2.7 to 12.1)†
40–64 yr	53.8	56.5	2.7 (1.3 to 4.1)†	57.9	62.0	4.0 (2.6 to 5.5)†
65–79 yr	62.4	61.7	–0.8 (–2.2 to 0.6)	66.4	65.5	–0.8 (–2.3 to 0.6)
Blood pressure ≤ 130/80 mm Hg						
All	47.6	43.1	–4.5 (–5.5 to –3.5)†	50.2	45.6	–4.5 (–5.6 to –3.5)†
< 40 yr	50.4	40.6	–9.8 (–15.2 to –4.3)†	61.4	49.2	–12.1 (–16.8 to –7.4)†
40–64 yr	45.0	40.1	–4.8 (–6.2 to –3.5)†	51.0	45.8	–5.2 (–6.6 to –3.7)†
65–79 yr	50.3	46.0	–4.3 (–5.7 to –2.8)†	48.1	45.0	–3.1 (–4.6 to –1.5)†
LDL-C ≤ 2.00 mmol/L						
All	54.8	59.4	4.6 (3.6 to 5.6)†	43.0	45.8	2.8 (1.7 to 3.8)†
< 40 yr	31.4	33.0	1.5 (–3.6 to 6.7)	27.2	26.8	–0.4 (–4.6 to 3.8)
40–64 yr	48.3	51.4	3.1 (1.7 to 4.5)†	36.9	38.7	1.7 (0.3 to 3.2)†
65–79 yr	63.9	68.8	4.8 (3.5 to 6.2)†	51.5	55.2	3.7 (2.1 to 5.2)†
All 3 clinical targets						
All	15.9	16.5	0.6 (–0.1 to 1.3)	13.0	13.3	0.3 (–0.4 to 1.0)
< 40 yr	6.3	7.8	1.5 (–1.3 to 4.3)	10.3	9.2	–1.2 (–4.0 to 1.7)
40–64 yr	12.4	12.8	0.4 (–0.6 to 1.3)	10.4	10.9	0.6 (–0.3 to 1.5)
65–79 yr	20.5	20.6	0.0 (–1.1 to 1.2)	16.4	16.2	–0.1 (–1.2 to 1.0)
Statin use						
All	53.9	54.0	0.1 (–0.9 to 1.1)	47.4	45.3	–2.2 (–3.2 to –1.1)†
< 40 yr	25.1	18.5	–6.6 (–12.2 to –1.0)†	14.3	8.6	–5.6 (–9.3 to –2.0)†
40–64 yr	51.3	50.1	–1.1 (–2.5 to 0.3)	42.8	39.3	–3.6 (–5.0 to –2.1)†
65–79 yr	58.3	59.1	0.8 (–0.6 to 2.2)	55.2	54.4	–0.8 (–2.3 to 0.7)
ACE inhibitor or ARB use						
All	53.2	51.9	–1.2 (–2.2 to –0.2)†	48.8	46.5	–2.3 (–3.4 to –1.3)†
< 40 yr	32.4	25.6	–6.9 (–12.7 to –1.1)†	20.1	13.8	–6.3 (–10.4 to –2.2)†
40–64 yr	50.7	48.7	–2.0 (–3.4 to –0.5)†	44.5	41.2	–3.4 (–4.9 to –1.9)†
65–79 yr	57.0	56.1	–0.9 (–2.3 to 0.6)	55.6	54.4	–1.3 (–2.8 to 0.3)

Note: ACE = angiotensin-converting enzyme, ARB = angiotensin receptor blocker, CI = confidence interval, HbA_{1c} = glycated hemoglobin, LDL-C = low-density lipoprotein cholesterol. *Difference shown is an absolute difference in proportions, 2020 minus 2015.

†Significant difference ($p < 0.05$); p values obtained from simple Z-tests of the difference.

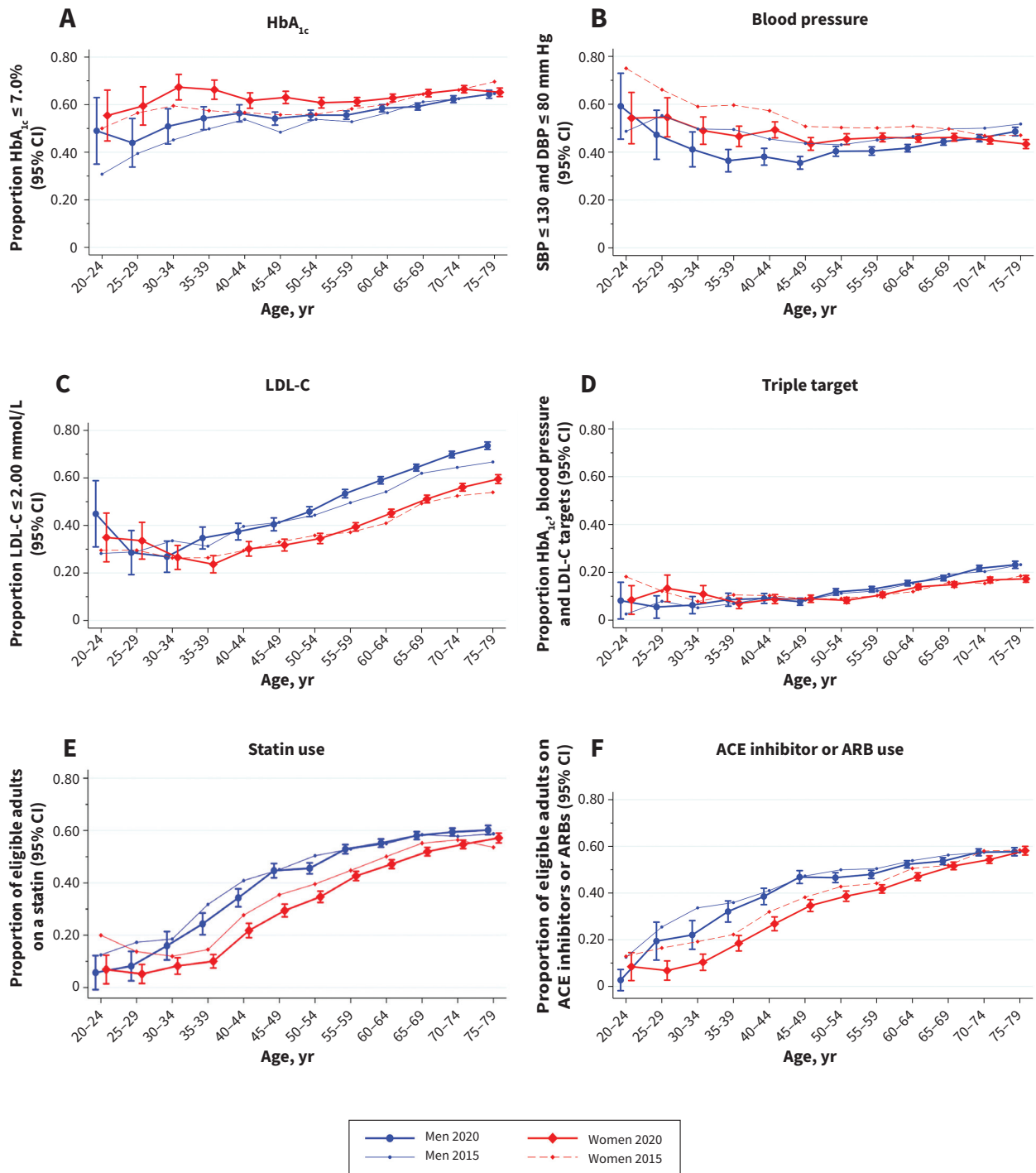


Figure 2: Diabetes target achievement for (A) glycated hemoglobin (HbA_{1c}), (B) systolic (SBP) and diastolic (DBP) blood pressure, (C) low-density lipoprotein cholesterol (LDL-C) and (D) all 3 targets, as well as use of (E) statins and of (F) angiotensin-converting-enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) in men and women of different age groups.

Interpretation

In this multiprovince, primary care-based study of the achievement of diabetes targets, we found that about 40% of adults were missing 1 or more diabetes measurements in the preceding 2 years. A small proportion of these adults may be under specialist diabetes care.²⁷ The

observed differences between people who were excluded from this analysis because targets were not measured, compared with those who had adequate testing, suggest the former are a group of adults who see their family physicians, but perhaps not for diabetes per se. Further study is needed to clarify the best approaches to increase measurement of these important components of clinical care.

Table 4: Adjusted odds ratios of diabetes target achievement*

Outcome	Adjusted OR (95% CI)†		
	Men	Women	Period effect‡
HbA_{1c} ≤ 7.0			
< 40 yr	0.60 (0.52–0.70) ^f	1.03 (0.89–1.18) ^b	1.27 (1.10–1.46)
40–64 yr	0.79 (0.75–0.84) ^e	0.97 (0.91–1.02) ^d	1.24 (1.18–1.30)
65–79 yr	Ref. ^c	1.21 (1.16–1.27) ^a	1.21 (1.15–1.27)
Blood pressure ≤ 130/80 mm Hg			
< 40 yr	1.14 (0.98–1.31) ^b	1.69 (1.47–1.93) ^a	0.64 (0.55–0.73)
40–64 yr	0.85 (0.80–0.89) ^f	1.08 (1.03–1.15) ^c	0.81 (0.78–0.84)
65–79 yr	Ref. ^d	0.97 (0.93–1.01) ^e	0.83 (0.79–0.86)
LDL-C ≤ 2.00 mmol/L			
< 40 yr	0.32 (0.28–0.37) ^e	0.25 (0.22–0.29) ^f	0.92 (0.79–1.07)
40–64 yr	0.57 (0.54–0.60) ^c	0.35 (0.33–0.37) ^d	1.00 (0.96–1.05)
65–79 yr	Ref. ^a	0.59 (0.56–0.62) ^b	0.99 (0.95–1.04)
All 3 clinical targets			
< 40 yr	0.36 (0.28–0.46) ^f	0.51 (0.40–0.64) ^e	1.00 (0.77–1.29)
40–64 yr	0.59 (0.55–0.64) ^c	0.50 (0.46–0.54) ^d	1.06 (0.99–1.12)
65–79 yr	Ref. ^a	0.78 (0.74–0.83) ^b	0.98 (0.93–1.03)
Statin use			
< 40 yr	0.32 (0.26–0.39) ^e	0.14 (0.11–0.17) ^f	0.60 (0.48–0.74)
40–64 yr	0.78 (0.74–0.83) ^c	0.53 (0.51–0.56) ^d	0.89 (0.86–0.93)
65–79 yr	Ref. ^a	0.85 (0.82–0.89) ^b	0.86 (0.83–0.90)
ACE inhibitor or ARB use			
< 40 yr	0.46 (0.39–0.55) ^e	0.23 (0.19–0.27) ^f	0.66 (0.55–0.80)
40–64 yr	0.84 (0.80–0.88) ^c	0.64 (0.61–0.68) ^d	0.89 (0.85–0.92)
65–79 yr	Ref. ^a	0.94 (0.90–0.99) ^b	0.87 (0.84–0.91)

Note: ACE = angiotensin-converting enzyme, ARB = angiotensin receptor blocker, CI = confidence interval, HbA_{1c} = glycated hemoglobin, LDL-C = low-density lipoprotein cholesterol, OR = odds ratio, Ref. = reference group.
*Adjusted ORs of diabetes target achievement, using men aged 65–79 years as the reference group, from logistic regression of 2015 and 2020 data (since the sex × age interaction term was clinically and statistically significant, we reported ORs for sex and age groups separately, relative to men age 65–79 yr as the reference group). The period effect (comparing 2020 against 2015 as the reference period) is estimated separately for each age stratum, since the period by age interaction effects were also clinically and statistically significant. Odds ratios for adjustment covariates, listed above, are not shown. Demographic subgroups by target achievement are indicated with superscript letters from a (best target achievement) through f (worst target achievement).
†Adjusted for coronary artery disease, stroke, heart failure, documented hypoglycemia and stage of chronic kidney disease, in addition to age and sex.
‡A value > 1 indicates that the target was more likely to be met in 2020.

Among those with complete measurements, glycemic target attainment increased from 2015 and 2020, particularly among younger adults. Conversely, the proportion meeting blood pressure targets decreased across all ages and sexes, particularly among adults younger than 40 years. Achievement of LDL-C targets remained similar between 2015 to 2020, showing a consistent pattern of lower target attainment among younger adults and women of all ages. Achievement of all 3 targets remained similarly low from 2015 to 2020. Fewer prescriptions for statins and for ACE inhibitors or ARBs, indicated to reduce cardiovascular risk, were provided to those younger than 40 years, women of all ages and patients in 2020 than in 2015. These findings indicate a

need to re-invigorate quality improvement efforts in diabetes care in Canada, with an emphasis on women and younger adults, and a focus on blood pressure and LDL-C control.

The improvement in HbA_{1c} control from 2015 to 2020 may reflect the increasing availability of hypoglycemia-neutral and weight-favourable medications (i.e., sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide-1 receptor agonists); however, the prescribing of these agents can still be improved.²⁸ In contrast to some previous studies, our study showed parity or superiority of HbA_{1c} control among women.^{15,29} However, women had lower LDL-C target achievement and lower use of statins and of ACE inhibitors or ARBs. Lower use of cardioprotective medications among women

has been documented in previous studies.^{15,16,30} For premenopausal women, the potential risk of adverse fetal outcomes in pregnancy may be a barrier, and must be balanced against the cardiovascular benefit conferred by these agents.³¹ The persistence of sex differences into older ages may be related to clinical inertia³² and additional barriers, such as perceptions of adverse effects, underappreciation of cardiovascular risk on the part of both clinicians and patients and treatment nonadherence.^{33–35}

Undercurrents of medical distrust and skepticism have been revealed by the COVID-19 pandemic.³⁶ Patient attitudes toward medical care are shifting; this may account for the decline in blood pressure control, as has been observed in Canada among people who do not have diabetes.^{37–39} Use of statins and of ACE inhibitors or ARBs may have been similarly affected. The COVID-19 pandemic, which was underway shortly before the index date of our 2020 cross-section, may have worsened target achievement, though it does not explain the improvement in HbA_{1c} targets from 2015 to 2020.⁴⁰ Furthermore, government and industry disinvestment in national programs has been identified as an important cause of the decline in blood pressure control in Canada.⁴¹

The benefits of multidisciplinary team care, registry-based case management and standardized self-management education are well established for patients with diabetes, but these interventions have not been widely adopted.^{42,43} Widescale implementation of these interventions are subject to barriers including “intervention fatigue” or oversaturation of priority issues, analogous to “alert fatigue” in clinical decision support systems;⁴⁴ lack of resources for registry-based care; increasing demands on health care resources; and ongoing challenges with leadership and health systems organization, especially in the face of the COVID-19 pandemic. These factors have led to a high degree of clinical inertia, with difficulty achieving timely intensification of medications even in relatively uncomplicated patients.⁴⁵ Digital health holds promise as an enabler of self-management and practice change.⁴⁰ However, reinvigorated national and provincial diabetes, hypertension and cardiovascular risk reduction programs will be critical to foster improved health outcomes in the next 5 years.⁴⁶

Limitations

Providers in the CPCSSN are self-selected and may differ from the general population of primary care providers in Canada, although the utility of CPCSSN for sentinel surveillance is clear.¹⁸ We were able to include only 48% of adults in the NRD, primarily because of missing measurements. Therefore, our results are generalizable only to adults who see a family physician for their diabetes, as indicated by diabetes measurements. Some adults with type 1 diabetes may have been included, although type 1 diabetes constitutes only 5% of adults with diabetes. Our data did not have the number of drug days dispensed, so we had to use a less precise definition of current medication use (i.e., ≥ 1 prescription within the last year). Although we did not have access to information about medications and laboratory tests ordered at nonparticipating sites, previous analyses suggests that the NDR captures most chronic medications.⁴⁷

We cannot comment on target achievement across income or ethnicity groups because data to enable such analyses were not available. We have no information on why adults did not have diabetes measurements or did not achieve diabetes targets. Acute and competing demands on primary care likely play large roles. We were unable to ascertain whether patients were having conversations about diabetes care or whether they declined therapeutic intensification, or the actual motivations for provider encounters, among other factors. Despite these limitations, our study provides recent comprehensive information about target achievement in primary care across several Canadian provinces.

Conclusion

In 2020, rates of diabetes target achievement in primary care practices across Canada ranged from 8.6% (statin use among women aged < 40 yr with guideline-based indications) to 65.5% (HbA_{1c} among women aged 65–79 yr), with variations across groups defined by age and sex. Achievement of diabetes targets across all age and sex groups should be improved, with a particular need to improve blood pressure and LDL-C management, as well as the use of cardioprotective medications among women and younger adults. Given the rising rates of prediabetes and diabetes, particularly in younger individuals, this study highlights the urgent need for a reinvigorated national effort to prevent diabetes complications.

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