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Research

Adults with diabetes mellitus in Newfoundland and Labrador: a population-based, cross-sectional analysis

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Abstract

Background: Although the province of Newfoundland and Labrador has the highest rates of chronic disease in Canada, the current state of many chronic diseases in the province, including diabetes mellitus, has not been well explored. We profiled the demographic characteristics associated with, and the management of, diabetes in Newfoundland and Labrador, including any rural–urban differences.

Methods: We performed a population-based, cross-sectional analysis using data from the provincial Chronic Disease Registry for fiscal year 2015/16. Patients in the study sample were 20 years of age or older, with documented identifiers for age, sex and geographic location. We examined demographic characteristics, results of screening and diabetes clinical tests (glycated hemoglobin [HbA_{1c}], low-density lipoprotein [LDL] cholesterol and urine albumin-to-creatinine ratio) and hospitalization rates. We described and compared demographic, clinical and hospitalization variables across urban and rural residents of the province.

Results: The study sample consisted of 66 325 individuals with diabetes in Newfoundland and Labrador (mean age 64.1 yr; 56.3% rural residents). Larger proportions of rural than urban residents with diabetes were aged 65 to 79 years (41.2% v. 37.5%), were female (50.2% v. 48.7%) and were identified as having the disease by laboratory tests only (19.6% v. 13.1%). Rural residents had worse clinical test outcomes than their urban counterparts, specifically with respect to HbA_{1c} (mean and standard deviation [SD], 7.41% [SD 1.49] v. 7.26% [SD 1.50]) and LDL cholesterol (mean 2.46 [SD 0.95] v. mean 2.36 [SD 0.94] mmol/L). A total of 13.7% of individuals were admitted to hospital during the cohort year, with slightly more rural residents admitted for renal disease (standardized difference 0.021, 95% confidence interval 0.005 to 0.036).

Interpretation: For many individuals with diabetes in Newfoundland and Labrador, recommended targets for diabetes management are not being met, and residents in rural areas have poorer clinical outcomes. To inform the development and implementation of targeted provincial strategies for chronic disease management, further research is needed to determine how outcomes relate to the availability of primary health care services.

The province of Newfoundland and Labrador has some of the highest rates of chronic disease in Canada, with more than 60% of individuals having at least 1 chronic disease.[1] The prevalence of diabetes mellitus increases with age, and Newfoundland and Labrador currently has a higher median age and a more rapidly aging population than any other province or territory.[2] The relation between age and diabetes prevalence is primarily due to type 2 diabetes, which makes up the majority of diabetes cases in Canada and is most often diagnosed in adults over the age of 25.[3,4]

The prevalence and economic burdens associated with diabetes in Newfoundland and Labrador are expected to grow, with an anticipated increase in prevalence of 23% over the next decade.[5] Furthermore, the geographic distribution of the province's population is unique, in that about 47% of individuals live in rural regions.[6] This presents challenges with respect to access to care, continuity of care, and the planning and implementation of diabetes programs.

Previous literature has described the prevalence and management of diabetes in Canada;[4,5] however, Newfoundland and Labrador lags behind other provinces and territories in examining this widespread chronic disease. There is a critical need to examine diabetes at the provincial level to inform the development of initiatives and strategies targeting areas of diabetes management that require attention. Recently, the Newfoundland and Labrador Centre for Health Information developed the Chronic Disease Registry, a new database that centralizes data for diabetes and other chronic diseases from various sources such as the Canadian Chronic Disease

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Surveillance System (CCDSS) and provincial laboratory test data.[7] We aimed to profile the current state of adult diabetes prevalence and management in Newfoundland and Labrador using the Chronic Disease Registry.

Methods

Study design

We conducted a population-based, cross-sectional study to profile the current state of diabetes management across Newfoundland and Labrador. We used laboratory and hospitalization data from the 2015 fiscal year (Apr. 1, 2015–Mar. 31, 2016).

Participants

We included individuals with type 1 or type 2 diabetes aged 20 years or older identified from the provincial Chronic Disease Registry. We included only those aged 20 years or older because Diabetes Canada recommends that management for adults with diabetes should occur in the community, in primary care settings, whereas diabetes management for children should occur within a pediatric team.[8–10] We included in our analyses all individuals who were living with a prevalent case of diabetes, as of the end of the 2015 fiscal year (i.e., Mar. 31, 2016).

Data sources

We acquired all data for this study from the Newfoundland and Labrador Centre for Health Information in July 2017. Specifically, we used data from the Chronic Disease Registry (a registry established in 2017 that synthesizes information from the CCDSS and medical laboratory data to identify patients with new and existing chronic disease).[7] The Chronic Disease Registry includes, for all cases of diabetes in Newfoundland and Labrador, data from the Provincial Meditech Database (e.g., laboratory test data), the Provincial Discharge Abstract Database (e.g., hospitalization data), the Medical Care Plan Claims Database, the Medical Care Plan Beneficiary Registration Database and the Provincial Mortality System. The registry replaced and includes data from the Provincial Diabetes Database, with a look-back period to 1994, although laboratory data were not added to the registry until 2009. The registry includes information about patient management, health services, health outcomes and associated costs; it informs policy- and decision-making, program planning and monitoring.[7]

The Chronic Disease Registry identifies and classifies individuals with diabetes using the CCDSS case definition, a laboratory case definition or both. The CCDSS case definition is based on at least 1 hospital admission or at least 2 physician visits with a diabetes diagnosis code from either the 9th revision of the *International Classification of Diseases* (ICD-9) or the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10) (i.e., ICD-9, 250; ICD-10, E10–E14) within a 2-year period.[11] ICD-9 codes are used in the physician billing database and do not distinguish between type 1 and type 2 diabetes; therefore, the Chronic Disease Registry does not differentiate between the 2 types.

To identify people with diabetes, the CCDSS links provincial health insurance registry records with physician billing claims and hospital discharge abstract records.[12] The laboratory case definition for diabetes requires any 2 of the following test results in a 2-year period: fasting plasma glucose greater than or equal to 7 mmol/L, glycated hemoglobin (HbA_{1c}) greater than or equal to 6.5%, 2-hour plasma glucose in a 75-g oral glucose tolerance test greater than or equal to 11.1 mmol/L or random plasma glucose greater than or equal to 11.1 mmol/L.[12] The CCDSS case definition has been validated for Canadian populations.[13,14] The addition of laboratory data can improve surveillance that relies upon administrative data alone.[15,16]

Using data from the Chronic Disease Registry, we calculated crude prevalence with the 2016 Canadian census population as the denominator.[17] Individuals remain in the Chronic Disease Registry until they leave the province or die.

Outcomes

We extracted demographic characteristics, including age, sex, census subdivision (i.e., community of residence) and case source (i.e., CCDSS, laboratory test or both) from the Chronic Disease Registry. We explored the quality of diabetes care using clinical data (HbA_{1c}, low-density lipoprotein [LDL] cholesterol and urine albumin-to-creatinine ratio). We investigated whether the clinical tests were completed within the study cohort year (i.e., Apr. 1, 2015–Mar. 31, 2016) and, for individuals with completed tests, whether the results met indicated targets as recommended in the 2013 clinical practice guideline of Diabetes Canada (previously known as the Canadian Diabetes Association).[18] For most patients with diabetes, the 2013 guideline recommended that these tests be performed at least once a year, more frequently if targets were not being met. The HbA_{1c} target was 7.0% or below for most patients,[19] the LDL cholesterol target was below 2.0 mmol/L, and the target for urine albumin-to-creatinine ratio was below 2.0 mg/mmol.[20,21]

We explored hospital separations (i.e., departure from hospital for any reason, including discharge, transfer or death) for individuals with diabetes across Newfoundland and Labrador. We identified and categorized hospital separations according to codes in the Canadian version of the ICD-10 for the most responsible diagnosis.[22]

We determined rural and urban status using the Standard Geographical Classification type for the patient's census subdivision (e.g., community) of residence. Each census subdivision is classified as a census metropolitan area, a census agglomeration, a census metropolitan influenced zone or a region with no metropolitan influence. A census subdivision was considered "urban" if it was classified as a census metropolitan area or census agglomeration; otherwise, the census subdivision was considered "rural."[23]

Statistical analysis

We calculated descriptive statistics for the demographic characteristics and clinical outcomes of individuals with

diabetes in Newfoundland and Labrador. We used statistical testing to compare differences between rural and urban dwellers. We used independent-sample *t* tests or Mann–Whitney *U* tests to compare continuous variables and the Pearson χ^2 test or the Fisher exact test to compare categorical variables, as appropriate, with *p* values less than 0.05 defined as significant. We calculated standardized differences for each urban–rural comparison. We excluded from the analyses individuals for whom relevant data (e.g., age, sex, geographic identifier) were missing.

For all analyses, we used IBM SPSS Statistics, version 25 (IBM Corporation) and R (version 4.0.2).

Ethics approval

The study was approved by the Newfoundland and Labrador Health Research Ethics Board (reference no. 20192750).

Results

A total of 67 898 individuals with diabetes aged 20 years or older were listed in the Chronic Disease Registry as of Mar. 31, 2016. We excluded 1573 individuals with missing data for age, sex or geographic identifier from all analyses. The mean age of those with diabetes was 64.1 (standard deviation [SD] 13.6) years, and 37 356 (56.3%) of the sample resided in a rural region (Table 1). Larger proportions of rural than urban residents with diabetes were 65 to 79 years old (41.2% v. 37.5%), were female (50.2% v. 48.7%) and met the diabetes case definition in the Chronic Disease Registry through laboratory tests only (19.6% v. 13.1%). The crude prevalence was greater in rural regions for all age groups and across both sexes.

Table 2 shows the rates of completed clinical tests and on-target results, as well as mean or median test values for

Table 1: Characteristics of patients with diabetes mellitus in Newfoundland and Labrador, fiscal year 2015/16

Characteristic	All patients		Urban		Rural		Standardized difference† (95% CI)
	No. (%)* *n* = 66 325	Crude prevalence, % (95% CI)	No. (%)* *n* = 28 969	Crude prevalence, % (95% CI)	No. (%)* *n* = 37 356	Crude prevalence, % (95% CI)	
Age, yr, mean ± SD	64.1 ± 13.6	NA	63.4 ± 14.1	NA	64.6 ± 13.1	NA	0.08 (0.068 to 0.098)
Age group, yr							0.112 (0.097 to 0.127)
20–34	1791 (2.7)	2.10 (2.00 to 2.20)	980 (3.4)	1.78 (1.67 to 1.89)	811 (2.2)	2.67 (2.49 to 2.86)	
35–49	7547 (11.4)	7.26 (7.10 to 7.43)	3628 (12.5)	6.25 (6.05 to 6.46)	3919 (10.5)	8.54 (8.27 to 8.81)	
50–64	22 545 (34.0)	17.65 (17.42 to 17.88)	9867 (34.1)	16.26 (15.94 to 16.58)	12 678 (33.9)	18.91 (18.58 to 19.24)	
65–79	26 267 (39.6)	32.59 (32.20 to 32.98)	10 864 (37.5)	30.80 (30.22 to 31.38)	15 403 (41.2)	33.98 (33.44 to 34.52)	
≥ 80	8175 (12.3)	40.03 (39.17 to 40.90)	3630 (12.5)	37.50 (36.28 to 38.72)	4545 (12.2)	42.32 (41.09 to 43.55)	
Sex							0.03 (0.014 to 0.045)
Male	33 451 (50.4)	16.58 (16.40 to 16.76)	14 849 (51.3)	14.25 (14.02 to 14.47)	18 602 (49.8)	19.08 (18.80 to 19.35)	
Female	32 874 (49.6)	15.20 (15.04 to 15.36)	14 120 (48.7)	12.34 (12.13 to 12.54)	18 754 (50.2)	18.42 (18.15 to 18.68)	
Case source							0.178 (0.162 to 0.193)
Laboratory only	11 118 (16.8)	NA	3789 (13.1)	NA	7329 (19.6)	NA	
CCDSS only	10 621 (16.0)	NA	4865 (16.8)	NA	5756 (15.4)	NA	
Both	44 586 (67.2)	NA	20 315 (70.1)	NA	24 271 (65.0)	NA	

Note: CI = confidence interval, CCDSS = Canadian Chronic Disease Surveillance System, NA = not applicable, SD = standard deviation.
*Except where indicated otherwise.
†Standardized difference refers to urban v. rural.

Table 2: Rates of completion and on-target results of clinical tests

Clinical test	Group; no. (%) of patients*			Standardized difference (95% CI)
	All patients *n* = 66 325	Urban *n* = 28 969	Rural *n* = 37 356	
HbA_{1c}				
Test completed	51 007 (76.9)	22 085 (76.2)	28 922 (77.4)	0.028 (0.013 to 0.043)
Result, %, mean ± SD†	7.35 ± 1.49	7.26 ± 1.50	7.41 ± 1.49	0.095 (0.077 to 0.113)
Result on target†	26 157 (51.3)	11 877 (53.8)	14 280 (49.4)	0.088 (0.071 to 0.106)
Low-density lipoprotein cholesterol				
Test completed	45 268 (68.3)	19 878 (68.6)	25 390 (68.0)	0.014 (–0.001 to 0.029)
Result, mmol/L, mean ± SD†	2.41 ± 0.95	2.36 ± 0.94	2.46 ± 0.95	0.107 (0.088 to 0.126)
Result on target†	17 175 (37.9)	8119 (40.8)	9056 (35.7)	0.107 (0.088 to 0.125)
Urine albumin-to-creatinine ratio				
Test completed	22 676 (34.2)	10 148 (35.0)	12 528 (33.5)	0.031 (0.016 to 0.047)
Result, mg/mmol, median (IQR)†	1.7 (0.8 to 5.4)	1.6 (0.8 to 5.1)	1.7 (0.8 to 5.6)	0.020 (–0.006 to 0.046)
Result on target†	12 429 (54.8)	5708 (56.2)	6721 (53.6)	0.052 (0.026 to 0.078)

Note: CI = confidence interval, HbA_{1c} = glycated hemoglobin, IQR = interquartile range, SD = standard deviation.
*Except where indicated otherwise.
†Mean or median result and percentage on target were calculated in relation to number of patients with the particular test completed in the study period. Mean and median values were calculated using individuals' most recent test results completed in the study period.

individuals with diabetes in Newfoundland and Labrador in 2015/16. Among those who had tests, the overall mean HbA_{1c} result was 7.35% (SD 1.49). The mean HbA_{1c} was higher among individuals residing in rural communities and the percentage of individuals meeting the recommended HbA_{1c} target established by Diabetes Canada was significantly lower for individuals residing in rural regions (HbA_{1c} result 7.41% [SD 1.49] v. 7.26% [SD 1.50]; HbA_{1c} on target 49.4% v. 53.8%). However, the standardized differences for these relations were small (0.095 and 0.088, respectively).

With respect to LDL cholesterol, although there was no rural–urban difference in the proportion of patients screened, rural residents had significantly higher LDL cholesterol levels and a lower proportion meeting target values than their urban counterparts (mean LDL cholesterol 2.46 [SD 0.95] v. 2.36 [SD 0.94] mmol/L; LDL cholesterol on target 35.7% v. 40.8%). The standardized differences for the comparisons of mean LDL cholesterol and proportion of individuals with results on target were small (0.107 for both).

A greater proportion of urban than rural residents had testing of urine albumin-to-creatinine ratio (35.0% v. 33.5%) and met the target established by Diabetes Canada (56.2% v. 53.6%). Additionally, there was a significant urban–rural difference in the median urine albumin-to-creatinine ratio values (1.60 v. 1.70 mg/mmol), although the standardized differences of all comparisons related to urine albumin-to-creatinine ratio were small (< 0.1).

Table 3 presents the rates of hospital separations for individuals with diabetes during fiscal year 2015/16, specifically identifying the reason for hospital admission. A total of 13.7% of individuals in the sample were admitted to hospital during the study year. A larger number of rural than urban residents were admitted for renal disease (14 v. 2), although the percentage of individuals hospitalized for renal disease in both groups was small (< 0.1%).

Interpretation

We profiled the current state of diabetes in Newfoundland and Labrador by examining diabetes management using the provincial Chronic Disease Registry. Unlike previous databases, the Chronic Disease Registry incorporates 2 case definitions for diabetes — the CCDSS definition and a laboratory definition — which allows for a more accurate determination of true diabetes prevalence than either source alone.

Importantly, this study identified more individuals with diabetes in Newfoundland and Labrador than the CCDSS (which relies solely on diagnosis codes from hospital and physician visits), suggesting that prevalence may be higher than previously estimated. Specifically, the CCDSS estimated that there were 57 060 individuals with diabetes in Newfoundland and Labrador in fiscal year 2015/16[24] (i.e., 9265 fewer individuals than we found using the Chronic Disease Registry). Our larger estimate likely includes patients who received care from primary care physicians paid by salary and alternate payment plans, who represent 35% of provincial physicians and are not included in the billing data.[25] As primary care funding models move away from traditional fee-for-service structures, organizations must consider the accuracy of their data and how representative they are of actual rates of chronic disease within the population. Future research should examine how these funding structures might affect estimates of chronic disease rates.

Table 3: Admission to hospital, by category of most responsible diagnosis

Reason for admission	Group; no. (%) of patients			Standardized difference (95% CI)
	All patients *n* = 66 325	Urban *n* = 28 969	Rural *n* = 37 356	
Most responsible diagnosis (any)*	9079 (13.7)	3956 (13.7)	5123 (13.7)	0.002 (–0.014 to 0.017)
Cardiovascular disease†	2299 (3.5)	1003 (3.5)	1296 (3.5)	0.0 (–0.015 to 0.016)
Diabetes‡	555 (0.8)	245 (0.8)	310 (0.8)	0.008 (–0.007 to 0.024)
Renal disease§	16 (< 0.1)	2 (< 0.1)¶	14 (< 0.1)	0.021 (0.005 to 0.036)

Note: CI = confidence interval.
*Includes all codes from the Canadian version of the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10-CA).
†Includes ICD-10-CA codes I00–I78 (e.g., ischemic heart disease, hypertensive disease, acute myocardial infarction, heart failure, stroke).
‡Includes ICD-10-CA codes E10–E11 (type I diabetes – type II diabetes).
§Includes ICD-10-CA codes N18–N19 (chronic kidney disease – unspecified kidney failure).
¶The Fisher exact test was used because of the small sample size.

We found that more men than women had diabetes in Newfoundland and Labrador, which is in line with the results of previous research.[4,24] Using data from the Canadian census, we determined that the province has a higher proportion of women than men overall (51.7%), and this is consistent in both rural (51.1%) and urban (52.3%) regions.[17] However, in our study, slightly more women than men had diabetes in rural areas. This may suggest differing rates of diagnosis for men and women in rural Newfoundland and Labrador, but more research is needed.

The high prevalence rates are particularly noteworthy when rural–urban differences are examined. Although less than half the population (i.e., 47%) currently resides in rural areas,[6] the rate of diabetes in these areas accounted for more than half (i.e., 56.3%) of the total number of individuals with diabetes in our study. This difference is likely attributable to demographic differences, such as age. The rural population includes a high proportion of aging individuals, and the province has a rural population higher than the national average,[6] which poses many challenges.

Although the Chronic Disease Registry is relatively new, our findings are similar to those of previous research conducted in Newfoundland and Labrador using other data sources. One study, published in 2010, examined the management of diabetes within a single jurisdiction in the province (the capital city, St. John's).[26] Attainment of targets for diabetes management indicators recommended by Diabetes Canada were examined, by means of chart audit, in a small sample (n = 160) with type 2 diabetes.[26] In that study, about 48%, 18% and 21% of patients met recommended targets for HbA_{1c}, LDL cholesterol and blood pressure, respectively. A similar study examining diabetes management in 4 Canadian regions (including St. John's) used chart audits to assess physician adherence to treatment guidelines.[27] This study found high rates of screening for glycemia and macrovascular disease, but noted that physicians fell short in terms of microvascular screening, management of hypertension and dyslipidemia, as well as delivery of appropriate levels of treatment intensity.[27] Additional literature related to diabetes in Newfoundland and Labrador is more than 2 decades old. These older studies described physician adherence to previous Diabetes Canada clinical practice guidelines and used chart audits to estimate rates of diabetes in the province.[28–30] They showed higher rates of diabetes than did provincial data sources. They also showed that physicians had poor adherence to clinical practice guideline recommendations, although patients had good blood glucose management. Relative to these previous studies, our findings suggest that physicians had better adherence to clinical practice guidelines but that blood glucose management had worsened.

Our findings show an opportunity for better management of diabetes, in accordance with Diabetes Canada clinical practice guidelines, across the province, especially in rural regions. For most individuals with diabetes, recommended targets are not being met. For example, only half of the individuals in this study had HbA_{1c} less than 7.0%, and the percentage meeting the LDL cholesterol target was even lower (about 38%). Our findings suggest that a greater proportion of rural than urban residents had diabetes and that these individuals had worse clinical test outcomes, specifically with respect to HbA_{1c} and LDL cholesterol.

A higher prevalence of diabetes may be a result of poorer access to health services.[31,32] In previous research, we identified the breadth of variability that exists in primary health care services across Newfoundland and Labrador and the limited delivery of some of these services.[33] In recent years, there have been a number of initiatives to develop and strengthen existing supports, such as the 2017 Chronic Disease Action Plan.[1] This action plan is part of a broader framework establishing goals and objectives to guide the reform of primary health care in the province.[2] Despite these recent initiatives, continuing research is needed to examine how the availability of primary health care services may be contributing to differences in the management of diabetes across rural and urban regions in the province.

Limitations

We used the Chronic Disease Registry to profile diabetes across Newfoundland and Labrador. The registry is considered

more representative of individuals with diabetes in this province than sources such as the CCDSS, because it uses 2 case definitions for diabetes. However, it does not differentiate between type 1 and type 2 diabetes.

Our sample included 5126 individuals (7.7%) whose diabetes was diagnosed in the study year, 2015/16. These people might not have had time to undergo all recommended tests or establish control of their blood glucose level; nonetheless, we felt it necessary to include them to ensure that we completely characterized diabetes prevalence in the province.

Another limitation was the criterion used to define community size, as categorized by census subdivisions,[23] which may not necessarily capture all aspects of rurality (e.g., population density, access to health care, economy, culture). Although the definition used was standard for Canadian communities, certain elements that affect access to health care may not be fully captured.

To calculate crude prevalence, we obtained population estimates from Canadian census data. However, given that the data used in this study were from an administrative database, it might have been more appropriate to use the number of individuals with provincial health insurance coverage as the denominator. Data from the Canadian census may underestimate the population of Medical Care Plan registrants by about 6.7%.[34]

This study may be subject to the quality issues typically associated with the use of secondary data. In addition, to our knowledge, the newly created Chronic Disease Registry has not been tested for completeness and validity, which may have affected the data quality.

Although clinical tests and hospital admissions are important indicators of diabetes management, the available data did not allow us to ascertain other important indicators, such as blood pressure control and frequency of eye and foot examinations. In addition, we had access to only a limited number of demographic variables for the population. Other demographic characteristics, such as race or ethnicity and socioeconomic status, may be related to diabetes management but are not available within the Chronic Disease Registry.

The diabetes cases included in this study were those that had been diagnosed and reported. Our data did not capture cases in which patients failed to report symptoms to a physician or instances in which patients had an incorrect diagnosis or were waiting for a diagnosis.

Conclusion

This study has shown the need for improved management of diabetes in Newfoundland and Labrador, particularly in accordance with current disease management guidelines. For high proportions of patients with diabetes, recommended targets for HbA_{1c}, LDL cholesterol and urine albumin-to-creatinine ratio were not being met. In addition, a greater proportion of individuals with diabetes were living in rural regions than in urban regions, and these individuals had poorer glycemic and cholesterol control than their urban counterparts. Use of the Chronic Disease Registry allowed us to capture a greater number of individuals with diabetes in Newfoundland and Labrador than has previously been reported by national databases. Given the widespread availability of laboratory data, the CCDSS should consider incorporating these measures into their case definitions. Future research should examine the causes of greater prevalence of diabetes in rural regions, specifically in relation to the availability of primary health care services, and should explore whether this may be associated with poorer diabetes management.

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