

Title: A profile of adults with diabetes mellitus in Newfoundland and Labrador: a population-based, cross-sectional analysis

Julia Lukewich¹ RN, PhD; Richard Buote², BSc, MSc; Shabnam Asghari³ MD, PhD; Kris Aubrey-Bassler⁴ MSc, MD; John Knight⁵ PhD; Maria Mathews⁶ PhD

1. Faculty of Nursing, Memorial University of Newfoundland, St. John's, NL, Canada
2. Division of Community Health and Humanities, Memorial University of Newfoundland, St. John's, NL, Canada
3. Center for Rural Health Studies, St. John's, NL, Canada; Discipline of Family Medicine, Memorial University of Newfoundland, St. John's, NL, Canada
4. Primary Healthcare Research Unit, Faculty of Medicine, Memorial University of Newfoundland, St. John's, NL, Canada
5. Health Analytics and Information Services, Newfoundland and Labrador Centre for Health Information, St. John's, NL, Canada
6. Department of Family Medicine, Schulich School of Medicine & Dentistry, London, ON, Canada

Corresponding author: Dr. Julia Lukewich

Faculty of Nursing, Memorial University
300 Prince Philip Drive, St. John's NL A1B 3V6
Email: jlukewich@mun.ca
Phone: (709) 864-8211

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Abstract

Background

Although Newfoundland and Labrador (NL) has the highest chronic disease rates in Canada, the current state of many chronic diseases, including diabetes mellitus (DM), is not well explored. This study profiles the demographic characteristics and management of DM in NL, including any rural-urban differences in these variables.

Methods

This study performed a population-based, cross-sectional analysis using data from the provincial Chronic Disease Registry during the 2015/16 fiscal year. Participants were aged 20 years or older with documented age, sex, and geographic identifiers. Demographic characteristics, screening and outcomes of DM clinical tests (hemoglobin A1c [HbA1c]; low-density lipoprotein cholesterol [LDL-C]; urine albumin creatinine ratio), and hospitalization rates were examined.

Results

Participants consisted of 66,247 individuals with DM in NL (mean age=64.1 years; 56.3% rural residents). A larger proportion of rural residents with DM were aged 65-79 (41.2%), female (50.2%), and identified by lab tests only (19.6%). Rural residents had worse clinical test outcomes than their urban counterparts, specifically with respect to HbA1c (7.40 ± 1.49 vs. 7.26 ± 1.50) and LDL-C (2.46 ± 0.95 vs. 2.36 ± 0.94). A total of 13.7% of participants were hospitalized during the cohort year, with slightly more rural residents hospitalized for renal disease ($p=0.011$).

Interpretation

Many individuals with DM in NL are not meeting recommended targets for DM management, and residents in rural areas have poorer clinical outcomes. Further research is needed to determine how outcomes relate to availability of primary healthcare services. Findings illustrate a need to examine DM at a provincial-level to inform initiatives/strategies targeted at areas requiring greater DM management.

Keywords: diabetes mellitus, chronic disease, diabetes management, rural health, primary healthcare, chronic disease guidelines, clinical outcomes

Introduction

Newfoundland and Labrador (NL) has the highest rates of chronic disease in Canada, with over 60% of individuals having at least one chronic disease (1,2). The prevalence of diabetes mellitus (DM) increases with age and NL currently has a higher median age and a more rapidly aging population than any other province/territory (3). The prevalence and economic burdens associated with DM in NL are expected to grow, with a 23% anticipated increase over the next decade (4). Furthermore, the geographical distribution of the population in NL is unique in that approximately 47% of individuals live in rural regions (5). This presents challenges with respect to access to care, continuity of care, and planning/implementation of DM programs.

Previous literature has described the prevalence and management of DM in Canada (4,6), however, NL lags behind other provinces/territories in examining this widespread chronic disease. To our knowledge, there has yet to be a population-based study specifically profiling the prevalence and management of DM in NL. A study conducted in 2010 examined the management of DM within a single jurisdiction in the province (i.e. NL's capital city, St. John's) and relied on chart audit. The attainment of Diabetes Canada recommended targets for diabetes management indicators (e.g. hemoglobin A1c [HbA1c], low-density lipoprotein cholesterol [LDL-C], blood pressure [BP]) were examined in a small sample (n=160) with DM Type II (7). The study demonstrated that approximately 48%, 18%, and 21% of patients met recommended targets for HbA1c, LDL-C, and BP, respectively. A similar study examining diabetes management in four Canadian regions (including St. John's, NL), used chart audits to assess physician adherence to treatment guidelines (8). The study determined high rates of screening for glycemia and macrovascular disease, but noted that physicians fell short in terms of microvascular screening, hypertension and dyslipidemia management, and delivering appropriate levels of treatment intensity. More recently, a 2014 study conducted in NL focused specifically on investigating factors associated with diabetes, a late diagnosis of diabetes, and differences between males and females (9). Additional literature related to DM in NL is over two decades old. These older studies described physician compliance with previous Diabetes Canada Clinical Practice Guidelines (CPG) and estimated rates of diabetes in the province using chart audit (10–12). There is a critical need to examine DM at a provincial-level to inform the development of initiatives/strategies targeted at areas requiring attention in DM management. Recently, the Newfoundland and Labrador Centre for Health Information (NLCHI) developed the Chronic Disease Registry, which is a new database that centralizes diabetes and other chronic disease data from various sources such as the Canadian Chronic Disease Surveillance System (CCDSS) and provincial laboratory test data. The purpose of this study was to profile the current state of DM prevalence and management in the province using NL's Chronic Disease Registry. We identified demographic characteristics of individuals with DM and the quality of DM management in NL, including rural-urban differences in these characteristics.

Methods

Study design

We conducted a population-based, cross-sectional study to profile the current state of DM management across NL.

Participants

We included individuals with DM aged 20 years or older identified from the provincial Chronic Disease Registry between April 1, 2015 and March 31, 2016. We excluded individuals without documented age, sex, or geographic identifier.

Data sources

All data were acquired from NLCHI. Specifically, this study used data from the Chronic Disease Registry (a registry that synthesizes information from the CCDSS and medical laboratory data to identify new and existing chronic disease patients; established in 2015) (13). The Chronic Disease Registry includes data from the Provincial Hospital Information System Database (e.g. lab test data), the Provincial Discharge Abstract Database (e.g. hospitalization data), the MCP Claims Database, the MCP Beneficiary Registration Database, and the Provincial Mortality System. The Registry includes information about patient management, health services, and health outcomes and associated costs, as well as informs policy-decision making, program planning, and monitoring (13). Data for the current study included individuals who met either the CCDSS or laboratory case definitions for DM. The CCDSS case definition for DM is ≥ 1 hospitalization(s) or ≥ 2 physician visits with a diabetes diagnosis code within a two-year period (14). To identify people with DM, the CCDSS links provincial health insurance registry records with physician billing claims and hospital discharge abstract records (15). The laboratory test case definition for DM requires any of the two following test results in a two-year period: fasting plasma glucose test result of ≥ 7 mmol/L; HbA1c test results of $\geq 6.5\%$; two hour plasma glucose in a 75g oral glucose tolerance test result of ≥ 11.1 mmol/L; or random plasma glucose test result of ≥ 11.1 mmol/L (16). Individuals remain in the Chronic Disease Registry until they leave the province or die.

Patient variables

Demographic characteristics including age, sex, census subdivision (i.e. municipality of residence), and case source (i.e. CCDSS, laboratory test, both) were extracted from the Chronic Disease Registry. The quality of DM care was explored using clinical data (HbA1c, LDL-C, and urine albumin creatinine ratio [UACR]). We investigated whether the clinical tests were completed within the study cohort year (i.e. April 1, 2015-March 31, 2016) and for individuals who had completed tests, whether the results met indicated targets as recommended by Diabetes Canada 2018 CPG (17). Diabetes Canada recommends that these tests be performed at least once

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3 a year for patients with DM (more frequently if targets are not being met). The HbA1c target is
4 $\leq 7.0\%$ for most patients (18), LDL-C target is $< 2.0\text{mmol/L}$, and the UACR target is
5 $< 2.0\text{mg/mmol}$ (19,20). Furthermore, we explored hospital separations for individuals with DM
6 across NL. Hospital separations were identified and categorized based on the ICD-10-CA code
7 of the most responsible diagnosis (9).
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10 Rural and urban status was determined using the Standard Geographical Classification
11 type for the census subdivision of the patient's place of residence. Census subdivisions are
12 classified as either a census metropolitan area, census agglomeration, census metropolitan
13 influenced zone, or a region with no metropolitan influence. Statistical Area Classification types
14 are ordered hierarchically, from 1 (within a metropolitan area) to 7 (outside of census
15 metropolitan area or census agglomeration area having no metropolitan influence) (21). Areas
16 coded 1–3 (metropolitan areas or census agglomerations) were classified as “urban”, while those
17 coded 4-7 were classified as “rural” (21).
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22 Data analysis

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24 We used IBM SPSS Statistics version 25 (IBM Corporation) to calculate descriptive
25 statistics of the demographic characteristics and clinical outcomes of individuals with DM in NL.
26 Rural/urban differences were compared statistically using independent samples t-tests or
27 Pearson's chi square tests, as appropriate. Alpha was set at $p < 0.05$.
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30 Approvals

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32 Study approval was obtained from the NL Health Research Ethics Board (Reference #:
33 20192750).
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36 **Results**

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38 There were 66,247 individuals with DM aged 20 years or older in the Chronic Disease
39 Registry between April 1, 2015 and March 31, 2016. We excluded 1,621 individuals without
40 documented age, sex, or geographic identifiers. Demographic characteristics are presented in
41 Table 1. Mean values were calculated from the participant's most recent HbA1c, LDL-C, or
42 UACR test completed in 2015. The mean age of individuals with DM was 64.1 ± 13.6 years and
43 56.3% ($n=37,312$) of participants resided in a rural region. A larger proportion of rural than
44 urban residents with DM were 65-79 years old (41.2% vs. 37.5%), female (50.2% vs. 48.7%),
45 and included in the Chronic Disease Registry through lab tests only (19.6% vs. 13.1%).
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50 Table 2 displays the rates of completed and on-target clinical test results for individuals
51 with DM in NL in 2015/16. Among those who had tests, the mean HbA1c result of all
52 participants was $7.34\% \pm 1.49$. A greater proportion of rural than urban residents had an HbA1c
53 test completed during the study cohort year (77.4% vs. 76.2%). In contrast, the mean HbA1c and
54 percentage of individuals meeting the recommended HbA1c target established by Diabetes
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Canada were significantly lower for individuals residing in rural regions (HbA1c 7.40 ± 1.49 vs. 7.26 ± 1.50 ; HbA1C on-target 49.4% vs. 53.8%). With respect to LDL-C, although there was little or no rural-urban difference in the proportion of patients screened, there was a similar trend of rural residents having significantly higher LDL-C levels than their urban counterparts (LDL-C 2.46 ± 0.95 vs. 2.36 ± 0.94 ; LDL-C on-target 35.7% vs. 40.8%). A greater proportion of urban than rural residents had UACR testing (35.0% vs. 33.5%) and met the target established by Diabetes Canada (56.4% vs 53.3%), but there were no urban/rural differences in the mean of UACR test values (14.7 ± 69.6 vs. 14.4 ± 56.2).

Table 3 presents the rates of hospital separations for individuals with DM during 2015/16, specifically identifying reason for hospitalization. A total of 13.7% of the individuals in the sample were hospitalized during the study cohort year. A larger proportion of rural than urban residents were hospitalized for renal disease (14 vs. 2), although the percentage in both groups was small (<0.01).

Interpretation

The aim of this study was to profile the current state of DM in NL by examining DM management using the provincial Chronic Disease Registry. To our knowledge, this is the first study to specifically profile DM management quality indicators in NL. Unlike previous databases, the Chronic Disease Registry incorporates two case definitions for diabetes (i.e. CCDSS and a laboratory definition), which provides a better representation of the true number of individuals with DM in NL. Importantly, this study identified a greater number of individuals with DM in NL than the CCDSS (which relies solely on diagnosis codes for diabetes from hospital and physician visits), suggesting that the prevalence may be higher than that which was previously estimated. Specifically, the CCDSS estimates that there are 57,060 individuals who have DM in NL (22) (i.e., 9,187 fewer individuals than identified in our study using NL's Chronic Disease Registry). The larger numbers likely represent patients who receive care from primary care physicians within alternate payment plans, which represent 35% of physicians in NL, that do not produce billing data (23). As primary care funding models evolve and move away from traditional fee-for-service structures, organizations must consider the accuracy of their data and how representative it is of actual rates of chronic disease amongst the population. Future research should examine how these funding structures might impact estimates of chronic disease rates. Our sample more closely aligned with the prevalence estimate for DM in NL from the Diabetes in Canada Report (i.e., approximately 67,000 in 2019), which uses the Diabetes Cost Model to estimate the rate of DM in each province (4). This model relies on national data from government sources to provide statistics on DM (e.g. prevalence, forecast projected rates) (4). Our study found that more males than females have DM in NL, which is in line with previous research (6, 22). NL has a higher proportion of females than males overall (51.1%), and this is consistent in both rural (50.6%) and urban (51.6%) regions. It is notable, however, that slightly more females than males had DM in rural NL. This may suggest that differing diagnosis rates exist between males and females in rural NL, but more research is needed. The high

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3 prevalence rates in NL are particularly noteworthy when examining rural/urban differences.
4 Although less than half of the population (i.e., 47%) currently reside in rural areas (5), the rate of
5 DM in these areas accounts for more than half (i.e., 56.3%) of the total number of individuals
6 with DM. This is likely attributable to demographic differences, such as age. The rural
7 population in NL is comprised of high rates of aging individuals and the province has a rural
8 population higher than the national average (4), which poses many challenges.
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12 The findings from this study demonstrate the opportunity for better management of DM
13 in accordance with Diabetes Canada CPG across the province (12), especially within rural
14 regions. The majority of individuals with DM are not meeting recommended targets. For
15 example, only half of the individuals in this study had an HbA1C of less than 7.0% and the
16 percentage meeting the LDL-C target was even lower (~38%). Findings suggest that a greater
17 proportion of rural residents have DM and that these individuals have worse clinical test
18 outcomes, specifically with respect to HbA1C and LDL-C. A higher prevalence of DM may be a
19 result of poorer access to health services (24,25). Previous research conducted by the study
20 authors identified the breadth of variability that exists in primary healthcare services across NL
21 and the limited delivery of some of these services (26). In recent years, there have been a number
22 of initiatives to develop and strengthen existing supports, such as the 2017 Chronic Disease
23 Action Plan (27). This action plan is part of a broader framework which establishes
24 goals/objectives to guide the reform of primary healthcare in the province (28). Despite these
25 recent initiatives, continuing research is needed to examine how the availability of primary
26 healthcare services may be contributing to the differences in the management of DM across
27 rural/urban regions in the province.
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34 Limitations

35 This was a novel study that used the Chronic Disease Registry to profile DM across NL.
36 The Registry is considered to be more representative of individuals with DM in NL than sources
37 such as the CCDSS, as it includes two case definitions for DM. A limitation of the study is that
38 the Chronic Disease Registry does not differentiate between Type I and Type II DM. Our sample
39 included 5,126 (7.7%) individuals diagnosed with diabetes in 2015/16. These individuals may
40 not have had time to undergo all recommended tests or establish control of their blood sugars.
41 Another limitation of this study is that the criteria used to define community size, as categorized
42 by census subdivisions (21), may not necessarily capture all aspects of rurality (e.g., population
43 density, access, economy, culture). Although the definition used was a standard for Canadian
44 communities, certain elements that affect access to healthcare may not be fully captured. This
45 study may be subject to quality issues typically associated with the use of secondary data. Lastly,
46 the diabetes cases in this study are those that have been diagnosed and reported. Data does not
47 capture cases in which patients fail to report symptoms to a physician, or instances where
48 patients are incorrectly diagnosed or waiting on a diagnosis.
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54 Conclusions and Future Directions

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3 This study demonstrates the need for improved management of DM in NL, particularly in
4 accordance with current disease management guidelines. In NL, high proportions of patients with
5 DM are not meeting recommended targets for HbA1c, LDL-C, and UACR. This study also
6 demonstrates that there is a greater proportion of individuals with DM living in rural regions than
7 in urban regions in NL, and that these individuals have poorer glycemic and cholesterol control
8 than their urban counterparts. The use of the Chronic Disease Registry allowed us to capture a
9 greater number of individuals with DM in NL than previously reported by national databases.
10 Given the widespread availability of laboratory data, the CCDSS should consider incorporating
11 these measures into their case definitions. Future research should examine the causes of greater
12 prevalence of DM in rural regions, specifically in relation to the availability of primary
13 healthcare services, and explore whether this may be associated with poorer DM management.
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Table 1. Characteristics of Study Participants; 2015/16 (N = 66,247), n (%)

	Total	Urban (n=28,935)	Rural (n=37,312)	p value
Age, years (mean ± SD)	64.1 ± 13.6	63.5 ± 14.1	64.6 ± 13.1	< 0.001
20-34 years	1787 (2.7)	976 (3.4)	811 (2.2)	< 0.001
35-49 years	7538 (11.4)	3623 (12.5)	3915 (10.5)	
50-64 years	22 503 (34.0)	9848 (34.0)	12 655 (33.9)	
65-79 years	26 249 (39.6)	10 858 (37.5)	15 391 (41.2)	
80+ years	8170 (12.3)	3630 (12.5)	4540 (12.2)	
Sex				
Male	33 429 (50.5)	14 836 (51.3)	18 593 (49.8)	< 0.001
Female	32 818 (49.5)	14 099 (48.7)	18 719 (50.2)	
Case Source				
Lab only	11 110 (16.8)	3786 (13.1)	7324 (19.6)	< 0.001
CCDSS only	10 621 (16.0)	4865 (16.8)	5756 (15.4)	
Both	44 516 (67.2)	20 284 (70.1)	24 232 (64.9)	

CCDSS = Canadian Chronic Disease Surveillance System

Table 2. Rates of completion and on-target clinical test results for patients with DM in NL in 2015/16

	Total (n=66,247)	Urban (n=28,935)	Rural (n=37,312)	p value
HbA1c test completed n(%)	50 942 (76.9)	22 057 (76.2)	28 885 (77.4)	< 0.001
HbA1c (mean ± SD)*	7.34 ± 1.49	7.26 ± 1.50	7.40 ± 1.49	< 0.001
HbA1c test on-target* n(%)	26 137 (51.3)	11 866 (53.8)	14 271 (49.4)	< 0.001
LDL-C test completed n(%)	45 211 (68.2)	19 855 (68.6)	25 356 (68.0)	.069
LDL-C (mean ± SD)*	2.41 ± 0.95	2.36 ± 0.94	2.46 ± 0.95	< 0.001
LDL-C test on-target* n(%)	17 152 (37.9)	8109 (40.8)	9043 (35.7)	< 0.001
UACR test completed n(%)	22 641 (34.2)	10 137 (35.0)	12 504 (33.5)	< 0.001
UACR (mean ± SD)*	14.5 ± 62.6	14.7 ± 69.6	14.4 ± 56.2	.649
UACR test on-target*n(%)	12 381 (54.7)	5714 (56.4)	6667 (53.3)	< 0.001

*Note: HbA1c, LDL-C, and UACR means ± SD and n (%) on-target include only individuals who had the test completed during the study cohort year. HbA1c = Hemoglobin A1c; LDL-C = Low-density lipoprotein cholesterol; UACR = Urine albumin creatinine ratio

Table 3. Percentage of Individuals Hospitalized with DM in NL in 2015/16 by category of Most-Responsible Diagnosis

	Total (n=66,247)	Urban (n=28,935)	Rural (n=37,312)	p value
Hospitalizations, n (%)				
Any most-responsible diagnoses ^a	9063 (13.7)	3952 (13.7)	5111 (13.7)	.882
Cardiovascular disease ^b	2294 (3.5)	1003 (3.5)	1291 (3.5)	.964
Diabetes ^c	554 (0.8)	245 (0.8)	309 (0.8)	.795
Renal disease ^d	16 (<0.1)	2 (<0.1) ^e	14 (<0.1)	.011

^aIncludes all ICD-10-CA codes (e.g. A00-B99 (certain infectious and parasitic diseases); F00-F99 (mental and behavioural disorders); J00-J99 (diseases of the respiratory system)); ^bIncludes ICD-10-CA codes I00-I78 (e.g. ischemic heart disease, hypertensive disease, acute myocardial infarction, heart failure, stroke); ^cIncludes ICD-10-CA codes E10-E11 (Type I diabetes-Type II diabetes); ^dIncludes ICD-10-CA codes N18-N19 (Chronic kidney disease-Unspecified kidney failure) ^eFischer's exact test was used due to the small sample size.