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Original quantitative research

Estimating the completeness of physician billing claims for diabetes case ascertainment: a multiprovince investigation

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Abstract

Introduction: Previous research has suggested that how physicians are paid may affect the completeness of billing claims for estimating chronic disease. The purpose of this study is to estimate the completeness of physician billings for diabetes case ascertainment.

Methods: We used administrative data from eight Canadian provinces covering the period 1 April 2014 to 31 March 2016. The patient cohort was stratified into two mutually exclusive groups based on their physician remuneration type: fee-for-service (FFS), for those paid only on that basis; and non-fee-for-service (NFFS). Using diabetes prescription drug data as our reference data source, we evaluated whether completeness of disease case ascertainment varied with payment type. Diabetes incidence rates were then adjusted for completeness of ascertainment.

Results: The cohort comprised 86 110 patients. Overall, equal proportions received their diabetes medications from FFS and NFFS physicians. Overall, physician payment method had little impact upon the percentage of missed diabetes cases (FFS, 14.8%; NFFS, 12.2%). However, the difference in missed cases between FFS and NFFS varied widely by province, ranging from −1.0% in Nova Scotia to 29.9% in Newfoundland and Labrador. The difference between the observed and adjusted disease incidence rates also varied by province, ranging from 22% in Prince Edward Island to 4% in Nova Scotia.

Conclusion: The difference in the loss of cases by physician remuneration method varied across jurisdictions. This loss may contribute to an underestimation of disease incidence. The method we used could be applied to other chronic diseases for which drug therapy could serve as reference data source.

Keywords: *physician billing, administrative data, data quality, health data, national, surveillance*

Highlights

- Some physician visits could be missed because salaried (NFFS) physicians may not shadow bill.
- Data from the Canadian Chronic Disease Surveillance System (CCDSS) were compared to prescription drug data to identify missing diabetes cases.
- How the physician was paid had little impact upon the number and percentage of missed diabetes cases.
- We adjusted the diabetes incidence rates for the missing cases; the largest percentage change between the observed and adjusted rates was for Prince Edward Island (22%) and the smallest was for Nova Scotia (4%).

Introduction

The Canadian Chronic Disease Surveillance System (CCDSS) is a collaborative network of provincial and territorial surveillance systems, supported by the Public Health Agency of Canada (PHAC). The partnership enables the pooling of population-based data on chronic diseases in Canada with the aim of better understanding the disease burden across the country

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to support both health promotion and disease prevention efforts and health resource planning. Through access to administrative health data on all residents who are eligible for provincial or territorial health insurance across the country, the CCDSS is able to generate national estimates of incidence, prevalence and associated trends for over 20 chronic diseases.[1] Administrative health data are extensively used in chronic disease research[2-11] and disease surveillance.[12-16]

In Canada, physician billing claims are used to remunerate physicians who are paid on a fee-for-service (FFS) basis; these records are also used for various secondary purposes, including disease surveillance. Physicians who are (1) paid a salary, (2) paid on a capitation basis, or (3) paid through some other blended non-fee-for-service (NFFS) mechanism, are frequently required to "shadow bill."[17] Shadow billing is an "administrative process whereby physicians submit service provision information using provincial/territorial fee codes; however, payment is not directly linked to the services reported. Shadow billing data can be used to maintain historical measures of service provision based on fee-for-service claims data."[17,p.iii]

Though the percentage of Canadian physicians paid on a NFFS basis has increased dramatically over the last two decades,[18] the quality and completeness of shadow billing records remains poorly understood.[19] For researchers and government agencies that have historically relied upon high-quality physician billing claims data for disease surveillance, systematic under-recording of clinical encounters or patient characteristics via shadow billing could undermine disease estimations.

Using prescription drug data as the reference standard for identifying diabetes incidence, a 2009 Ontario study reported a relative under-identification of diabetes in the physician billing claims data of patients cared for by NFFS family physicians.[2] A subsequent study investigated the completeness of capture of physician billing claims for FFS and NFFS physicians in Manitoba.[20] The authors found a loss of physician billing claims associated with physician forms of payment, which resulted in some underestimation of diabetes incidence.[20] However, to our knowledge, there has been only one multisite study[21] to examine the impact of physician remuneration on chronic disease estimation in administrative health data. The purpose of our study was to compare the completeness of capture of incident diabetes among physicians paid by FFS and NFFS methods across multiple Canadian provinces.

Methods

Study design and data sources

The PHAC, in collaboration with all provinces and territories, conducts national surveillance of diabetes to support the planning and evaluation of related policies and programs through the CCDSS.[22] The CCDSS Data Quality Working Group collaboratively developed the project protocol and completed the analyses. We undertook a multiprovince cohort study using administrative health data from British Columbia, Saskatchewan, Manitoba, Ontario, Quebec, Prince Edward Island, Nova Scotia and Newfoundland and Labrador (jurisdictions with access to both the physician registry and prescription drug data) covering the period 1 April 2014 through 31 March 2016.

We used five administrative data sources. The first was physician billing claims, which are completed for physician services. These data contain a physician identification number and diagnosis codes recorded using the International Classification of Diseases (ICD), 9th revision, Clinical Modification[23] codes or some variation thereof. The second source was the Discharge Abstract Database (DAD) and MED-ÉCHO, which compile data when a patient is discharged from an acute care facility. These data contain up to 25 diagnosis codes recorded using the ICD, 10th revision, Canadian version (ICD-10-CA[24]). Our reference standard data source for disease incidence was prescription drug data, which contain information for prescription medications dispensed by outpatient pharmacies. Each record contains the date of dispensation, drug identification number and prescriber identification number. The provincial health insurance registry of each jurisdiction was also used. It contains dates of health insurance coverage as well as demographic information such as date of birth, sex and residential or correspondence postal code. Finally, we used the health care provider registry in each province to describe physicians' characteristics, including specialty and method of payment.

Patient cohort

The patient cohort included all incident diabetes cases identified by prescription drug records among residents aged one year and older in all provinces except Ontario and Newfoundland and Labrador, where data were available for residents aged 67 years and older, and Saskatchewan, where data were available for residents aged 65 years and older.[25] The cohort inclusion criteria were: (1) at least one prescription for a glucose-lowering drug identified by the World Health Organization Anatomical Therapeutic Chemical (ATC) code of A10 in the two-year accrual period from 1 April 2014 to 31 March 2016; (2) continuous health insurance coverage during the two-year period before and the two-year period after the index prescription date, that is, the date that a diabetes prescription medication was first identified in prescription drug records during the observation period; and (3) age of two years or older (or 67 years or older in Ontario and Newfoundland and Labrador, and 65 years or older in Saskatchewan) on the index prescription date.

ATC code A10 captures blood glucose–lowering drugs such as metformin and insulins and their analogues, but not supplies such as glucose test strips. To capture incident cases only, individuals were excluded from the study if they had a prescription with an ATC code of A10 within the two-year period prior to their index prescription date. The prescriber identification number associated with the index diabetes medication prescription was linked to the corresponding number in the provider registry to determine physician payment method (i.e. FFS vs. NFFS). Individuals were excluded if the payment method of the provider who made the index prescription was not recorded in the registry and/or if the providers in the provider registry did not match between the CCDSS and prescription drug databases. Women with obstetrical or pregnancy-related diagnosis codes were also excluded.

The cohort was stratified into two mutually exclusive groups: (1) individuals with an index prescription from a FFS physician, and (2) individuals with an index prescription from a NFFS physician. FFS physicians were defined as physicians who received only FFS payments, while NFFS physicians were defined as physicians who received something other than 100% FFS payment.

Denominator

The denominator for the incidence rates included all people with or without diabetes and continuous health insurance coverage during the two-year period before and two-year period after the index prescription date, aged 2 years or older (or 67 years and older in Ontario and Newfoundland and Labrador, and 65 years and older in Saskatchewan) on the index prescription date. The denominator for the diabetes incidence rates was tailored to the specific purpose of this study. Therefore, these rates are not comparable to those in other CCDSS publications.

Outcome measures

Using the patient cohort, we identified whether the individual met the diabetes case definition used by the CCDSS.[26-28] A case was defined as an individual with one hospitalization or two physician billing claims within two years having an ICD-9-CM[23] or ICD-9[29] code of 250 or ICD-10-CA[24] code of E10, E11, E13 or E14[27,28] (diabetes types 1 and 2 could not be distinguished). The sensitivity was 86%, specificity was 97% and positive predictive value (PPV) was 80%.[28] We defined the case diagnosis date as either the date of hospital discharge or the date of the second qualifying physician billing claim, whichever came first.

Concordance between the administrative data case definition and the reference standard prescription drug claim was evaluated for patients for whom the case diagnosis date fell within the two years preceding or two years following each patient's index prescription date. To avoid cases of potential gestational diabetes, women aged 10 to 54 were excluded if the qualifying case diagnosis date fell in the 120 days before and up to 180 days following a hospital record containing any obstetrical or pregnancy-related diagnosis codes: ICD-9[29] 641–676, V27; ICD-9 CM[23] 641–679, V27; and ICD-10[30] and ICD-10-CA[24] O10-16, O21-95, O98, O99, Z37.

Statistical analysis

The patient cohort was characterized in terms of age group (1–19, 20–64, ≥ 65 years) and sex. The prescribing physicians were characterized by sex, age group (< 35, 35–60, ≥ 61 years) and specialty (other specialist vs. family physician). All physician characteristics were assessed at the index prescription date. The patient cohort and their prescribing physicians were described using frequencies and percentages. A χ^2 statistic was used to test for differences in characteristics between the FFS and NFFS groups. All analyses were done for each province and overall.

We determined the percentage of individuals identified in the prescription drug data that did not meet the diabetes case definition in the CCDSS; these were classified as missed cases. This assessment was conducted by province and overall, as well as for subgroups defined by age group.

The crude diabetes incidence rate was estimated by dividing the number of cases found using the CCDSS case definition (among the patient cohort) by the denominator (people with continuous health insurance coverage), multiplied by 100 for each province. These rates were for those aged two years and older (67 years and older in Ontario and Newfoundland and Labrador, and 65 years and older in Saskatchewan), for the provincial population in the observation period from 1 April 2014 to 31 March 2016 using the CCDSS case definition. Incidence rates were adjusted for the number of FFS and/or NFFS cases found from adding missed cases (first, only FFS, then only NFSS, and finally both FFS and NFSS missed cases to the numerator). Crude rates were used to estimate the completeness of physician billings for diabetes case ascertainment because they provide information about the total magnitude of the effect of missing data within a province.

All analyses were conducted using SAS version 9.3 or 9.4.[31] The SAS code was developed by PHAC's CCDSS operations team, pilot tested by the team in Prince Edward Island and, once finalized, distributed to all participating data centres. The provincial teams then modified the code for their settings, generated the agreed output datasets and submitted them to PHAC, which then pooled the results from all provinces. All counts and related statistics greater than 0 and less than 5 were suppressed to avoid residual disclosure and to provide more reliable estimates. Also, to calculate the rates, all counts were rounded at random using a base of 10, and therefore individual cell values may not add up to the totals.

Results

The overall cohort comprised 86 110 patients (43 770 FFS and 42 350 NFFS; 43 650 males and 42 070 females) and 17 665 physicians (6054 FFS and 11 611 NFFS; 10 412 males and 7250 females). The provincial patient cohorts ranged in size from 1460 in Prince Edward Island to 31 620 in Ontario (Table 1). About half (50.8%) of patients received their index prescription from a FFS physician. On average, each FFS physician prescribed to 7.2 patients and each NFFS physician prescribed to 3.6 patients (data not shown).

The majority of the patients were 65 years and older, which was anticipated given the composition of the patient cohorts from Saskatchewan, Ontario and Newfoundland and Labrador. The largest number of FFS patients (26 310) were aged 20 to 64, while the largest number of NFSS patients (34 600) were 65 years and older (Table 1). There was almost no difference in the sex distribution of FFS and NFFS patients; however, the type of remuneration method was statistically significantly different in at least one physician age group ($\chi^2 = 123.546$; $p < 0.001$; $df = 2$; data not shown).

According to our definition of FFS remuneration (100% of payments on FFS basis), Manitoba had the largest percentage of FFS physicians (77.1%), while Ontario had the smallest (5.7%; Figure 1). British Columbia had the largest percentage (83.6%) of family physicians classified as FFS physicians, while Ontario had the smallest (0.2%). Nova Scotia had the highest percentage (56.7%) of NFSS physician specialists and Manitoba had the lowest (2.6%; Figure 2).

Individuals identified as a case of diabetes in the prescription drug data who did not meet the CCDSS administrative diabetes case definition were classified as missed. Overall, 13.5% of those diagnosed were missed. Prince Edward Island had the highest rate of missed cases (17.6%) and Nova Scotia had the lowest (4.8%). Quebec data were not shown, as the data by physician remuneration type were not available; however, 19.3% missed cases were observed. For FFS and NFFS physicians, the overall percentages were 14.8% and 12.2%, respectively. However, the differences varied widely by province, ranging from −1.0% to 29.9% in Nova Scotia and Newfoundland and Labrador, respectively. For most provinces, the percentage of missed cases was greater for NFFS than FFS physicians, with the exceptions of Ontario[32] and Prince Edward Island. Prince

TABLE 1
Distribution of patients (counts and percentages), by physician remuneration method (fee-for-service vs. non-fee-for-service),[a] by age group and by province, fiscal years 2014/15 to 2015/16

Province	1–19 years				20–64 years				≥ 65 years[b]				Age 1+				Total (FFS + NFFS)	Total (%)
	FFS	NFFS	FFS + NFFS	%	FFS	NFFS	FFS + NFFS	%	FFS	NFFS	FFS + NFFS	%	FFS	%	NFFS	%		
British Columbia	260	310	580	2.2	16 090	2 980	19 060	71.3	6 040	1 070	7 110	26.6	22 380	83.7	4 360	16.3	26 750	100.0
Saskatchewan[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2 090	780	2 880	100.0	2 100	72.9	780	27.1	2 880	100.0
Manitoba	330	40	360	2.3	9 110	2 630	11 740	75.6	2 860	580	3 440	22.2	12 290	79.1	3 240	20.9	15 530	100.1
Ontario[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1 600	30 010	31 620	100.0	1 600	5.1	30 010	94.9	31 620	100.0
Prince Edward Island	—	20	20	2.1	100	910	1 010	69.2	60	380	420	28.8	160	10.5	1 310	89.5	1 460	100.1
Nova Scotia	20	40	50	0.9	1 020	820	1 840	33.6	2 180	1 420	3 600	65.7	3 210	58.5	2 280	41.5	5 480	100.2
Newfoundland and Labrador[b]	N/A	N/A	N/A	N/A	—	0	N/A	N/A	2 020	380	2 400	100.0	2 020	84.3	380	15.7	2 400	100.0
Total	610	420	1 020	N/A	26 310	7 330	33 650	N/A	16 850	34 600	51 450	N/A	43 770	50.8	42 350	49.2	86 110	N/A

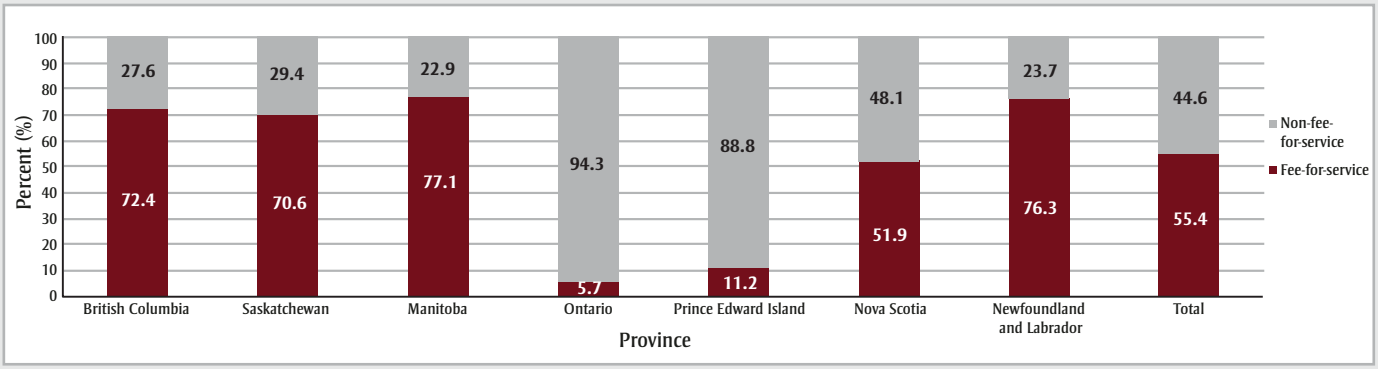
Abbreviations: FFS, fee-for-service; NFFS, non-fee-for-service.

Notes: N/A signifies counts that were not available and could not be calculated. "—" signifies counts greater than 0 but less than 5, which were suppressed and not included in the totals. Percentages were calculated based on non-rounded counts. Counts were randomly rounded to an adjacent multiple of 10.

[a] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

[b] For Ontario and Newfoundland and Labrador, data were only available for ≥ 67 years; Saskatchewan data were for ≥ 65 years.

FIGURE 1
Proportion of physicians by remuneration method (fee-for-service vs. non-fee-for-service)[a] and by province, fiscal years 2014/15 to 2015/16



[a] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

Edward Island had the highest percentage of missed cases (26.7%) from FFS physicians, while Nova Scotia had the lowest (3.8%). For NFFS physicians, Newfoundland and Labrador had the highest percentage of missed cases (36.8%). Nova Scotia had the lowest percentage of missed cases (4.8%) among NFFS physicians (Figure 3).

For patients aged 1 to 19 years for whom the prescribing physician was remunerated by the FFS method, 50% of the cases were missing in Prince Edward Island. Manitoba had the lowest (15.2%) for this physician type and age group. Prince Edward Island had the highest percentage (22.2%) of missed cases among the 20 to 64 age group, while Nova Scotia had the lowest (5.9%). For those aged 65 years and older, Prince Edward Island had the highest percentage (20.0%) of missed cases, while Nova Scotia had the lowest (2.8%).

For patients aged 1 to 19 years for whom the prescribing physician was remunerated by the NFFS method, British Columbia had the highest percentage (53.3%) of missed cases and Nova Scotia had the lowest (3.2%). British Columbia had the highest percentage (23.1%) of missed cases among the patients aged 20 to 64 for whom the prescribing physician was paid by NFFS methods, while Nova Scotia had the lowest (7.4%). For patients 65 years of age or older for whom the prescribing physician was remunerated by NFFS methods, Newfoundland and Labrador had the highest percentage (36.8%) of missed cases, while Nova Scotia had the lowest (4.2%; Figure 4).

Figure 5 presents the diabetes incidence rates* adjusted for cases missed by both FFS and NFFS methods among those aged one year and older (72% of the denominator), except for in Ontario and Newfoundland and Labrador, where data were reported for residents aged 67 years and older, and in Saskatchewan, where data were reported for residents aged 65 and older. Ontario and Saskatchewan had the highest incidence rate (1.5% for both), adjusted from 1.4% in Ontario and 1.4% in Saskatchewan. Newfoundland and Labrador experienced the lowest incidence rate of 0.43%, adjusted from the observed rate of 0.38%. The largest percentage change between the observed and adjusted rates was for Prince Edward Island (22.5%) and the smallest was for Nova Scotia (4.7%).

Discussion

The aim of this study was to estimate the completeness of the physician billings data for estimating chronic disease. Overall, 13.5% of cases were missed. We determined that the overall percentage of missed cases found among FFS physicians was generally similar to that for NFSS physicians (14.8% vs. 12.2%, respectively). However, differences varied by province; for example in Nova Scotia, the missing rates were very similar for FFS and NFFS (3.8% and 4.8%, respectively); whereas the rates were very different in Newfoundland and Labrador (6.9% and 36.8%, respectively), where physicians do not practise shadow billing.[33]

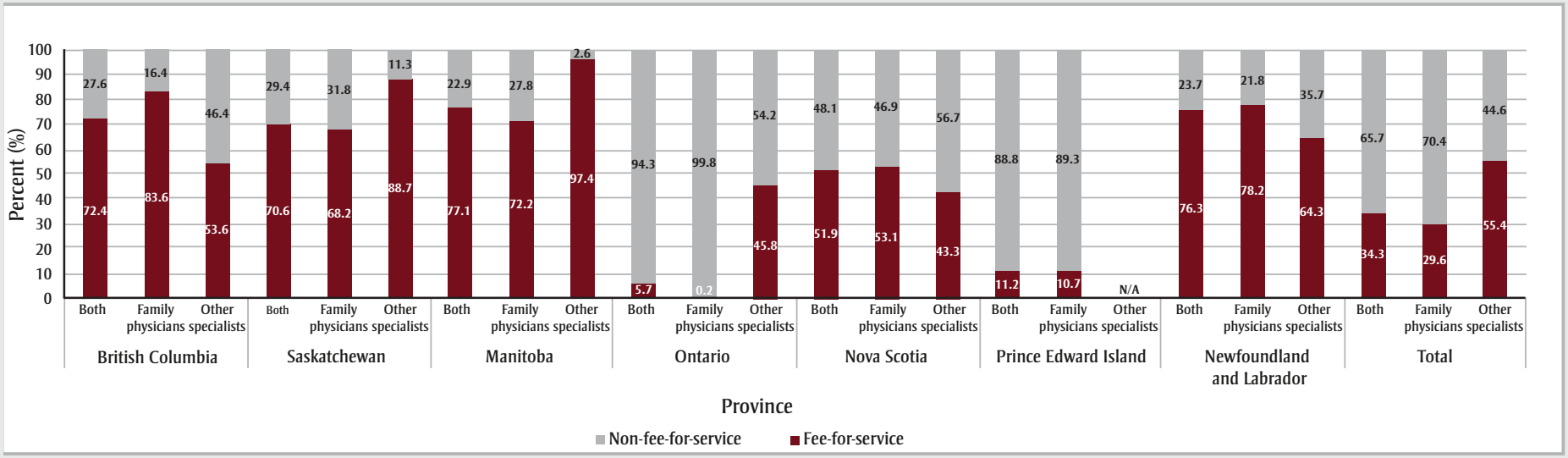
We expected some missed cases among FFS physicians. Some physician billing claims may not be captured in claims databases, possibly through administrative error or failure to submit claims. Compared to NFFS physicians, FFS physicians may have seen more patients with other health problems that were not recorded because there was not enough room on the claim form.[32] One potential source of discordance between diabetes prescriptions and presence of diagnostic information on physician billing claims is misclassification bias, as some FFS physicians may have a NFFS component to their practice or may have changed to NFFS remuneration. Hybrid payment methods and changes in payments are not always captured in the provincial provider registries and may vary across provinces. Heterogeneity across provinces in the capture of remuneration method and shadow-billed claims was reported in a previously published paper.[19]

The percentage of missed cases was higher in the younger physician age groups, compared to older age groups, for both FFS and NFFS physicians, suggesting that the sensitivity of ascertainment differs based on the age of the physicians. Finally, the physicians who prescribed the initial glucose-lowering therapy may not be the primary care provider, or therapy may have been discontinued, or it may have been initiated for reasons other than diabetes.

Our study found similarities and differences with a study conducted in Manitoba.[20] Previously, Lix et al. reported that a smaller percentage of FFS physicians' cases were missing a diabetes diagnosis:

* The methods were tailored to the specific purpose of this study; therefore, these rates are not comparable to those in other CCDSS publications.

FIGURE 2
Proportion of physicians by remuneration method (fee-for-service vs. non-fee-for-service)[a] and type (family physician vs. other specialist),[b] by province, fiscal years 2014/15 to 2015/16

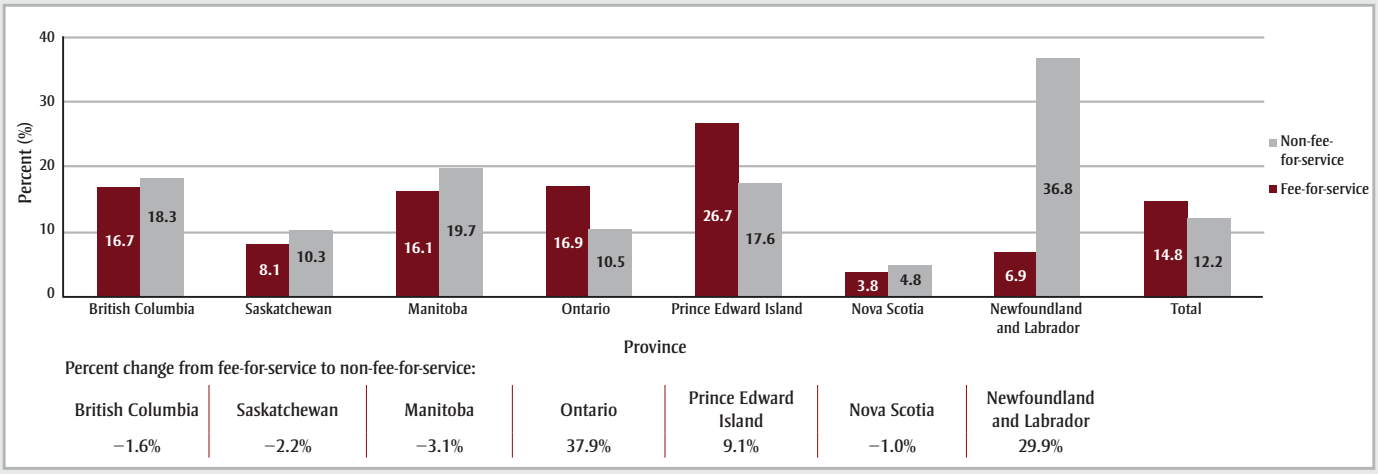


Notes: In Ontario, many family physicians who provide comprehensive care of the type that would be managing patients with chronic diseases such as diabetes are no longer being paid solely on a fee-for-service basis.[32]

[a] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

[b] Types of physicians include family physician, other specialist, or both.

FIGURE 3
Proportion of missed cases by provider remuneration method (fee-for-service vs. non-fee-for-service)[a] and by province, fiscal years 2014/15 to 2015/16



Notes: Percentages were calculated based on non-rounded counts. Counts were randomly rounded to an adjacent multiple of 10.

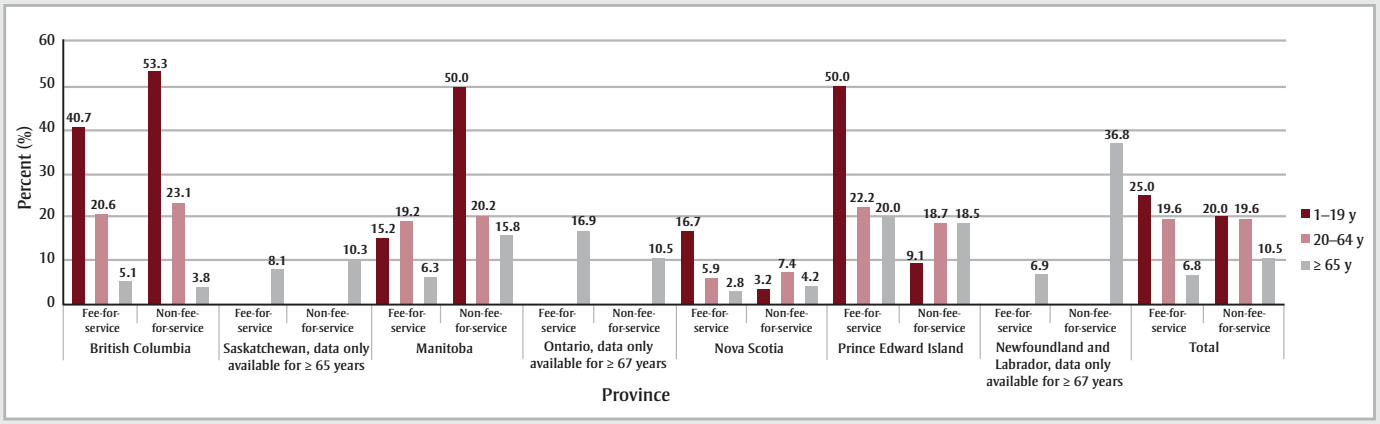
[a] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

14.9% vs. 18.7% for NFFS physicians. In our study, the percentage of missed cases among FFS and NFFS physicians was more similar overall (14.8% and 12.2%, respectively), although the percentage remained relatively smaller among FFS physicians in Manitoba (16.1%, compared with 19.7% for NFSS physicians). The Manitoba study also found a higher percentage of missed diagnoses in the younger age group than the older age group. We also found that a greater percentage of FFS patients were younger, whereas a greater percentage of NFSS patients were older. In the previous Manitoba study,[20] the percentage change between the observed and adjusted results for cases missed by both FFS and NFFS diabetes incidence rates was 15.8%, while in our study, the percentage change was 20.2% for Manitoba.

Underestimation of disease incidence when using administrative data (i.e. hospital discharge abstracts and physician billing claims) may occur because of different billing practices and policies. For example, if a jurisdiction has a large number of missing cases from NFFS physicians, it may mean that they are not practising shadow billing. Thus, it may be important to monitor missing cases by remuneration type over time to consider any adjustments or data quality documentation for reporting.

It is also important to consider strategies for adjusting prevalence and incidence estimates for possible underestimation. One strategy may be to use prescription drug data to estimate the physician billing claims records underestimation for disease surveillance, although using this data source alone may not be sufficient.[5] When prescription drug data were used, for example, based on the CCDSS case definition, we estimated a 0.9% crude diabetes incidence rate in the Manitoba population

FIGURE 4
Proportion of missed cases by provider remuneration method (fee-for-service vs. non-fee-for-service),[a] by patient age group and by province, 2014/15 to 2015/16

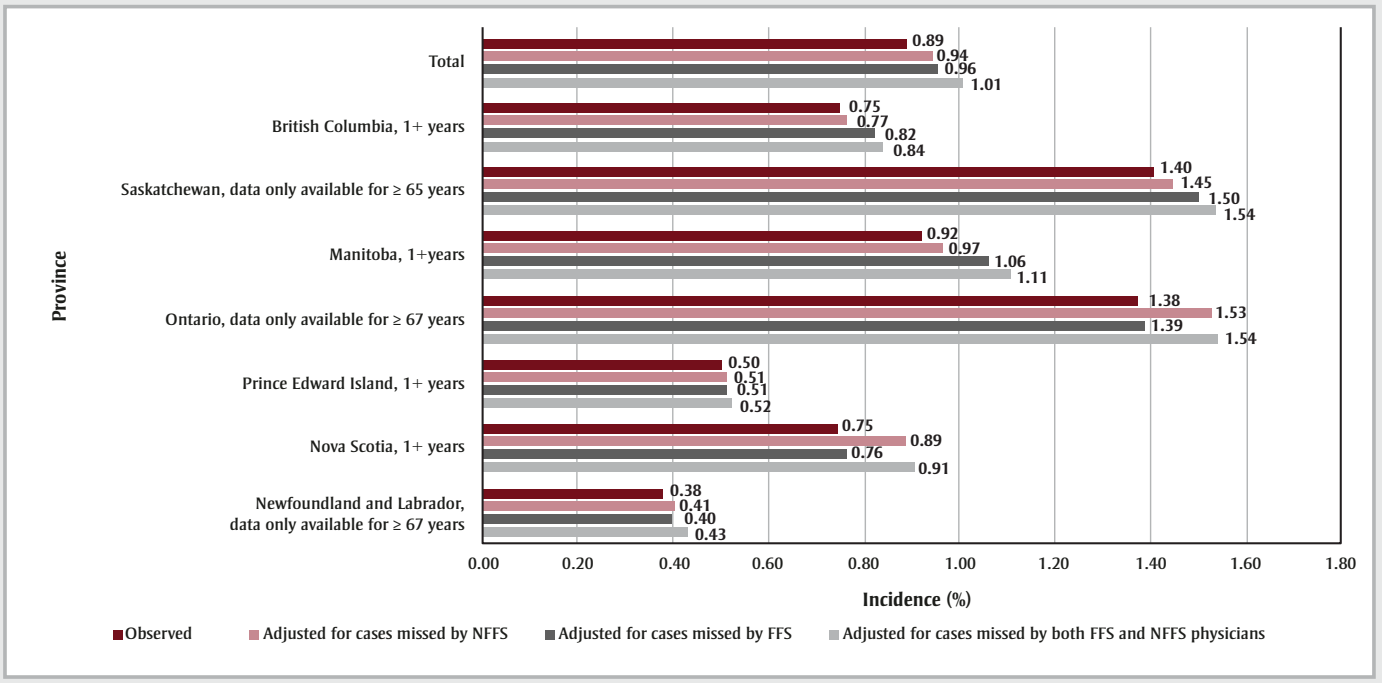


Abbreviation: y, years.

Notes: Missing data: counts were not available and statistics could not be calculated. Percentages were calculated based on non-rounded counts. Counts were randomly rounded to an adjacent multiple of 10.

[a] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

FIGURE 5
Crude observed and adjusted incidence rates[a] (%) of diabetes to account for cases missed, by remuneration method (fee-for-service vs. non-fee-for-service)[b] and by province, fiscal years 2014/15 to 2015/16



Abbreviations: FFS, fee-for-service; NFFS, non-fee-for-service.

Notes: Percentages were calculated based on non-rounded counts. Counts were randomly rounded to an adjacent multiple of 10. The methods were tailored to the specific purpose of this study; therefore, these rates are not comparable to those in other CCDSS publications.

[a] The CCDSS cannot currently accurately differentiate between type 1 and type 2 diabetes over time.

[b] Fee-for-service physicians were paid 100% on a fee-for-service basis. Non-fee-for-service physicians received other forms of payment (less than 100% fee-for-service).

aged 1 year and older during the study period (Figure 5). However, when cases identified in the prescription drug data were used to adjust for underestimation, the incidence rate increased to 1.1%.* An additional strategy may be to use other population-based data such as electronic medical records, which are increasingly being adopted in population-based chronic disease research and surveillance studies to adjust for underestimation.[34]

Strengths and limitations

Our study has several strengths. It included data from multiple provinces, which improves the generalizability of the findings relative to previous single-province studies. Also, it uses data from the CCDSS, which uses a validated standardized case definition for diabetes. Additionally, the method could be applied to other heath conditions for which the sensitivity and specificity of prescription drug data for case capture is high.

The study also has limitations. First, cases that were missed may have been overestimated because women of childbearing age with gestational diabetes were not excluded from the prescription drug databases of British Columbia, Manitoba, Quebec, Prince Edward Island and Nova Scotia (72% of the denominator). However, the overestimation was likely minimal, considering the rate of gestational diabetes[35] and considering that a significant proportion of the cohort were either males or aged 65 and over.

Second, physicians were classified as either FFS or NFFS, but many physicians are now paid through blended remuneration schemes or may have changed from one method to another over the study period. However, given that we used only two fiscal years of diabetes prescription information, the possibility of physicians switching payment method during the study period may be minimal.

Third, the results may be sensitive to the definitions used to ascertain missed and non-missed cases. We examined the two-year periods before and after the index prescription date; these periods were chosen to align with the observation period required by the CCDSS diabetes case definition. Previous research has shown that when prescription drug data were added to the CCDSS diabetes case definition in the adult population, the sensitivity was 90.7%, specificity was 97.5% and PPV was 81.5%,[5] versus 89.3%, 97.6% and 81.9%,[5] respectively, without prescription claims. Other research showed that 5.6% of diabetes cases were missed when prescription claims records were excluded[36] and Tu et al. found that when a combination of prescriptions for antidiabetic medications and laboratory tests results is used, patients with diabetes can be identified within an electronic medical record (EMR) with accuracy similar to administrative data.[4] While it is possible that individuals without diabetes might receive a prescription for a diabetes drug, the contribution of these false positives to the percentage of missed cases is unknown.

Fourth, our findings are not applicable to diabetes patients treated with lifestyle modification only, as they are not captured in prescription drug data. Fifth, the completeness of prescription drug data varied as Ontario and Newfoundland and Labrador data were available for patients aged 67 and older and Saskatchewan data for patients aged 65 and older. Sixth, while age-standardized rates were not required

to examine the impact of missing physician billings within a province, readers should use caution for cross-jurisdictional comparisons.

Conclusion

We adopted a population-based approach to assessing the completeness of physician billing claims data for chronic disease surveillance. We relied upon prescription drug data to evaluate completeness; this source is known to be sensitive for diabetes case ascertainment.[5] Our study showed that when using prescription drug data to assess the completeness of cases in the CCDSS, there is loss of data. Overall, the percentage of missed cases was comparable across physician remuneration methods. However, this varied widely by province. Where it did occur, loss of data may have contributed to underestimation of disease incidence. The method we used could be applied over time and in other jurisdictions to address systematic differences in shadow billing practices, as well as to other chronic diseases for which drug therapy could serve as reference data source.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors's contributions

JE—conceptualization, formal analysis, methodology, project administration, validation, visualization, writing—original draft, writing—review and editing. YJG—formal analysis, methodology, validation. KH—conceptualization, methodology, project administration, writing—original draft, writing—review and editing. SB—conceptualization, methodology, project administration, validation, writing—original draft, writing—review and editing. HG—visualization, writing—original draft, writing—review and editing. LY—formal analysis, methodology. KAMP, AA, MG, PL, YL, YN, JS, RP—data curation, methodology, validation, visualization, writing—review and editing. LML—conceptualization, methodology, supervision, visualization, writing—original draft, writing—review and editing. JMP—methodology, visualization, writing—original draft, writing—review and editing.

Statement

The analyses, conclusions, opinions and statements expressed in this article are those of the authors and do not reflect those of the funding or data sources; no endorsement by PHAC, CIHI, the provincial/territorial governments or the Government of Canada is intended or should be inferred.

References

1. Public Health Agency of Canada. The Canadian Chronic Disease Surveillance System — an overview [Internet]. Ottawa (ON): Government of Canada; [updated 2020, cited 2020 August]. Available from: https://www.canada.ca/en/public-health/services/publications/canadian-chronic-disease-surveillance-system-factsheet.html

2. Alshammari AM, Hux JE. The impact of non-fee-for-service reimbursement on chronic disease surveillance using administrative data. Can J Public Health. 2009;100(6):472-4. https://doi.org/10.1007/BF03404347

3. Wranik DW, Durier-Copp M. Physician remuneration methods for family physicians in Canada: expected outcomes and lessons learned. Health Care Anal. 2010;18(1):35-59. https://doi.org/10.1007/s10728-008-0105-9

4. Tu K, Manuel D, Lam K, Kavanagh D, Mitiku TF, Guo H. Diabetics can be identified in an electronic medical record using laboratory tests and prescriptions. J Clin Epidemiol. 2011; 64(4):431-5. https://doi.org/10.1016/j.jclinepi.2010.04.007

5. Lipscombe LL, Hwee J, Webster L, Shah BR, Booth GL, Tu K. Identifying diabetes cases from administrative data: a population-based validation study. BMC Health Serv. Res. 2018;18(1):316. https://doi.org/10.1186/s12913-018-3148-0

6. Nakhla M, Simard M, Dube M, et al. Identifying pediatric diabetes cases from health administrative data: a population-based validation study in Quebec, Canada. Clin Epidemiol. 2019;11:833-43. https://doi.org/10.2147/CLEP.S217969

7. Kiran T, Victor JC, Kopp A, Shah BR, Glazier RH. The relationship between primary care models and processes of diabetes care in Ontario. Can J Diabetes. 2014;38(3):172-8. https://doi.org/10.1016/j.jcjd.2014.01.015

8. Shiff NJ, Jama S, Boden C, Lix LM. Validation of administrative health data for the pediatric population: a scoping review. BMC Health Serv Res. 2014;14: 236. https://doi.org/10.1186/1472-6963-14-236

9. Leong A, Dasgupta K, Bernatsky S, Lacaille D, Avina-Zubieta A, Rahme E. Systematic review and meta-analysis of validation studies on a diabetes case definition from health administrative records. PLOS ONE. 2013; 8(10): e75256. https://doi.org/10.1371/journal.pone.0075256

10. Lix LM, Yogendran MS, Leslie WD, et al. Using multiple data features improved the validity of osteoporosis case ascertainment from administrative databases. J Clin Epidemiol. 2008;61(12): 1250-60. https://doi.org/10.1016/j.jclinepi.2008.02.002

11. Simard M, Dubé M, Gaulin M, Trépanier P-L, Bureau d'information et d'études en santé des populations, Institut national de santé publique du Québec (INSP). La prévalence de la multimorbidité au Québec : portrait pour l'année 2016-2017 [The prevalence of multimorbidity in Quebec: portrait for 2016-2017] [Internet]. Québec City (QC): INSP; 2019 [cited 2020 Jul]. Available from: https://collections.banq.qc.ca/ark:/52327/3993949

12. BC Centre for Disease Control. Chronic disease dashboard [Internet]. Victoria (BC): BC Centre for Disease Control; [updated 2020, cited 2020 Jul]. Available from: http://www.bccdc.ca/health-professionals/data-reports/chronic-disease-dashboard

13. Manitoba Health, Provincial Information Management and Analytics. Annual statistics: 2020–2021. Winnipeg (MB): Manitoba Health; [updated 2020, cited 2023 Aug]. 103 p. Available from: https://www.gov.mb.ca/health/annstats/as2021.pdf

14. Government of Prince Edward Island. Health for all Islanders: promote, prevent, protect—PEI CPHO report 2016. Charlottetown (PE): Government of Prince Edward Island; 2016. 84 p. Available from: https://www.princeedwardisland.ca/sites/default/files/publications/cphorpt16_linkd.pdf

15. Saskatchewan Ministry of Health. Stroke surveillance in Saskatchewan 2014/2015. Regina (SK): Saskatchewan Ministry of Health; 2019 [cited 2020 Jul]. 8 p. Available from: https://publications.saskatchewan.ca/api/v1/products/103315/formats/114576/download

16. Diabetes Care Program of Nova Scotia, Nova Scotia Health Authority. Nova Scotia diabetes statistics report 2016. Halifax (NS): Diabetes Care Program of Nova Scotia; 2016. 89 p. Available from: https://www.cdha.nshealth.ca/diabetes-care-program-nova-scotia/ns-diabetes-statistics

17. Canadian Institute for Health Information (CIHI). The status of alternative payment programs for physicians in Canada, 2003–2004 and preliminary information for 2004–2005. Ottawa (ON): CIHI; 2006 [cited 2022 Apr]. 40 p. Available from: https://publications.gc.ca/collections/Collection/H115-13-2004E.pdf

18. Canadian Institute for Health Information (CIHI). Physicians in Canada, 2019. [Slide deck.] Ottawa (ON): CIHI; 2020. 59 p. Available from: https://www.cihi.ca/sites/default/files/document/physicians-in-canada-report-en.pdf

19. Lix LM, Walker R, Quan H, et al. Features of physician services databases in Canada. Chron Dis Inj Can. 2012; 32(4):186-93.

20. Lix LM, Kuwornu JP, Kroeker K, et al. Estimating the completeness of physician billing claims for diabetes case ascertainment using population-based prescription drug data. Health Promot Chron Dis Prev Can. 2016;36(3):54-60. https://doi.org/10.24095/hpcdp.36.3.02

21. Erler A, Beyer M, Muth C, Gerlach FM, Brennecke R. Garbage in - garbage out? Validität von Abrechnungsdiagnosen in hausärztlichen Praxen [Garbage in - garbage out? Validity of coded diagnoses from GP claims records]. Gesundheitswesen. 2007;71(12):823-31. German. https://doi.org/10.1055/s-0029-1214399

22. Public Health Agency of Canada. Canadian Chronic Disease Surveillance System (CCDSS) [Internet]. Ottawa (ON): Government of Canada; [modified 2023 Aug 28; cited 2023 Aug 28]. Available from: https://health-infobase.canada.ca/ccdss/

23. World Health Organization. International classification of diseases, ninth revision, clinical modification (ICD-9-CM) [Internet]. Geneva (CH): WHO; 1977. Available from: https://www.cdc.gov/nchs/icd/icd9cm.htm

24. World Health Organization. Canadian coding standards for ICD-10-CA and CCI. 2022. Available from: https://secure.cihi.ca/estore/productSeries.htm?pc=PCC189

25. Government of Canada. Osteoporosis and related fractures in Canada: report from the Canadian Chronic Disease Surveillance System 2020 [Internet]. Ottawa (ON): Government of Canada; 2020 [cited 2021 Aug]. Available from: https://www.canada.ca/en/public-health/services/publications/diseases-conditions/osteoporosis-related-fractures-2020.html#tc2

26. Magliano DJ, Chen L, Islam RM, et al. Trends in the incidence of diagnosed diabetes: a multicountry analysis of aggregate data from 22 million diagnoses in high-income and middle-income settings. 2021;9(4):203-11. https://doi.org/10.1016/s2213-8587(20)30402-2

27. Lix LM, Ayles J, Bartholomew S, et al. The Canadian Chronic Disease Surveillance System: a model for collaborative surveillance. Int J Popul Data Sci. 2018;3(3):433. https://doi.org/10.23889/ijpds.v3i3.433

28. Hux J, Ivis F, Flintloft V, Bica A. Determination of prevalence and incidence using a validated administrative data algorithm. Diabetes Care. 2002;25(3):512-6. https://doi.org/10.2337/diacare.25.3.512

29. World Health Organization. International statistical classification of diseases, injuries, and causes of death, 9th revision. Geneva (CH): WHO; 1977. Available from: https://apps.who.int/iris/bitstream/handle/10665/40492/9241540044_eng_v1_p1.pdf;sequence=1

30. World Health Organization. International statistical classification of diseases and related health problems, tenth revision, 2nd ed. Geneva (CH): WHO; 2004. Available from: https://apps.who.int/iris/handle/10665/42980

31. SAS Institute, Inc. SAS/STAT 9.4 User's Guide. Cary (NC): SAS Institute, Inc.; 2011.

32. Kiran T, Kopp A, Moineddin R, Glazier RH. Longitudinal evaluation of physician payment reform and team-based care for chronic disease management and prevention. CMAJ. 2015;187(17): E494-E502. https://doi.org/10.1503/cmaj.150579

33. Squires J, Sikdar K, Stares J, Collins K. Enhancing chronic disease surveillance in Newfoundland and Labrador: adjustment of rates based on physician payment method. St. John's (NL): Centre for Health Information Newfoundland & Labrador; 2010. 17 p. Available from: https://www.nlchi.nl.ca/images/Physician_Payment_Method_Model_June_2010.pdf

34. Desai JR, Wu P, Nichols GA, Lieu TA, O'Connor PJ. Diabetes and asthma case identification, validation, and representativeness when using electronic health data to construct registries for comparative effectiveness and epidemiologic research. Med Care. 2012;50:S30-S35. https://doi.org/10.1097/MLR.0b013e318259c011

35. Centre for Surveillance and Applied Research, Public Health Agency of Canada. Perinatal Health Indicators Data Tool, 2020 edition. Public Health Infobase. Ottawa (ON): Public Health Agency of Canada; 2020. Available from: https://health-infobase.canada.ca/phi/data-tool/index?Dom=1

36. Koleba T, Pohar SL, Johnson JA. Prescription drug data and the National Diabetes Surveillance System case definition. Can J Diabetes. 2007;31(1):47-53. https://doi.org/10.1016/S1499-2671(07)11010-8