The Projection of Prevalence and Cost of Diabetes in Canada: 2000 to 2016

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ABSTRACT

OBJECTIVE

The objective of this study was to project the prevalence and cost of diabetes mellitus in Canada and its provinces for the years 2000 to 2016.

METHOD

The total costs per capita, including hospitalizations, day procedures, physician services, prescription drugs and estimated outpatient dialysis services, for individuals with diabetes were measured using 1996 administrative data from Saskatchewan Health, Saskatchewan, Canada, and organized within 5-year age groups. The general population projection was based on the Statistics Canada provincial median population projections from 2000 to 2016. Diabetes incidence, prevalence and mortality projections for this time period were obtained from previous projection estimates for Manitoba, Canada.

RESULTS

The number of individuals with diabetes in the general population in Canada will increase from approximately 1.4 million patients in 2000 to 2.4 million patients in 2016. The total healthcare costs are projected to increase from Can $4.66 billion

RÉSUMÉ

OBJECTIF

L'objectif de cette étude était d'extrapoler la prévalence et les coûts du diabète sucré au Canada et dans chaque province de 2000 à 2016.

MÉTHODE

Le coût total per capita du traitement du diabète, comprenant les hospitalisations, les interventions d'un jour, les services des médecins, les médicaments délivrés sur ordonnance et les services externes estimatifs de dialyse, a été calculé à partir des données administratives de 1996 de la Saskatchewan, Canada, et partagé en tranches d'âge de 5 ans. La projection pour la population générale était basée sur les projections médianes de la population de Statistique Canada entre 2000 et 2016. Les projections de l'incidence et de la prévalence du diabète ainsi que de la mortalité liée au diabète pour cette période ont été obtenues à partir de projections antérieures pour le Manitoba, Canada.

RÉSULTATS

Le nombre de personnes atteintes de diabète dans la population générale au Canada passera d'environ 1,4 million en 2000 à 2,4 millions en 2016. On prévoit que le coût total des soins de santé passera de 4,66 milliards de dollars canadiens en 2000 à 8,14 milliards de dollars canadiens en 2016 (valeur du dollar de 1996). On a observé d'importantes différences des tendances des coûts liés au diabète d'une province et d'un territoire à l'autre.

CONCLUSION

Le modèle de projection utilisé pour cette étude a montré que si la hausse de la prévalence du diabète suit les tendances actuelles, les coûts des soins de santé pour les personnes atteintes de diabète au Canada augmenteront de 75 % entre 2000 et 2016.

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Keywords: comorbidity, cost, diabetes complications, incident cases, modelling, mortality, prevalent cases

in 2000 to $8.14 billion in 2016 (1996 dollar values). Important differences in diabetes-related cost trends were noted across provinces and territories.

CONCLUSION

The projection model used in this study showed that if the increase in the prevalence of diabetes follows current trends, healthcare costs for people with diabetes in Canada will increase by 75% between 2000 and 2016.

INTRODUCTION

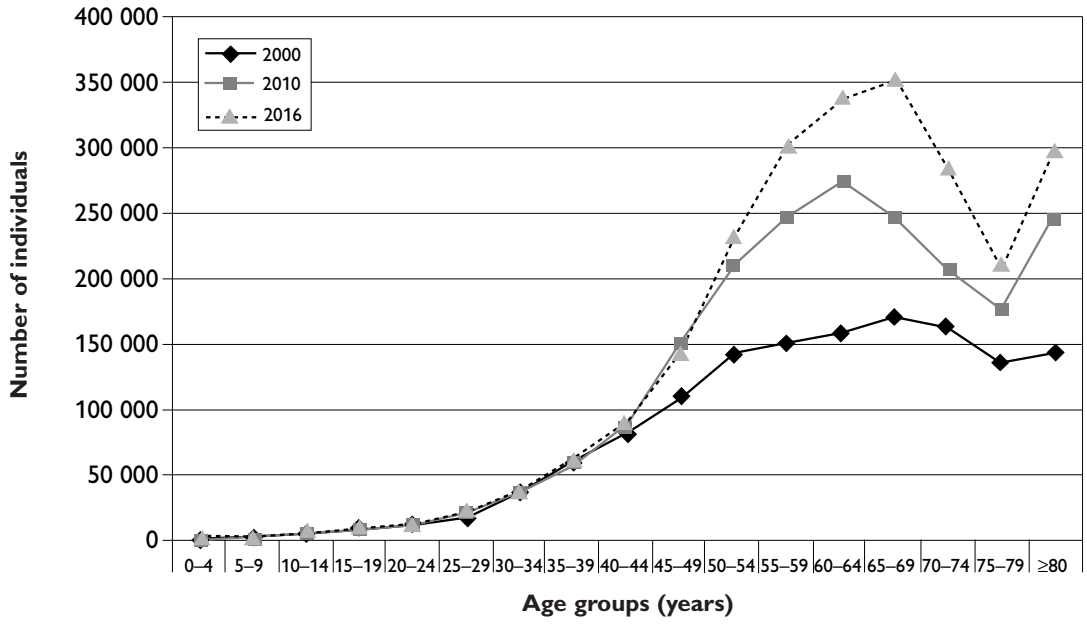
Chronic conditions, including diabetes mellitus and cardiovascular disease (CVD), impart a major health burden in Canada in terms of economic, clinical and humanistic outcomes. As the prevalence and severity of diabetes increase with age, the ageing of the population will likely increase the economic burden of the consequences of diabetes to society.

The economic burden of diabetes in Canada is an important piece of information for government and insurance planners. Available estimates, however, have been based on models and assumptions, not on actual observed healthcare costs for populations, and have varied greatly. For example, Health Canada estimated that the direct cost of hospitalization and drug therapy for diabetes in Canada in 1998 was almost Can $400 million (1). Dawson and colleagues recently estimated that the direct medical costs of diabetes and related comorbidities in 1998 were US $2.6 billion, or approximately Can $3.86 billion (2).

Using United States (US) data, Caro and colleagues focussed on individual characteristics of persons with diabetes to model the progression of the costs of diabetes over time resulting from increasing comorbidities (3). Added to this progression is the increasing incidence of diabetes in a population; this trend was projected into the future for the US, but the model did not take changes in age- and sex-specific incidence and mortality rates into account (4). Using a dynamic forecasting model, which accounts for both incidence and mortality rates, Blanchard and colleagues projected the prevalence of diabetes in Canada and the province of Manitoba in the coming decade (5). Their report also incorporated complications and comorbidities of diabetes, and associated costs, although they did not calculate overall costs, or costs for specific age groups or for specific types of cases. More recently, the authors' group reported the increasing costs associated with diabetes and major comorbidities, obtained using administrative data from Saskatchewan Health, Saskatchewan, Canada (6).

The objective of this study was to project the prevalence of diabetes and the associated healthcare costs in Canada and its provinces for the years 2000 to 2016, taking into account

Figure 1. Predicted age-specific diabetes population in Canada in 2000, 2010 and 2016



population-based age distribution along with age-specific prevalence of diabetes and healthcare costs.

METHOD

Identification of base population

The base population was identified using the Statistics Canada population projections for Canada, and all Canadian provinces and territories (7). From the various population projection models, a median projection model was selected to represent the changing patterns of the population during the projection period from 2000 to 2016. Since the other data in the authors' projection model did not include sex, males and females were combined in the projections. The data were generally divided into 5-year age bands; the last age group was ≥80 years of age. Statistics Canada population projections do not include Registered First Nations people, so this subgroup was assumed to have the same increase in prevalence of diabetes as the general population. The general population projections were calculated separately for all of Canada and for each Canadian province and territory.

Projections of the incidence and prevalence of diabetes

The model associates age-specific incidence and prevalence rates of diabetes with specific age groups in future years. The prevalence of diabetes in the Canadian general population was estimated by multiplying the yearly population estimates by the incidence, prevalence and mortality rates for persons with diabetes as modelled by Blanchard and colleagues for Manitoba (5,8). Estimates of population growth are not available for Registered First Nations people, so, for the purposes of modelling, they were assumed to be equal to those of the general population.

For general projections of mortality rate, the modelled increase in deaths (about 50% over the entire time period) in Manitoba (5) during the time period was assumed to apply to the entire population of Canadians with diabetes. Age-specific mortality rates were obtained from the 1996 data for people with diabetes in Saskatchewan (9). These data were projected to increase linearly in each age group over time to correspond with the general change in mortality rates.

Healthcare costs

Healthcare costs were estimated based on administrative data from 34 444 individuals who met the study criteria for having diabetes in Saskatchewan in 1996 (6,9). Saskatchewan Health provides coverage for the use of hospital, medical and drug services to all residents of Saskatchewan and these individuals are registered with the province. Persons who were identified within the linkable administrative databases as having a clinical diagnosis of diabetes in the years of 1991 to 1996 were included in the current analysis. Individuals were classified as having diabetes if, during the period from 1991 to 1996, they had ≥1 outpatient dispensation record for

Table 1. Predicted healthcare costs of patients with diabetes in Canadian provinces and territories between 2000 and 2016

	Healthcare costs (millions of $)*				*% change (2000–2016)*		
	2000	**2005**	**2010**	**2016**	**Healthcare cost**	**Total population**	**Diabetes prevalence**
Newfoundland	79.4	94.0	111.3	135.4	70.5	-4.3	64.8
Prince Edward Island	21.9	25.3	29.4	35.7	63.0	5.9	62.3
Nova Scotia	149.8	175.5	206.0	249.3	66.4	2.9	63.5
New Brunswick	119.0	139.8	164.1	198.0	66.4	-0.6	62.7
Quebec	1295.4	1508.8	1747.0	2069.0	59.7	2.0	53.2
Ontario	1763.0	2131.0	2551.4	3143.6	78.3	18.2	76.5
Manitoba	189.6	214.9	247.9	295.3	55.8	2.8	52.1
Saskatchewan	165.8	188.7	214.5	250.3	51.0	0.1	50.1
Alberta	386.1	477.6	584.2	733.3	89.9	14.0	85.8
British Columbia	635.1	775.9	941.2	1177.9	85.5	22.6	84.3
Yukon	3.0	3.7	4.6	6.0	103.9	2.9	87.1
Northwest Territories	3.1	4.0	5.3	7.1	128.3	11.5	107.8
Nunavut	1.4	2.0	2.8	3.7	170.1	27.1	146.3
Canada (totals)†	4657.8	5592.5	6658.1	8142.7	74.8	11.9	71.9

*Monetary values are expressed in 1996 Canadian dollars.
†Values were obtained from the Canadian total population projection model.

insulin or an oral antihyperglycemic agent, ≥2 physician visits with a diagnosis of diabetes within a 2-year period, or ≥1 hospitalization for diabetes, using the International Classification of Diseases, Ninth Revision (ICD-9), diagnostic code 250 (6,9). Due to lack of data on drug therapy, this cohort did not include Registered First Nations people.

Total healthcare costs per capita for hospitalizations, physician services, prescription drugs, day surgeries and estimated outpatient dialysis were calculated for persons in 5-year age bands (6,9). The costs of incident, prevalent and death cases were estimated separately for each year to allow for a specific cost distribution for each of these groups. The total healthcare costs per capita for each 5-year age band were multiplied by the projected number of persons in the group for each of the years 2000 to 2016. The results are shown both by age groups and by the total costs in each projected year. All cost estimates are expressed in 1996 Canadian dollars.

Costs were initially categorized according to major diabetes-related complications: CV, renal and ophthalmic (i.e. ICD-9-based claims by ophthalmologists and drug costs) (6). Because the amputation-related costs were very small (<0.1% of the total costs), they were included in the costs for "other conditions." The percentage of people with comorbidities in each age group was assumed to remain the same for all future years.

The average total costs per capita for incident and prevalent cases of diabetes based on Saskatchewan data were $3343 and $3203, respectively. The variation between these costs within age groups was small except for in younger age groups (i.e. <20 years) where the costs for incident cases of diabetes were $1500 to $4000 greater than for prevalent cases. The costs for individuals who died during the year were more than 3 times greater than the costs for survivors. The number of deaths was very low in the age groups <40 years (9).

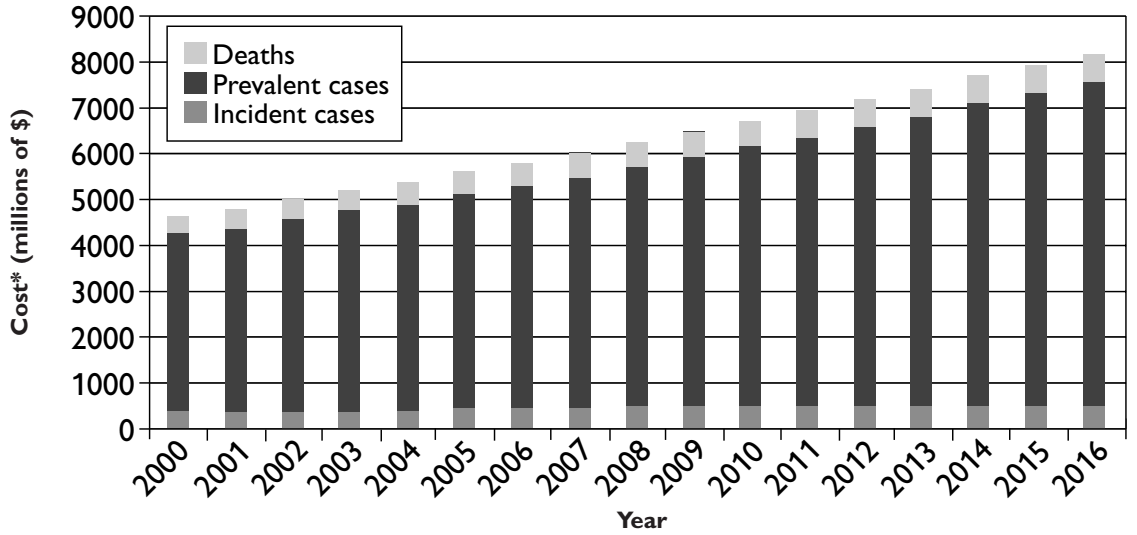
The diabetes cost projection estimates were tested for variations in the Canadian population projections (7).

RESULTS

The projection model showed that the number of prevalent cases of diabetes in Canada will increase from 1.4 million persons in 2000 to approximately 2.0 million persons in 2010 and 2.4 million persons in 2016 (Figure 1). This indicates an increase in the number of cases of diabetes in Canada of approximately 72%, while the estimated population of 30.75 million persons in 2000 is projected to increase by about 12% by 2016. The increase in the population of people with diabetes will be highest in Alberta, British Columbia, Ontario, and the territories (Table 1). The prevalence of diabetes will be highest in the age groups between 55 years and 69 years and in the group ≥80 years (Figure 1) and will largely result from the ageing of the Canadian population (7).

Based on this model, the total healthcare costs for individuals with diabetes in Canada are estimated to increase by approximately 75% from $4.66 billion in 2000 to >$8.14 billion in 2016 (Table 1). The increase in the costs of diabetes per province largely reflects the changes in the provincial population of people with diabetes. The greatest increase in costs will occur in the territories (>100%), Alberta (89.9%), and British Columbia (85.5%) (Table 1), again reflecting the relatively greater ageing of these populations.

Figure 2. Distribution of the direct healthcare costs for individuals with diabetes in Canada by diabetes status (i.e. incident, prevalent or death cases), 2000–2016



*Monetary values are expressed in 1996 Canadian dollars.

The model also showed that the overall national increase in costs largely results from the 81% increase in the costs of prevalent cases of diabetes from 2000 to 2016 (Figure 2). During the same time period, the total costs of incident cases of diabetes will increase by about 36%, and the costs of cases of death of people with diabetes will increase by approximately 51%. The proportion of costs due to prevalent cases of diabetes will increase from 82.6% to 85.7% during this time period (Figure 2).

During the projection period, the overall healthcare costs will not change substantially in the youngest age groups, i.e. those ≤49 years of age, and the increase in total costs will be highest in the older age groups. In the age groups of 55 years to 59 years, 60 years to 64 years, 65 years to 69 years and ≥80 years, the increase in healthcare costs will be 99%, 110%, 102% and 96%, respectively (Figure 3).

Costs attributable to CV diagnoses will account for approximately 27.0% of the total healthcare costs for individuals with diabetes, nephropathy and dialysis will account for approximately 6.8% and ophthalmic diseases for about 2.5% (Figure 4). Approximately 64% of the total healthcare costs are attributed to other reasons, including amputations. Hospital costs represent the largest proportion of the costs of managing individuals with diabetes, accounting for about 50% of the costs of prevalent cases of diabetes and patients with diabetes who died during the year, and about 60% of the costs of incident cases of diabetes (9).

The influence of the selected Statistics Canada population growth scenario to the whole Canada cost projections was ±1.8% in year 2016 when a high or low population growth scenario was compared to the medium growth scenario.

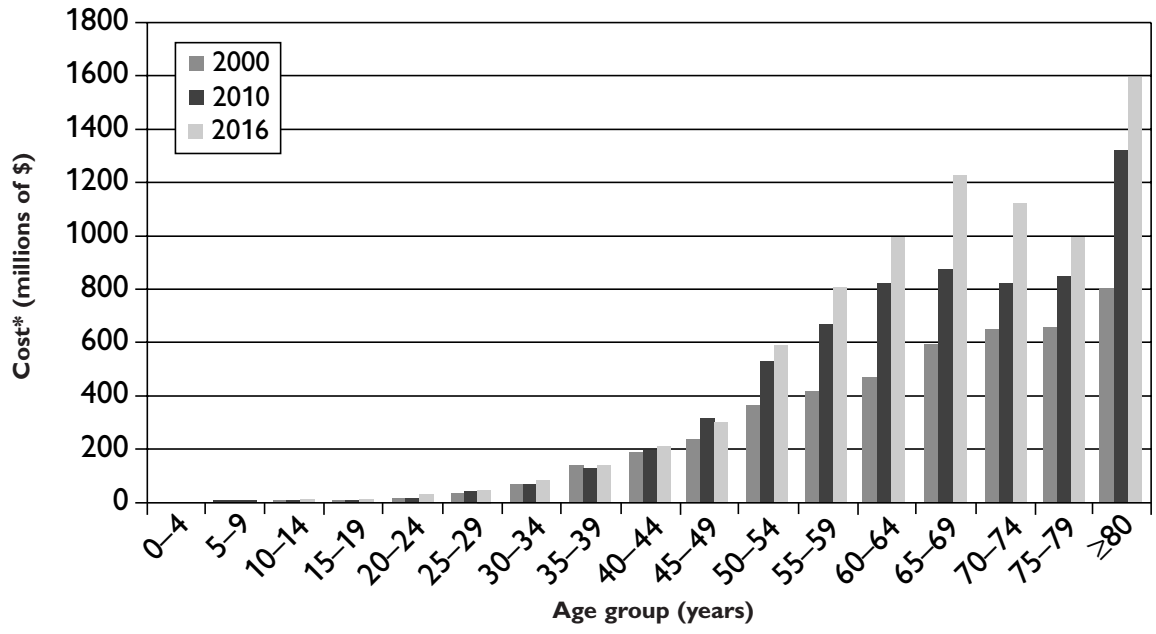
DISCUSSION

The projection model showed that if the current trends continue, both the number of individuals with diabetes and the healthcare costs in Canada will increase by >70% between the years 2000 and 2016. During this time period, the overall population is projected to increase by 12%, while the prevalence of diabetes will increase by ≈72%. These changes will be highest in the provinces that have the highest increase in their population size and where the ageing of the population is rapid.

Analysis of costs according to the age of the population with diabetes demonstrated that the costs will increase most in the age groups between 55 years and 69 years, and in the group ≥80 years. The increase in the number of persons with diabetes will be greatest in these age groups. Because the mean costs in the age groups <65 years are less than or equal to the overall mean values of costs, the total costs of patients with diabetes will not increase at much higher a rate than the prevalence of diabetes. Cost increases will be greatest for cases of diabetes that remain in the prevalence stage. Given the distribution of costs for major comorbidities, it is likely that CV complications will contribute to a substantial proportion of the increase (6).

The current model has several advantages over previous estimates, including incorporation of more refined age

Figure 3. Projected total direct healthcare costs for individuals with diabetes in Canada by age group in 2000, 2010 and 2016



*Monetary values are expressed in 1996 Canadian dollars.

groups (5-year intervals), allowing for improved alignment between population changes, changes in disease state and costs; and identification of changes due to complications and disease progression.

The reliability of the cost data is very good, since it is based on administrative data from Saskatchewan Health, which are relatively complete in terms of the number of patients, their diagnoses and healthcare costs (9). The model utilized 1996 dollar values. Inflation adjustment with respect to the Consumer Price Index from 1996 to 2003 would increase these estimates by 15.5% (10).

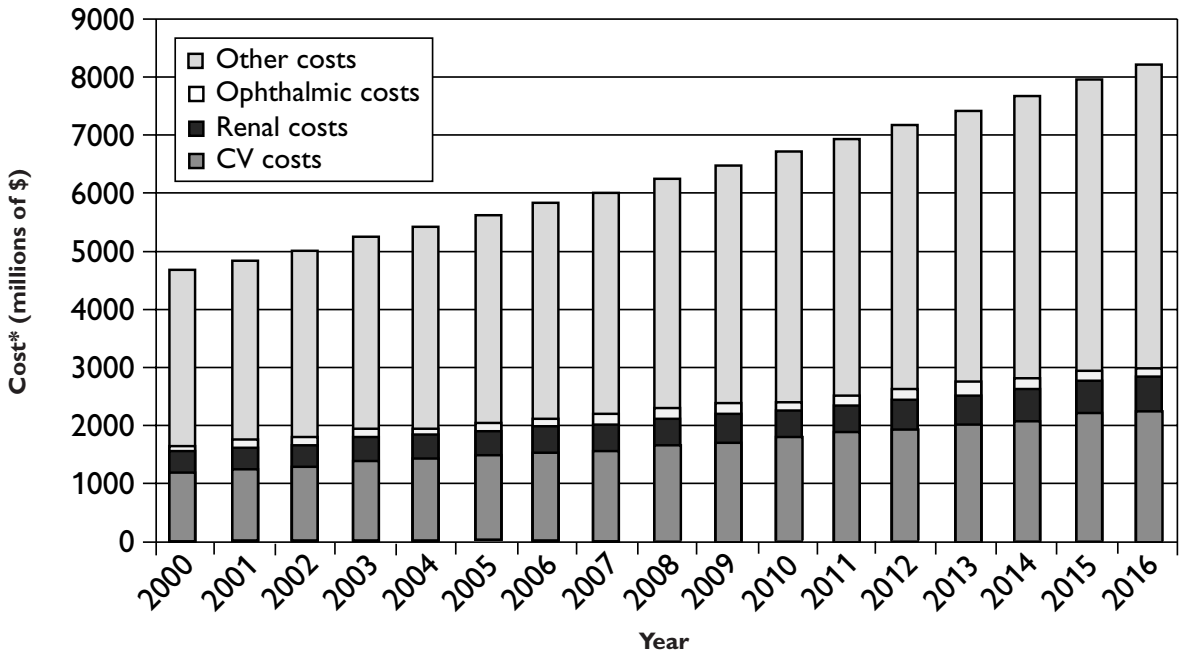
Nevertheless, there are some uncertainties in the projection model, including: 1) population projections for Canada and its provinces; 2) the projected rates of diabetes in the population; 3) changes in patterns and management of diabetes comorbidities and complications; and 4) estimates of total healthcare costs per capita.

Statistics Canada's median projection of population changes was used in this model. This represents a relatively conservative estimate of change in the total population. A sensitivity analysis of the different Canadian population projections showed that the high and low population growth projections had very minor impacts on the diabetes-related costs at the end of the projected time period. However, it is likely that the population projections in some of the provinces may be overestimated or underestimated, e.g. depending on the in and out migration.

Defining the proportion of the general population with diabetes is a challenging task. Except for the drug-use criteria, the authors' case definition has been validated for the populations of people with diabetes in Manitoba (8) and Ontario (11), and has been adopted by the National Diabetes Surveillance System (12). The increase in the prevalence of diabetes is assumed to follow a linear model derived from Manitoba (5). In the model, the increase in the population with diabetes is mainly the result of the ageing of the population, i.e. increase of the population with a high risk of diabetes. Although the age-specific incidence rates of diabetes do not vary much from 2000 to 2016, the excess of new cases of diabetes compared to deaths of the patients with diabetes causes a constant increase in the prevalence of diabetes. It is likely that the changes in the incidence and prevalence rates of diabetes will be fairly similar in all Canadian provinces, indicating that the projection model derived from Manitoba can be used for the entire country.

Comparison of the results of this study to those of Dawson and colleagues for Canada in 1998 (2) shows that the number of diagnosed prevalent cases of diabetes is comparable to the projection for this study for the year 2000. The estimate of direct medical costs by Dawson and colleagues (Can $3.86 billion) is about 17% lower than that found in this study, indicating that these 2 studies resulted in relatively comparable estimates of total healthcare cost at the beginning of the period (2). The diabetes cost projections of

Figure 4. Distribution of the direct healthcare costs for individuals with diabetes by major comorbidities and other reasons for utilization of health services, 2000–2016



*Monetary values are expressed in 1996 Canadian dollars.

CV = cardiovascular

Dawson and colleagues were calculated using the proportion of total 1998 health expenditures that could be allocated to diabetes (2). The major difference between these 2 estimation methods is in the costs of the complications: the present study showed a significantly higher proportion of costs related to renal disease (6.8%) and ophthalmic diseases (2.5%) (6) compared to estimates by Dawson and colleagues (1.9% and 0.2%, respectively) (2). These differences are likely due to different inclusion criteria for costs, and differences in data sources.

It is possible that changes might occur in risk factors for diabetes that were not identified in this study based on the historical trends in incidence, prevalence and mortality rates of diabetes. These changes, e.g. in lifestyle or immigration patterns among ethnic groups with a high prevalence of diabetes, could bias the prevalence and cost estimates in either direction. The authors plan future analyses based on longer periods of observation and more stable estimates for the incidence and prevalence of major complications and comorbidities in people with diabetes.

The model used in this study was based on the assumption that the prevalence rates of major comorbidities such as CVD and renal disease would remain constant during the projected time period. Furthermore, the projections in this study cannot completely account for changes in management strategies for diabetes and comorbidities and complications of diabetes. An increasing number of patients with diabetes will live for longer periods of time, and it is possible that the proportion of individuals with diabetes-related complications in older age groups will increase. Recent increases in the rate of dialysis among older subjects, for example, are not reflected in the projections of this study. Therefore, it is likely that these projections will underestimate total healthcare costs. Conversely, the model also assumes that beneficial, preventive effects of initiatives, such as the use of acetylsalicylic acid or angiotensin converting enzyme inhibitor, will remain constant during the projected period. If the use of these practices continues to increase and the prevention of long-term complications becomes more common in clinical practice, this model may overestimate healthcare costs. The currently available data do not permit the estimation of the relative changes in comorbidity rates over time.

Several limitations in the cost estimates have been discussed previously (6,9). The databases used in this study do not record services provided at the health district level, such as those associated with diabetes educators and dietitians in both the inpatient and outpatient settings, podiatry, and auxiliary costs of transplants (e.g. transplant coordinators and costs for living donors). As these resources are paid for from the global budget at the health district level, they are not captured separately in the provincial administrative databases. Costs for these services cannot be estimated with the approach used in this study, so the overall total costs are therefore underestimated.

Finally, a major restriction of the model is that it does not include the Aboriginal population as a separate group. According to the model of Blanchard and colleagues (5), the prevalence and diabetes-related costs of the Aboriginal peoples will increase at a much higher rate than in the general population, especially because of the greater increases in the younger adult age groups (i.e. 30 years to 55 years). In this present projection model, the authors elected to not project prevalence and costs for this population because of limited data on the costs (i.e. prescription medications) for Registered First Nations people in Saskatchewan and population projections in Canada. The cost estimates will therefore be underestimates of the true future cost of healthcare for diabetes in Canada and in the provinces with large Aboriginal populations.

The projection model presented in this paper demonstrates prevalence and estimates cost trends for the situation where nothing changes in the future. The utilization of the model is thus largely restricted to planning healthcare resources and budgets. The real challenge of the cost modelling is to estimate the possible influence of new treatments and diabetes prevention programs (13-15). In the future, the authors plan to use this prevalence and cost projection model to estimate the cost-effectiveness of such interventions and programs.

ACKNOWLEDGEMENTS

This project was supported by grants from GlaxoSmithKline, the Institute of Health Economics and the Alberta Heritage Foundation for Medical Research (AHFMR). The data were provided to the Institute of Health Economics in-kind by Saskatchewan Health.

Jeffrey A. Johnson holds a Canada Research Chair in Diabetes Health Outcomes and a Population Health Investigator Award with the Alberta Heritage Foundation for Medical Research.

The authors thank Winanne Downey, Patricia Beck and William Osei from the Population Health Branch of Saskatchewan Health, and members of the Alliance for Canadian Health Outcomes Research in Diabetes (ACHORD) for their comments on an earlier draft of this manuscript.

This study is based in part on de-identified data provided by Saskatchewan Health. The interpretation and conclusions contained herein do not necessarily represent those of the Government of Saskatchewan or Saskatchewan Health.

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