

Estimates of the Number of Prevalent and Incident Human Immunodeficiency Virus (HIV) Infections in Canada, 2008

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ABSTRACT

Objective: To estimate the number of prevalent and incident HIV infections in Canada in 2008.

Methods: We applied multiple methods to estimate national HIV prevalence and incidence in Canada, including the workbook method, two statistical modelling methods, and an iterative spreadsheet model.

Results: The estimated number of people living with diagnosed or undiagnosed HIV infection (including AIDS) continues to rise, from an estimated 57,000 in 2005 to 65,000 in 2008. Nearly half (48%) of these HIV-infected persons were men who have sex with men (MSM) and 22% were women. An estimated 16,900 persons with prevalent infection (26% of total prevalent infections) were unaware of their HIV-infected status and this proportion varied from an estimated 19% of HIV-infected MSM, to 25% of HIV-infected people who inject drugs, and 35% of HIV-infected heterosexuals. An estimated 3,300 new infections occurred in Canada in 2008, which was about the same as the estimate of 3,200 in 2005. Of those new infections, 26% were among women and 12.5% were of Aboriginal descent; in terms of exposure category, MSM continued to comprise the greatest proportion of new infections (44%) and heterosexuals who originated in countries where HIV is endemic comprised 16%.

Conclusion: HIV incidence in Canada is not decreasing. Aboriginal people and people from HIV-endemic countries continue to be over-represented in Canada's HIV epidemic. People unaware of their HIV infection are a priority for being tested and diagnosed to enable them to take advantage of care services and receive counselling to prevent further spread of HIV.

Key words: HIV; prevalence; incidence

La traduction du résumé se trouve à la fin de l'article.

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The Centre for Communicable Diseases and Infection Control (CCDIC) of the Public Health Agency of Canada (PHAC) monitors the epidemiology and trends of infectious diseases of public health importance in Canada, including HIV/AIDS (human immunodeficiency virus/acquired immunodeficiency syndrome). To help accomplish this, CCDIC conducts ongoing surveillance of diagnosed cases of HIV and AIDS and presents these national surveillance data in reports that provide a description of persons diagnosed with HIV or AIDS in Canada.¹ However, surveillance data do not fully reflect the magnitude of the HIV epidemic because such data are subject to reporting delays, under-reporting and changing patterns in HIV testing behaviours. Surveillance data also do not include individuals who are untested and undiagnosed.

To provide a more accurate picture of the HIV epidemic, estimates of HIV prevalence (the total number of people who are living with HIV at a point in time) and incidence (the number of new HIV infections in a population in a defined period of time) are required, and the development of such estimates is a task undertaken around the world to monitor the HIV epidemic.²⁻⁸ Estimates of HIV prevalence are important to help plan treatment and care services, and estimates of HIV incidence support the development and evaluation of prevention programs.

We used surveillance data along with additional sources of information and statistical modelling to estimate the number of prevalent and incident HIV infections in Canada in 2008, including both diagnosed and undiagnosed cases.

METHODS

We applied multiple methods to estimate the national number of prevalent and incident HIV infections in Canada in 2008, including the workbook method,⁶ two statistical modelling methods,^{9,10} and an iterative spreadsheet model.¹¹ The workbook method focused on identifying populations that are at high risk of infection through their risk behaviours and these populations were classified according to the following exposure categories: men who have sex with men (MSM), people who inject drugs (PWID), a separate category for persons with both risk behaviours (MSM-PWID), heterosexual/endemic (non-PWID heterosexual with origin in a country where heterosexual sex is the predominant mode of HIV transmission and HIV prevalence is high (primarily countries in sub-Saharan Africa and the Caribbean)), heterosexual/non-endemic

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Table 1. Estimated Number of Prevalent HIV Infections and Associated Ranges of Uncertainty in Canada at the End of 2008 and 2005 by Exposure Category, Sex and Ethnicity (Point Estimates, Ranges and Percentages Are Rounded)

Classification	2008			2005		
	Point	Range	Percentage	Point	Range	Percentage
Exposure category*						
MSM	31,330	25,400-37,200	48%	27,700	22,400-33,000	48%
MSM-PWID	2030	1400-2700	3%	1820	1200-2400	3%
PWID	11,180	9000-13,400	17%	10,100	8100-12,100	18%
Heterosexual/non-endemic	10,710	8300-13,100	17%	9050	7000-11,100	16%
Heterosexual/endemic	9250	6800-11,700	14%	7860	5800-9900	14%
Others	500	300-700	1%	470	280-660	1%
Sex						
Female	14,300	12,200-16,400	22%	12,200	10,400-14,000	22%
Male	50,700	41,800-59,600	78%	44,800	36,600-53,000	78%
Ethnicity						
Aboriginal	5200	4300-6100	8.0%	4200	3500-4900	7.4%
Non-Aboriginal	59,800	49,700-69,900	92.0%	52,800	43,500-62,100	92.6%
Total	65,000	54,000-76,000	100%	57,000	47,000-67,000	100%

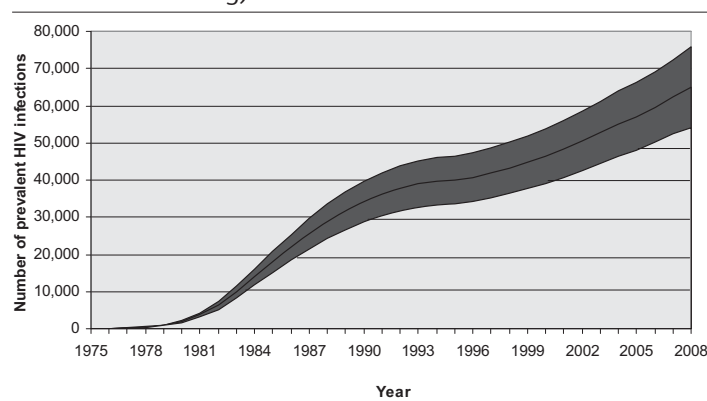
* MSM: men who have sex with men; MSM-PWID: men who have sex with men and inject drugs; PWID: people who inject drugs; Heterosexual/non-endemic: heterosexual contact with a person who is either HIV-infected or at risk for HIV or heterosexual contact as the only identified risk; Heterosexual/endemic: origin in a country where HIV is endemic; Other: recipients of blood transfusion or clotting factor, perinatal and occupational transmission.

(non-PWID heterosexual who has had sexual contact with a person who is either HIV-infected or at risk for HIV, or heterosexual contact as the only identified risk) and other (primarily recipients of blood transfusion or clotting factor, perinatal and occupational transmission).¹ The number of prevalent or incident HIV infections was calculated for each population by multiplying an estimated prevalence or incidence rate by an estimated population size; data for these rates and populations were obtained from the Canadian research literature. The total estimated number of prevalent or incident infections for a province was the sum of the estimated number in each population. The statistical modelling methods calculated incident infections based on a parametric formulation of duration of time between HIV infection and the diagnosis of HIV infection; in brief, these models backcalculated HIV incidence from HIV surveillance data on diagnosed cases and from data on the HIV testing behaviour of these populations.^{9,10} The iterative spreadsheet model incorporated elements of workbook and statistical modelling methods.¹¹ The results of these methods were averaged to generate exposure category-specific estimated numbers of prevalent and incident HIV infections in Ontario, Quebec, British Columbia, Alberta, Saskatchewan and Manitoba. Over 98% of HIV and AIDS cases in Canada are reported from these provinces.¹

The remaining four provinces and three territories of Canada had insufficient data to use the above methods and we derived estimates for these provinces and territories by extrapolating from the above 6 provinces based on the respective proportions in provincial/territorial HIV surveillance data, stratified by exposure category. These surveillance data were obtained from the national HIV and AIDS surveillance reporting system¹ with enhancements from two sources: the Laboratory Enhancement Study in Ontario¹² and surveillance data from Quebec.¹³ The overall national number of prevalent or incident HIV infections was calculated as the sum of the number across all provinces and territories.

Estimates of the numbers of prevalent and incident HIV infections among women and Aboriginal persons were derived from the overall estimates using the distribution of cases by reported gender and Aboriginal status from the national HIV and AIDS surveillance data, stratified by province/territory.

The number of undiagnosed individuals living with HIV infection in Canada was computed as the current number of prevalent infections (which includes both diagnosed and undiagnosed cases) minus

Figure 1. Estimated number of prevalent HIV infections in Canada by year (range of uncertainty indicated by shading)

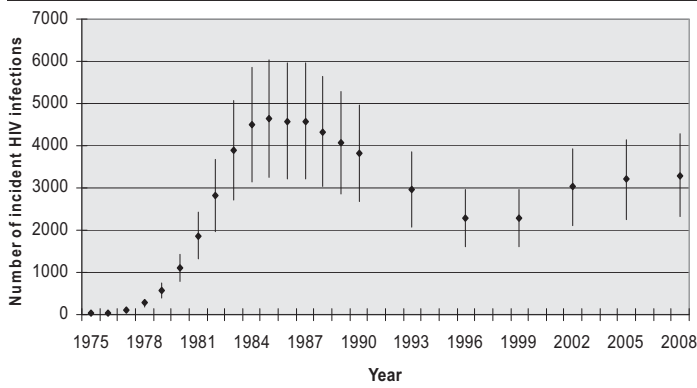
the number of living diagnosed cases, for each exposure category and then summed. The number of living diagnosed cases was calculated as the cumulative number of diagnosed cases, adjusted for duplicates and under-reporting (using unpublished data from provincial and national HIV surveillance systems) and mortality (using data from Statistics Canada, provincial vital statistics, national reports of AIDS deaths¹ and Canadian cohort studies¹⁴⁻¹⁶). We also validated these estimated proportions of HIV-infected persons who are undiagnosed by comparing with directly measured proportions from data in Canada's national second generation HIV surveillance program among people who inject drugs and among gay, bisexual and other men who have sex with men (refs. 17,18; PHAC, unpublished data). In this program, participants are asked if they are aware of their HIV status and a blood sample is taken to directly assess HIV status.

Ranges of uncertainty for the national HIV estimates were developed based on a conservative consideration of results from a variety of modelled scenarios. This approach to uncertainty is similar to the approach taken in other fields (e.g., information theory and artificial intelligence) where information of varying quality is combined. It also relates to work in public health where decisions are based on expert judgement in addition to formal statistical inference.¹⁹

RESULTS

At the end of 2008, an estimated total of 65,000 (range: 54,000-76,000) people in Canada were living with diagnosed or undiag-

Figure 2. Estimated number of incident HIV infections in Canada for selected years (bars indicate range of uncertainty)



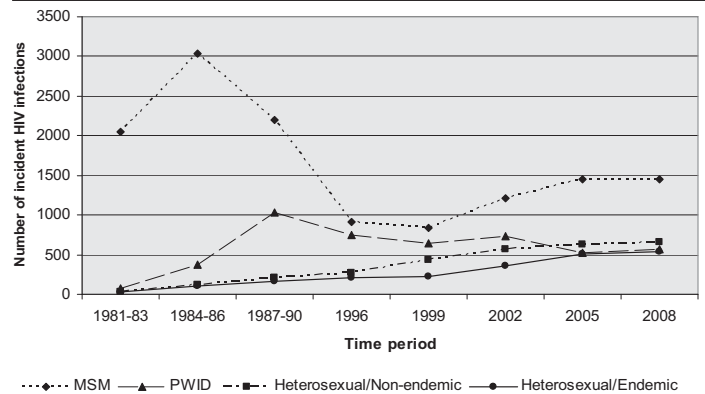
nosed HIV infection (including AIDS), a 14% increase from the 2005 estimate (Table 1). The estimated prevalence rate in Canada in 2008 was 0.2% (range: 0.16-0.23%). Figure 1 presents the estimated number of prevalent HIV infections over time in Canada with associated ranges of uncertainty.

The estimated number of new HIV infections in 2008 was 3,300 (range: 2,300-4,300) which was about the same as the estimate in 2005 (Table 2). The estimated incidence rate in Canada in 2008 was 9.9 per 100,000 population (range: 6.9-12.9 per 100,000 population). The proportion of new infections attributed to the heterosexual/endemic exposure category was 16% whereas approximately 2.2% of the Canadian population were born in an HIV-endemic country.²⁰ Therefore, the estimated incidence rate in 2008 among individuals from HIV-endemic countries was 8.5 times higher than among other Canadians (72.5 per 100,000 population among people from HIV-endemic countries and 8.5 per 100,000 population among other Canadians). Figure 2 presents the estimated number of incident HIV infections over time and Figure 3 presents this trend by exposure category.

There were an estimated 14,300 (12,200-16,400) women living with diagnosed or undiagnosed HIV infection (including AIDS) in Canada (22% of the national total) at the end of 2008, compared to 12,200 (10,400-14,000) estimated for 2005 (Table 1). For incidence, there were 860 (600 to 1,120) new HIV infections among women (26% of all new infections) in 2008, very similar to the estimate of 845 (590 to 1,100) for 2005 (26% of all new infections) (Table 2). With respect to exposure category, a slightly lower proportion of new HIV infections among women was attributed to the heterosexual category in 2008 compared to 2005 (71% versus 73%), whereas a slightly higher proportion was attributed to PWID (29% in 2008 and 27% in 2005).

An estimated 5,200 (4,300 to 6,100) Aboriginal persons were living with diagnosed or undiagnosed HIV infection (including AIDS) in Canada in 2008, representing 8.0% of all prevalent HIV infections, compared to 4,200 (3,500 to 4,900) (7.4%) in 2005. An estimated 410 (300 to 520) new HIV infections occurred in Aboriginal persons in 2008 (12.5% of all new infections) and the corresponding figure for 2005 was 335 (240 to 430) (10.5%). Since Aboriginal persons represent 3.8% of the Canadian population,²¹ the HIV incidence rate among Aboriginal persons was about 3.6 times higher than among non-Aboriginal persons in 2008 (32.6 per 100,000 for Aboriginal population and 9.0 per 100,000 for non-Aboriginal pop-

Figure 3. Estimated number of incident HIV infections per year over time period in Canada, by exposure category (range of uncertainty omitted)



ulation). The proportion of new infections in Aboriginal persons attributed to PWID was 66% in 2008 and 63% in 2005.

There have been 67,442 positive HIV tests reported to CCDIC from November 1985, when testing began, to December 2008,¹ which translates to about 70,400 after adjusting for under-reporting and duplicates. Of these, we further estimated that approximately 22,300 have died. Thus, there were an estimated 48,100 Canadians living with HIV infection in 2008 who were aware of their HIV-infected status. Since there was an estimated total of 65,000 persons living with diagnosed or undiagnosed HIV infection (including AIDS) in Canada in 2008, the remaining 16,900 (range of 12,800-21,000) persons, or 26% of prevalent infections, were unaware of their HIV infection. This figure was slightly less than the estimate of 27% in 2005. The estimated proportion of persons unaware of their HIV infection varied by exposure category (19% in MSM, 25% in PWID, and 35% in the two combined heterosexual exposure categories).

DISCUSSION

Approximately 65,000 Canadians were estimated to be living with diagnosed or undiagnosed HIV infection (including AIDS) at the end of 2008. This number will increase as new infections continue and survival improves due to new treatments, which will mean increased future care requirements. The estimated number of new infections occurring in Canada in 2008 was about the same as the estimated number for 2005; overall HIV incidence is not decreasing in Canada.

Estimated HIV incidence among the PWID exposure category in Canada in 2008 was slightly higher compared to the 2005 estimates. However, the HIV epidemic in this group shows different trends in different jurisdictions in Canada. In the majority of jurisdictions, the trend in reported newly diagnosed cases of HIV infection in PWID was stable or declining,¹ which is consistent with the trend in most high-income countries. The role of injecting drug use in national epidemics in Europe and the United States has declined over the past decade.²² In contrast, injecting drug use was the main HIV exposure category among Aboriginal persons in Canada, and the overlap group of persons who both were Aboriginal and inject drugs accounted for the majority of the increasing number of new diagnoses of HIV infection reported in the province of Saskatchewan in recent years.¹ We found that HIV incidence among MSM in Canada increased from 1999 to 2005, but levelled

Table 2. Estimated Number of Incident HIV Infections and Associated Ranges of Uncertainty in Canada in 2008 and 2005 by Exposure Category, Sex and Ethnicity (Point Estimates, Ranges and Percentages Are Rounded)

Classification	2008			2005		
	Point	Range	Percentage	Point	Range	Percentage
Exposure category*						
MSM	1450	1000-1900	44%	1450	1000-1900	45%
MSM-PWID	90	50-130	3%	85	40-130	3%
PWID	570	390-750	17%	520	360-680	16%
Heterosexual/non-endemic	655	450-860	20%	630	440-820	20%
Heterosexual/endemic	530	370-690	16%	515	360-670	16%
Others	<20			<20		
Sex						
Female	860	600-1120	26%	845	590-1100	26%
Male	2440	1700-3180	74%	2355	1610-3100	74%
Ethnicity						
Aboriginal	410	300-520	12.5%	335	240-430	10.5%
Non-Aboriginal	2890	2000-3780	87.5%	2865	1960-3770	89.5%
Total	3300	2300-4300	100%	3200	2200-4200	100%

* See footnote to Table 1

off from 2005 to 2008. The re-emergence of the epidemic among MSM is clearly apparent in many high-income countries from 2000 to 2005.²²⁻²⁴ Heterosexual HIV transmission (combined heterosexual/non-endemic and heterosexual/endemic categories) accounted for 36% of new infections in Canada in 2008, which is similar to the rate in Western Europe (29%)²² and to the epidemic in the United States (slightly more than one third of new HIV infections).^{2,22}

Despite widespread availability of anti-retroviral treatment and extensive promotion of HIV testing, an estimated 26% of HIV infections remained undiagnosed in Canada in 2008. This situation is similar to that in other high-income countries. For example, the proportion of HIV-infected persons who were undiagnosed was estimated to be 21% in the USA in 2006,² 30% in the EU in 2008,²⁵ and 27% in the UK in 2008.²⁶ We estimated that 19% of people living with HIV among MSM in Canada were unaware of their HIV-infected status, which is comparable with a recent report (20%) from Australia,²⁷ slightly lower than the rates estimated in the US (23.5%)²⁸ and the UK (26.9%),²⁶ and much lower than the rate from a survey in Scotland (41.7%).²⁹ We estimated that 25% of people living with HIV among those who inject drugs in Canada were unaware of their HIV status, which is similar to recent estimates in the UK (25.5%),²⁶ but higher than estimates in the US (14.5% of male PWID and 13.7% of female PWID).²⁸ We estimated that 35% of people living with HIV in the heterosexual exposure category in Canada were unaware of their serostatus, which is slightly higher than the rates estimated in the UK (27.1%)²⁶ and the US (26.7% of men and 21.1% of women).²⁸ The size of the undiagnosed group is difficult to estimate because without testing, its members are "hidden" to the health care and disease monitoring systems. It is important to reach this group since undiagnosed individuals are unable to benefit from available treatments or appropriate counselling to prevent the further spread of HIV. The transmission rate of HIV from undiagnosed persons is likely higher than from tested and diagnosed persons,³⁰ and studies have found that the frequency of high-risk sexual behaviour was reduced substantially after HIV diagnosis.³¹ Stemming the HIV/AIDS epidemic requires increasing the number and proportion of people living with HIV who are tested and informed of their serostatus.³⁰

The HIV estimation process in Canada used a combination of methods and included data from a wide variety of sources. However, the data available were not always sufficient for the methods to estimate exposure category-specific numbers. Several other lim-

itations need to be acknowledged. Estimates for the Aboriginal sub-population relied on ethnic variables in the HIV and AIDS surveillance data that were not consistently reported at the national level. Exposure category information in surveillance data was also incomplete and this may have led to the misclassification of some cases. Furthermore, insufficient information was available to distinguish infections acquired outside Canada from those acquired within. These national estimates do not necessarily reflect local trends in HIV prevalence and incidence. For example, we found that new HIV diagnoses among the PWID exposure category were stable or declining in the majority of jurisdictions, while there was a substantial increase in recent years in the province of Saskatchewan.¹ The estimates were not stratified by age because of insufficient data. Despite these limitations, these evidence-based estimates of prevalent and incident HIV infections portray a plausible picture of the epidemic in Canada in 2008 and provide a robust foundation to further the development of HIV/AIDS policies and programs.

Aboriginal people and people from HIV-endemic countries continue to be over-represented in Canada's HIV epidemic. These findings highlight the need for specific measures to address the unique aspects of the HIV epidemic within certain subpopulations. To successfully control the HIV epidemic in Canada, more effective strategies deployed on an appropriate scale are needed to prevent new infections and provide services for all key populations. In addition, the availability of high-quality data is essential for developing reliable estimates to better understand and monitor the full scope of the HIV epidemic in Canada.

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RÉSUMÉ

Objectif : Estimer le nombre d'infections à VIH prévalentes et incidentes au Canada en 2008.

Méthode : Nous avons estimé la prévalence et l'incidence nationales du VIH au Canada par la méthode des cahiers, deux méthodes de modélisation statistique et un modèle itératif sur feuille de calcul électronique.

Résultats : Le nombre estimatif de personnes vivant avec une infection à VIH diagnostiquée ou non diagnostiquée (y compris le sida) continue d'augmenter. Il est passé d'environ 57 000 en 2005 à 65 000 en 2008. Près de la moitié (48 %) de ces personnes infectées par le VIH étaient des hommes ayant des relations sexuelles avec des hommes (HRSH), et 22 % étaient des femmes. Environ 16 900 personnes ayant une infection prévalente (soit 26 % de cette population) ignoraient qu'elles étaient infectées. Cette proportion variait : elle était d'environ 19 % chez les HRSH, de 25 % chez les utilisateurs de drogues injectables et de 35 % chez les hétérosexuels. Il y a eu quelque 3 300 nouveaux cas d'infection au Canada en 2008, environ le même nombre qu'en 2005 (3 200 selon les estimations). Sur ces nouveaux cas d'infection, 26 % étaient des femmes et 12,5 % étaient des personnes d'ascendance autochtone; du point de vue du risque, les HRSH représentaient encore la plus grande proportion des nouveaux cas d'infection (44 %), et les hétérosexuels venant de pays où le VIH est endémique représentaient 16 % des cas.

Conclusion : L'incidence du VIH au Canada ne diminue pas. Les Autochtones et les ressortissants de pays où le VIH est endémique sont encore surreprésentés dans l'épidémie de VIH au Canada. Les personnes qui ignorent qu'elles sont infectées par le VIH devraient être testées et diagnostiquées en priorité pour qu'elles puissent recevoir les soins et les conseils nécessaires pour prévenir la propagation du virus.

Mots clés : VIH; prévalence; incidence