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Coverage of the 2016 Census: level and trends

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by Julien Bérard-Chagnon and Marie-Noëlle Parent
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Highlights

- The CNU rates of Canadian censuses are relatively low and stable over time;
- Despite this, undercoverage and overcoverage tend to increase;
- CNU rates fluctuate, sometimes considerably, based on population characteristics:
  - Young adults, especially men, show particularly high CNU rates. CNU rates are also higher among individuals who live in the territories, on Indian reserves, who are single, separated, or whose mother tongue is a language other than English or French;
- Canadian CNU rates and the characteristics of harder-to-enumerate populations are similar to what is observed internationally.

List of acronyms

CMA: census metropolitan area.

COS: Census Overcoverage Study.

DA: Demographic Analysis.

CNU: census net undercoverage.

NPR: non-permanent resident.

PES: Post Enumeration Survey.

RRC: Reverse Record Check.

UNECE: United Nations Economic Commission for Europe.

WHI: Whole Household Imputation.

Introduction

Censuses are the cornerstone of a country's demographic measure. Census data are vital for planning public programs and services to the population and for scientific research. Although the intent of a census is to paint a comprehensive portrait of the population, in reality, it is hard to do a complete enumeration. According to the United Nations Economic Commission for Europe (UNECE), "census designers and administrators must keep in mind that no matter how much effort is expended, complete coverage and accuracy in the census data are unattainable goals" (UNECE 2015: §366).

Overall, the level of coverage of Canadian censuses is very high compared with other censuses conducted around the world. However, some segments of the population are not covered as well. This can affect the quality of census data by making them slightly less representative of the population and possibly reducing the scope of studies conducted using these data. Users must be aware of the nature and extent of census data limitations to interpret the data properly, particularly for analyses of certain population subgroups.

This analysis examines the level of coverage of the 2016 Census for different sociodemographic characteristics. In addition, the 2016 results are compared with those of the previous five censuses. The coverage level and trends are also compared with those observed in a few selected countries.

While certain coverage characteristics are known, this study aims to increase our understanding of the mechanisms underlying census coverage issues by presenting the results for the most recent census and showing how it has changed over several censuses.

Census coverage: context

Coverage errors can be divided into two categories: undercoverage and overcoverage. Undercoverage occurs when people who should have been counted were not, while overcoverage counts individuals more than once or counts those who should not have been counted.[1] These errors can occur for various reasons, including misinterpreting the residency rules in the census. Census net undercoverage (CNU) is the difference between undercoverage and overcoverage.

Statistics Canada has been conducting coverage studies to measure census coverage since 1961 (Dolson 2010). The results of coverage studies are published on the Statistics Canada website approximately 28 months after each census and the technical reports are published a few months later. These reports provide information on the methods used to estimate coverage and on the level of coverage errors.[2]

Since the 1961 Census, undercoverage has been estimated with the Reverse Record Check (RRC). This survey uses a representative sample of the population likely to be enumerated and that is independent of the current census. Sampled individuals who were missed in the census but should have been counted are then identified through record linkage and field collection operations.

Overcoverage has been evaluated since the 1991 Census.[3] Different methods have been used in the past to estimate it, but since 2006, the Census Overcoverage Study (COS) is used. For the 2016 COS, overcoverage was estimated by linking the 2016 Census Response Database to itself, then linking it to a list of individuals likely to be enumerated based on administrative data sources.

In this document, the analysis is based on census data from 1991 to 2016, the censuses for which undercoverage and overcoverage estimates are available. The CNU is expressed as a rate calculated by dividing the CNU by the census count adjusted for coverage. A positive value means that a given group is undercovered, while a negative value represents overcoverage.

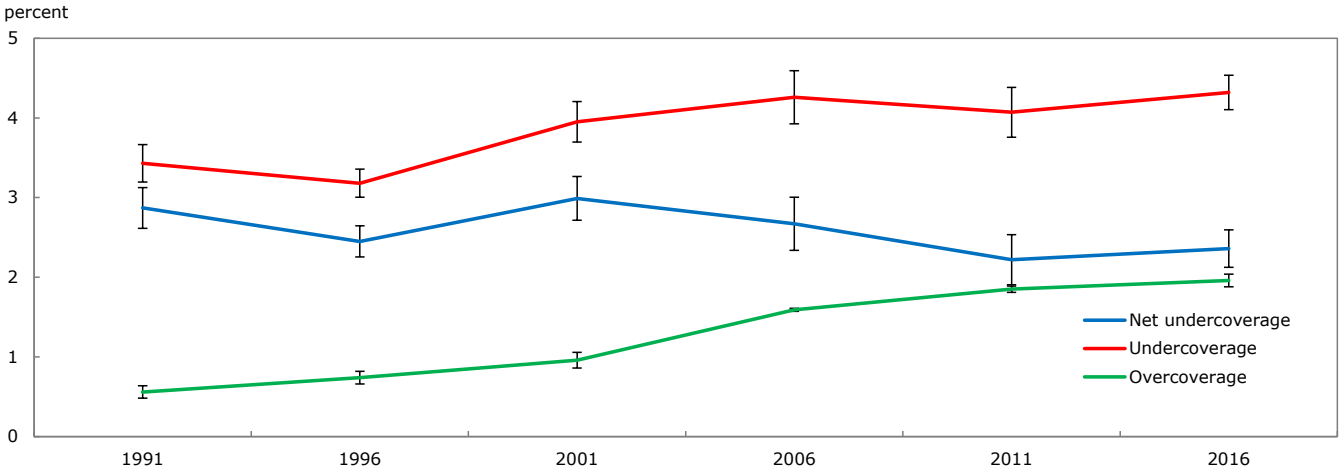
It is important to mention two points related to the census coverage analysis in this study. First, the methodologies used to conduct the censuses and measure coverage change with each census. These changes can affect census coverage estimates and comparisons over time. Furthermore, since coverage studies are sample surveys, standard error provides some insight into the accuracy of the estimates. Confidence intervals at a 95% level are presented for most of the charts in this article.

1. Overcoverage that results from including individuals who should not have been counted, such as people visiting Canada, is not measured at this time. This overcoverage is considered insignificant.
2. For more information on the methods used to estimate coverage for the 1991 to 2016 censuses, see Statistics Canada (1994, 1999, 2004, 2010, 2015, 2019b).
3. To calculate population estimates, Statistics Canada's Demographic Estimates Program estimated overcoverage for the 1971 to 1986 censuses indirectly (Statistics Canada 2016).

Although CNU rates remain relatively stable over time, undercoverage and overcoverage are increasing

The chart below shows the evolution of the CNU over the past 25 years at the national level.

Chart 1
Census net undercoverage, undercoverage and overcoverage (percent), Canada, 1991 to 2016



Note: Confidence intervals are calculated at the 95% confidence level.
Source: Statistics Canada, Census Coverage Studies.

The CNU for the 2016 Census is estimated at 2.36% or approximately 850,000 individuals. It has remained fairly constant from one census to another over the past 25 years, varying from a minimum of 2.22% in 2011 to a maximum of 2.99% in 2001. However, the CNU has been declining to a certain degree since 2001. CNU levels for 2011 and 2016 are statistically significantly lower than those for 2001.

Although CNU rates have changed very little overall in the past six censuses, undercoverage and overcoverage rates have increased. From 1991 to 2016, undercoverage rose 0.89 percentage points from 3.43% to 4.32%. This increase is statistically significant. In addition, overcoverage rose more sharply, from 0.56% in 1991 to 1.96% in 2016, a gain of 1.40 percentage points. This increase is also statistically significant.

Two factors may account for this. First, census collection and coverage evaluation methods change over time. For instance, the introduction of mail-outs of the census questionnaire for certain dwellings in 2006 had an impact on coverage in those areas.

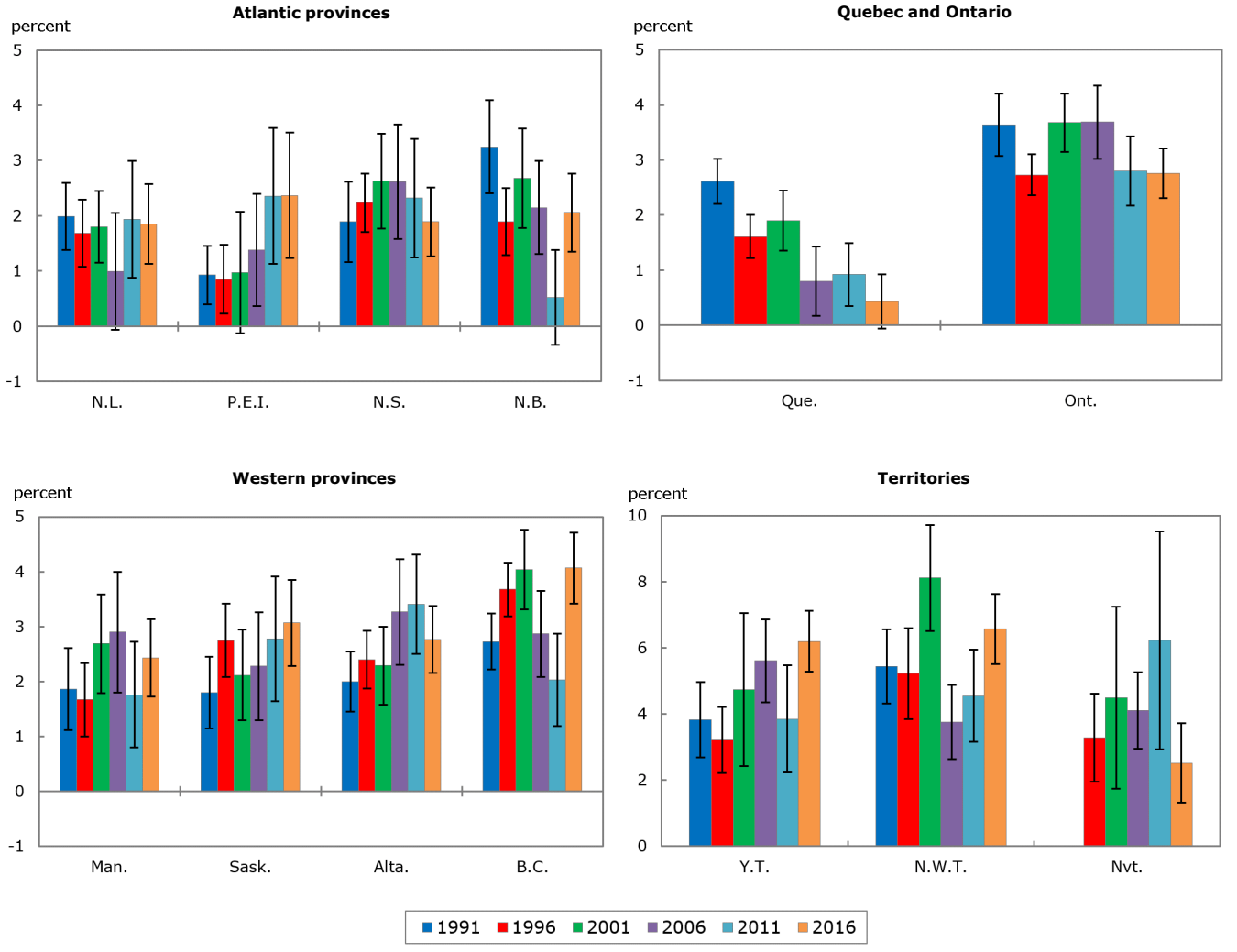
Second, several changes in the demographic composition of the Canadian population can also contribute to increased coverage errors. Recent immigrants and non-permanent residents (NPRs) are two rapidly growing demographic groups that have particularly high missed rates in the census (Bérard-Chagnon et al. 2019). The growth of these groups can contribute to higher undercoverage because missed individuals are one of the factors considered when calculating undercoverage. On the other hand, the increase in the number of children in shared custody over the past several years can affect overcoverage because these children are sometimes inadvertently counted in two different households. For example, nearly one-third of overcoverage cases in the 2011 Census among non-identical households were related to children of parents living in separate households (Statistics Canada 2015).

CNU rates are generally higher in the territories and lower in Quebec and the Atlantic provinces

CNU rates generally vary by province and territory. For a better glimpse of the situation, the charts below are presented in four parts: the Atlantic provinces, Quebec and Ontario, the Western provinces, and the territories.

In 2016, Yukon and the Northwest Territories had CNU rates above 6%, the highest among provinces and territories. It is harder to accurately enumerate the population of the territories because they live in remote areas where there are additional challenges with field operations. Among the provinces, British Columbia had the highest CNU rate (4.07%), while Quebec reported the lowest (0.43%).

Chart 2
Census net undercoverage (percent) by province and territory, 1991 to 2016



Notes: Confidence intervals are calculated at the 95% confidence level. The scale for the territories differs from that of the provinces due to higher CNU rates. Data for Nunavut are not available for 1991.

Source: Statistics Canada, Census Coverage Studies.

An analysis of the trends since 1991 reveals some interesting findings.

Since the 1991 Census, the Atlantic provinces and Quebec have typically had lower CNU rates and the territories higher rates. Among the provinces, British Columbia usually has the highest CNU rates.

New Brunswick saw a decline in its CNU rate in 2011, estimated at 0.52%. However, it increased to 2.06% in 2016, the level usually observed for this province since 1991. This result is mainly due to the particularly low undercoverage rate in 2011 (2.64%) compared with the other censuses.

CNU rates in Prince Edward Island have shown a slight upward trend since 1991. Rates in this province rose from less than 1% in 1991, 1996 and 2001 to 2.37% in 2016. Prince Edward Island had the lowest rates among all provinces in the first three censuses examined. However, because of the size of the province's population, margins of error tend to be higher, making it more difficult to identify the trend.

Quebec has had particularly low CNU rates since 2006, with less than 1% for each census. In fact, this province had the lowest rates among all provinces and territories in 2006 and 2016. The introduction of mail-outs of the census questionnaire in 2006 improved coverage for Quebec, since there is a larger proportion of mail-outs for enumeration in this province.[4]

CNU rates are relatively uniform for the Western provinces and tend to be higher than for the entire country. Since 1991, British Columbia has been the only province whose CNU rate has exceeded 4%, which was observed in 2001 and 2016. The higher rates observed in British Columbia can partly be attributed to the province's demographic make-up. More than one-quarter of the British Columbia population is made up of immigrants. As mentioned, immigrants—especially recent immigrants—are more likely to be missed.

Between 1991 and 2016, the Northwest Territories had the highest CNU rate for a province or territory (8.11% in 2001).

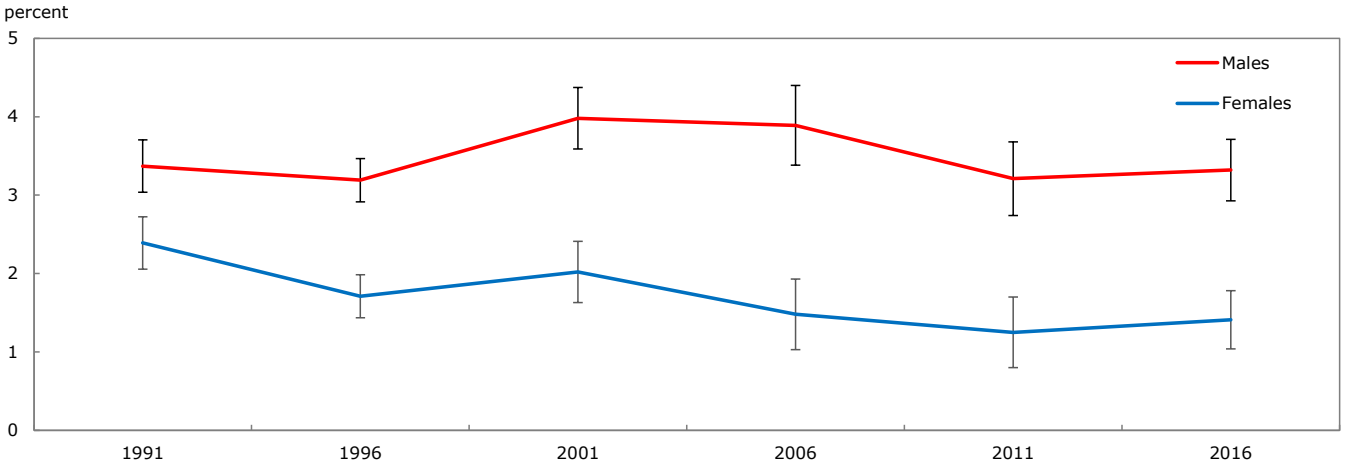
4. However, the link between the proportion of questionnaires mailed out and the undercoverage rate has never clearly been established and remains a hypothesis.

CNU RATES ARE HIGHER AMONG MEN THAN AMONG WOMEN

The chart below shows the progression of CNU rates by sex.

CNU rates among men are statistically significantly higher than among women for all censuses examined. The CNU rate for men in 2016 was 3.32%, 1.91 percentage points higher than the women's rate. This gap stems from undercoverage; the undercoverage rate for men is higher than for women (5.27% compared with 3.39%).

Chart 3
Census net undercoverage (percent) by sex, Canada, 1991 to 2016

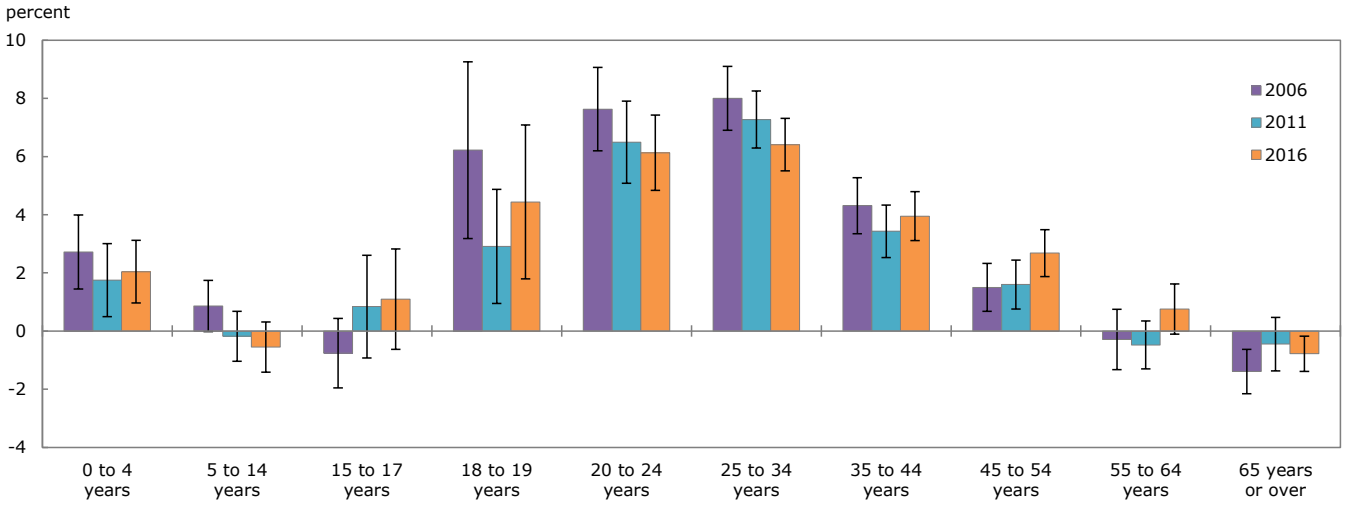


Note: Confidence intervals are calculated at the 95% confidence level.
Source: Statistics Canada, Census Coverage Studies.

CNU RATES ARE HIGHER AMONG INDIVIDUALS AGED 20 TO 34

A look at the CNU of the most recent Canadian censuses shows that certain age groups are harder to enumerate than others. The chart below presents the findings at the national level for 10 broad age groups.

Chart 4
Census net undercoverage (percent) by age group, Canada, 2006 to 2016



Notes: Different age groups were used prior to 2006. They are therefore not presented here. However, they show similar trends. Confidence intervals are calculated at the 95% confidence level.

Source: Statistics Canada, Census Coverage Studies.

CNU rates are higher among individuals aged 20 to 34. In 2016, the CNU rate for this age group was about 6%. Conversely, CNU rates are lower among children, especially those between 5 and 17 years, and individuals 55 years and older. In 2016, individuals aged 5 to 14 years and 65 years and older had slightly negative CNU rates, which is net overcoverage.

The variations observed by age mainly stem from changes in undercoverage. In 2016, undercoverage reached a peak of 9.64% among those aged 20 to 24, while it was estimated at less than 1% among those 65 and older. Generally speaking, young adults are harder to enumerate because they are often in a transition period in their lives that includes residential mobility, entry into the labour market and the start of postsecondary studies. This period can lead to both undercoverage and overcoverage (Burgess 1988).

Overcoverage trends also influence the results observed by age group. In 2016, the overcoverage rate reached 3.51% among individuals aged 20 to 24. Note that the overcoverage rate for children aged 5 to 17 (3.49%) was also relatively high. These results partially explain the lower CNU rates for these groups. As previously mentioned, higher overcoverage among children 5 to 17 years is mostly due to certain children who are in shared custody and counted by both parents.

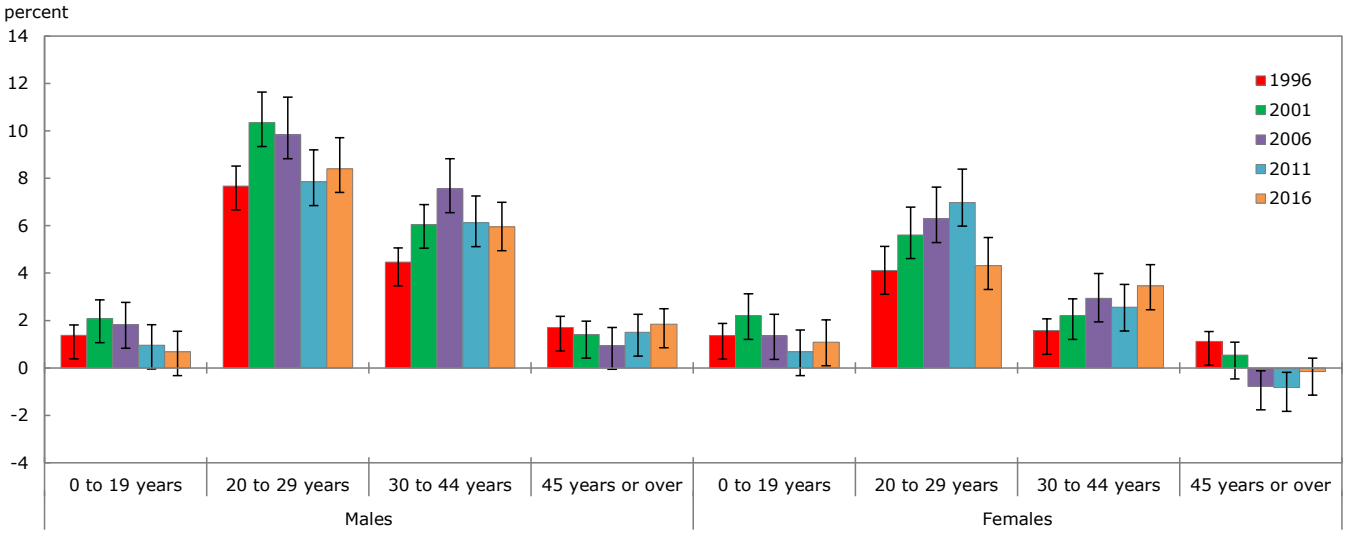
Interestingly, the overall decline in CNU rates observed between 2006 and 2016 tends to be higher among young adults. For example, the CNU rates of individuals aged 25 to 34 fell from 8.00% in 2006 to 6.41% in 2016.

CNU RATES AMONG YOUNG MEN ARE HIGHER

CNU rates by age tend to differ for men and women. The chart below shows the CNU trends for four broad age groups.

The main observation from this chart is that coverage-related differences between men and women are greater among young adults. In 2016, the CNU rate among men aged 20 to 29 was just above 8%, almost twice that among women in the same age group. This difference is statistically significant. Differences by sex decline for the next two age groups but remain statistically significant. CNU rates among men aged 0 to 19 are very similar to those of women in the same age group. Parents complete the census form for their children so differences by sex are expected to be low for children.

Chart 5
Census net undercoverage (percent) by sex and age group, Canada, 1996 to 2016

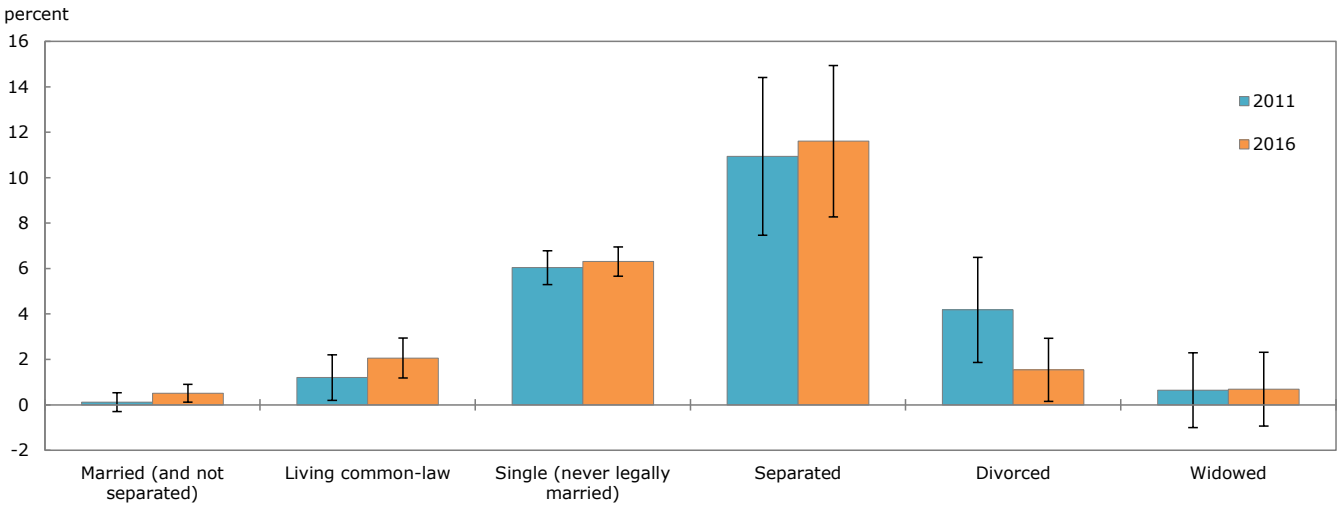


Note: Confidence intervals are calculated at the 95% confidence level.
Source: Statistics Canada, Census Coverage Studies.

CNU RATES ARE HIGHER AMONG SEPARATED OR SINGLE INDIVIDUALS

The chart below shows CNU rates by de facto marital status. It should be noted that it is more difficult to compare the evolution in CNU rates by de facto marital status because the groups in the coverage study tables have changed over time.[5] However, the groups are exactly the same in 2011 and 2016, which makes some analyses possible.

Chart 6
Census net undercoverage (percent) by marital status, Canada, 2011 and 2016



Note: Confidence intervals are calculated at the 95% confidence level.
Source: Statistics Canada, Census Coverage Studies.

CNU rates among separated individuals exceeded 10% in 2011 and 2016. They are higher than those of other marital statuses and the differences are statistically significant. Rates for single individuals are also higher, around 6% for both censuses studied. Conversely, married, common-law or widowed individuals have the lowest CNU rates, at less than 2%. Furthermore, the CNU rate of divorced individuals declined somewhat between 2011 and 2016, but this decrease is not statistically significant.

Interestingly, according to 2016 data, the CNU rate among separated men is almost three times higher than among women (17.65% compared with 6.40%). The difference between men and women is also significant for divorced individuals, with the CNU rate among men at 4.81% compared with -0.76% among women.

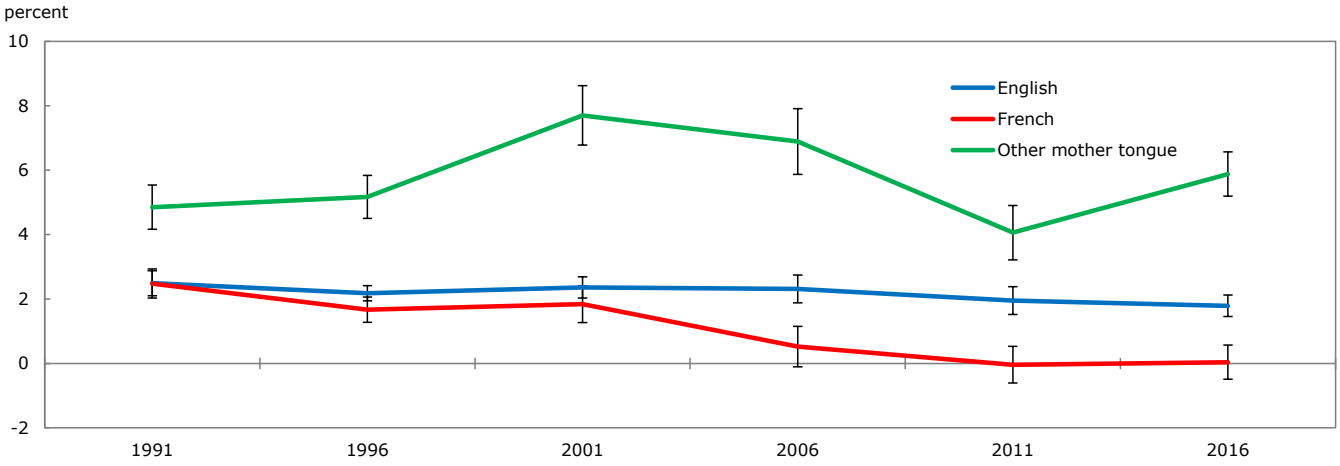
Separated and single individuals are usually younger and more mobile, two factors associated with higher CNU levels. Conversely, married or common law-individuals are generally less mobile and in a more stable period of their lives. Having a spouse also means there are more people in the household who can fill out the census questionnaire. Widows are usually older, which is correlated with a lower CNU rate.

5. For example, in 1991, the "married" and "separated" marital statuses were combined. These were disaggregated as of the 2006 Census.

CNU rates are higher among individuals whose mother tongue is neither English nor French

The chart below shows CNU rates by mother tongue. It is important to note that some respondents provide more than one mother tongue in the census. In 2016, this applied to less than 3% of the population enumerated. Since these numbers are relatively small and in the interest of comparisons over time, only the main single response categories (English, French and other language) are discussed in this section.[6]

Chart 7
Census net undercoverage (percent) by mother tongue, Canada, 1991 to 2016



Note: Confidence intervals are calculated at the 95% confidence level.
Source: Statistics Canada, Census Coverage Studies.

CNU rates among Canadians who report a mother tongue other than English or French are always statistically significantly higher than the rest of the population. In 2016, the CNU rate for this group was almost 6%, compared with 1.79% among the English-mother-tongue population and 0.04% among the French-mother-tongue population.

First, language itself is a major obstacle to be properly enumerated in the census, particularly if the respondent has not learned one of Canada's two official languages.[7] In addition, part of the allophone population is made up of recent immigrants and NPRs who, as previously mentioned, are more likely to be missed.

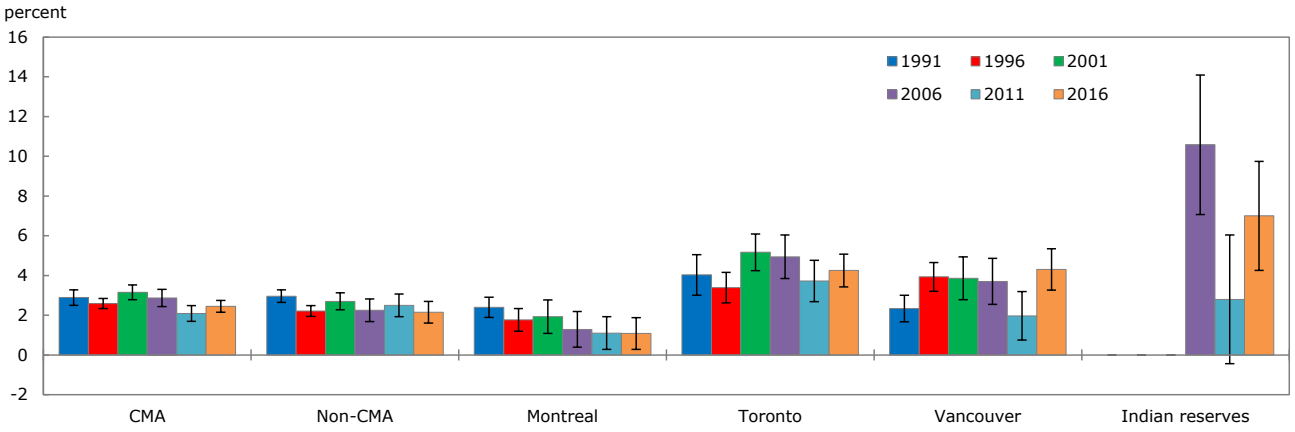
It is interesting to note that CNU rates among the French-mother-tongue population have been particularly low over the past three censuses. The results for this group has been statistically significantly different than those of the English-mother-tongue group since 2006. The majority of individuals whose mother tongue is French live in Quebec, so what this result may be in part due to the decline in CNU rates in this province since 2006.

6. In addition, unlike previous coverage studies, respondents could enter only one mother tongue in the 2016 coverage studies.
7. Two things must be mentioned: Census questionnaires are available in other languages if respondents ask for them. Also, respondents can be enumerated by proxy if another household member completes the questionnaire.

CNU rates tend to be slightly higher in census metropolitan areas and on Indian reserves

Previous results highlighted the variations in CNU rates from one province or territory to another. Differences also exist in sub-provincial areas though. The chart below shows the evolution of CNU rates for census metropolitan areas (CMAs),[8] non-CMAs, the three most populous CMAs (Montréal, Toronto and Vancouver)[9] and Indian reserves.

Chart 8
Census net undercoverage (percent) by CMAs, non-CMAs, the three most populous CMAs and Indian reserves, Canada, 1991 to 2016



Notes: Confidence intervals are calculated at the 95% confidence level. These results do not take into account that CMA borders change over time. The results for the Indian reserves presented here are available only as of 2006 and do not include reserves that were incompletely enumerated in the previous census, which are not covered in coverage studies.

Source: Statistics Canada, Census Coverage Studies.

In general, CNU rates tend to be slightly higher in CMAs than in non-CMAs. However, these differences, noticeable for every cycle except in 2011, are not statistically significant. This result is mainly due to somewhat higher undercoverage in CMAs.

Montréal's CNU rates are the lowest among the three most populous CMAs in the country. In 2016, the CNU rate of this CMA was 1.08%, compared with more than 4% for Toronto and Vancouver. The difference between the three CMAs stems mostly from undercoverage, which is higher in Toronto and Vancouver. These results are mainly the reflection of differences in the previously mentioned census collection methods and the demographic composition of the three CMAs.

CNU rates of Indian reserves are considerably higher than the national average. In 2006, CNU rates for reserves exceeded 10%. It is worth nothing that the CNU rate among reserves was estimated at 2.80% in 2011, which is much lower than the 2006 and 2016 rates. This difference is mostly due to the fact that certain field operations steps were done differently in 2011.[10]

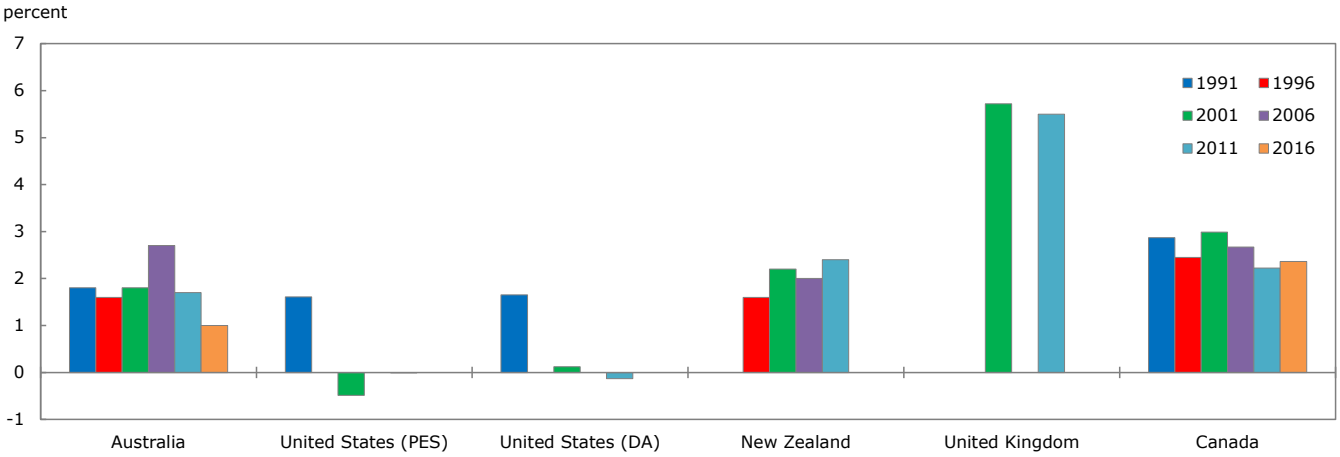
8. A CMA is formed by one or more adjacent municipalities centered on a population centre. A CMA must have a total population of at least 100,000, of which 50,000 or more must live in the core. To be included in a CMA, adjacent municipalities must have a high degree of integration with the core, as measured by commuting flows derived from data on place of work from the previous census.
9. Only the results for these three CMAs are presented because the sample size of coverage studies makes it harder to analyze results for less populous CMAs.
10. More specifically, the Whole Household Imputation (WHI) process was different in 2011 in some geographic areas, including reserves. For more information, see Statistics Canada (2019a: 19).

Canadian CNU rates are overall similar to those observed in other countries

Given the strategic importance of census data for a country, most countries that conduct traditional censuses[11] employ various methods for evaluating census coverage (UNECE 2015: §370). This section examines the overall trends and attempts to make inferences to situate the general CNU level of Canadian censuses in an international context. However, it is important to be cautious when analyzing the evolution of census coverage for some countries. The national context and methods used to conduct and evaluate censuses vary—sometimes significantly—from one country to another (Kerr 1998).

The chart below shows the national CNU rates over the past few censuses for Australia, the United States, New Zealand, the United Kingdom and Canada. The statistical system in these countries is quite similar to Canada's.

Chart 9
Census net undercoverage (percent) by country, 1991 to 2016



Note: The New Zealand censuses shown here were conducted in 1996, 2001, 2006 and 2013 respectively, while the United States censuses were conducted in 1990, 2000 and 2010.

Sources: Australian Bureau of Statistics (2018) (Australia), Hogan et al. (2013) (United States), Statistics New Zealand (2014) (New Zealand), Office for National Statistics (2012; 2013) (United Kingdom), Statistics Canada, Census Coverage Studies (Canada).

Australia, New Zealand and the United Kingdom estimate their census coverage using a Post Enumeration Survey (PES). The survey attempts to produce a count of the population that should have been enumerated and is usually conducted a few weeks after the census. The United States uses two methods to estimate coverage in its censuses: a PES and a Demographic Analysis (DA). The DA is a demographic method that reconstructs the population using several data sources such as vital statistics. The DA is independent of the census with which it is compared.

Australia's CNU rates are slightly lower than Canada's. The difference is slightly bigger for 2016, with the Australian census reporting a CNU rate of 1.0%, compared with 2.36% for Canada. The CNU rates for censuses in New Zealand tend to be between Australia's and Canada's.

United Kingdom censuses have the highest CNU rates of all the countries examined here. Rates exceeded 5% in 2001 and in 2011. Undercoverage is also higher in United Kingdom censuses. For example, in 2011, the undercoverage rate of the United Kingdom census was estimated at 6.1% compared with 4.07% in Canada (Office for National Statistics 2013).

Interestingly, CNU rates were lower, and even negative, in the United States in 2000 and 2010, according to both methods used. This situation may be due to higher overcoverage in United States censuses, with rates reaching 2.8% in 2010 (Hogan et al. 2013). This overcoverage offsets undercoverage, resulting in a CNU rate close to zero. As mentioned earlier, overcoverage in Canadian censuses is less than 2%.

11. A traditional census uses field collection to enumerate the population. Collection can be done using electronic questionnaires. This approach differs from others where enumeration is carried out using other data, such as administrative data.

The characteristics of populations that tend to be less well covered by censuses of these countries are similar to those observed in Canada.

Young adults, particularly men, are also less well covered by Australian and New Zealand censuses (Australian Bureau of Statistics 2018; Statistics New Zealand 2014).

Ethnic origin also correlates with census coverage in other countries. In the United States, CNU rates are higher among Blacks, Hispanics, American Indians and Alaska Natives (Hogan et al. 2013). A similar situation exists in New Zealand for the Maoris and in Australia for the Aboriginal peoples.

An international study conducted in the late 1990s also shed light on other census coverage characteristics (Simpson and Middleton 1998). Single and divorced men, recent immigrants, and ethnic minorities were less well covered in the censuses of different countries. These results generally correspond to groups among which the CNU is higher in Canada.

Interestingly, coverage of American censuses differs from that of Canadian censuses for young children. In the United States, the DA reports a relatively high CNU rate among young children (O'Hare 2017). In Canada, the CNU rate among young children is close to that of the overall population. A review of studies on this topic suggests that the higher CNU for young children in the United States mostly stems from children of young mothers, enumeration errors when the children were not related to the respondents and children living in hard-to-count households (O'Hare et al. 2019).

Conclusion

The objective of this article was to examine the coverage level and trends of Canadian censuses. CNU rates are relatively low and stable over time. Despite this, undercoverage and overcoverage tend to increase. This can be caused by changes in census collection and coverage estimate methods, as well as demographic changes in the Canadian population.

Coverage fluctuates, sometimes considerably, based on population characteristics. CNU rates are higher among young adults, particularly men. CNU rates are also higher among individuals who live in the territories, on Indian reserves, who are single, separated, or whose mother tongue is a language other than English or French. Canadian CNU rates and the characteristics of harder-to-enumerate populations are similar to what is observed internationally.

These results are a reminder that some caution must be used with census data. O'Hare (2019) reported that a relatively low CNU rate can hide significant undercoverage or overcoverage as well as large differences between demographic groups. Furthermore, coverage errors are not calculated for all characteristics available in censuses, so coverage for certain groups likely to be less well covered, like less educated individuals or those with lower incomes, is not well known.

Harder-to-enumerate populations often face physical, economic, social and cultural barriers. Although perfect coverage is practically unattainable, there are different measures statistical agencies can take before and during collection to reduce coverage errors, and after collection to measure coverage and inform users. This article was written with that strategy in mind.

The results of this study reaffirm the complexity of the mechanisms underlying coverage errors. Factors associated with undercoverage are not always the same as those associated with overcoverage. Both these factors are also on the rise. Consequently, a more in-depth analysis of the factors associated with undercoverage and overcoverage is a relevant avenue of research to better understand the causes and evolution of the CNU.

Finally, more and more national statistical agencies are examining the possibility of implementing methods other than a traditional census (UNECE 2015: §57). A potentially interesting avenue is to use administrative data to support or replace certain census operations. Statistics Canada is also exploring this approach by considering different sources such as tax data and vital statistics records (Statistics Canada 2017). To date, research activities have shown that administrative data coverage is very high, sometimes even higher than that of current censuses, at the provincial and territorial level. However, using these data poses several challenges for more detailed geographic levels and for certain subpopulations of interest. The increased use of administrative data in censuses can also have an impact on coverage studies, which are based on the same data.[12] It will be interesting to see how these different factors will be brought together to maintain, or even increase, the level of coverage of Canadian censuses and the quality of coverage measurement in the coming decades.

12. Coverage studies should ideally be independent of the census for which coverage is being estimated.

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