



Advanced Medical Imaging Equipment for Older Adults Across Canada

Context

Canada's population is aging, and this demographic shift is impacting the country's health care system.¹⁻³ The number of older adults (> 65 years) in Canada has more than tripled in the last 4 decades,⁴ and it is estimated that this demographic will represent one-third of the population by 2056.³ Older adults use more health care services than younger people,⁵ and account for approximately half of Canada's health care spending.³ Further, aging is associated with complex health states that can require distinct standards of care and diagnostic practices when compared to younger patients.⁶⁻¹⁰

As the use and cost of health services increases with age, so does the demand for medical imaging procedures. In fact, the demand for medical imaging procedures is already rising faster than the growth of Canada's aging population.^{2,7,11} Other Organisation for Economic Co-operation and Development (OECD) countries are experiencing a similar demographic shift,¹² yet Canada is behind its international counterparts in terms of advanced medical imaging units, ranking 30th and 26th in CT units and MRI per 1 million population, respectively.¹³

It is critical that health systems are equipped to handle the challenges that come with an aging population,⁸ ensuring adequate access to essential health technologies, including medical imaging, may play an important role in the optimal delivery of health care to this demographic.^{7,11}

Objective

The purpose of this report is to provide a summary of the exam volume and unit availability of advanced medical imaging equipment, specifically CT, MRI, and PET-CT in adults 65 years or older across Canada. This information may provide insight for health care planning and policy when considering the needs of the aging population in Canada.

Methods

To identify use of medical imaging in older adults, a literature search was conducted in the National Library of Medicine's PubMed database. The search was limited to articles published in English over the past 5 years. When a relevant article was identified in PubMed, the "Related Articles" feature was screened to supplement the search. Additionally, a grey literature search was conducted.

A retrospective cohort study reporting trends in medical imaging for the province of Ontario by Smith-Bindman et al. (2019)¹⁴ was identified and used to estimate exams conducted in older adults across the country. This paper included an evaluation of utilization trends in medical imaging between 2000 and 2016 among individuals in Ontario.¹⁴ The total person-years for the duration of the cohort and calculated rates for 2016 reported by Smith-Bindman et al. (2019) was used to give an estimate of the rates of total number of exams at 2016 for 3 age categories (younger than 18, 18 to 64 years, and 65 years and over) for Ontario;¹⁴ these were then used to estimate the overall proportion of MRI, CT, and nuclear medicine exams conducted in older adults and those under 65 years of age.

The number of exams conducted in older adults for each modality was calculated using exam data for Ontario from the Canadian Medical Imaging Inventory (CMII) 2019–2020 report.¹³ Population data from Statistics Canada¹⁵ was used to derive the number of older and younger adults in Ontario, assuming 17% of the overall population were aged 65 years and over. From this, the number of exams per person was calculated for the 2 age groups (≥ 65 and < 65 years) and a ratio of the number of exams per person for older versus younger patients was determined for each modality. This ratio was then used to derive the number of exams per younger person (< 65 years) for each jurisdiction, based on the following formula:

$$\text{Total exams} = (x) (\text{population of } < 65) + (\text{ratio of the number of exams per person } \geq 65 \text{ versus } < 65) (x) (\text{population of } \geq 65)$$

By calculating the number of exams per person under the age of 65, using the previously provided formula, an estimated exam volume in adults aged 65 and older in each jurisdiction could be obtained by using the following formula:

$$\text{Exams conducted in people ages } > 65 = (\text{ratio of the number of exams per person } \geq 65 \text{ versus } < 65) (x) (\text{population aged } > 65)$$

Unit equivalents for each respective imaging modality that would be required to conduct the estimated volume of exams, assuming no change in patterns of utilization from the overall population, was calculated using exams per unit from the 2019–2020 CMII report.¹³ (This report classified older adults as those who are 65 years of age or older.)

Results

The only study identified in the literature search for publications on the use of imaging equipment in older adults in Canada was authored by Smith-Bindman et al., as described previously. Based on the calculations using data extracted from Smith-Bindman et al.,¹⁴ exam volume in older adults is estimated to account for 47%, 22%, and 46% of total exams for CT, MRI, and nuclear medicine, respectively. Estimated exams per 1,000 older adults based on the same proportion of exams in older adults are shown in [Table 4](#) in Appendix 1.

CT

Based on a calculated ratio of 4.17 for the number of exams per person 65 years or older versus younger than 65 years, it is estimated that 2,562,039 CT exams (47%) in Canada were conducted in older adults. Of the 549 existing CT units in Canada, it is estimated that 260 would be required for dedicated use in the older population.

New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island performed the highest proportion of overall CT exams (53% each) in the older adult population. The same provinces have the highest proportion (21%) of older adults in its total population.¹⁵ When looking at unit equivalence used in older adults, it is estimated that 9 out of the 17 existing CT units operating in New Brunswick, 8 out of the 15 existing CT units operating in Newfoundland and Labrador, 9 out of the 17 existing CT units operating in Nova Scotia, and 1 out of the 2 existing CT units operating in Prince Edward Island would be dedicated to the this population ([Table 1](#)).

MRI

Based on a calculated ratio of 1.35 for the number of exams per person 65 or older versus younger than 65, it is estimated that 515,604 MRI exams (22%) in Canada were conducted in older adults. Of the 378 existing MRI units in Canada, it is estimated that 84 would be required for dedicated use in the older population.

Among jurisdictions with MRI units, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island performed the highest proportion of overall MRI exams (27% each) in older adults. The same provinces have the highest proportion (21%) of older adults in its total population.¹⁵ When looking at unit equivalence used in older adults, it is estimated that 3.7 units out of the 14 existing MRI units operating in New Brunswick, 1.3 units out of the 5 existing MRI units operating in Newfoundland and Labrador, 2.9 units out of the 11 existing MRI units operating in Nova Scotia, and 0.26 of the 1 existing MRI unit operating in Prince Edward Island would be dedicated to this population ([Table 2](#)).

Table 1: Estimated Number of CT Exams and Unit Equivalence in Older Adults

Province or territory	Total population (proportion of older adults %) ¹⁵	Total exams for the overall population ¹³	Number of exams in older adults (% of overall exams) ^a	Total units ¹³	Exams per unit ¹³	Unit equivalent for older adult use
Alberta	4,362,576 (13%)	449,433	172,684 (38%)	55	8,172	21
British Columbia	5,094,796 (19%)	805,584	398,623 (50%)	69	11,675	34
Manitoba	1,369,954 (16%)	240,269	106,444 (44%)	22	10,921	10
New Brunswick	777,128 (21%)	162,322	85,393 (53%)	17	9,548	9
Newfoundland and Labrador	523,427 (21%)	98,967	52,064 (53%)	15	6,598	8
Northwest Territories	45,070 (8%)	5,789	1,573 (27%)	1	5,789	0.3
Nova Scotia	970,243 (21%)	170,603	89,750 (53%)	17	10,036	9
Nunavut	38,592 (4%)	3,081	457 (15%)	1	3,081	0.14
Ontario	14,544,701 (17%)	1,842,982	849,615 (46%)	169	10,905	78
Prince Edward Island	157,419 (21%)	19,349	10,179 (53%)	2	9,675	1
Quebec	8,503,483 (19%)	1,491,087	73,7827 (50%)	164	9,092	81
Saskatchewan	1,172,479 (16%)	124,918	55,341 (44%)	16	7,807	7
Yukon	41,362 (13%)	5,437	2,089 (38%)	1	5,437	0.4
Canada	37,601,230 (18%)	5,419,821	2,562,039 (47%)	549	9,872	260

^a Calculations were based on the ratio of the number of exams per person that were 65 years or older versus younger than 65 years of 4.17.

Table 2: Estimated Number of MRI Exams and Unit Equivalence For Older Adults

Province or territory	Total population (proportion of older adults %) ¹⁵	Total exams for the overall population ¹³	Number of exams in older adults (% of overall exams) ^a	Total units ¹³	Exams per unit ¹³	Unit equivalent for older adult use
Alberta	4,362,576 (13%)	215,593	36,259 (17%)	44	4,890	7.4
British Columbia	5,094,796 (19%)	255,038	61,445 (24%)	52	4,905	13
Manitoba	1,369,954 (16%)	95,250	19,518 (21%)	14	6,165	2.9
New Brunswick	777,128 (21%)	46,309	12,250 (27%)	14	6,804	3.7
Newfoundland and Labrador	523,427 (21%)	21,929	5,801 (27%)	5	3,308	1.3
Northwest Territories	45,070 (8%)	0	0	0	4,386	0
Nova Scotia	970,243 (21%)	50,664	13,402 (27%)	11	0	2.9
Nunavut	38,592 (4%)	0	0	0	4,606	0
Ontario	14,544,701 (17%)	1,107,814	240,396 (22%)	124	0	27
Prince Edward Island	157,419 (21%)	5,348	1,415 (27%)	1	8,934	0.26
Quebec	8,503,483 (19%)	44,8130	107,966 (24%)	102	5,348	25
Saskatchewan	1,172,479 (16%)	81,652	16,732 (21%)	10	4,393	2.0
Yukon	41,362 (13%)	2,496	4,20 (17%)	1	8,165	0.17
Canada	37,601,230 (18%)	2,330,223	515,604 (22%)	378	6,165	84

^a Calculations were based on the ratio of the number of exams per person 65 years or older versus younger than 65 years of 1.35.

PET-CT

Based on a calculated ratio of 3.86 for the number of exams per person 65 years or older versus younger than 65, it is estimated that 57,690 PET-CT exams (46%) in Canada were conducted in older adults. Of the 57 existing PET-CT units in Canada, it is estimated that 26 would be required for dedicated use in the older population.

Among provinces with PET-CT units, New Brunswick, Newfoundland and Labrador, and Nova Scotia performed the highest proportion (51% each) of overall exams in older adults. The same 3 provinces are among the provinces with the highest proportion of older adults within its total population.¹⁵ When looking at unit equivalence used in older adults, it is estimated that 1 of the 2 existing PET-CT units operating in New Brunswick would be dedicated to the older population. For both Newfoundland and Labrador and Nova Scotia, it is estimated that 0.51 of the 1 existing PET-CT units available in each of these provinces would need to be dedicated to the older adult population ([Table 3](#)).

Limitations

The estimated volume of exams conducted in older adults was calculated using data from a retrospective study conducted in Ontario,¹⁴ as literature on exam volumes aggregated by age in other jurisdictions were not identified. There are limitations to note with the method used to calculate the estimated proportion of exams in older adults. First, the utilization rates reported in the study by Smith-Bindman et al. (2019)¹⁴ are limited to Ontario and may not be applicable to other jurisdictions in Canada as there may be varying practice patterns. Second, the utilization rates reported by Smith-Bindman et al. (2019)¹⁴ were based on a 4-year period (2012 to 2016), while total person-years was assessed from the duration of the cohort study (2000 to 2016). This would overestimate the total exams in the older adult population for all jurisdictions, although the proportion of exams calculated for use in older adults would be expected to be more representative of the average percentage. Use of an average percentage disregards any trends over time, which for each of the imaging modalities addressed in this report has been toward increasing utilization. Furthermore, to align with the CMII 2019–2020 exam volume data, population data were obtained from Statistics Canada's 2019 census. Hence, the results do not consider any changes in use between 2016 and 2019. Third, the rate for nuclear medicine imaging exams extracted from the retrospective study may not be limited to PET-CT. It is likely that the estimated volume of PET-CT exams in older adults is underestimated given the high proportion of use in oncology (around 80% of all PET-CT exams in Canada)¹³ and the prevalence of cancer among older adults.¹⁶

The calculated unit equivalence assumes unit use is limited to older adults, which does not reflect how imaging units are used in the Canadian health system. Unit equivalence represents the number of units that would be dedicated to older adult use only and is based on estimated exam volumes in this report, as well as rates (exams per unit) reported by the 2019–2020 CMII report.¹³ This assumes that there are no changes in rates (exams per unit) of use of the imaging modalities from the overall population.

Unexpected downtime, geographic distribution, wait-lists, availability of health professionals, and other factors can impact use and accessibility of imaging for older adults, although were not considered in this analysis.

Table 3: Estimated Number of PET-CT Exams and Units Equivalence For Older Adults

Province or territory	Total population (proportion of older adults %) ¹⁵	Total exams for the overall population ¹³	Number of exams in older adults (% of overall exams) ^a	Total units ¹³	Exams per unit ¹³	Unit equivalent for older adult use
Alberta	4,362,576 (13%)	12,175	4,459 (37%)	4	3,044	1.5
British Columbia	5,094,796 (19%)	2,822	5,368 (48%)	4	2,822	1.9
Manitoba	1,369,954 (16%)	2,180	925 (42%)	1	2,180	0.42
New Brunswick	777,128 (21%)	2,149	1,089 (51%)	2	1,075	1
Newfoundland and Labrador	523,427 (21%)	1,704	864 (51%)	1	1,704	0.51
Northwest Territories	45,070 (8%)	0	0	0	0	0
Nova Scotia	970,243 (21%)	2,818	1,428 (51%)	1	2,818	0.51
Nunavut	38,592 (4%)	0	0	0	0	0
Ontario	14,544,701 (17%)	23,564	10,415 (44%)	20	1,178	8.8
Prince Edward Island	157,419 (21%)	0	0	1	0	0
Quebec	8,503,483 (19%)	67,849	32,272 (48%)	23	2,950	11
Saskatchewan	1,172,479 (16%)	2,050	870 (42%)	1	2,050	0.42
Yukon	41,362 (13%)	0	0	0	0	0
Canada	37,601,230 (18%)	125,775	57,690 (46%)	57	2,206	26

^a Calculations were based on the ratio of the number of exams per person 65 years or older versus younger than 65 years of 3.86.

Conclusion

This report estimated that the proportion of exams in older adults represent 47%, 22%, and 46% of the total exams in Canada for CT, MRI, and PET-CT, respectively. The increasing size of the older adult population may exacerbate the already rising need for additional medical imaging equipment. Canada continues to fall behind many OECD countries in terms of number of units per million people and exams per 1,000 people. The findings of this report indicate that provinces with the highest proportion of older adults, including Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland and Labrador, conduct the most CT and MRI exams in older adults compared to other provinces. Similarly, for PET-CT, Nova Scotia, New Brunswick, and Newfoundland and Labrador conduct the most overall exams in this population.

The results of this report should be interpreted with caution. Lack of available data on the use of imaging modalities in older adults among jurisdictions may have resulted in inaccurate exam volumes and overestimation of unit equivalence for older adult use. Future studies should investigate and compare use in older adults versus the general population among all jurisdictions in Canada, in addition to accounting for factors that may impact use, such as geographic distribution of imaging equipment.

Appendix I: Exams Per Older Adults for CT, MRI, and PET-CT

Table 4: Estimated Exams per 1,000 Older Adults Versus Exams per 1,000 General Population

Province or territory	CT exams per 1,000 older adults	CT exams per 1,000 population ^a	MRI exams per 1,000 older adults	MRI exams per 1,000 population ^a	PET-CT exams per 1,000 older adults	PET-CT exams per 1,000 population ^a
Alberta	304	102	64	49	7.9	2.8
British Columbia	412	158	63	50	5.5	2.2
Manitoba	486	175	89	69	4.2	1.6
New Brunswick	523	208	75	59	6.7	2.8
Newfoundland and Labrador	474	190	53	42	7.9	3.3
Northwest Territories	426	129	0	0	0	0
Nova Scotia	440	175	66	52	7.0	2.9
Nunavut	296	79	0	0	0	0
Ontario	344	126	97	76	4.2	1.6
Prince Edward Island	308	123	43	34	0	0
Quebec	457	175	67	53	20	8.0
Saskatchewan	295	106	89	69	4.6	1.7
Yukon	389	133	78	61	0	0
Canada	391	143	79	62	8.8	3.3

Note: Exams per 1,000 older adults are based on estimated volume of exams from the report.

^a Data from the 2019–2020 Canadian Medical Imaging Inventory Survey.

References

1. Muratov S, Lee J, Holbrook A, et al. Senior high-cost healthcare users' resource utilization and outcomes: a protocol of a retrospective matched cohort study in Canada. *BMJ Open*. 2017;7(12):e018488.
2. Wang L, Nie JX, Tracy CS, Moineddin R, Upshur RE. Utilization patterns of diagnostic imaging across the late life course: a population-based study in Ontario, Canada. *Int J Technol Assess Health Care*. 2008;24(4):384-390.
3. Canadian Medical Association. Seniors care. 2022; <https://www.cma.ca/seniors-care>. Accessed 2022 Sep 14.
4. Canadian Institute for Health Information (CIHI). Infographic: Canada's seniors population outlook: uncharted territory. 2022; <https://www.cihi.ca/en/infographic-canadas-seniors-population-outlook-uncharted-territory>. Accessed 2022 Sep 14.
5. Institute of Medicine (U.S.) Committee on the Future Health Care Workforce for Older Americans. Health status and health care service utilization. *Retooling for an Aging America: Building the Health Care Workforce*. Washington (DC): National Academies Press; 2008: <https://www.ncbi.nlm.nih.gov/books/NBK215400/>. Accessed 2022 Sep 14.
6. Government of Canada. Action for seniors report. 2014; <https://www.canada.ca/en/employment-social-development/programs/seniors-action-report.html>. Accessed 2022 Sep 14.
7. The state of seniors health care in Canada. Ottawa (ON): Canadian Medical Association; 2016: <https://www.cma.ca/sites/default/files/2018-11/the-state-of-seniors-health-care-in-canada-september-2016.pdf>. Accessed 2022 Sep 14.
8. Kilinger LZ. Diagnostic challenges in the older patient. *Chiropr Man Therap*. 2012;20(1):28.
9. Cardinal Points Imaging of the Carolinas. Senior health and imaging: what role does radiology play in geriatric care? 2021; <https://cardinalpointsimaging.com/2021/11/18/senior-health-and-imaging-what-role-does-radiology-play-in-geriatric-care/>. Accessed 2022 Sep 14.
10. Palmer WJ. Medical imaging in elderly patients: do benefits outweigh the risk? *Wolters Kluwer Health*. 2020; <https://www.wolterskluwer.com/en/expert-insights/medical-imaging-in-elderly-patients-do-benefits-outweigh-the-risks>. Accessed 2022 Sep 14.
11. Enhancing patient care through medical imaging. Ottawa (ON): Canadian Association of Radiologists; 2019: <https://www.ourcommons.ca/Content/Committee/421/FINA/Brief/BR10596272/br-external/CanadianAssociationOfRadiologists-e.pdf>. Accessed 2021 Mar 25.
12. World Health Organization. Ageing and health. 2022; <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>. Accessed 2022 Sep 14.
13. Chao YS, Sinclair A, Morrison A, Hafizi D, Pyke L. The Canadian Medical Imaging Inventory 2019-2020. (CADTH health technology review). *Can J Health Technol*. 2021;1(1):1-215. <https://cadth.ca/sites/default/files/ou-tr/op0546-cmii3-final-report.pdf>. Accessed 2022 Jan 10.
14. Smith-Bindman R. Trends in use of medical imaging in US health care systems and in Ontario, Canada, 2000-2016. *JAMA*. 2019;322(9).
15. Statistics Canada. Table: 17-10-0005-01. Population estimates on July 1st, by age and sex. 2022; <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501>. Accessed 2022 Sep 14.
16. Santos C. Publicly funded PET-CT indications: comparison of Canada with other countries. *Canadian Medical Imaging Inventory Service Report*. Ottawa (ON): CADTH; 2021: https://www.cadth.ca/sites/default/files/pdf/public_funded_pet_ct_internat_comp.pdf. Accessed 2022 Mar 2.

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