

Prevalence of Wheelchair and Scooter Use Among Community-Dwelling Canadians

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Background. Mobility impairments are the third leading cause of disability for community-dwelling Canadians. Wheelchairs and scooters help compensate for these challenges. There are limited data within the last decade estimating the prevalence of wheelchair and scooter use in Canada.

Objective. The aims of this study were: (1) to estimate the prevalence of wheelchair and scooter use in Canada and (2) to explore relevant demographic characteristics of wheelchair and scooter users.

Design. This study was a secondary analysis of a cross-sectional national survey.

Methods. The Canadian Survey on Disability (2012) collected data on wheelchair and scooter use from community-dwelling individuals aged 15 years and over with a self-identified activity limitation on the National Household Survey. Prevalence estimates were calculated as weighted frequencies, with cross-tabulations to determine the number of wheelchair and scooter users in Canada, by province, and demographic characteristics (ie, age, sex) and bootstrapping to estimate the variance of all point estimates.

Results. There were approximately 288,800 community-dwelling wheelchair and scooter users aged 15 years and over, representing 1.0% of the Canadian population. The sample included 197,560 manual wheelchair users, 42,360 powered wheelchair users, and 108,550 scooter users. Wheelchair and scooter users were predominantly women, with a mean age of 65 years. Approximately 50,620 individuals used a combination of 2 different types of devices.

Limitations. The results are representative of individuals living in the community in Canada and exclude individuals in residential or group-based settings; estimates do not represent the true population prevalence.

Conclusion. This analysis is the first in more than 10 years to provide a prevalence estimate and description of wheelchair and scooter users in Canada. Since 2004, there has been an increase in the proportion of the population who use wheelchairs and scooters, likely related to an aging Canadian population. These new prevalence data have potential to inform policy, research, and clinical practice.

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Wheelchair and Scooter Use and Community-Dwelling Canadians

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According to the Canadian Survey on Disability (CSD) (2012), 13.7% of the Canadian population experience some form of disability.¹ Mobility impairment affects 7.2% of the population (1.9 million people) and is the third highest cause of disability.¹ Additionally, 8 of 10 individuals with a disability use an assistive device, such as a walker, wheelchair, or scooter, to compensate for these challenges.¹ Unfortunately, not everyone has access to the appropriate devices to meet their daily needs. In 2009, more than 300,000 Canadians aged 15 years and over with mobility impairment had only some or none of their equipment needs met, primarily due to the cost to purchase or maintain.²

In Canada, funding for public health care falls under provincial jurisdiction; therefore, access to wheelchairs and scooters differs based on the province or territory of residence. Although there is legislation requiring the provinces to cover costs associated with hospitalization, this legislation does not extend to costs associated with management of chronic conditions in the community. Each of the provinces and territories allocates health funding differently; some allocate part of their funding toward basic wheelchair and scooter provision, and others do not, and national health insurance programs may cover specific groups (ie, veterans, First Nations). As a result, access to wheelchairs and scooters may depend on personal resources and access to private health insurance programs or workers' compensation funding.

Wheelchairs and scooters differ in terms of physical demands for propulsion, cost, transportability, and appropriateness for indoor or outdoor use. These factors affect the selection of devices and their use in daily life. For example, manual wheelchairs (MWCs) are less costly, with the mean cost varying with the type of MWC provided (mean cost ranges from \$204 to \$2,331 [USD], SD=\$206–\$951)³; more maneuverable; and offer a range of options for postural support. However, they are more physically demanding to operate,⁴ particularly outdoors. In comparison, powered wheelchairs (PWCs) require little physical effort, making long-distance travel easier,

and they offer greater independent control over positioning and postural support features, but require higher cognitive ability, are difficult to transport, and are more expensive (mean cost ranges from \$4,323 to \$5,237 [USD], SD=\$2,238–2,608).³ Scooters offer a less expensive powered option (mean cost=\$2,047 [USD], SD=\$803).³ They are more readily available without assessment and prescription,⁵ but typically require some capacity for ambulation, offer very limited options for postural support, and are used primarily outdoors and for long-distance travel. Wheelchair and scooter users may select one device based on the relative advantages for their situation or a combination of devices to address daily needs and activity requirements. Just as an individual may use different shoes for different activities, it is unreasonable to expect that a single wheelchair or scooter will meet all the daily needs of the individual. The benefits or drawbacks of each device may contribute to prevalence of use and may be relevant in the development of research agendas and public policy and in clinical practice decision making.

To effectively plan for health resource allocation (ie, device funding and service provision), it is critical to know the prevalence of wheelchair and scooter use in Canada. The most recent estimates of wheelchair use prevalence in Canada were published in 2004 and reported on data gathered from the Canadian Community Health Survey in 2000–2001.⁶ At that time, there were approximately 155,000 community-dwelling Canadians who used a wheelchair for mobility, representing 0.6% of the sampled population.⁶ This report provided basic prevalence estimates for wheelchairs, but did not include scooters, differentiate between wheelchair and scooter types, or examine demographic factors associated with wheelchair and scooter use. The CSD presents an opportunity to explore demographic trends and current prevalence of wheelchair and scooter use to inform resource allocation, research, and policy direction across Canada.

The purpose of this study was to examine wheelchair and scooter use in

Canada, compare prevalence among demographic groups, and investigate provincial differences. To gain a more complete picture of wheelchair and scooter use in Canada, we posed the following questions:

1. How many community-dwelling wheelchair and scooter users are there in Canada, and what is the distribution by province and wheelchair and scooter type?
2. What is the demographic profile of wheelchair and scooter users in Canada (ie, age, sex, health condition), and does this profile differ by province or device type?
3. What is the prevalence of multiple wheelchair and scooter use in Canada?
4. How many wheelchair and scooter users are ambulatory, and do they differ from nonambulatory wheelchair and scooter users in important ways?

Method

Design

We based this cross-sectional study on analyses of data from the CSD, a postcensal survey conducted by Statistics Canada between September 2012 and January 2013. Data were collected by Statistics Canada under the authority of the Statistics Canada Act.

Sample

The CSD sample included individuals aged 15 years or over with a self-identified activity limitation on the National Household Survey (NHS).⁷ The sample of individuals with disabilities was identified using a stratified sampling procedure to ensure representation across age ranges and geographical areas. The total sample size for the CSD was approximately 45,500 individuals (overall response rate of 75.0%).⁷ This representative sample excluded individuals in collective living arrangements (ie, long-term care facilities) and those living on First Nations reserves.

Data Collection

Questions were administered through computer-assisted telephone interviews,

with accommodations for individuals who were unable to use the standardized system. The interview was available in English, French, and Inuktitut. A full description of the data collection procedures is available from Statistics Canada, and available in the CSD *Concepts and Methods Guide*.⁷

Data Analysis

We analyzed data from survey respondents who indicated they used an MWC, a PWC, or a scooter. Analytic variables included mobility device type (MWC, PWC, or scooter), sex, age at time of survey, province or territory of residence, main cause of the condition limiting activity, and ability to walk 15 m without assistance. Using these data, we calculated prevalence estimates for wheelchair and scooter use nationally and by province or territory. Territorial data were aggregated. Descriptive estimates included mean age, sex, and wheelchair and scooter type, where sample size allowed. To further describe the variability of wheelchair and scooter users, we reported on the ability to walk 15 m without assistance and the main cause of the condition limiting an individual's activities (cause of activity limitation). We are unable to report on multiple device use or ambulation status at the provincial level due to small cell sizes, which do not meet the standard for Statistics Canada data release.⁸

Data were obtained from the Statistics Canada Research Data Centre at the University of British Columbia in Vancouver, British Columbia, Canada. We used WesVar software (version 5.1, Westat Inc, Rockville, Maryland) to conduct bootstrapping analysis, using sampling weights to estimate the variance of all point estimates with 1,000 replications and a Fay variance estimation factor of 0.75.

In accordance with Statistics Canada rules, we rounded frequency counts to the nearest 10 individuals and calculated proportions following rounding. Confidence intervals (CI) and standard error were calculated based on unrounded numbers. Due to small cell sizes, the responses "I don't know" or "not applicable" were not reported. Values with a

coefficient of variation (CoV) between 16.6% and 33% are noted as marginal and values with CoVs above 33% are noted as unacceptable in tables and figures.

Role of the Funding Source

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Results

The values reported in this section reflect all individuals who indicated use of each specific mobility device type (ie, MWC, PWC, or scooter); therefore, some individuals may be counted more than once if they reported use of more than one device. Where results are reported by device type, estimates include all individuals who indicated they used the device in question, with the exception of the *Multiple Device Use* section, which presents mutually exclusive and combined use categories. Estimates provided for all wheelchair and scooter users (ie, not presented by device type) include each respondent only once, regardless of how many devices were used.

Prevalence and Demographic Profile of Wheelchair and Scooter Users Nationally and by Province

There were approximately 288,800 (95% CI=258,230, 319,370) community-dwelling wheelchair and scooter users aged 15 years or over in Canada. Among these wheelchair and scooter users, 197,560 (95% CI=172,320, 222,800) used an MWC, 42,360 (95% CI=32,200, 52,514) used a PWC, and 108,550 (95% CI=88,890, 128,200) used a scooter. Community-dwelling wheelchair and scooter users represented 1.0% of the Canadian population aged 15 years or over. The number of wheelchair and scooter users by province ranged from 480 (95% CI=290, 450) (in the territories) to 121,170 (95% CI=53,490, 94,460) (in Ontario). Manitoba had the highest proportion of wheelchair and scooter users by population. Provincial prevalence by device type is summarized in Table 1.

Wheelchair and Scooter Use and Community-Dwelling Canadians

Table 1.

National and Provincial Prevalence, Sex, and Mean Age of WCS Users (All WCS and by Device Type)^a

	% Total Population ≥15 y				Female (% WCS Users)	Mean Age (y)
	All WCS	MWC Users	PWC Users	Scooter Users		
Canada	288,800 (1.0%)	197,560 (0.7%)	42,360 (0.2%)	108,550 (0.4%)	175,210 (60.7%)	65.05
Province						
NL	4,830 (1.1%)	4,160 (1.0%)	780 ^b (0.2%)	450 ^b (0.1%)	3,120 ^b (64.6%)	59.34
PE	1,160 (1.0%)	860 (0.7%)	210 ^b (0.2%)	410 ^b (0.4%)	580 ^b (50.0%)	64.00
NS	10,150 (1.3%)	6,910 (0.9%)	1,470 ^b (0.2%)	3,370 ^b (0.4%)	5,630 (55.5%)	66.86
NB	7,780 (1.2%)	5,930 (0.9%)	1,350 ^b (0.2%)	1,430 ^b (0.2%)	4,360 (56.0%)	59.08
QC	54,410 (0.8%)	45,330 (0.7%)	6,940 ^b (0.1%)	14,300 ^b (0.2%)	34,240 (62.9%)	65.18
ON	121,170 (1.1%)	73,970 (0.7%)	16,320 ^b (0.2%)	54,340 (0.5%)	77,960 (64.3%)	64.90
MB	13,500 (1.4%)	9,290 (1.0%)	1,930 ^b (0.2%)	5,110 ^b (0.5%)	7,890 (58.4%)	67.36
SK	10,080 (1.2%)	6,260 (0.8%)	1,350 ^b (0.2%)	5,050 (0.6%)	5,790 (57.4%)	63.89
AB	18,920 (0.6%)	11,830 (0.4%)	3,950 ^b (0.1%)	8,400 (0.3%)	10,990 (58.1%)	64.24
BC	46,320 (1.2%)	32,650 (0.9%)	8,010 ^b (0.2%)	15,490 ^b (0.4%)	24,390 (52.7%)	66.44
Territories	480 (0.6%)	370 (0.5%)	60 ^b (0.1%)	130 ^b (0.2%)	260 (54.2%)	64.55

^a NL=Newfoundland, PE=Prince Edward Island, NS=Nova Scotia, NB=New Brunswick, QC=Quebec, ON=Ontario, MB=Manitoba, SK=Saskatchewan, AB=Alberta, BC=British Columbia, MWC=manual wheelchair, PWC=powered wheelchair, WCS=wheelchair and scooter.

^b Marginal results; should be interpreted with caution due to high level of error associated with the results.

There were more female wheelchair and scooter users in all age categories except 15 to 24 years, where the balance was nearly equal. The mean age of wheelchair and scooter users nationally was 65 years (95% CI=63.44, 66.67), ranging from 59.08 (New Brunswick) to 67.36 (Manitoba). Disease or illness was the largest known cause of activity limitation (19.3%). Additional provincial break-

down regarding age, sex, and causes of activity limitation associated with wheelchair and scooter use is shown in Figure 1.

Demographic Profile by Device Type

The mean age for PWC users (56.1 years [95% CI=53.5, 59.6]) was lower than

that of both MWC users (65.4 years [95% CI=63.4, 67.4]) and scooter users (66.8 years [95% CI=64.6, 69.1]). Among MWC users, there was a higher proportion of women (63.4% [95% CI=57.8, 69.0]) than for PWC users (50.4% [95% CI=38.0, 62.7]) or scooter users (52.1% [95% CI=43.5, 60.8]). Table 2 reports the prevalence of wheelchair and scooter use by age category, device type, and sex. Wheelchair and scooter users comprise 4.2% of the total community-dwelling population over age 75 years. Figure 1 presents the cause of activity limitation by device type and sex; nearly half (45.6%) of PWC users indicated the cause of activity limitation was due to disease or illness, compared with an overall rate of 19.4%. A much smaller proportion of PWC users (9.4%) than either MWC users (18.8%) or scooter users (20.2%) reported aging as the primary cause of activity limitation. A higher proportion of men (21.1%) than women (9.3%) reported a work-related accident or injury as the primary cause of activity limitation.

Multiple Device Use

Approximately 50,620 individuals used 2 devices, either 1 of each or 2 of the same type, comprising 17.5% of all wheelchair

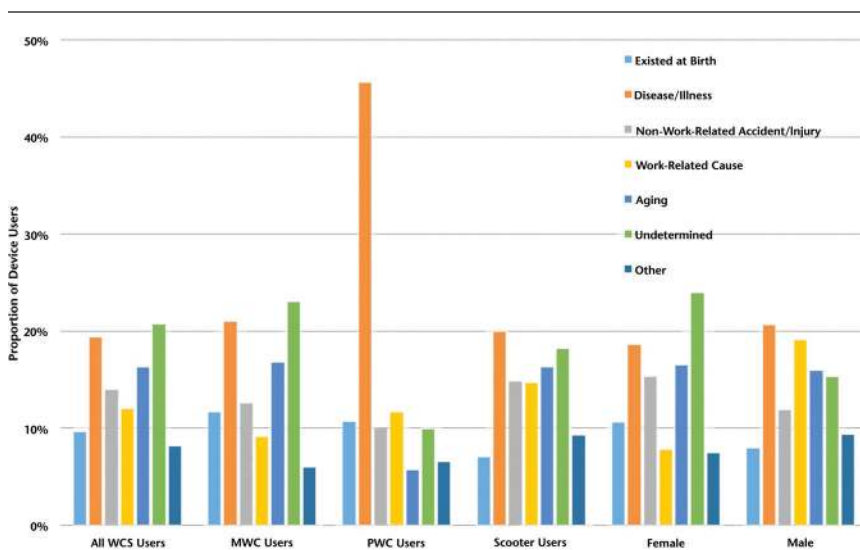


Figure 1.

Cause of activity limitation for WCS users by device type and sex. WCS=wheelchair and scooter, MWC=manual wheelchair, PWC=powered wheelchair.

Table 2.
Prevalence of WCS Device Type and Sex by Age Category^a

Age Category (y)	Prevalence (% Total Population in Age Category)				Female (% WCS Users)
	MWC	PWC	Scooter	All WCS	
15–24	7,080	2,270 ^b	520 ^c	8,490	4,220 ^b
	0.2%	0.1%	0.0%	0.2%	49.7%
25–44	16,620	8,400 ^b	4,740 ^b	24,980	14,340 ^b
	0.2%	0.1%	0.1%	0.3%	57.4%
45–64	65,250	16,870 ^b	41,870	97,440	53,100
	0.7%	0.2%	0.4%	1.0%	54.5%
65–74	38,810 ^b	7,980 ^b	26,940 ^b	63,300	44,790 ^b
	0.2%	0.0%	0.1%	0.2%	70.8%
75+	69,800	6,830 ^b	34,470	94,590	58,750
	3.1%	0.3%	1.5%	4.2%	62.1%

^a MWC=manual wheelchair; PWC=powered wheelchair; WCS=wheelchair and scooter; all WCS=manual wheelchair, powered wheelchair, and scooter users.
^b Marginal results; should be interpreted with caution due to high level of error associated with the results.
^c These estimates do not meet Statistics Canada’s quality standards. Conclusions based on these data will be unreliable and, most likely, invalid.

and scooter users. An additional 4,520 individuals use all 3 devices (MWC, PWC, and scooter), comprising 1.6% of all wheelchair and scooter users. Figure 2 provides additional details regarding multiple device use.

Ambulation Status

Nearly half of all wheelchair and scooter users indicated they could not walk 15 m at all, whereas approximately 1 in 20 reported no difficulty (Fig. 3).

Discussion

Prevalence of Wheelchair and Scooter Use in Canada and the Provinces

Community-dwelling wheelchair and scooter users account for approximately 1.0% of the Canadian community-dwelling population aged 15 years or over. Because this percentage does not include any individuals in residential or long-term care, the true prevalence of wheelchair and scooter users in the total population is likely to be higher.⁶ Excluding individuals who use only a scooter, wheelchair users (ie, MWC and PWC) account for approximately 0.8% of the community-dwelling Canadian population aged 15 years or over. The estimated proportion of wheelchair users is higher than the previous Canadian estimate of 0.6%⁶ and the most recent estimate (2002) from the United States, which reported an overall prevalence of 0.6%.⁹ One factor likely contributing to this increase is the aging population. In the 2011 census, Statistics Canada reported a 14.1% increase in individuals over the age of 65 years since the previous census in 2006.¹⁰ Other factors for the higher prevalence might include increased availability and declining cost of mobility devices and increased identification of need for a wheelchair or scooter. We also expect there may be reduced social stigma related to wheelchair and scooter use, particularly scooters. The rising prevalence of wheelchair and scooter use may have implications for service provision and funding policies, particularly as the population ages. There may be greater demands placed on prescribers to provide assessment, procurement, and training services.

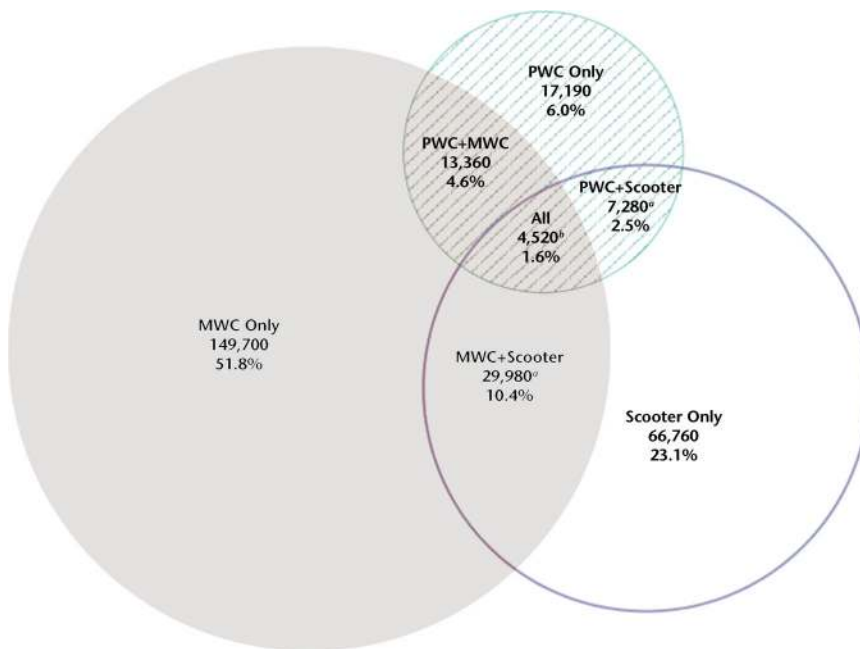


Figure 2
Wheelchair and scooter prevalence and proportion of use by single and multiple device types. MWC=manual wheelchair, PWC=powered wheelchair. Area of circles is proportional to prevalence estimates for each category. ^a Marginal results; should be interpreted with caution due to high level of error associated with the results. ^b These estimates do not meet Statistics Canada’s quality standards. Conclusions based on these data will be unreliable and, most likely, invalid.

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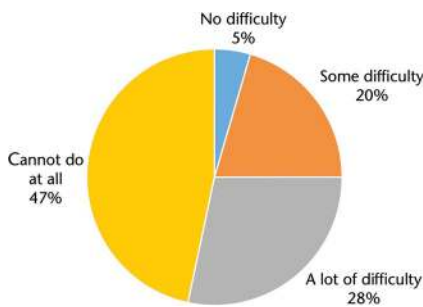


Figure 3. Proportion of wheelchair and scooter users who have difficulty walking 15 m.

The prevalence, selection, and use of specific devices across provinces are varied. For example, the proportion of scooter use ranges from 9% of the total wheelchair and scooter use (in Newfoundland) to 50% (in Saskatchewan), whereas MWC use ranges from 60% of total wheelchair and scooter use (in Ontario) to 86% (in Newfoundland). These differences may reflect provincial funding for wheelchairs and scooters, health care policies affecting acquisition and accessibility, or other factors such as climate, geography, and public attitudes toward wheelchair and scooter use. Although there are contrasting rates of scooter use, it is not surprising that Ontario has a high prevalence (0.5%), as it is one of the only provinces in Canada to provide funding for scooters. Manitoba (0.5%) and Saskatchewan (0.6%) report higher prevalence rates despite having no available funding for scooters and access to PWCs on a cost-free loan basis for qualified individuals. These findings speak to a more complex decision-making process, which is not dependent solely on the available funding. The high proportion of MWC users in provinces such as Newfoundland may be related to mean provincial age or to environmental factors, including climate and geography, which may make PWC use more difficult.¹¹ It also may be reflective of the strict funding guidelines for mobility devices, which may limit availability of a higher cost alternative (ie, PWC).¹² These factors should be explored to determine the reasons contributing to these interprovincial differences and whether there may be more cost-effective methods of providing access to wheelchairs and scooters while continu-

ing to meet the needs of individuals who require assistance with mobility.

There is less variation between provinces in PWC use rates, possibly because greater physical limitations restrict an individual's choice in device type. In the territories, however, PWC use is below the national average. This finding may reflect decreased accessibility leading to out-migration of individuals with disabilities or differences in wheelchair and scooter funding allocation in the territories as compared with the provinces. Differences in population demographics, including mean age, also may play a role in determining the types of devices, as there are demographic trends associated with age and device type. For example, Alberta has the lowest median age of all provinces in Canada, which could account for the lower overall numbers of wheelchair and scooter users.¹³

Demographic Profile of Wheelchair and Scooter Users in Canada and the Provinces

Aged between 15 and 24 years, there appears to be no difference between the sexes, but in all other age categories, there were more women than men, especially in the 65 to 74 years category (70.8%). These data are consistent with data from the United States and France, both reporting significantly more women using wheelchairs across all age categories.^{14,15} Women in Canada have a higher prevalence of chronic diseases, including arthritis, multiple sclerosis, and back problems,¹⁶ which may be associated with wheelchair and scooter use and may help explain this difference.

Wheelchair and scooter use increased with age up until 65 years, dropped in the 65 to 74 years category, and increased dramatically in the highest age bracket (75+ years). In some provinces, individuals qualify for wheelchair and scooter funding through disability plans until they receive a federal pension at age 65 years, which may partially explain this decrease. The increase following age 75 years may correspond to the proportion who report aging as the primary cause of activity limitation. Powered wheelchair users were younger, on average, than other wheelchair and scooter users. This

finding supports similar US findings that despite the majority of MWC users being elderly, 2 out of 3 PWC users are not.⁹ As PWC users were more likely to report disease or illness as the primary cause of activity limitation, the mean age may be reflective of the age of onset or earlier mortality associated with their health condition.

Multiple Device Use in Canada

Nearly 20% of wheelchair and scooter users have more than one device. Multiple device use has been discussed in the multiple sclerosis literature, where 60% of middle- and older-aged people reported using 2 or more mobility devices.¹⁷ Multiple devices may address specific needs. For example, an individual may use an MWC in the home and a scooter for longer distances outdoors. Alternately, PWC users may have a backup MWC should they experience a failure of the device,¹⁸ or they may have a backup MWC for situations where a PWC is not a viable option due to accessibility. Multiple device use also may be indicative of disease progression, where a device fails to meet the individual's needs over time. In addition, multiple device use may speak to the individual differences between users and the need for more than one device to maximize potential benefits. There may be implications for prescribing clinicians and funders, as it highlights the importance of addressing client-specific needs to ensure the correct devices or combination of devices are provided. Prescribers need to ensure that they are familiar with the benefits and limitations of different device types and have the skills to provide appropriate assessment and training. Therapists also may need to advocate on behalf of their clients for multiple devices, and funders may need to be fully informed about the rationale for these recommendations.

Mobility and Ambulation

Wheelchair and scooter users vary in their ability to ambulate. A small proportion report no difficulty at all walking 15 m. These individuals may require a wheelchair or scooter to complete a portion of their daily or weekly activities, but they do not require assistance at all times. For example, an individual may

use a wheelchair or scooter intermittently for longer distances or when fatigued.¹⁹ Just as ambulatory individuals may use different modes of transportation for various distances (ie, walking versus riding a bicycle), individuals with disabilities also require different devices that best suit their needs. An exploration of the unmet needs of wheelchair and scooter users may reveal a higher proportion who require additional devices, but do not have access to them, as many wheelchair and scooter funding models typically cover only one device, which is used for basic or essential mobility (ie, full-time use).²⁰ This research would provide additional support for changes to funding models and service provision, to ensure individuals' needs are met. Nearly one-quarter of the individuals who use wheelchair or scooters in Canada report using only a scooter. As scooters are typically used for longer distances,⁵ and not within living environments, this proportion may correspond to the number of individuals who are partially ambulatory yet sometimes require a wheelchair or scooter.

Limitations

There are several limitations to this study to consider. As this is a national data set with population-level prevalence estimates, it is generalizable within the Canadian context; however, we cannot speak to generalizability in other countries or regions. We completed the analysis using data from the CSD conducted in 2012–2013; therefore, prevalence estimates are current only to the date of the survey. In addition, as the NHS and postcensal surveys were voluntary, these data may not reflect individuals who chose not to participate in the census. This survey was dependant on data from the NHS; therefore, coverage or sampling errors in that survey will be reflected in this sample.⁷ The CSD does not account for those individuals living in institutional or other group-based care or for those individuals under the age of 15 years. Therefore, the CSD underestimates the total Canadian population use. The most recent published prevalence of wheelchair uses in residential care estimates 1 out of 2 residents use a mobility device for daily mobility.⁶

Implications for Future Research

While the analyses in this study provide cross-sectional prevalence estimates and initial data regarding demographic indicators, further research is needed to understand the impact of these factors on the overall use of wheelchairs and scooters and on the types of devices used. Longitudinal data would enable a more thorough understanding of the life course of wheelchair users and the relationship of a variety of demographic factors that may predict the need for a wheelchair or scooter.

Although this study identifies potential differences in wheelchair and scooter use across provinces, we are unable to explore the causes of those differences. Further research could expand on differences in the proportion of wheelchair and scooter users by province when compared with the proportion of the Canadian population, controlling for relevant provincial demographic profiles, to determine whether funding or other policies are contributing to rates of wheelchair and scooter use. Further research also could explore the unmet needs of wheelchair and scooter users, including needs for additional assistive technologies and accessibility and assistance needs related to wheelchair and scooter use. In addition, analysis of the prevalence of wheelchair and scooter use does not provide insight into the activity and participation needs of these individuals. As individuals were identified in the NHS based on self-reported activity limitation, an analysis of the activities in which they experience limitation would inform potential clinical interventions.

In conclusion, more than 288,000 community-dwelling Canadians, comprising 1.0% of the Canadian community-dwelling population aged 15 years and over, require use of a wheelchair or scooter for day-to-day mobility. Wheelchair and scooter users are predominantly women and use an MWC. Increased use of all wheelchairs and scooters in later life is consistent with increased mobility impairment and higher burden of disease associated with aging.

All authors provided concept/idea/research design. Ms Smith, Mr Giesbrecht, and Dr Miller provided writing. Ms Smith and Dr Miller provided data analysis and interpretation. Dr Miller provided project management, facilities/equipment, institutional liaisons, and administrative support. Mr Giesbrecht, Dr Mortenson, and Dr Miller provided consultation (including review of manuscript before submission).

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