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ORIGINAL RESEARCH

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ABSTRACT

Background: Around the world, variations and inequities in access to assistive technology (AT) are evident. Development of legislation, policies, and programmes has not kept pace with the increasing demand for AT. Therefore, context-specific needs assessment is required, which can assist in anticipating the accessibility and human support needs of individuals with impairments, and in turn, inform resource allocation and prioritisation of services. The purpose of this cross-sectional study was to describe the current use and unmet needs of AT use in community-dwelling Canadians experiencing activity limitation or participation restriction (disability).

Data and methods: Bootstrapping was used to estimate the prevalence of AT use and unmet needs using data from the 2012 Canadian Survey on Disability (CSD). The total sample size for the CSD was 45,443 individuals.

Results: Among the estimated 3,775,920 Canadians with a disability (13.7% of the Canadian population), 3,579,580 used some form of AT. Among these individuals, 3,050,750 use glasses or contact lenses and 1,109,060 use bathroom aids. The results of the study showed that the most common unmet need was for hearing aids (0.86% of the total population), followed by bathroom aids (0.36%).

Interpretations: This study comes at a time when global attention is focussed on research on access to AT. This study using data from the CSD will serve disability and social policy analysts at all levels of government, as well as associations for persons with disabilities and researchers working in the field of disability policy and programmes.

➤ **IMPLICATION FOR REHABILITATION**

The current initiatives on assistive technology, including the World Health Organization's Global Cooperation on Assistive Technology (GATE) project, recognize the substantial gap between the need for and provision of assistive devices. In Canada, for example, as well as in other countries, despite rapid growth in innovation, unmet needs for assistive devices persist and multiple barriers have been reported by individuals in accessing needed assistive devices. A better understanding of the met and unmet needs of assistive technology users can assist in anticipating accessibility and human support needs of individuals with disabilities, and in turn, inform resource allocation and prioritization of services.

- The study estimates the prevalence of assistive device use in community dwelling Canadians and describes the unmet needs for assistive devices of Canadians with activity limitation (disability).
- This study provides evidence on the use and unmet assistive technology needs for disability and social policy analysts at all levels of government, as well as associations for persons with disabilities and researchers working in the field of disability policy and programmes.
- The results of this study can be used for planning and evaluating services, programmes and policies for Canadian adults with disabilities to help enable their full participation in society.

Introduction

Assistive technology (AT) is an essential facilitator of independence and participation. According to the World Health Organization (WHO), AT "promotes well-being" and supports persons with disabilities to live healthy, productive, independent and dignified lives, as well as participating in education, the labour market, and social life [1]. This broad definition incorporates devices ranging from "low-tech" mobility devices, such as walking sticks, to "high-tech" speech synthesisers or stair-climbing wheelchairs. Beyond assisting those with disease and the ageing population, AT can reduce the need for formal health and support services and long-term care, as well as the burden on carers [1]. The WHO, through the Global Cooperation on Assistive Technology, recognizes the central importance of access to AT to promote independence, and substantial gap between the need for and provision of AT [2–8].

Variations and inequities in access to AT are evident in Canada and globally, and the development of legislation, policies, and programmes have not kept up with the increasing use of AT [9,10]. Barriers to accessing AT devices and services can arise when programmes are highly variable and complex [10]. Despite rapid growth in innovation, unmet needs for ATs persist and

context-specific needs assessment is required to understand the AT landscape [11]. Inequity in access to AT is evident when there are programmes offering funding for AT for individuals meeting certain eligibility criteria but not for individuals having similar needs but who do not meet these criteria [9]. It is clear that the need to adopt a stronger systems thinking perspective within the AT field should allow for more equitable, more resilient, and more sustainable AT across high-, middle-, and low-income contexts [12].

In particular, there is a need to address the unmet needs for assistive technology faced by Canadians. Canada has been ranked third-to-last in a detailed new study comparing healthcare systems in 11 developed nations [13]. According to the study, Canada's experiences comparatively higher prevalence of chronic conditions, long wait times in emergency rooms and to see specialists, and poor availability of after-hours care [14]. Moreover, recent studies have shown that since 2004, in Canada, there has been a 2% increase in the prevalence of walking aid use [15] and the proportion of Canadians who use wheelchairs and scooters, likely related to an ageing population [16]. Furthermore, nearly 10% of wheeled mobility device users identified an unmet need for an additional mobility device or residence adaptation [17,18].

Canada does not have federal universal legislation specific to AT funding and services, as this responsibility is delegated to the provinces. Federal, provincial, and territorial governments offer numerous programmes to provide AT devices and services to Canadian adults [10]. Many government programmes are the payer of last resort, meaning that other programmes, such as private and workers' insurance, need to be accessed prior to seeking funding from those programmes. The most commonly funded and serviced devices address mobility issues and range from wheeled walkers to powered mobility devices [10]. Device funding from the government for communication, vision, and hearing issues is inconsistent across provincial and territorial programmes, ranging from full funding to none at all [10]. In addition, multiple barriers to efforts to obtain the needed AT devices have been reported in Canada, including the cost of AT, which was cited as the most common reason for unmet needs [19]. Government-funded programmes often do not cover repairs and maintenance, such that consumers must pay the remainder of the costs [10]. A better understanding of the met and unmet needs of AT users could assist in anticipating the accessibility and human support needs of individuals with disabilities, and in turn, inform resource allocation and the prioritisation of services. For instance, it could help policymakers focus on the top ATs that should be funded. No previous population-based studies have examined the prevalence of unmet needs for AT users in the Canadian population with disabilities.

The purpose of this study was to describe current use and unmet needs for AT in Canada, based on the Canadian Survey on Disability (CSD), *via* the following:

1. Estimating the prevalence of AT use in community-dwelling Canadians experiencing activity limitation (disability); and
2. Estimating the prevalence of unmet AT needs among community-dwelling Canadians experiencing activity limitation (disability).

Data and methods

Canadian survey on disability

This cross-sectional study is based on a secondary analysis of data collected in a national cross-sectional survey. The data are from the 2012 Canadian Survey on Disability (CSD), [20] collected by Statistics Canada from 24 September 2012 to 13 January 2013 under the authority of the Statistics Canada Act. The 2012 CSD is a post-censal national survey of Canadian adults whose everyday activities are limited because of a long-term condition or health-related problem, and it provides a range of data on different impairments and disability that can cause participation restriction.

Sample

The population covered by the CSD [20] was based on a self-identified sample of volunteers [21] aged 15 and over identified by the National Household Survey (Census/NHS 10 May 2011) who have an activity limitation or participation restriction associated with a physical or mental health condition and were living in Canada at the time of the Census/NHS. A full description of the recruitment criteria procedures is available from Statistics Canada and in the CSD Concepts and Methods Guide [20]. The total sample size for the CSD was 45,443 individuals [20].

Data collection

The questions were administered using computer-assisted telephone interviews. A full description of the data collection procedures and weighting calculation is available from Statistics Canada, as well as in the CSD Concepts and Methods Guide [20]. Information collected included disability type and severity, assistance received and required, and use of AT [20]. For most questions on the CSD questionnaire, pre-coded answer categories were supplied and the interviewers were trained to assign a respondent's answer to the appropriate category.

Data analyses

The data were obtained from the Statistics Canada Research Data Centre at the University of British Columbia in Vancouver, British Columbia, Canada. Data were analysed from survey respondents who indicated they use or need AT. The analytic variables included the AT type, as well as the respondent's sex and age at the time of the survey [22]. The descriptive estimates (mean for continuous data, counts [%] for categorical data) included age, sex, and AT type. To estimate the population-level data from a sample, bootstrapping analyses were done. WesVar software (Version 5.1; Westat Inc., Rockville, MD) was used for conducting bootstrapping analyses, 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 the Statistics Canada guidelines, [22] the frequency was rounded to the nearest 10 individuals, and proportions were calculated following rounding. Confidence intervals (CIs) and standard errors were calculated based on unrounded numbers. Due to small cell sizes, the responses "I don't know" or "not applicable" were not reported.

Results

Among the estimated 3,775,920 Canadians with a disability (13.7% of the Canadian population, as per census data linked to the CSD) approximately 95% used some form of AT. The results of this study count individuals who reported using AT, the estimate for all individuals using AT is 3579580. Therefore, where results are reported by device type, estimates include all individuals who indicated they used the device in question; in this case, some

individuals may be counted more than once if they reported use of more than one device. However, the estimates provided for all AT users (i.e., not presented by device type) include each respondent only once, regardless of how many devices were used.

Prevalence of assistive device use

The mean age of AT users nationally was 60.88 years (SE 0.174). Among these users, 3,050,750 (95% CI 2,980,217.79; 3,121,278.23) used glasses or contact lenses. The 20 most prevalent assistive devices used in Canada are reported in Table 1. There was a higher proportion of females who use AT in most of age categories, and the most prevalent devices used were glasses or contact lenses, canes, walking sticks or crutches, and orthotics or braces for both males and females. Three categories report the proportion of females (%) below 50% – diabetic aids (49.45%), dressing

devices (47.52%) and hearing aids (39.81%), indicating more males use these devices.

Prevalence of unmet assistive device needs

Among people with disability, 37% had self-reported unmet needs (5% of the total population). The overall point estimate for unmet need is 1002890. The results showed that the most common unmet needs were hearing aids (6% of people with disability); bathroom aids, such as raised a toilet seat or grab bars (2.6% of individuals with disability); and supportive devices, such as therapeutic cushions or pillows, special chairs, or an adjustable bed (2.5% of individuals with disability). Table 2 lists the 20 most prevalent AT needed. With the exception of hearing aids and motorised wheelchair, the proportion of females needing devices is higher. The categories of impairment for which AT were most needed are reported in Table 3.

Table 1. 20 most prevalent assistive devices used in Canada.

Question: Because of your condition. do you use …

	Prevalence	% Total Population	Female (%)	Mean Age
Glasses or contact lenses	3050750	11.09	57.54	62.26
Bathroom aids (i.e., raised toilet seats)	1109060	4.03	63.08	68.85
Cane, Walking Stick or Crutches	962290	3.50	57.76	67.6
Orthotic or Brace	884540	3.21	56.96	57.69
Supportive Device such as therapeutic cushion, pillow, special chairs or an adjustable bed	689070	2.50	59.43	60.39
Orthopaedic Footwear	701900	2.55	62.33	59.12
Diabetic Aids, i.e., blood glucose monitor	613620	2.23	49.45	65.69
Walk in bath or shower	577640	2.10	58.45	66.58
Access ramp or ground level entrance	555850	2.02	62.91	65.19
Grasping Tool or Reach Extender	471970	1.72	66.44	59.37
Magnifiers	471560	1.71	56.02	63.02
Walker	465340	1.69	67.85	73.73
Device for dressing	416930	1.52	47.52	65.36
Automatic or easy to open doors	411230	1.49	62.86	66.2
Widened doorways or hallways	347470	1.26	60.49	66.65
Other	336430	1.22	55.05	60.46
Large Print Reading Materials	325330	1.18	61.18	60.25
Hearing Aid	314470	1.14	39.81	70.83
Electrotherapy Device for Pain	301700	1.10	56.27	56.12
Dark lined paper or dark inked pen	262190	0.95	65.42	58.46

Results are reported by device type, estimates include all individuals who indicated they used the device in question, some individuals may be counted more than once if they reported use of more than one device.

Table 2. 20 most prevalent assistive devices needed in Canada.

Question: Which aids or assistive devices do you need but do not have?

	Total	% Total Population	Female (%)	Mean Age
Hearing aid	237560	0.86	46.68715	64.64
Bathroom aids (raised toilet seat or grab bars)	98710	0.36	68.26056	60.75
Supportive devices. such as therapeutic cushions or pillows. special chairs. or an adjustable bed	93830	0.34	63.42321	54.39
Walk in Bath or Shower	84130	0.31	69.07167	61.41
Glasses and/or contact lenses	72360	0.26	55.22388	50.75
Electrotherapy device for pain. such as a TENS machine	61770	0.22	63.0565	52.28
Scooter	59900	0.22	62.53756	59.91
Grasping tool. reach extender	57710	0.21	67.89118	59.71
Diabetic aids. such as a blood glucose monitor or needles	54970	0.20	63.52556	52.65
Other devices related to moving. bending. reaching or fine motor	54840	0.20	73.14004	60.06
Orthotic or brace	46390	0.17	58.41776	48.55
Aids for persons who are deaf or hard of hearing	38790	0.14	62.05208	63.12
Walker	36330	0.13	65.45555	62.12
Lift device or elevator	35900	0.13	56.32312	57.46
Personal computer or laptop with specialized software or other adaptations	32280	0.12	51.45601	44.73
Motorised Wheelchair	32220	0.12	47.57914	61.34
Other hearing devices	32150	0.12	39.9689	63.43
Orthopaedic Footwear	29470	0.11	61.35053	55.91
Access ramp or ground-level entrance	26520	0.10	69.9095	60.29

[*]Results are reported by device type, estimates include all individuals who indicated they used the device in question, some individuals may be counted more than once if they reported use of more than one device.

Table 3. Category of impairment for which AT were most needed.

Category	Prevalence	% Total Population	% Female	Mean Age
Moving around. bending or reaching. fine motor skills	406930	1.48	67.08279	60.47
Other aids. devices. or specialized equipment	397050	1.44	58.76086	56.83
Hearing Condition	296030	1.08	45.71496	64.7
Seeing Condition	129170	0.47	58.14044	55.07
Learning	93510	0.34	58.58197	43.19

*Results are reported by device type, estimates include all individuals who indicated they used the device in question, some individuals may be counted more than once if they reported use of more than one device.

Discussion

According to the 2012 CSD, nearly 14% of community-dwelling Canadians (15 years and older) reported living with a disability; of these, more than 90% reported using at least one aid or device to assist them to participate more fully in society [20]. The results of this study based on the CSD data, [20] shows approximately 37% of users of AT indicated needing at least one other aid or device that they did not have. The prevalence of AT use and need that emerged in the current study can be compared with the findings resulted in the latest US, 18% of the total population (2010) [23,24] and Taiwanese (2011) censuses [25] which conclude that the use of AT has increased over the past decade.

Prevalence of assistive device use

More people use AT to compensate for mobility impairments than any other general type of impairment [26,27]. Regardless of the type of AT, use increases with age; our study showed that for the 20 most prevalent assistive devices used in Canada, mean ages range from 56.12 to 73.73 years old. Although our study found a relatively low mean age of use, as compared to other studies suggesting AT use increases with age, these findings [28] could be the result of the sampling method in the survey, as individuals living in long-term care, who may be more likely to use AT, were not included. Increases in the prevalence and rate of AT use over the time covered in this report may be due to medical and technological advances, public policy initiatives, or population changes. For example, more people are in need of AT because of advances in health and medical technology, such advances have improved survival in persons who have experienced severe trauma (injury) and disease [27]. While in the past the available devices were limited to primary activities, nowadays, technological advances allow individuals to have a wide range of devices capable of supporting almost every activity that the individual perceives as compromised. As the availability of solutions increases, the demand increases accordingly. Technological advances in composite materials, microelectronics, and microcomputers have influenced and improved AT design, making them lighter, safer, stronger, easier to use, and in some cases, less expensive. The increased availability and the low cost of devices and materials, as well as the increased identification of individuals who may need a device, potentially also contribute to higher prevalence estimates. Moreover, due to market demands, as need increases there is more competition in supply causing costs to come down. However, newer technology (i.e., rehab robots) are going to be expensive until there is an increasing demand, which is met by industry competition.

Prevalence of unmet assistive device needs

Among people with disability, 27% had self-reported unmet needs. Here, the overall unmet need is comparable to the rate described in a 2005 synthesis of studies from high-income countries, [28] but it is lower than the 60–70% found in studies from lower income countries, such as India, Bangladesh, and Uganda [29–31]. This may be related to Canada's robust universal health care system, where people largely have access to the devices they require. Otherwise, as Wang [9] et al. would suggest, it could be related to the higher income. Individuals with disabilities in Canada had the greatest need for devices facilitating activities of daily living, such as bathroom aids (raised toilet seat or grab bars), supportive devices (therapeutic cushions or pillows, special chairs, or an adjustable bed), or devices for walk-in baths or showers.

The main categories of impairment which cause the unmet need of AT were moving around, bending or reaching; and fine motor skills. Moreover, results about needs reported by category of impairment estimated that nearly 400,000 individuals would require AT for a reason other than those listed in the survey. This is a substantial number, and it may speak to the survey design, as respondents may not have been able to identify the reason from the available options. This result brings into question the clarity and completeness of the categories highlighted by the survey, including whether categories were unclear, or whether there were missing categories.

Findings about the presence of unmet needs in AT suggest that issues at all level of devices access and provision persist and this is caused by a range of social, demographic and structural factors [7]. Since we now have an awareness of which data are most used and most needed, that this can help provinces allocate funding to assistive technology provision services more effectively.

In this perspective, the findings of the current study in the Canadian context can be useful to fulfil Canada's international agreement relating to the United Nations Convention on the Rights of Persons with Disabilities, [32] with the purpose of upholding and safeguarding the rights of persons with disabilities and enabling their full participation in society. This is an issue that is being addressed worldwide. The GATE initiative, in fact, has proposed an international framework based on theoretically grounded research which could inform whether AT should be included in health and social services, as well as how and where AT funding and services would fit in the structure of health and social systems [3,4, 6,7]. The key concepts included a person-centred team approach; sustainability indicators to monitor, measure, and respond to needs for service design and delivery; and education, research, and training for competent practice.

Limits of the study

Several limitations related to the use of a national self-report survey to estimate prevalence of AT use should be acknowledged. First, biases associated with the survey may have influenced the accuracy of the results, as self-reports are prone to under-reporting of disability/functional limitation and over reporting of functional ability [33]. Second, since a single item for activity limitations on the Census/NHS was used to identify a subsample

of respondents, the findings should be interpreted with caution. However, restrictions on the performance of daily activities are not necessarily a consequence of an activity limitation that requires the use of AT (i.e., restrictions could be perceived as due to environmental factors or other conditions). Moreover, since the identified sample only included individuals who reported difficulty with daily tasks, individuals who use AT but reported no difficulty may have been missed in this study. This survey was dependent on data from the Census/NHS; therefore, coverage or sampling errors in the survey will be reflected in this sample. For example, individuals living in institutions like residential care facilities or on First Nations reserves were not included in the CSD, nor were individuals under the age of 15 years. However, as this is a national dataset with population-level prevalence estimates, it is generalizable in the Canadian context.

In addition, we completed the analyses using data from the CSD conducted in 2012–2013; therefore, prevalence estimates are current only to the date of the survey. Moreover, as the Census/NHS and post-censal surveys were voluntary, these data may not reflect individuals who chose not to participate in the census. Finally, due to cell sizes it was not possible to report unmet need by age category or sex.

While the analyses in this study provide cross-sectional prevalence estimates and initial data regarding demographic indicators, further research is needed to understand the influence of these factors on the overall use of AT and the types of devices used. Longitudinal data would enable a more thorough understanding of the life course of AT users and the relationship of a variety of demographic factors that may predict the need for AT. In addition, analysis of the prevalence of AT use does not provide insight into the activity and participation needs of these individuals. As individuals were identified in the Census/NHS based on self-reported activity limitation, an analysis of the activities in which they experience limitation would inform potential clinical interventions.

Conclusion

It is well established that the provision of AT should consider individuals' specific needs, the context in which they move, and the activities in which they need and want to engage. According to estimates from the 2012 CSD, among individuals with a disability, AT users had a high prevalence of both met and unmet needs, and they reported greater needs for activity of daily living impairment. Our study using data from the CSD will serve disability and social policy analysts at all levels of government, as well as associations for persons with disabilities and researchers working in the field of disability policy and programmes. The CSD will be used for planning and evaluating services, programmes, and policies for Canadian adults with disabilities to help enable their full participation in society.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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