RESEARCH ARTICLE

Wheelchair service provision education in Canadian occupational therapy programs

Ed M. Giesbrecht[1]*, **Paula W. Rushton**[2,3], **Evemie Dubé**[3]

1 Department of Occupational Therapy, University of Manitoba, Winnipeg, Manitoba, Canada,
2 Occupational Therapy Program, University of Montreal, Montreal, Quebec, Canada, **3** CHU Sainte Justine Research Centre, Montreal, Quebec, Canada

* ed.giesbrecht@umanitoba.ca

Abstract

Occupational therapists in Canada play a central role in wheelchair service provision. Inadequate entry-to-practice professional education has been identified as a major concern in the delivery of wheelchair related services. The goal of this study was to describe the current education provided in Canadian occupational therapy programs and to map this content against the recommended WHO 8-step wheelchair service provision process. The study used a descriptive cross-sectional online survey design. Educators were recruited from accredited occupational therapy programs in Canada. Participants completed a short socio-demographic questionnaire and a survey with 97 closed- and open-ended questions regarding the wheelchair service provision education provided in their curriculum. Survey data was then mapped according to the WHO 8-step wheelchair service provision process. Twenty-nine educators from all Canadian occupational therapy programs (n = 14) were enrolled. Most participants (55.2%) were full-time faculty members that had been teaching in occupational therapy programs for an average time of 10.9 years. All programs covered at least 4 of the WHO recommended steps, but only 5 programs covered all steps. *Assessment* and *Prescription* steps were covered in every program while the *Referral & Appointment*, *Funding & Ordering*, *Fitting* and *User Training* steps were covered in most programs. The pedagogic approach, the amount of time dedicated to wheelchair-related content, and the type of evaluation used varied greatly between programs. This study is the first to provide a detailed description of wheelchair service provision education across all Canadian occupational therapy programs according to the WHO 8 steps and provides a foundation for collaborative efforts to promote best practice in entry-to-practice professional education.

Introduction

Personal mobility is a fundamental human right, according to Article 20 of the United Nations Convention on the Rights of Persons with Disabilities [1]. For those with a mobility impairment, a wheelchair is an essential assistive technology. Wheelchair provision is a multi-faceted and complex intervention, requiring the provider to consider the interaction of the person (physical, cognitive, affective components), environment (physical, social, institutional)

and activities of choice (self-care, productivity and leisure) [2]. Appropriate wheelchair service provision addresses the barriers that compromise an individual's functioning [2], independence [3] and well-being [2]. Inappropriate wheelchair service provision can result in poorer health outcomes (e.g., physiological complications [4] and pressure injuries [5]), decreased functional abilities [6], decreased quality of life [7], social isolation [8], exclusion [8], and even death [8].

To promote best practice, the World Health Organization (WHO) published wheelchair provision guidelines in 2008 [9], in which they described an eight-step process: *Referral & Appointment*; *Assessment*; *Prescription*; *Funding & Ordering*; *Product Preparation*; *Fitting*; *User Training*; and *Follow-up, Maintenance & Repairs*. Evidence from subsequent studies implementing this process report positive impacts on wheelchair user satisfaction, participation, health, quality of life, daily wheelchair use, and activities of daily living [10–14]. The health care professionals primarily responsible for wheelchair service provision (i.e., occupational therapy [OT], physical therapy [PT], and prosthetics & orthotics [P&O]) often lack the competencies required for comprehensive service delivery [14]. The need for a competent workforce is a pressing issue for countries around the world as evidenced by prioritization in the WHO Global Cooperation on Assistive Technology [15], the 2017 Global Priority Research Agenda [16], the first Global Research, Innovation, and Education on Assistive Technology Summit [17, 18], and the 2018 Wheelchair Stakeholders' Meeting [19]. A recent position paper posits that capacity building and delivery of adequate education and training for all wheelchair service providers is critical to developing sustainable wheelchair provision systems [20].

Entry-to-practice education programs are pivotal in ensuring clinical competence. Emergent evidence benchmarking preparatory wheelchair service provision training against the WHO 8-step process [9] highlights shortcomings in current educational programs. Globally, ~ 21% of OT, PT and P&O university programs do not include any wheelchair provision education and, among those that do, there is considerable variability in content, pedagogical approach, evaluation and hours taught [21]. In low- and lower-middle income countries, ~75% of programs lack any content on wheelchair provision [14]. In Colombian occupational therapy (n = 7) [22] and physical therapy (n = 2) programs [23], student (n = 199) knowledge does not align with the WHO 8-step wheelchair service provision process. Programs in Romania [24] and the Philippines [25] have identified a need to improve wheelchair service provision in their rehabilitation programs. A recent World Federation of Occupational Therapists survey (n = 1050) confirmed a lack of professional preparation with 29% (n = 305) of respondents indicating they received insufficient or no training on wheelchair provision [26]. This evidence highlights insufficient entry-to-practice training among providers of wheelchair service [14, 19].

Most OT, PT and P&O university programs are approved according to international minimum education standards and/or accredited by national organizations. For example, all but 357 of the 96,551 OT programs worldwide are approved by the World Federation of Occupational Therapists (WFOT) [27]. In Canada, all 14 OT entry-to-practice programs are approved by WFOT [27] and accredited by the Canadian Association of Occupational Therapists (CAOT) [28]. However, while each programs' curriculum is WFOT approved and CAOT accredited, the incorporated content is not prescribed. As a result, there is variability across programs including wheelchair service provision specific content. Existing literature on entry-to-practice wheelchair provision education in Canada is sparse, but there is evidence that education is lacking in the *User Training* step [29] and this lack of preparation is reflected in limited implementation in clinical practice [30–32]. Surveying and documenting wheelchair service provision education delivered in Canadian OT programs would provide a more accurate and in-depth understanding of national training practices. Furthermore, this could

highlight gaps in education relative to the WHO 8-step process, identify where the greatest diversity exists among programs, and provide insights into potential opportunities for sharing of resources and strategies. Thus, the objective of this study was to describe wheelchair service provision education offered in Canadian OT entry-to-practice programs and map the content to the WHO 8-step wheelchair service provision process. This study is a first step towards the development of a national strategic plan to enhance wheelchair service provision education and develop a Community of Practice among Canadian OT program educators in this area. This vision has the potential to impact over 1000 students who graduate from these programs each year [28] and further the development of a competent workforce of wheelchair service providers in Canada.

Materials & methods

Design

This study employed a descriptive cross-sectional online survey design. It is part of a larger study aiming to develop a profile of wheelchair education provided in Canadian university occupational therapy curricula and a strategic plan for addressing identified gaps. The study was approved by the Research Ethics Board of the CHU Sainte-Justine (#2020–2336).

Recruitment

A volunteer sample was recruited from the 14 accredited Canadian OT programs. An invitation was sent via email to the director of each program, requesting 1–3 educators to participate. Individuals were eligible to participate if they were (1) a faculty member or guest lecturer in the OT program; (2) currently teaching wheelchair content or were in the process of planning to teach wheelchair content; and (3) able to read and speak in English or French (the two official Canadian languages). Recruitment took longer than expected due to the onset of the COVID-19 pandemic; the online survey remained open from August 2019 to May 2021. Participants provided written informed consent prior to participation and were not reimbursed for their time.

Measurement

The research team, composed of two wheelchair service provision education experts, developed the online survey, which was designed to describe the current wheelchair service provision education offered in the OT program in relation to the WHO 8-step process. The initial iteration of the survey was piloted by four graduate students and one research assistant who provided feedback on the clarity of questions and an estimated completion time of 30–40 minutes. The final version consisted of 97 closed and open-ended questions. The survey was divided into three sections: (1) university program demographic and descriptive information (5 questions); (2) identification of the educators completing the survey (2 questions); and (3) wheelchair service provision content, instructional method and evaluation according to the WHO 8-steps of wheelchair provision (90 questions). If a respondent indicated they did not include content on a specific WHO step, the survey would skip over the follow-up questions and immediately move to the next WHO step. Close-ended questions were either dichotomous (yes/no) or multiple-choice. Open-ended questions were to specify the teaching resources used, the "other" category or to provide the number of courses or hours dedicated to wheelchair-related content. In addition, each educator completed a 16-item sociodemographic questionnaire about their own personal information (e.g., age, sex, education, faculty position,

teaching experience). Both the survey and sociodemographic questionnaire were administered using SurveyMonkey (SurveyMonkey Canada Inc., Ottawa, Canada).

Data collection

Upon receiving informed consent to participate in the larger study, educators were emailed the link to the short sociodemographic questionnaire. Once this questionnaire was completed by each educator recruited from the OT program, the link to the survey was emailed with the request that one survey per program be collaboratively completed. The Tailored Design Method [33] was used to maximize response rate, in that reminder emails were sent to programs who had not yet completed the survey 2, 4 and 6 weeks following the initial email invitation.

Data analysis

Survey data were exported from SurveyMonkey into SPSS Statistics (IBM Corp, Armonk, New York) Version 26.0 for analysis. Data were analyzed using descriptive statistics (means, standard deviations, frequencies). The teaching resources provided in the open-ended survey questions and shared with the researchers were categorized as in-house content (e.g., power point slide decks, case studies, lab guides, online modules), provincial/local resources (e.g., local practice guidelines, provincial forms, supplier forms, rehabilitation centers forms, display of products by vendors) or open-source resources (e.g., training programs, textbooks, articles). The research team then conducted a systematic mapping process to compare the education offered in each program compared to the WHO 8-steps to identify patterns in education.

Results

Participants

A total of 29 educators were enrolled, representing all 14 Canadian OT programs (average of 1.86 per program, median 1, range 1 to 5). All 14 entry-to-practice programs were master's level; the 5 programs in the province of Quebec were Bachelors-Masters continuum programs. Participants reported that programs ranged in total duration from 2 to 5 years and that 9 of 14 (64%) were taught in English. The average number of students admitted per year was 78 (range 38–140). Sociodemographic characteristics of the study participants are described in Table 1. Participants ranged in age from 31 to 63 years (48.3 years ± 7.9) and were mostly women with full-time faculty member positions. Most participants (79.3%) had taken additional courses specific to wheelchair service provision since the completion of their clinical degree, but only 4 participants had additional certification related to wheelchair service provision (e.g., from the International Society of Wheelchair Professionals ISWP).

Description of wheelchair-related content

Only 5 programs covered all the WHO recommended 8 steps of wheelchair service provision, with all programs covering at least four of the eight steps. Step 2 (*Assessment*) and 3 (*Prescription*) were covered in all programs. Most programs also covered step 1 (R*eferral & Appointment*), 4 (*Funding & Ordering*), 6 (*Fitting*) and 7 (*User Training*). Step 5 (*Product Preparation*) and 8 (*Follow-up, Maintenance & Repairs*) were the least frequently covered steps. The approximate amount of time dedicated to wheelchair-related content varied greatly between programs from 2.5 to 48 hours (Table 2).

Table 1. Participants' sociodemographic characteristics.

Characteristic	Value
Age in years, mean (SD, range)	48.3 (7.9, 31–63)
Gender, n (%)	
Man	3 (10.3)
Woman	25 (86.2)
Non-binary	1 (3.4)
Primary Language, n (%)	
French	7 (24.1)
English	22 (75.9)
Highest Level of Education, n (%)	
Bachelor	6 (20.7)
Master (OT/research)	11 (37.9)
PhD	12 (41.4)
Years teaching in OT program, mean (SD, range)	10.9 (6.9, 1–29)
Position in OT university program, n (%)	
Full-time faculty member	16 (55.2)
Part-time faculty member	1 (3.4)
Adjunct faculty member	5 (17.2)
Invited presenter	2 (6.9)
Clinician	4 (13.8)
Clinical faculty	1 (3.4)
Currently practicing clinically, n (%)	15 (51.7)
Practice includes wheelchair service provision, n (%)	12 (41.4)
Years teaching wheelchair content, mean (SD, range)	9.2 (7.2, 0–30)
Role in delivery of wheelchair education, n (%)	
Coordinate a course that is exclusively wheelchair-specific	3 (10.3)
Coordinate a course that includes wheelchair-specific content	13 (44.8)
Teach within a course that is exclusively wheelchair-specific	3 (10.3)
Teach wheelchair-specific content within a course	14 (48.3)
Assist within a course that is exclusively wheelchair-specific	2 (6.9)
Assist with wheelchair-specific content within a course	6 (20.7)
Other wheelchair-relevant involvement	5 (17.2)
Participated in developing wheelchair course, n (%)	23 (79.3)
Continuing education obtained on wheelchair service provision, n (%)	23 (79.3)
Continuing Education offered through a university program	2 (6.9)
Conference workshop	21 (72.4)
Educational opportunity offered by a private organization	8 (27.6)
Online course	2 (6.9)
Self-study	15 (51.7)
Other	4 (13.8)
Certification related to wheelchair service provision, n (%)	4 (13.8)
Member of one or more wheelchair-related organizations, n (%)	10 (34.5)
Rehabilitation Engineering and Assistive Technology Society of North America	9 (31.0)
International Society of Wheelchair Professionals	7 (24.1)
International Society of Prosthetics and Orthotics	2 (6.9)
Other	4 (13.8)

https://doi.org/10.1371/journal.pone.0262165.t001

Table 2. Time allotted to teaching each of the WHO wheelchair service provision steps by program.

Program	Step 1 Referral & Appointment	Step 2 Assessment	Step 3 Prescription	Step 4 Funding & Ordering	Step 5 Product Preparation	Step 6 Fitting	Step 7 User Training	Step 8 Follow-up, Maintenance Repairs	Total time	Number of steps covered
1		18h	9h	4h	4h	4h	6h	3h	48h	7
2	0.17h	2.3h	0.5h	0.17h	2.3h	0.5h	0.33h	1.5h	7.8h	8
3	2h	7.5h	6.5h	2h	3.5h	1h	6h	1h	29.5h	8
4	0.25h	2.5h	3h	0.25h	0.25h	0.5h	0.25h	0.25h	7.3h	8
5	0.25h	1h	0.5h	0.5h			0.25h		2.5h	5
6	1h	6h	4h	1h		3h		1h	16h	6
7	1h	21h	10h	2h	0.33h	0.75h	13h	0.67h	48.8h	8
8	1h	5h	5h	1h		5h			17h	5
9		3h	2h			2h	1h		8h	4
10	1h	9h	6h	1h		2h			19h	5
11		4h	1h	1h			2h		8h	4
12	0.5h	6h	2h	0.5h	0.5h	0.5h	1.5h	0.5h	12h	8
13	2h	8h	10h	2h	3h	2h	2h		29h	7
14	0.17h	3h	3h	0.5h		3h	2h		11.5h	6
Mean	0.7h	7h	4.5h	1.1h	0.98h	1.7h	2.5h	0.57h	18.9h	
Median	0.5h	5.5h	3.5h	1h	0.13h	1.5h	1.3h	0.13h	14h	
Standard deviation	0.7h	5.9h	3.4h	1h	1.5h	1.6h	3.6h	0.85h	14.8h	
Number of programs	11	14	14	13	7	12	11	7		

Delivery of wheelchair-related content (pedagogic approach, resources, evaluation)

The integration of wheelchair service provision education in the curricula of participating programs is described in Table 3. For most programs, wheelchair related content was distributed throughout the curricula as part of mandatory courses. Only a limited number of programs offered wheelchair related content in full mandatory courses or full optional courses. Lectures and laboratories with instructors were the most frequent pedagogic approaches used to deliver wheelchair content. Educators were mostly using written evaluation to evaluate students' knowledge in each step with step 4 and 8 being the less evaluated. Other methods of evaluation included practical evaluation and oral presentations. Two programs (14.3%) also reported that data about students' learning was collected outside of course-related evaluation using the ISWP Basic Test [34] and administering wheelchair-related outcome measures before and after some components (i.e., skills training). Most programs (93%) used in-house content combined with open-source resources and provincial/local resources. Provincial/local resources were mostly forms or guides from provincial governments, local rehabilitation centers and wheelchair suppliers. Open-source resources that were the most used by educators were documents from the Rehabilitation Engineering and Assistive Technology Society of North America [35], the World Health Organization [36, 37] and the Wheelchair Skills Program [38].

Discussion

This study was novel in several regards. First, this study is the first of which we are aware that explored specific practice in education and evaluation of wheelchair service provision content

Table 3. Delivery, teaching and evaluation approaches for each WHO wheelchair service provision step.

WHO Step	Programs included	Course Format							Teaching Method						Evaluation				
		Only part of a course	Only full courses			Part of a course and Full mandatory course	Part of a course and Full optional course	Full courses (mandatory and optional) and part of a course	Lecture	Lab (I)	Lab (S)	Lab (W)	Online module	Other	Written	Practical	Online	Other	None
			Mandatory	Optional	Mandatory and optional														
1	11	6 (55%)	0 (0%)	1 (9%)	0 (0%)	4 (36%)	0 (0%)	0 (0%)	10 (91%)	6 (55%)	0 (0%)	3 (27%)	2 (18%)	2[a,c] (18%)	6 (55%)	3 (27%)	1 (9%)	3[e,f] (27%)	3 (27%)
2	14	8 (57%)	0 (0%)	0 (0%)	0 (0%)	4 (29%)	2 (14%)	0 (0%)	10 (71%)	9 (64%)	4 (29%)	5 (36%)	4 (29%)	1[c] (7%)	12 (86%)	7 (50%)	2 (14%)	2[g] (14%)	1 (7%)
3	14	7 (50%)	0 (0%)	0 (0%)	0 (0%)	4 (29%)	2 (14%)	1 (7%)	11 (79%)	11 (79%)	3 (21%)	4 (29%)	2 (14%)	2[b,c] (14%)	11 (79%)	4 (29%)	2 (14%)	2[e,g] (14%)	1 (7%)
4	13	5 (38%)	0 (0%)	0 (0%)	0 (0%)	4 (31%)	3 (23%)	1 (8%)	11 (85%)	5 (38%)	0 (0%)	1 (8%)	1 (8%)	0 (0%)	5 (38%)	0 (0%)	1 (8%)	2[e] (15%)	7 (54%)
5	7	5 (71%)	0 (0%)	0 (0%)	1 (14%)	1 (14%)	0 (0%)	0 (0%)	7 (100%)	5 (71%)	1 (14%)	1 (14%)	0 (0%)	0 (0%)	4 (57%)	1 (14%)	2 (29%)	0 (0%)	2 (29%)
6	12	7 (58%)	1 (8%)	1 (8%)	0 (0%)	3 (25%)	0 (0%)	0 (0%)	11 (92%)	6 (50%)	3 (25%)	1 (8%)	0 (0%)	1[c] (8%)	6 (50%)	1 (8%)	1 (8%)	0 (0%)	6 (50%)
7	11	9 (82%)	0 (0%)	1 (9%)	0 (0%)	1 (9%)	0 (0%)	0 (0%)	8 (73%)	6 (55%)	1 (9%)	1 (9%)	2 (18%)	1[d] (9%)	8 (73%)	3 (27%)	2 (18%)	0 (0%)	2 (18%)
8	7	4 (57%)	0 (0%)	1 (14%)	0 (0%)	2 (29%)	0 (0%)	0 (0%)	5 (71%)	3 (43%)	1 (14%)	0 (0%)	1 (14%)	0 (0%)	2 (29%)	0 (0%)	1 (14%)	0 (0%)	4 (57%)

[a] vendors and a wound care day of 5 hours

[b] case-studies with pairs

[c] site visits to local clinics that specialize in wheelchair assessment or prescription

[d] online videos from Wheelchair Skills Program

[e] oral presentations

[f] complete a form for a client

[g] observation during lab and feedback.

Note: Lab (I) = with instructors; Lab (S) = with simulated clients; Lab (W) = with wheelchair users.

https://doi.org/10.1371/journal.pone.0262165.t003

across the 8-step framework specific to occupational therapy programs. Second, this study engaged every accredited entry-to-practice university program in Canada, providing a comprehensive national overview. The participation of all 14 programs reflects the programs' prioritization of this content area and commitment to enhancing preparation of occupational therapists for clinical practice.

The total number of individuals involved in teaching wheelchair-specific content is unknown, but our experience suggests that the 29 study participants represent a majority of educators in OT programs in Canada. The composition of study participants reflected a broad spectrum of educator roles, with roughly half being full-time faculty and 40% actively practicing in clinical wheelchair service delivery. They typically had extensive experience coordinating or teaching this content area and nearly 80% had engaged in wheelchair-related continuing education activities. While a third of participants were active members of an assistive technology organization, less than 15% had wheelchair service provision certification.

There was considerable diversity in the time allocated to wheelchair-specific content across programs, ranging from 2.5 to over 48 hours. Likewise, there was a broad range of steps covered across the 14 programs. While half of the programs were quite comprehensive, covering 7 or 8 steps, nearly one third addressed only 4–5 steps. This variability may reflect the lack of wheelchair-specific content requirements in Canadian OT program accreditation standards [20, 21]. Similar issues and patterns of diversity have been reported in other middle- [14] and high-income countries as well [21]. Decisions about which steps to include may relate to relevance identified by course coordinators, perceptions of whether particular steps fall within a regional scope of practice, or prioritization within given time constraints. A post-hoc exploration found a weak correlation (r = 0.41) between the amount of time allocated and the number of steps covered, but this was not a statistically significant relationship. The programs appear to fall into three broad groupings with 35% providing 8 hours or less, 35% providing 12–19 hours and 30% providing 26–49 hours. Similarly, there appear to be some regional trends with western programs (n = 3; m = 28.4 hours covering 7.7 steps) higher than eastern programs (n = 6; m = 18.8 hours covering 5.7 steps) followed by central programs (n = 5; m = 12.7 hours covering 6.4 steps), although the small number of programs precludes a meaningful statistical analysis. Individual programs clearly address this content area differently in terms of time explicitly dedicated to wheelchair service provision. Despite evidence suggesting that occupational therapists are more likely to provide [39], and be knowledgeable in, wheelchair service provision than other professions [40], there is clearly room for improvement and greater uniformity in their professional education as suggested by D'Innocenzo [41]. While national accreditation processes require programs to ensure competency across the professional roles defined in the Profile of Practice [42], they do not explicate content-specific requirements [43].

Regarding individual steps, *Assessment* and *Prescription* were universally addressed, suggesting these are high priority topics. In most programs, *Assessment* is given the most teaching time. This is not surprising given the magnitude of resources available and broadly accepted practice standards. Likewise, the *Prescription* step addresses clinical reasoning and application of information garnered during assessment, which is essential to clinical practice. It is influenced to some degree by product knowledge, which is an evolving market and often addressed collaboratively with vendors, which might explain the lower number of hours allocated in most programs. *User Training* was assigned the third highest duration among the 11 programs that included this step. This is a somewhat higher ratio than a previous survey of 11 Canadian OT programs that found 7 included wheelchair skills training, 57% providing less than 5 hours of content [29]. A recent survey among OTs practicing in one Canadian province reported one third felt their professional education inadequately prepared them to provide training to clients and caregivers [31] while a qualitative study among rehabilitation clinicians in the

American Midwest reported very limited education on such training was provided before entering practice [44]. Over 30% of wheelchair service providers in a global survey felt unprepared to deliver wheelchair skills training and 24% reported inadequate professional training as a barrier to offering this service component [39]. Collectively, this suggests the *User Training* step merits further attention in entry-to-practice programs. Wheelchair skills training has a growing body of evidential literature, and typically entails 2–4 hours of experiential learning, using a bootcamp approach, to adequately prepare students for clinical application [45–48]. In our study, programs with fewer total hours tended to spend one hour or less on the *User Training* step; however, most programs that did not address the *User Training* step at all had 16 hours or more of content suggesting this decision was not entirely related to time. The *Funding & Ordering* step was addressed in nearly every program but received fairly brief exposure, approximately one hour on average. Content on this topic typically reflects funding agencies, programs and vendors specific to regional jurisdictions. While Canada has a nationally funded health care system, each province and territory administers its own health insurance plan with vastly differing access to wheelchair products and funding [49]. *Product Preparation* and *Follow-up*, *Maintenance & Repairs* steps were reported by only half of programs nationally. In clinical practice, occupational therapists may have access to technicians, either in-house or through a suppling vendor, whom they rely on to perform many of these functions during wheelchair service delivery. Consequently, educators (many who currently practice in this area) may pragmatically consider this an area of lower priority. A recent analysis of knowledge test performance among wheelchair service providers globally [40] found *Follow-up* to be among the lowest scoring domains, indicating this gap is not unique to occupational therapy and may be an area of priority for curriculum reform. It should be noted that the *Referral & Appointment* step was allocated the least amount of time but was covered in nearly 80% of programs.

The delivery of content across steps was generally spread throughout the duration of entry-to-practice programs. The different aspects of wheelchair service delivery are included both earlier and later in occupational therapy curricula and, in many cases, throughout. A relatively small number of programs offer courses that deal exclusively with wheelchair service delivery; rather, most integrate this information into a broader course or courses within the program. All programs include wheelchair-specific content as part of their core curriculum. Only a small proportion of programs offer elective courses addressing this specific topic; this is not surprising given that Canadian entry-to-practice programs have little, if any, elective content. Lecture was the most prevalent method of content delivery across the 8 steps. Hands-on labs of some sort were used at least 50% of the time, aside from the *Funding* and *Follow-up* steps. Use of authentic and simulated wheelchair users was more common for teaching the *Assessment* and *Prescription* steps, allowing students to observe or practice these skills either on campus or in a clinic setting. This type of experiential learning is optimal, but the lower frequency of use reflects the resource and pragmatic challenges of bringing in clients or volunteers and providing sufficient time/access for students to practice, particularly with larger class cohorts. Only six programs utilized on-line modules, primarily for the *Assessment* step. There appears to be considerable opportunity yet for programs to leverage on-line and asynchronous learning strategies to supplement or support the lecture and lab components of wheelchair-related content, as has been proposed in several publications [20, 22]. It is possible that programs may have begun developing these types of resources during the COVID pandemic [50, 51],which occurred subsequent to most of the survey responses.

With respect to evaluation, written exams were used most commonly across all steps. Practical exams were used less frequently; half of the programs evaluated the Assessment step in this manner. Student evaluations did not necessarily incorporate every step in the wheelchair

provision process even if it was taught. The *Funding*, *Fitting*, and *Follow-up* steps were not evaluated at least half of the time. Given that wheelchair-related content is typically taught as a component in a larger (typically skills-based) course, educators need to constrain and prioritize content that is most essential for evaluation. *Assessment* and *Prescription* were rarely excluded, corresponding with the prevalence of inclusion and time allocated. Likewise, *User Training* was evaluated by most of the 10 programs that included this component.

Several factors should be acknowledged as limitations with this study. While we had respondents from every Canadian OT program, there were typically 1–3 individuals from each site collectively responding to the survey and we might have a more comprehensive summary if we were able to hear from all wheelchair content educators. Two of the study authors have primary responsibility for wheelchair service provision education in their respective occupational therapy programs. To minimize bias in data collection, we enrolled other educators involved in wheelchair-related content delivery from these two programs. While the program-specific responses accurately reflect content and delivery, the absence of the two study authors as participants may have impacted both the demographic profile and level of detail for course content, delivery and evaluation for these two sites. Time allocated to the 8 steps were based on participant estimates and their interpretation of the step descriptions; where participants provided a time "range" we reported the more conservative (lower) value. While data from this study is the most comprehensive to date in terms of Canadian education, it may not be reflective of practice in other national programs or disciplines, particularly those in less-resourced settings. This study provides important quantitative information about how wheelchair-related content is incorporated into Canadian OT programs. Future study could also investigate the quality of this education provided, including student perspectives.

Conclusions

This study is the first to provide a detailed description of wheelchair service provision education across all Canadian OT programs. It highlights the differing amounts of time allocated to wheelchair service provision education among programs, exposes that only 35.7% of programs cover all of the 8 steps recommended by the WHO and identifies the lack of experiential and online pedagogic strategies used for both content delivery and evaluation. These findings provide a foundation for subsequent collaborative efforts to promote best practice in entry-to-practice professional education at a national level. Future research should investigate how programs negotiate extent and scope of wheelchair service provision content, including barriers and facilitators of change and innovation.

Supporting information

S1 File. Sociodemographic questionnaire.
(PDF)

S2 File. Educator survey.
(PDF)

S3 File. Redacted.
(XLSX)

Acknowledgments

Author Contributions

Conceptualization: Ed M. Giesbrecht, Paula W. Rushton.

Data curation: Paula W. Rushton.

Formal analysis: Evemie Dubé.

Funding acquisition: Ed M. Giesbrecht, Paula W. Rushton.

Investigation: Ed M. Giesbrecht, Paula W. Rushton.

Methodology: Ed M. Giesbrecht, Paula W. Rushton.

Project administration: Ed M. Giesbrecht, Paula W. Rushton.

Resources: Paula W. Rushton.

Software: Paula W. Rushton.

Supervision: Ed M. Giesbrecht, Paula W. Rushton.

Validation: Ed M. Giesbrecht, Paula W. Rushton.

Writing – original draft: Ed M. Giesbrecht, Paula W. Rushton, Evemie Dubé.

Writing – review & editing: Ed M. Giesbrecht, Paula W. Rushton, Evemie Dubé.

References

1. Convention on the Rights of Persons with Disabilities.: United Nations; 2018 [cited 2018 April 17]. Available from: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-15&chapter=4&clang=_en.

2. Gowran RJ. Wheelchair and Seating Provision Special Issue. Irish Journal of Occupational Therapy. 2012; 39(2).

3. Sapey B, Stewart J, Donaldson G. Increases in wheelchair use and perceptions of disablement. Disability & Society. 2005; 20(5):489–505.

4. Thyberg M, Gerdle B, Samuelsson K, Larsson H. Wheelchair seating intervention. Results from a client-centred approach. Disability and Rehabilitation. 2001; 23(15):677–82. https://doi.org/10.1080/09638280110049900 PMID: 11720118

5. Groah SL, Schladen M, Pineda CG, Hsieh C-HJ. Prevention of pressure ulcers among people with spinal cord injury: a systematic review. PM&R. 2015; 7(6):613–36. https://doi.org/10.1016/j.pmrj.2014.11.014 PMID: 25529614

6. Kittel A, Marco AD, Stewart H. Factors influencing the decision to abandon manual wheelchairs for three individuals with a spinal cord injury. Disability and Rehabilitation. 2002; 24(1–3):106–14. https://doi.org/10.1080/09638280110066785 PMID: 11827144

7. Chaves ES, Boninger ML, Cooper R, Fitzgerald SG, Gray DB, Cooper RA. Assessing the influence of wheelchair technology on perception of participation in spinal cord injury. Archives of Physical Medicine and Rehabilitation. 2004; 85(11):1854–8. https://doi.org/10.1016/j.apmr.2004.03.033 PMID: 15520981

8. Policy Brief: Access to Assistive Technology.: World Health Organization; 2020 [cited 2021 July 13]. Available from: https://www.who.int/publications/i/item/978-92-4-000504-4

9. Guidelines on the provision of manual wheelchairs in less resourced settings.: World Health Organization; 2008 [cited 2021 July 13]. Available from: http://www.who.int/disabilities/publications/technology/wheelchairguidelines/en/.

10. Borg J, Larsson S, Östergren P-O, Rahman AA, Bari N, Khan AN. User involvement in service delivery predicts outcomes of assistive technology use: A cross-sectional study in Bangladesh. BMC Health Services Research. 2012; 12(1):1–10. https://doi.org/10.1186/1472-6963-12-330 PMID: 22995203

11. Toro ML, Eke C, Pearlman J. The impact of the World Health Organization 8-steps in wheelchair service provision in wheelchair users in a less resourced setting: a cohort study in Indonesia. BMC Health Services Research. 2016; 16:26. https://doi.org/10.1186/s12913-016-1268-y PMID: 26801984

12. Visagie S, Scheffler E, Mlambo T, Nhunzvi C, Van der Veen J, Tigere D. Impact of structured wheelchair services on satisfaction and function of wheelchair users in Zimbabwe. African Journal of Disability. 2016; 5(1):1–11. https://doi.org/10.4102/ajod.v5i1.222 PMID: 28730049

13. Shore S. The long-term impact of wheelchair delivery on the lives of people with disabilities in three countries of the world. African Journal of Disability. 2017; 6(1):1–8. https://doi.org/10.4102/ajod.v6i0. 344 PMID: 28936417

14. McSweeney E, Gowran RJ. Wheelchair service provision education and training in low and lower middle income countries: a scoping review. Disability and Rehabilitation: Assistive Technology 2017:1–13. https://doi.org/10.1080/17483107.2017.1392621 PMID: 29092684

15. Global Cooperation on Assistive Technology (GATE). World Health Organization; 2014 [cited 2018 Jan 3]. Available from: http://www.who.int/phi/implementation/assistive_technology/phi_gate/en/.

16. Global priority research agenda for improving access to high-quality affordable assistive technology.: World Health Organization; 2017 [cited 2021 July 13]. Available from: https://apps.who.int/iris/handle/ 10665/254660.

17. Smith RO, Scherer MJ, Cooper R, Bell D, Hobbs DA, Pettersson C, et al. Assistive technology products: a position paper from the first global research, innovation, and education on assistive technology (GREAT) summit. Disability and Rehabilitation: Assistive Technology. 2018; 13(5):473–85. https://doi. org/10.1080/17483107.2018.1473895 PMID: 29873268

18. de Witte L, Steel E, Gupta S, Ramos VD, Roentgen U. Assistive technology provision: towards an international framework for assuring availability and accessibility of affordable high-quality assistive technology. Disability and Rehabilitation: Assistive Technology. 2018; 13(5):467–72. https://doi.org/10.1080/ 17483107.2018.1470264 PMID: 29741965

19. Wheelchair Stakeholders' Meeting: Executive Summary.: World Learning; 2018 [cited 2021 July 13]. Available from: https://wheelchairnetwork.org/wp-content/uploads/2019/08/01a-WL-Wheelchair-Two-Pager-FINAL.pdf.

20. Gowran RJ, Bray N, Goldberg M, Rushton P, Barhouche Abou Saab M, Constantine D, et al. Understanding the Global Challenges to Accessing Appropriate Wheelchairs: Position Paper. International Journal of Environmental Research and Public Health. 2021; 18(7):3338. https://doi.org/10.3390/ ijerph18073338 PMID: 33804868

21. Fung KH, Rushton PW, Gartz R, Goldberg M, Toro ML, Seymour N, et al. Wheelchair service provision education in academia. African Journal of Disability. 2017; 6:340. https://doi.org/10.4102/ajod.v6i0.340 PMID: 28936415

22. Toro-Hernández ML, Vargas-Chaparro MC. Final Year Students' Knowledge on Basic Manual Wheelchair Provision: The State of Occupational Therapy Programs in Colombia. Occupational Therapy International. 2020; 2020(3025456). https://doi.org/10.1155/2020/3025456 PMID: 32410924

23. Toro-Hernández ML, Mondragón-Barrera MA, Torres-Narváez MR, Velasco-Forero SE, Goldberg M. Undergraduate physiotherapy students' basic wheelchair provision knowledge: a pilot study in two universities in Colombia. Disability and Rehabilitation: Assistive Technology. 2019; 15(3):336–41. https:// doi.org/10.1080/17483107.2019.1580776 PMID: 31094586

24. Gowran RJ, Goldberg M, Comanescu G, Ungureanu C, Garcia FDS, Xavier CA, et al. Developing country-specific wheelchair service provision strategic plans for Romania and the Philippines. Disability and Rehabilitation: Assistive Technology. 2019; 14(6):612–27. https://doi.org/10.1080/17483107.2018. 1539131 PMID: 30822183

25. Kirby RL, Doucette SP. Relationships between wheelchair services received and wheelchair user outcomes in less-resourced settings: a cross-sectional survey in Kenya and the Philippines. Archives of Physical Medicine and Rehabilitation. 2019; 100(9):1648–54. e9. https://doi.org/10.1016/j.apmr.2019. 02.002 PMID: 30851236

26. Alvarez L, Wallcook S, von Zweck C, Timbeck R, Ledgerd R, Ledgerd R. Global indicators of assistive technology use amongst occupational therapists: Report from the World Federation of Occupational Therapists' Global Survey. Global Perspectives on Assistive Technology. 2019:411.

27. Ledgerd R, World Federation of Occupational Therapists. WFOT report: WFOT human resources project 2018 and 2020. World Federation of Occupational Therapists Bulletin. 2020; 76(2):69–74.

28. Canadian Occupational Therapy University Programs.: Association of Canadian Occupational Therapy University Programs; 2020 [cited 2021 July 12]. Available from: https://www.acotup-acpue.ca/English/ sites/default/files/Website%20Canadian%20Occupational%20Therapy%20University%20Programs% 202020_EN.PDF.

29. Best KL, Miller WC, Routhier F. A description of manual wheelchair skills training curriculum in entry-to-practice occupational and physical therapy programs in Canada. Disability and Rehabilitation: Assistive Technology. 2015; 10(5):401–6. https://doi.org/10.3109/17483107.2014.907368 PMID: 24702609

30. Best KL, Routhier F, Miller WC. A description of manual wheelchair skills training: current practices in Canadian rehabilitation centers. Disability and Rehabilitation: Assistive Technology. 2015; 10(5):393–400. https://doi.org/10.3109/17483107.2014.907367 PMID: 24702608

31. Kirby RL, Smith C, Parker K, Han L, Theriault CJ, Doucette SP. Practices and views of occupational therapists in Nova Scotia regarding wheelchair-skills training for clients and their caregivers: an online survey. Disability and Rehabilitation: Assistive Technology. 2020; 15(7):773–80. https://doi.org/10.1080/17483107.2020.1749890 PMID: 32255698

32. Kirby RL, Keeler L, Wang S, Thompson K, Theriault C. Proportion of wheelchair users who receive wheelchair skills training during an admission to a Canadian rehabilitation center. Topics in Geriatric Rehabilitation. 2015; 31(1):58–66.

33. Dillman DA. Mail and Internet surveys: The tailored design method—2007 Update with new Internet, visual, and mixed-mode guide. 2nd ed. Hoboken, New Jersey: John Wiley & Sons; 2011.

34. Gartz R, Goldberg M, Miles A, Cooper R, Pearlman J, Schmeler M, et al. Development of a contextually appropriate, reliable and valid basic Wheelchair Service Provision Test. Disability and Rehabilitation: Assistive Technology 2016; 12(4):333–40. https://doi.org/10.3109/17483107.2016.1166527 PMID: 27100362

35. RESNA Wheelchair Service Provision Guide.: Rehabilitation Engineering & Assistive Technology Society of North America; 2011 [cited 2021 July 13]. Available from: https://www.resna.org/Portals/0/Documents/Position%20Papers/RESNAWheelchairServiceProvisionGuide.pdf.

36. Wheelchair Service Training Package—Basic Level.: World Health Organization; 2012 [cited 2021 July 13]. 90]. Available from: https://www.who.int/publications/i/item/9789241503471.

37. Wheelchair Service Training Package—Intermediate level.: World Health Organization; 2013 [cited 2021 July 13]. Available from: https://www.who.int/publications/i/item/9789241505765.

38. Wheelchair Skills Program (WSP) manual and forms.: Wheelchair Skills Program (WSP); 2020 [cited 2021 July 13]. Available from: https://wheelchairskillsprogram.ca/en/skills-manual-forms/.

39. Kirby RL, Smith C, Parker K, Theriault CJ, Sandila N. Practices and views of wheelchair service providers regarding wheelchair-skills training for clients and their caregivers: a global online survey. Disabil Rehabil Assist Technol. 2021:1–8. Epub 2021/10/28. https://doi.org/10.1080/17483107.2021.1989505 PMID: 34706198.

40. Goldberg M, Alharbi M, Kandavel K, Burrola-Mendez Y, Augustine N, Toro-Hernandez ML, et al. An exploratory analysis of global trends in wheelchair service provision knowledge across different demographic variables: 2017–2020. Assist Technol. 2021:1–11. Epub 20211202. https://doi.org/10.1080/10400435.2021.1992541 PMID: 34705605.

41. D'Innocenzo ME, Pearlman JL, Garcia-Mendez Y, Vasquez-Gabela S, Zigler C, Rosen P, et al. Exploratory investigation of the outcomes of wheelchair provision through two service models in Indonesia. PLoS One. 2021; 16(6):e0228428. Epub 20210601. https://doi.org/10.1371/journal.pone.0228428 PMID: 34061868; PubMed Central PMCID: PMC8168880.

42. Profile of practice of occupational therapists in Canada.: Canadian Association of Occupational Therapists; 2012 [cited 2021 July 29]. Available from: https://www.caot.ca/document/3653/2012otprofile.pdf.

43. Academic Accreditation Standards and Self-Study Guide.: Canadian Association of Occupational Therapists; 2019 [cited 2021 July 12]. Available from: https://caot.in1touch.org/uploaded/web/Accreditation/CAOT%20Accreditation%20Self%20Study%20Guide%202017%20English%20rv%202019.pdf

44. Rusek CT, Kleven M, Walker C, Walker K, Heeb R, Morgan KA. Perspectives of inpatient rehabilitation clinicians on the state of manual wheelchair training: a qualitative analysis. Disabil Rehabil Assist Technol. 2021:1–9. Epub 2021/10/24. https://doi.org/10.1080/17483107.2021.1993359 PMID: 34686071.

45. Rushton PW, Daoust G. Wheelchair skills training for occupational therapy students: comparison of university-course versus "boot-camp" approaches. Disability and Rehabilitation: Assistive Technology. 2019; 14(6):595–601. https://doi.org/10.1080/17483107.2018.1486468 PMID: 29996670

46. Coolen A, Kirby R, Landry J, MacPhee A, Dupuis D, Smith C, et al. Wheelchair skills training program for clinicians: a randomized controlled trial with occupational therapy students. Archives of Physical Medicine and Rehabilitation. 2004; 85(7):1160–7. https://doi.org/10.1016/j.apmr.2003.10.019 PMID: 15241768

47. Giesbrecht EM, Wilson N, Schneider A, Bains D, Hall J, Miller WC. Preliminary evidence to support a "boot camp" approach to wheelchair skills training for clinicians. Archives of Physical Medicine and Rehabilitation. 2015; 96(6):1158–61. https://doi.org/10.1016/j.apmr.2014.10.002 PMID: 25450122.

48. Giesbrecht E, Carreiro N, Mack C. Improvement and retention of wheelchair skills training for students in entry-level occupational therapy education. American Journal of Occupational Therapy. 2021; 75(1): https://doi.org/10.5014/ajot.2021.040428 PMID: 3339906460p1-p9.

49. Smith EM, Roberts L, McColl MA, Martin Ginis KA, Miller WC. National evaluation of policies governing funding for wheelchairs and scooters in Canada. Canadian Journal of Occupational Therapy. 2018; 85 (1):46–57. https://doi.org/10.1177/0008417417719723 PMID: 29506405

50. Gustafsson L. Occupational therapy has gone online: What will remain beyond COVID-19? Australian Occupational Therapy Journal. 2020; 67(3):197. https://doi.org/10.1111/1440-1630.12672 PMID: 32538488

51. Gomez INB. Reflections on the role of occupational therapy programmes on the mental health of stakeholders' transition to e-learning during the COVID-19 pandemic. World Federation of Occupational Therapists Bulletin. 2020.