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Employment issues and assistive technology use for persons with spinal cord injury

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Abstract—In this study, we examined associations between assistive technology (AT) cost, underwriting, ownership, use, employment, and employer accommodations for two groups (civilian and veteran) of working age adults (18–64 yr) with spinal cord injury or dysfunction (SCI/D). The project included the development of a survey instrument, and initial findings indicate that AT is important for the employment success of individuals with SCI/D. The majority of the AT devices owned by the respondents were characterized as important to work, and these devices were 3.5 times more expensive. The mean cost of assistive devices was 68% to 124% greater for persons who were self-employed compared with persons employed by others. Education was related to employment status for both groups. In addition, satisfaction with assistive devices was very high regardless of employment status or history.

Key words: activity participation, assistive technology, assistive technology cost, disability, education, employment status, employment success, health status, spinal cord injury, work history

INTRODUCTION

Spinal cord injury or dysfunction (SCI/D) includes conditions that reflect a broad constellation of altered physiology, secondary medical complications, and changed social roles, all of which influence activity participation [1]. SCI/D is defined as an acute traumatic lesion of neural elements in the spinal canal that results in temporary or permanent sensory deficit, motor deficit, and/or bladder dysfunction. Estimates of the national prevalence of SCI/D in the United States range from 250,000 to 400,000 individuals (http://www.spinalcord.uab.edu). Approximately 22 percent of these individuals are U.S. veterans, of whom more than 40 percent were injured during military service [2–5]. Life expectancy of persons with SCI/D has improved dramatically from 20–33 years in 1987 to 55–65 years in 1995 (when injury occurred at age 20) [4–7]. Individuals most likely to incur SCI/D are young with many productive workforce years ahead of them.

Abbreviations: AACD = augmentative and alternative communication device, ACT = assistive computer technology, ARC = Allocation Resource Center, AT = assistive technology, ATA = assistive technology act, DRES = Disability Resources and Educational Services, MMIL = manual mobility and independent living, NPPD = National Prosthetic Patient Database, PMIL = powered mobility and independent living, P&O = prosthetic and orthotic, SCI/D = spinal cord injury or dysfunction, SD = standard deviation, SSA = Social Security Administration, UIUC = University of Illinois at Urbana-Champaign, VA = Department of Veterans Affairs.

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The definitions of assistive technology (AT) devices and services in this study are the same as those first set forth in the 1988 Technology Related Assistance for Individuals with Disabilities Act.* This Act defined an AT device as ". . . any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities."†

The Assistive Technology Act (ATA) definition of an AT service is:

> Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device, including . . . evaluation of the needs of an individual . . . . Purchasing, leasing, or otherwise providing for the acquisition by an individual with a disability of an assistive technology device. Selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing assistive technology devices; . . . Training and technical assistance . . . .

These AT definitions have been widely used and adopted in each piece of legislation subsequent to the ATA and related to persons with disabilities (e.g., Individuals with Disabilities Education Act, Americans with Disabilities Act).

AT improves the functional independence of persons with SCI/D and affords them greater opportunity for societal participation and integration [8–9]. These technologies are designed to circumvent environmental barriers, maximize independence, and increase activity participation among persons with physical disabilities [10]. Logically, the improvements in functional independence, societal participation, and integration attributed to AT should also enhance the employability of persons with SCI/D [11]. However, little is known about the extent of AT in the workplace and the role that AT may play in reducing employment-related barriers and enhancing employment outcomes for persons with SCI/D.

Literature regarding AT use and ownership focuses largely on elderly persons with disabilities [8–9]. When available, the research relevant to younger, working-age individuals focuses on types of AT available and does not fully discuss the relationship of AT to employment, cost, or life-productivity outcomes [11]. While some investigators have suggested that AT ownership and use may be related to cost, a paucity of knowledge exists regarding AT costs and the underwriting of AT costs associated with purchase, repair, or replacement of AT devices [12–13].

While cost for treating SCI/D is not directly related to the cost of AT, knowledge of AT costs does provide insight into the financial burdens faced by individuals with SCI/D. SCI/D treatment costs reported in the literature include direct costs associated with inpatient hospitalizations, outpatient services, physician services, equipment, medications, attendant care, supplies, environmental modifications, nursing home care, household assistance, and vocational rehabilitation. Average direct costs of treatment for the first year after injury was reported in 1995 as $300,000 a person [14]. Recurring treatment charges ranged from $17,275 to $33,439 annually, with a lifetime treatment cost of $969,659 a person. Total direct SCI/D treatment costs nationwide exceeded $7,000,000,000 in 1995 [5,14–20]. To paint a more accurate picture of the total direct costs incurred after SCI/D, we should add the costs of AT purchased and used after injury and over a lifetime to the direct SCI/D treatment costs. This study addressed this knowledge gap because it identified a preliminary set of direct costs attributed to AT purchases (ownership) and use (e.g., repair, replacement) up to 25 years after SCI/D. This study also explored the relationship between AT costs, underwriters of AT costs, employment status, employment history, and employer accommodations for AT use and ownership.

METHODS

In this study, we used prospective and retrospective data collected from two groups of working-age adults (18–64 yr) with SCI/D. The prospective data were collected with a telephone survey. The development of the survey instrument became an important part of this project because at initiation of the study, a standardized survey for collection of self-reported data regarding AT cost, use, and ownership in conjunction with employment status and history, employer accommodations, salary history, productivity, and quality of life did not exist. In addition to disability, demographic, health status, and

*Known popularly as "the Tech Act," which was reauthorized in 1998 as the Assistive Technology Act.

†Section 3, subsection 2, of the Assistive Technology Act of 1998 (Public Law 105-394).

physical activity information, the survey (i.e., Assistive Technology and Employment Interview) contained items for other self-reported outcome data, but the focus of this article is on AT costs in relationship to employment. We used secondary data sources to identify potential subjects and abstract data not included on the survey from existing databases.

Sampling Procedures

The study samples included a group of college-educated civilians of working age with SCI/D and a group of working-age veterans with SCI/D whose educational histories were mixed. These two populations were chosen because of their complementary educational backgrounds. The veteran group included a large number of individuals with high school educations that complemented the baccalaureate and graduate-professional degrees of the civilian group and thereby increased the probability that the study would assess AT use in jobs that do not require college training. The project also included concomitant secondary data analyses with existing databases (i.e., the National Prosthetic Patient Database [NPPD] [21] of the Department of Veterans Affairs [VA] and the Disability Resources and Educational Services [DRES] Student Database at the University of Illinois at Urbana-Champaign [UIUC]).

The first group of potential participants, civilians, was identified from the UIUC DRES Student Database. At initiation of the study, 170 alumni with SCI/D were in this database and valid addresses and phone numbers were available for 140 of them. The second group of participants, veterans with SCI/D, was identified with the VA Spinal Cord Dysfunction Registry. After identifying all veterans with SCI/D, we randomly selected a pool of 400 potential veteran participants from the national VA database maintained by the VA Allocation Resource Center (ARC). The ARC database is an integrated-cost and clinical database of all veterans who receive care in a given fiscal year. We filtered this random selection to exclude nursing home residents, veterans who were hospitalized a total of 90 days within the past calendar year, veterans 65 years and older, and individuals positively cross-referenced with the Burroughs death file. We then cross-referenced the resulting list of 400 veterans with the VA NPPD to identify those veterans with SCI/D who also received AT from the VA; 200 veterans were randomly selected from this list for possible study enrollment.

We do not know whether the civilians served in the military, but we do know that they did not access any VA healthcare services. We mailed individuals in both groups a letter informing them that they would be contacted by telephone and that their participation in a telephone survey would be requested at that time. Each participant was given the option to participate or not participate, and human subjects institutional review board approval was obtained from all participating institutions.

Prospective Data Collection: Telephone Survey

The telephone survey we used in this study was constructed from multiple reference sources and pilot-tested with five civilians and five veterans. Following the pilot test, we revised the survey and the final version was titled the “Assistive Technology and Employment Interview.” The development of the survey was not the focus of this article, but the final version can be downloaded at http://www.dri.uiuc.edu/research/p02-05c/default.htm. Once developed, the survey consisted of six sections, each focusing on one of the following research questions:

1. What AT devices are owned by individuals with SCI/D?
2. How much did these devices cost?
3. For individuals employed at time of survey, did device cost vary by disability severity, employer category, or importance of the device to work?
4. Who underwrites the purchase, maintenance, and replacement costs of the devices owned?
5. Which AT devices are identified as important to work?
6. Are there any unmet AT needs in terms of workplace accommodations, repair, and overall satisfaction?

Data Analyses

Descriptive and comparative analyses were conducted for the total sample, for each cohort separately, and by subgroup when sample sizes were large enough. In addition, logistic regression models were created with AT as a predictor of employment and U.S. Social Security Administration (SSA) benefits data for adjustment of potentially confounding factors, such as disability severity, health status, hospitalization, physical activity level, functional status, and comorbid conditions.

Because of questions about the accuracy of manufacturer recall costs, the cost of the AT devices reported by all respondents was averaged across manufacturers of the product. If the respondent named the specific device, manufacturer, and model number, we contacted the manufacturer to obtain a direct sale price. If the manufacturer did not sell directly to consumers, we used the average retail price of the device from five retailers as an estimate. In addition, we used the NPPD for veterans to identify the recorded VA cost for the original device, all repairs, and replacement of each device reported by the respondents. Since original cost data in the NPPD are only available from 1998 to the present, comparative analyses excluded the 1997 data.

We also compared the NPPD retrospective data from 1998 through 2002 and the prospective data to assess the reliability and accuracy of self-reports. A similar comparison was not possible for the UIUC alumni group, since no such national database is available for these individuals.

RESULTS

Of the 200 veterans, 98 agreed to participate in the survey (49% response rate), and 93 of the 140 UIUC alumni agreed to participate in the survey (66% response rate). Therefore, the overall project response rate was 56 percent (191/340).

Demographic and Injury Characteristics

Demographic characteristics for each group are presented in **Table 1**. The veteran group was significantly older than the civilian group (mean age 48 and 40 years, respectively), more likely to be male (96% vs 71%, respectively), nonwhite (33% vs 4.4%, respectively), and single (54% vs 43%, respectively). The two respondent groups were similar in disability severity. In the civilian group 57 percent reported having paraplegia (loss of function in the lower body and limbs from an injury or dysfunction to part of the spinal cord below the cervical section of the spine) and 43 percent had tetraplegia (paralysis of the cervical region of the spine that resulted in loss of function in both the upper and lower limbs). The veteran group was evenly split with regard to disability severity; 47 percent reported having paraplegia and 47 percent tetraplegia, with six subjects not responding.

Overall, 83 percent of the veterans reported having less than $10,000 in annual personal income compared with 8.0 percent of the civilians. Conversely, 54 percent of the civilians had personal salaries of $35,000 to $75,000 in contrast to 8.0 percent of the veterans. A similar difference was observed for household income with 45 percent of the civilians reporting household incomes in excess of $75,000 compared with only 22 percent of veterans.

Table 1.
Sociodemographic data for survey respondents. Data presented as frequency, number (percent), or mean ± standard deviation.

Sociodemographic Category	Civilians (N = 93)	Veterans (N = 98)
Mean Age at Disability Onset*	14.9 ± 8.13	29.2 ± 10.2
Mean Age at Time of Survey*	40.1 ± 9.24	48.0 ± 10.3
Mean Years with Disability*	25.5 ± 12.3	19.5 ± 12.4
Education Level	***N* = 93**	***n* = 97**
High School	0	3 (3.1)
High School/GED	0	27 (28)
Trade School	0	2 (2.1)
Some College	0	34 (35)
Bachelor's Degree	34 (37)	18 (19)
Some Graduate School	4 (4.3)	2 (2.1)
Graduate Degree	55 (59)	11 (11)
Gender*	***N* = 93**	***n* = 94**
Male	66 (71)	90 (96)
Female	27 (29)	4 (4.3)
Marital Status*	***n* = 92**	***n* = 94**
Married	52 (57)	43 (46)
Widowed	0	3 (3.2)
Separated	0	5 (5.3)
Divorced	6 (6.5)	22 (23)
Never Married	34 (37)	21 (22)
Race/Ethnicity*	***n* = 92**	***n* = 95**
White/Non-Hispanic	88 (96)	64 (67)
American Indian	0	3 (3.2)
African American	1 (1.1)	17 (18)
Hispanic	1 (1.1)	7 (7.4)
Asian	2 (2.2)	1 (1.1)
Other	0	3 (3.2)
Household Income* ($)	***n* = 88**	***n* = 75**
<10,000	5 (5.7)	5 (6.7)
10–14,999	5 (5.7)	10 (13)
15–24,999	3 (3.4)	15 (20)
25–34,999	9 (10)	9 (12)
35–49,999	9 (10)	3 (4.0)
50–74,999	17 (19)	17 (23)
75–99,999	15 (17)	11 (15)
≥100,000	25 (28)	5 (6.7)
Personal Income* ($)	***n* = 88**	***n* = 87**
<10,000	7 (8.0)	72 (83)
10–14,999	5 (5.7)	2 (2.3)
15–24,999	3 (3.4)	1 (1.1)
25–34,999	7 (8.0)	4 (4.6)
35–49,999	25 (28)	5 (5.7)
50–74,999	23 (26)	2 (2.3)
75–99,999	7 (8.0)	1 (1.1)
≥100,000	6 (6.8)	0

Note: n values vary because some respondents either could not or chose not to answer specific questions.
*Statistically significant difference between civilians and veterans, $p < 0.001$.
GED = general equivalency diploma.

In the civilian sample, 37 percent had completed a bachelor's degree and 63 percent had completed at least some graduate school. Of the veteran group, 33 percent had no college, 35 percent had completed some college, and 19 percent had completed at least a bachelor's degree.

The average age at time of injury (14.9 yr) for the civilians was significantly ($p < 0.001$) younger than the veterans average age at time of injury (29.2 yr). The mean number of years with the disability, at the time of the survey, ranged from 19 to 25 years for the total sample, and the civilians had lived significantly more years with their disabilities.

Functional Status

We assessed functional limitations with 20 items on the survey. These items were calibrated* with a 4-point rating scale. The more positive the functional scale score, the higher the level of functioning. The civilians had a slightly lower level of functioning as evidenced by a mean ± standard deviation (SD) logit score of – 0.92 ± 1.96) for the civilians compared with a mean ± SD logit score of – 0.40 ± 1.90 for the veterans, but these scores were not significantly different.

*We used rating scale analysis (also known as Rasch analysis) to create an equal-interval measure from the sum of responses to individual items. The derived measure is expressed in terms of log-odd units (logits). The zero point of the scale is set at the mean item difficulty.

Comorbid Conditions

As noted in **Table 2**, most civilians and veterans (99% and 82%, respectively) reported having one or more comorbid conditions. The mean number of comorbid conditions reported by civilians since 1997 was 4.02. Over the same time period, the veterans reported experiencing significantly ($p < 0.001$) more comorbid conditions, mean = 5.22.

To assess the chronicity of comorbidities over the 5 years prior to the interview (1997–2002), we asked respondents to identify all years in which each comorbid condition was experienced. The number of years was summed across all conditions. The mean of this "chronicity value" for the civilians was significantly less than that for the veterans (17.9 and 26.5, respectively; $p < 0.001$). That is, the veterans experienced more chronic comorbid conditions over the years compared with the civilians. When asked to rate their own physical health, civilians reported that they were in better overall health than the veterans (**Table 3**), but the number of days spent in bed ($p = 0.20$) or in the hospital ($p = 0.16$) over the past 12 months did not vary significantly between groups.

Table 2.
Self-reported comorbid medical conditions of survey respondents. Data presented as frequency, number (percent), or mean ± standard deviation.

Comorbidity Parameter	Civilians (N = 93)	Veterans (N = 98)	p-Value
Disability/Comorbidity Category			
Chronicity Score	17.9 ± 11.5	26.5 ± 13.2	<0.001*
Mean No. of Comorbid Conditions	4.02 ± 2.2	5.22 ± 2.3	<0.001*
Has Had a Comorbid Condition	92 (99)	80 (82)	0.07
Respiratory Problem	27 (29)	49 (50)	0.002*
Bowel Problem	18 (19)	48 (49)	<0.001*
Bladder Problem	61 (66)	75 (76)	0.07
Pressure Ulcer	41 (44)	41 (42)	0.8
Pain	58 (62)	75 (76)	0.03*
Upper-Limb Problem	46 (50)	59 (60)	0.14
Spasticity	54 (58)	76 (78)	0.004*
Heart Problem	12 (13)	16 (16)	0.48
Digestive Problem	9 (9.7)	19 (19)	0.05
Feelings of Sadness	27 (29)	34 (35)	0.40
Other	21 (23)	20 (20)	0.71

*Statistically significant difference between civilians and veterans.

Table 3.
Self-reported health status of survey respondents. Data presented as frequency, number (percent), or mean ± standard deviation.

Health Status	Civilians (N = 93)	Veterans (N = 98)	p-Value
Health Status*			
Excellent	21 (23)	13 (13)	—
Very Good	24 (26)	18 (18)	—
Good	36 (39)	29 (30)	—
Fair	9 (9.7)	26 (27)	—
Poor	3 (3.2)	12 (12)	—
Days of Restricted Activity (Past Year)	20.37 ± 53.7	32.9 ± 71.7	0.20
Hospital Days (Past Year)	4.0 ± 17.4	8.1 ± 22.5	0.16

*Statistically significant difference between civilians and veterans, $p = 0.002$.

Social Security Benefits for Civilian and Veteran Groups

Most of the civilians and veterans (83% and 91%, respectively) responded to the question about SSA benefit history. The majority (84%) of the veterans reported receiving SSA benefits at the time of interview, whereas a minority (25%) of the civilians reported receiving benefits at the time of the survey. Of the civilians, 30 percent reported no benefits in the 5 years preceding the interview compared with only 14 percent of veterans.

SCI/D disability benefits for veterans who were injured during military service are not affected or reduced by other sources of income such as social security disability income. However, nonmilitary service-related disability benefits for veterans are reduced in accordance with other sources of income with a maximum allowable benefit of $807 a month.

Assistive Technology Ownership

Table 4 presents reported AT device ownership by group. On average, the civilian group reported owning significantly ($p = 0.007$) more devices than the veterans (average of 5.19 and 4.19 devices, respectively), and most notably, civilians owned more powered mobility devices.

Powered mobility and independent living (PMIL) devices were the second most frequently reported category of AT devices owned by civilians and veterans. Manual mobility and independent living (MMIL) devices were the most frequently reported for both groups. For the civilians, the PMIL devices most frequently reported were powered residential devices (e.g., power doors, lifts) and motorized wheelchairs/carts. The PMIL devices most frequently reported by the veterans were motorized wheelchairs, powered residential devices, and power-assisted motor vehicle operation devices.

Approximately 20 percent of the civilians and 34 percent of the veterans owned prosthetic and orthotic (P&O) devices, and 30 percent of the civilians and 19 percent of veterans owned assistive computer technology (ACT) devices. Augmentative and alternative communication devices (AACDs), such as phone equipment or writing instruments, were owned by fewer respondents; 17 percent of the civilians and 6 percent of veterans reported ownership of such devices. As anticipated, respondents from both groups who had tetraplegia owned significantly more AT devices overall than their counterparts with paraplegia.

Self-Reported Assistive Technology Ownership and the National Prosthetic Patient Database

The average number of devices identified in the NPPD (mean ± SD = 10.53 ± 9.57) was significantly ($p < 0.001$) greater than the average number of devices reported by the veterans (mean ± SD = 2.57 ± 2.01) between 1998 and 2002 (**Table 5**). The most notable discrepancy between the two sources is the number of MMIL devices. A similar pattern was observed with regard to device repair history. Overall, as shown in **Table 6**, the number of repairs recorded in the NPPD was more than four times greater than the number of repairs self-reported by veterans.

Cost of Assistive Technologies Owned

From 1998 to 2002, the average cost per device per person across all device categories was mean ± SD = $2,155.20 ± $2,210.90 for the civilians and $2,032.40 ± $2,559.90 for veterans. **Table 7** presents the results of the estimated device costs. As expected, PMIL devices were the most expensive on average. The average cost of each PMIL device for the civilians was mean ± SD = $9,472.26 ± $5,987.30 and $7,946.87 ± $4,504.58 for the veterans. The most expensive PMIL devices were powered motor vehicle operation devices, followed by powered residential control devices. MMIL devices were the second most expensive devices owned and, as noted earlier, were the most frequently reported category of AT owned and used by both groups. These devices include manual wheelchairs, manual exercise equipment, and manual motor vehicle control devices. Thus, the two most frequently owned AT device categories were also the most expensive.

Table 4.
Self-reported assistive technology devices owned by survey respondents. Data presented as frequency (number) or mean ± standard deviation (SD).

Device Category	Civilians (N = 93)			Veterans (N = 98)			p-Value
	Owners	Devices	Mean ± SD	Owners	Devices	Mean ± SD	
Manual Mobility and Independent Living	90	281	3.12 ± 1.64	89	240	2.78 ± 1.45	0.14
Powered Mobility and Independent Living	45	101	2.23 ± 1.20	55	88	1.57 ± 0.78	0.003*
Prosthetic & Orthotic	19	26	1.37 ± 0.76	34	48	1.41 ± 0.78	0.85
Assistive Computer Technology	28	42	1.50 ± 0.75	19	24	1.26 ± 0.45	0.18
Assisted Listening	0	0	—	1	4	1.00 ± 0.00	—
Assisted Seeing	1	2	2.00 ± 0.00	0	0	—	—
Augmentative and Alternative Communication	16	21	1.33 ± 0.62	6	7	1.17 ± 0.41	0.55
Total Across Categories	—	475	—	—	417†	—	0.01*
Mean Across Categories	—	—	5.19 ± 2.72	—	—	4.19 ± 2.32	0.007

*Statistically significant difference between civilians and veterans.
†Total number of devices reflects self-reported ownership between 1997 and 2002. National Prosthetic Patient Database purchase cost records are limited to devices obtained in or after 1998.

Table 5.
Assistive technology devices (mean ± standard deviation) owned by veterans between 1998 and 2002 as recorded in National Prosthetic Patient Database (NPPD) vs self-report.

Device Category	NPPD (N = 98)	Self-Report (n = 95*)	p-Value
Manual Mobility and Independent Living	7.49 ± 1.33	1.95 ± 1.33	<0.001†
Powered Mobility and Independent Living	2.23 ± 1.20	1.57 ± 0.78	0.003†
Prosthetic & Orthotic	2.49 ± 2.06	1.25 ± 0.55	<0.001†
Assistive Computer Technology	1.97 ± 0.68	1.33 ± 1.85	0.06
Assisted Listening	2.00 ± 0.00	1.00 ± 0.00	—
Assisted Seeing	2.00 ± 0.00	0	—
Augmentative and Alternative Communication	1.23 ± 0.60	1.00 ± 0.00	0.72
Total Devices Owned Across Categories	916	208‡	—
Mean Devices Owned per Person Across Categories	10.53 ± 9.57	2.57 ± 2.01	<0.001

*Three veterans did not report device ownership in or after 1998.
†Statistically significant difference between NPPD and self-report.
‡Total number of devices reflects self-reported ownership between 1998 and 2002. NPPD purchase cost records are limited to devices obtained in or after 1998.

Table 6.
Assistive technology repairs (mean ± standard deviation) for veterans between 1998 and 2002 as recorded in National Prosthetic Patient Database (NPPD) vs self-report.

Device Category	NPPD (N = 98)	Self-Report (n = 95*)	p-Value
Manual Mobility and Independent Living	5.58 ± 4.86	0.75 ± 1.68	<0.001†
Powered Mobility and Independent Living	6.77 ± 7.89	2.50 ± 3.71	0.006†
Prosthetic & Orthotic	1.35 ± 0.61	0.17 ± 0.58	<0.001†
Assistive Computer Technology	5.67 ± 2.08	1.44 ± 3.97	0.12
Assisted Listening	0	1.33 ± 0.58	—
Assisted Seeing	0	0	—
Augmentative and Alternative Communication	1.33 ± 0.58	3.00 ± 0.00	0.13
Mean Devices Repaired per Person Across Categories	8.68 ± 9.11	1.97 ± 3.39	<0.001†

*Three veterans did not report device repairs in or after 1998.
†Statistically significant difference between NPPD and self-report.

Table 7.
Self-reported average cost per device of survey respondents. Data presented as mean ± standard deviation.

Device Category	Civilians (n = 90)	Veterans (n = 97)	p-Value
Manual Mobility and Independent Living (MMIL)			
Wheelchair	1,558.74 ± 992.82	1,079.24 ± 562.73	—
Ambulatory Support	89.78 ± 78.60	111.87 ± 205.01	—
Seating/Cushion/Bed	366.42 ± 266.46	741.68 ± 692.08	—
Independent Living	242.23 ± 458.26	649.69 ± 2,583.74	—
Motor Vehicle Devices	1,195.16 ± 3,641.24	853.15 ± 1,038.77	—
Exercise Equipment	1,638.50 ± 408.00	1,337.70 ± 920.03	—
Cost Per MMIL Device	859.04 ± 961.26	859.17 ± 1,386.36	0.99
Powered Mobility and Independent Living (PMIL)			
Wheelchair/Cart	5,673.74 ± 2,270.92	5,860.42 ± 2,554.26	—
Motor Vehicle Devices	14,407.71 ± 6,497.32	10,821.67 ± 8,518.80	—
Residential Devices	6,011.88 ± 6,930.74	10,260.13 ± 6,502.11	—
Cost Per PMIL Device	9,472.26 ± 5,987.30	7,946.87 ± 4,504.58	0.18
Prosthetics & Orthotics (P&O)			
Foot/Leg/Back Braces, Orthotics, Joints	61.08 ± 55.43	296.73 ± 395.38	—
Arm/Hand Brace/Splint	24.40 ± 3.67	382.01 ± 1,331.50	—
Cost Per P&O Device	46.87 ± 47.70	177.97 ± 302.24	0.02*
Assistive Computer Technology (ACT)			
Manual Input (e.g., head sticks)	353.03 ± 597.27	52.73 ± 27.02	—
Voice Input/Output	180.30 ± 71.33	134.98 ± 58.69	—
Environmental Controls	114.90 ± 59.34	131.07 ± 35.74	—
Adjustable Tables	163.76 ± 81.38	93.77 ± 101.80	—
Cost Per ACT Device	228.23 ± 325.57	106.67 ± 53.47	0.07
Assisted Listening Device (ALD)	0	309.67 ± 0.00	—
Cost Per ALD	0	309.67 ± 0.00	—
Assisted Seeing Device (ASD)			
Magnification Device	995.00 ± 0.00	0	—
Cost Per ASD	995.00 ± 0.00	0	—
Augmentative and Alternative Communication Device (AACD)			
Phone Equipment	257.62 ± 234.85	57.50 ± 38.89	—
Writing Instruments	32.79 ± 34.40	12.50 ± 0.00	—
Augmentative Communication	20.00 ± 0.00	0	—
Cost Per AACD	153.37 ± 212.44	34.00 ± 29.82	0.08
Total Mean Cost per Device	2,155.20 ± 2,210.90	2,032.40 ± 2,559.90	0.70

Note: n values vary because some respondents either could not or chose not to answer specific questions.
*Statistically significant difference between civilians and veterans.

On average, P&O devices were significantly more expensive for the veterans than for the civilians.

Noting the earlier difference in PMIL device ownership by participants with tetraplegia, we compared the cost of AT devices for those with paraplegia and tetraplegia for individuals employed during the past 5 years. Since no significant differences were found between groups for disability severity, cost data for individuals with paraplegia and tetraplegia were combined across the civilian and the veteran groups. As expected, the total average cost per person for all devices was significantly greater for respondents with tetraplegia (mean ± SD = \$2,972.29 ± \$2463.70) compared with those with paraplegia (\$1,621.90 ± \$2,011.00), which corresponded to their ownership of more AT devices overall, especially PMIL devices.

The cost of AT for individuals employed during the past 5 years was compared by employer category. Because of the small number of veterans in this employment category, the data were combined for both groups. As seen in **Table 8**, the average cost per person for all AT devices was 68 to 124 percent greater for individuals who were self-employed than for those who worked in any of the four remaining employment categories.

Cost of Assistive Technology Devices Identified as Important to Work

The cost reported by participants from both groups employed during the past 5 years for devices identified as important to work was compared with that of AT devices identified as not important to work. The results are summarized in **Table 9** and indicate that overall, the average cost of devices reported as important to work was significantly greater than the average cost of devices with little or no work importance ($t_{(373)} = 5.60$; $p < 0.001$. AACD was the only device category for which the mean cost of devices reported as not important for work exceeded that of the AACD identified as important to work ($t_{(127)} = 2.40$; $p = 0.02$).

Funding Sources for Assistive Technology Procurement, Repair, and Replacement

As expected (**Table 10**), the civilian group reported using a greater number of funding sources than the veterans when purchasing their AT devices and they also more frequently contributed their own money. The sources of funding reported for AT repairs and replacement were consistent with those reported for procurement. That is, the civilians reported paying for repairs and replacements out of pocket and veterans reported that the VA covered repair and replacement costs.

Table 8.
Self-reported average cost of assistive technology devices by employment category for individuals employed in the past 5 years (civilians and veterans combined, $n = 114$). Data presented as mean ± standard deviation.

Device Category	Government	Not For Profit	Other	Private	Self-Employed
Manual Mobility and Independent Living	732.33 ± 446.18	887.21 ± 568.85	740.78 ± 608.54	728.37 ± 459.19	1,135.88 ± 516.39
Powered Mobility and Independent Living	9,323.00 ± 6,554.85	9,656.33 ± 6,316.64	7,559.76 ± 3,945.30	9,026.05 ± 3,831.53	21,866.33 ± 11,757.30
Prosthetics & Orthotics	35.86 ± 15.44	49.17 ± 0.00	35.42 ± 16.03	60.93 ± 73.21	0
Assistive Computer Technology	145.15 ± 63.77	76.69 ± 29.83	152.18 ± 36.74	462.10 ± 590.38	0
Assisted Listening	0	0	0	0	0
Assisted Seeing	995.00 ± 0.00	0	0	0	0
Augmentative and Alternative Communication	120.32 ± 97.32	0	201.37 ± 0.00	76.71 ± 71.65	0
Total Mean Cost	2,028.93 ± 2,303.93	2,151.74 ± 1,187.26	1,779.70 ± 1,267.58	2,379.42 ± 2,509.54	3,994.30 ± 4,009.10

Table 9.
Self-reported average cost of devices by work importance of survey respondents (civilians and veterans combined, $n = 106$). Data presented as mean ± standard deviation.

Device Category	Important to Work	Not Important to Work	*p*-Value
Manual Mobility and Independent Living	723.46 ± 848.84	483.67 ± 635.94	0.02*
Powered Mobility and Independent Living	9,533.10 ± 7,525.10	5,545.40 ± 5,964.60	0.25
Prosthetics & Orthotics	93.55 ± 253.91	75.44 ± 71.45	0.79
Assistive Computer Technology	214.21 ± 369.26	227.97 ± 226.51	0.92
Assisted Listening	309.67 ± 0.00	0	—
Assisted Seeing	0	995.00 ± 0.00	—
Augmentative and Alternative Communication	76.59 ± 93.91	180.63 ± 29.76	0.02*
Total Mean Cost	2,469.60 ± 5,237.00	714.21 ± 1,877.80	<0.001*

*Statistically significant difference by work importance.

Table 10.
Self-reported funding sources of survey respondents for initial procurement, repair, and replacement of assistive technology.

Funding Source	Civilians (N = 93)	Veterans (N = 98)
Original Purchaser(s)		
Out of Pocket	75	8
VA	4	90
Medicare	12	0
Medicaid	7	0
Private Insurance	62	2
Rehabilitation Agency	26	0
Employer	20	0
School	3	0
Other	17	1
Repairs		
Out of Pocket	67	11
VA	2	56
Medicare	8	0
Medicaid	2	0
Private Insurance	25	2
Rehabilitation Agency	7	0
Employer	5	0
School	1	0
Other	4	3
Replacements/Upgrades		
Out of Pocket	33	6
VA	0	67
Medicare	3	0
Medicaid	2	0
Private Insurance	19	1
Rehabilitation Agency	4	0
Employer	5	0
School	0	0
Other	3	1

VA = Department of Veterans Affairs.

Employment Characteristics

Consistent with the disability determination process, univariate logistic regression analyses revealed that the odds of employment significantly decreased with a history of receiving SSA benefits (decreased odds 0.121). The odds of receiving benefits were found to increase with lower levels of functional status (increased odds 1.457), more years since injury (increased odds 0.971), and lower levels of education (increased odds for bachelor's degree or higher 0.175). The odds of receiving SSA benefits also increased with age at time of disability (increased odds 1.048) and higher chronic comorbidity scores (increased odds 1.039).

Education was significantly ($\chi^2_2 = 61.572$, $p < 0.001$) related to employment status for both groups. For the civilians, 77 percent of individuals with graduate degrees and 68 percent of individuals with undergraduate degrees and/or some graduate education were currently employed. For civilians, 84 percent with undergraduate degrees and 96 percent with graduate degrees reported working for pay in the 5 years prior to the interview. As for veterans, 83 percent with at least some college reported that they had worked in the 5 years prior to the interview and 76 percent who reported being employed at time of interview had at least some college education.

Work History

The civilians were significantly more likely to be working at the time of interview or to have worked for pay in the past 5 years compared with the veterans (91% and 30%, respectively, **Table 11**). At the time of the interview, 73 percent of the civilians reported they were working at a job for pay compared with only 18 percent of the veterans. Further, of those respondents who were not currently employed, 18 percent of the civilians had worked for pay during the 5 years prior to the interview, while only 12 percent of the veterans had done so. The majority of veterans, 70 percent, reported that they had not worked in the 5 years prior to the interview compared with only 8.6 percent of the civilians. Although no significant predictors of employment were found in the logistic models for the civilians, several factors were found that potentially affect employment status for veterans. Specifically, one factor identified in multivariate logistic regression that increased the probability of employment was an education level of bachelor's degree or above (increased odds 15.4).

More than one-third or 35 percent of the civilians reported they were working in the private sector at time of interview, while 37 percent reported employment with government entities. The largest employer category for veterans was some "other" type of employer, which encompassed 57 percent of those who responded to this item (n = 12).

Assistive Technology and Employment

The civilians who were working at the time of interview or who had worked during the 5 years prior to the interview (n = 86) reported owning 400 different types of devices, 80 percent of which were subsequently identified as important to work. The majority (59%) of all

Table 11.
Self-reported employment status of civilian and veteran survey respondents.* Data presented as frequency and number (percent).

Employment Status	Civilians (N = 93)	Veterans (n = 97)
Currently Working	68 (73)	17 (18)
Not Currently Working, but Worked in Past 5 Yr	17 (18)	12 (12)
Not Worked in Past 5 Yr	8 (8.6)	68 (70)

Note: n values vary because some respondents either could not or chose not to answer specific questions.
*Statistically significant difference between civilians and veterans at $p < 0.001$.

devices identified by the civilians as being important to work were in the MMIL device category. In addition, PMIL devices accounted for 24 percent, ACT devices for 8 percent, and P&O devices for 6 percent. The specific devices identified as most important to work by the civilians were motorized wheelchairs, foot/leg braces and prosthetics, arm/hand braces and prosthetics, manual-exercise devices, manual computer input devices, powered environmental control devices, adjustable-height workstations, adaptive telephone equipment, and AACD.

The veterans who were employed or who reported working during the 5 years preceding the interview (n = 29) reported owning 88 different types of devices, 77 percent of which were characterized as being important to work. The majority of all devices identified by these veterans as important to work were MMIL devices (57%). The AT devices most frequently identified as being important to work by the veterans were manual wheelchairs, manual independent living devices, ambulatory support devices, motorized wheelchairs, and residential control devices. For total devices overall, 91 percent of ambulatory support devices (e.g., crutches, canes, walkers), 83 percent of manual independent living devices (e.g., reachers), 80 percent of residential control devices (e.g., power door operators), 71 percent of manual motor vehicle control devices, 50 percent of environmental control and magnification devices, and 43 percent of arm/hand prosthetics or braces were identified by civilians and veterans as being important to work.

DISCUSSION

The rules for receipt of service-related disability benefits may account for the large proportion of veterans who reported that they received SSA benefits at the time of interview. The unemployment level experienced by this group at the time of interview may also account for this finding.

This study assessed AT ownership by two groups of working-age adults with SCI/D and the role of AT in their lives. With only 35 percent of persons with disabilities employed full-time (http://www.nod.org), 13.1 million people using AT devices in the United States [22], and as many as 66 percent of those who are employed and use AT reporting that their devices aided them in securing employment [23], improving our understanding of the relationship between AT and employment is critical. To that end, the present study does not offer causal inferences regarding the effect of AT on productivity and employment outcomes of treatment and control groups. Instead, this study suggests relational tenets and trends useful for future investigations of AT and employment.

The results indicate that AT ownership and use relates to and is important for employment success of persons with SCI/D. In terms of the cost of AT, devices identified as important to work were 3.5 times more expensive than other devices. However, research suggests that employers must recognize that these costs represent investments in that they serve to enhance employee retention and productivity (http://www.nod.org). Also notable was that the mean cost of AT devices was 68 to 124 percent greater for persons who were self-employed than for any other type of employment. Depending on the individual's underwriting resource options, this extraordinary additional cost to self-employed individuals could be a substantial barrier to those for whom entrepreneurial work at home is the only or most viable employment option (e.g., individuals with tetraplegia, individuals who have difficulty finding alternate transportation resources or who have routine medical appointments that require time away from a "traditional" office setting). This may explain, in part, why very few respondents were self-employed at time of interview or in their most recent position.

With regard to underwriting of AT costs, individuals who were working for pay or who had worked for pay in the 5 years prior to the interview were more likely to have purchased at least one AT device out of pocket compared with individuals who had not worked in the 5 years prior to the interview. Because of the length of the survey and administrative time constraints, the interview did not include data regarding underwriters for each device, and we recommended that the questionnaire be modified in the future to include these items so our understanding of how funding policies of underwriters may affect the type of devices they are able and/or willing to underwrite can be improved.

The National Council on Disability suggested that AT use can improve opportunities for successful outcomes [24]. This study found that access to workplace accommodations appears to have been quite good for both groups, and AT satisfaction levels for all respondents were very high regardless of employment status and employment history. Furthermore, successful outcomes included a large number of workplace accommodations that were already at the workplace or implemented specifically for the respondent, which suggests that the unemployment of individuals with SCI/D is unlikely to be a function of the unavailability of AT in the workplace or the unwillingness of employers to provide necessary AT or other workplace accommodations.

The more frequent use of AT and corresponding increase in AT expenditures by persons with greater disability severity may indicate that these individuals are endeavoring to compensate for functional limitations with AT. Since improved functional status is significantly associated with employment, future research efforts might investigate the extent to which individuals with SCI/D maximize their use of AT to ameliorate the limitations of their conditions and to pursue employment.

Finally, a limitation of this study relates to the discrepancy regarding the AT ownership between the self-reported data by veterans and the data abstracted from the NPPD for these same veterans. The NPPD recorded nearly five times more AT devices than were self-reported by the veterans. Determination of the reasons for this discrepancy is of use to policy makers since resources allocated to AT may be saved if the AT device is likely to be abandoned. If the discrepancy is demonstrated to be an artifact of recall limitations, then this could pose a substantial methodological limitation on AT outcome research. This problem is further compounded by the lack of data sets that document original AT ownership and cost information. The underlying reasons for this discrepancy should be investigated in future studies, preferably with a study design that includes two (or more) data sources for comparison purposes.

CONCLUSIONS

In summary, the two groups are comparable in that they both comprise persons with SCI/D of working age with similarities in disability severity and physical function. The two groups significantly differed according to levels of college education and years living with disabilities. Veterans also reported a significantly greater number of chronically recurring comorbidities. The veterans also were more likely to be SSA beneficiaries, and the likelihood of employment decreased according to whether or not the participant received SSA benefits. The groups differed in AT ownership: civilians reported owning more PMIL and the money for purchase or repair of their devices more often came out of pocket than for veterans. Self-employed persons incurred the greatest AT costs, and the AT devices considered important to employment were significantly more expensive than devices not considered important to employment. Higher education was found to be associated with a significantly greater likelihood of employment.

Furthermore, by identifying the cost of AT devices that contribute to a reduction in employment-related barriers and/or enhance employment outcomes of persons with disabilities, the results of this study may inform policy makers as they discuss issues related to AT for working-age individuals with disabilities. Results may also inform vocational rehabilitation agencies about additional return-to-work support options for these individuals.

FUTURE RESEARCH RECOMMENDATIONS AND POLICY IMPLICATIONS

This study is a first step toward determination of the causal relationship between AT ownership/use and employment for individuals with SCI/D. Suggestions for future investigations are—

1. Conduct additional studies on the relationship between SSA benefit status, AT costs, and employment history. Consider screening some Social Security Disability Income and Social Security Income applicants who have SCI/D for AT need and access (particular attention could be paid to powered devices, such as powered motor vehicle control devices, which are very expensive technologies and likely unavailable to an applicant).
2. Begin an AT ownership and cost database for SSA beneficiaries. This information could be useful for future research studies that attempt to identify employment support options that may include AT.
3. Conduct similar future studies with individuals who are employed and have disabilities other than SCI/D to identify AT devices that contribute most to their

successful employment. From these studies, “AT profiles” can be developed and compared, providing useful information as to whom AT may assist in the successful transition to employment.

4. Further investigate the findings noted here relative to the cost of work-related AT for self-employment. Determine the role that start-up assistance plays in supporting individuals who are interested in self-employment. Track this information for cost-effectiveness purposes.
5. Further investigate the differences found in the recall of self-reported ownership of AT devices and AT devices recorded in the NPPD. If this finding is consistent throughout future investigations, financial support may be adjusted to increase support for those technologies that are identified most often as important for employment.
6. Continue use of the questionnaire developed for this study and improve upon its usefulness in collecting AT information from individuals with disabilities.

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