Assistive technology's potential to improve employment of people with disabilities

Douglas Kruse (dkruse@smlr.rutgers.edu)
Rutgers University
Lisa Schur
Rutgers University
Hazel-Anne Johnson-Marcus
North Carolina State University
Lauren Gilbert
North Carolina State University
Antonio Di Lallo
North Carolina State University
Weibo Gao
North Carolina State University
Hao Su
North Carolina State University

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Abstract

Purpose:

This study investigates how access to assistive technologies affects employment and earnings among people with disabilities

Methods:

We first document employment and earnings gaps associated with specific disabilities using 2017-2021 American Community Survey and 2014 Survey of Income and Program Participation data. We then use accommodations data from the 2012, 2019, and 2021 Current Population Survey (CPS) Disability Supplements to examine employment and earnings growth for people with disabilities related both to any, and to technology-based, accommodations. We also provide a case example of a specific new assistive technology: a “wearable robot” that assists people with upper body impairments.

Results:

Almost all disability types are linked to lower employment and earnings, with especially low employment among those with mobility impairments and particularly low earnings among those with cognitive impairments. About one-tenth of workers with disabilities received any accommodations, and 3-4% received equipment-based accommodations in the 2012-2021 period; these figures increased slightly over the period. The occupations with the highest disability accommodations rates had greater disability employment growth from 2012 to 2021, but disability pay gaps did not decrease more in these occupations. The exoskeleton in our case example can address the estimated employment deficits associated with lifting, reaching, grasping, and pushing/pulling for people with upper body impairments.

Conclusion:

Assistive technology accommodations have potential for increasing employment opportunities for people with disabilities.

I. Introduction

People with disabilities face large disparities in employment outcomes. The employment rate of working-age people with disabilities is only half that of people without disabilities (34.8% compared to 65.4% in 2022)(1). Even when employed, people with disabilities earn, on average, significantly less per year than those without disabilities (2). Due in large part to lower employment and earnings, people with disabilities are more than twice as likely to live in poverty than those without disabilities (3). They also face other employment disparities at work, often including negative attitudes from supervisors and co-workers (4), lower rates of training and participation in decisions (5), and lower job security reflected in higher risks of layoff (6) and higher rates of precarious contingent work (7).

Can assistive technology (AT) help mitigate these disparities and play a positive role in the employment of people with disabilities? There has been a tremendous increase in the use of assistive technologies in general over the past several decades, helping people with disabilities in a wide range of activities, and many have also benefited the general population (8,9). This includes a vast expansion of technologies that can help people with disabilities be productively employed, illustrated by thousands of assistive technologies referenced at the Job Accommodations Network (10).

While there are many examples of how AT can help the employment of people with disabilities, there has been little systematic and representative evidence on its effects on their employment, pay, and job retention. Prior literature focuses on the causes or consequences of accommodations analyzed at the individual level. Here we take a different approach, by focusing on occupation-level measures that reflect the potential availability of accommodations in different occupations, and assessing how these measures relate to employment outcomes for people with disabilities over the past decade.

In this paper we present a) new estimates of the employment and earnings gaps associated with disability, b) an occupation-level analysis of the relationship between AT accommodations and the employment and earnings of people with disabilities over the 2012-2021 period, and c) a description of a new assistive technology, a “wearable robot”, that illustrates the promise of AT for improving employment outcomes in the future among people with disabilities.

II. Literature Review

The potential value of accommodations in general is indicated by Maestas et al., who find that “47 to 58 percent of accommodation-sensitive individuals lack accommodation and would benefit from some kind of employer accommodation to either sustain or commence work.” (11) They find that among individuals who could benefit from accommodations, those who were actually accommodated in 2014 were 13.2 percentage points more likely to work in 2018 than those who were not accommodated in 2014.

The literature is generally consistent with this finding of favorable effects of employer accommodations, mostly focused on job retention rather than finding new jobs. Two recent reviews found strong evidence that accommodations for people with disabilities are linked to continued employment and faster return to work (12, 13). Longitudinal comparisons find that employer accommodations are linked to increased employment duration with the current employer and delayed labor force exits (14, 15, 16, 17, 18). Along with increasing employment duration for existing jobs, accommodations appear to be speed the return to work (19, 20, 21). Accommodations appear to slow applications for disability insurance benefits, but do not reduce subsequent claims for these benefits (16, 18). People with disabilities themselves report positive effects of employer accommodations (22). A review of 37 studies on pandemic-related workplace accommodations found that the pandemic had both positive impacts (e.g., reduced stigma from accommodations, and more rapid implementation) and negative impacts (e.g., new accommodation needs) on accommodations for people with disabilities (23). These benefits and costs may be particularly salient for certain groups such as neurodiverse individuals, for whom telework has been found to help create accessible workspaces and resolve tensions between productivity and wellbeing, but also create communication problems in a virtual environment (24, 25, 26).

The provision of accommodations by employers reflects both employer and worker characteristics, although employer characteristics appear to be much more important (27, 28, 29). Among employer characteristics, there is significant variation by industry, and large employers are more likely than smaller employers to provide accommodations (27, 30).

The findings are less robust with respect to specific accommodations involving AT. The Assistive Technology Act of 2004 defines AT as "any item, pi

Case study literature on AT can provide more insights. One study found that AT interventions demonstrated positive outcomes on job performance and skills (34), and users of job-related AT report substantial benefits to their productivity and self-esteem (22). Similarly, Collins et al found that AT enhanced job outcomes for young adults with intellectual disabilities (18). Several authors, however, note cautions, arguing that an individualized approach of providing AT neglects many employment challenges and barriers faced by people with disabilities (35), and the successful provision of AT is complicated by employers' perspectives, the accessibility of AT, and the availability of support from vocational and rehabilitation services (36). The costs of AT are found to be no more on average than the costs of other accommodations (37).

Regarding access to AT accommodations, Black workers appear to have higher use but lower growth in access to AT in general (38), and Ward-Sutton et al. argue that access to AT among people with disabilities reflects historical inequities between African Americans and Whites (39), although Brucker et al. find no significant racial difference in employer accommodations after controlling for other characteristics (30). Access to AT in general (not just for employment) is lower among people of color and those with low educational attainment, low household income, later disability onset, and a mental rather than physical disability (40).

An additional important factor is co-worker reactions. While most co-workers support disability accommodations, they can sometimes generate jealousy and resentment (41). Employer policies and practices as well as supervisor knowledge and support are critical in ensuring people with disabilities have the accommodations they need and that they are part of a workplace "culture of inclusion" (41, 42, 43).

III. Employment and Earnings Gaps

Before providing new evidence on accommodations, we first document employment and earnings deficits faced by people with disabilities that accommodations may help to reduce. To do this we use data from the 2017-2021 American Community Survey (ACS) and the 2014 Survey of Income and Program Participation SSA Supplement (SIPP), both conducted by the U.S. Census Bureau. The ACS has a very large sample (9,246,283 million people age 18-64) and includes six disability questions identifying four impairments (hearing, vision, cognitive, and mobility) and two activity limitations (difficulty dressing or bathing, and difficulty going outside home alone). The 2014 SIPP is less recent and has a smaller sample (20,120 people age 18-64), but has the advantage of more detailed disability questions, allowing a finer look at physical and mental conditions that accommodations may help to address. We use the same techniques on each database, predicting employment using linear probability models and the natural logarithm of hourly pay using a Heckman selection model. The control variables are listed at the bottom of Table 1. These techniques allow ready translation of the results into percentage differences in employment and pay associated with the disability variables. All results use population weights supplied with the datasets.

Almost all disability types and conditions are linked to lower employment and earnings, as shown in Table 1. ACS data in columns 1 and 3 show the smallest (but still highly significant) deficits for people with visual or hearing impairments. The largest employment deficits are among people with mobility impairments (.343 lower employment probability, or 34.3 percentage points, compared to people without disabilities) and those otherwise limited in going outside alone (35.9 points lower). Among those who are employed, the largest pay deficits are among those with cognitive impairments (-.193 log points which translates to 17.6% lower pay) and those otherwise limited in going outside alone (-.185 log points which translates to 16.8% lower pay).

The SIPP employment results in column 2 of Table 1 show reduced employment probabilities of more than 0.10 (10 percentage points) among those who have difficulty walking 3 blocks, standing for one hour, or lifting and carrying 10 pounds, and those who have a speech impairment, developmental disability, or Alzheimer's, senility, or dementia. All of the other conditions are associated with reduced employment except for difficulty in sitting for one hour.

The SIPP pay results in column 4 show pay deficits of 10% or more associated with an intellectual disability (-.536 log points which translates to 41.5% lower pay), visual impairment (11.7% lower pay), "other" mental/emotional condition (11.3% lower pay), difficulty picking up a glass or grasping a pencil (11.0% lower pay), and difficulty walking three blocks (10.9% lower pay). It is noteworthy that some conditions appear to significantly limit employment but not the pay of those who become employed with those conditions, such as difficulty lifting and carrying 10 pounds, standing for one hour, and pushing or pulling large objects.

IV. Accommodations

Accommodation data and rates

To assess how accommodations may help to reduce these employment and earnings gaps we turn to data from the 2012, 2019, and 2021 Current Population Survey Disability Supplements (CPS). In these supplements, employees were asked "Have you ever requested any change in your current workplace to help you do your job better? For example, changes in work policies, equipment, or schedules." If yes, employees were asked what types of changes they had requested, and whether the request was fully or partially granted. Here we assess both any type of accommodation, and an accommodation based on "new or modified equipment." Note that "new or modified equipment" is a broader category than assistive technology, since the equipment may not be specifically designed to address a disability; as we will see, however, employees with disabilities were more likely than employees without disabilities to request and be granted new or modified equipment, so it is very likely that much of this equipment is assistive technology. We do not know if the accommodation was made for a new or existing employee. The disability measure is based on the same six questions used in the ACS, identifying four impairment types and two activity limitations. The 2012, 2019, and 2021 supplements have sample sizes of 54,113, 43,167, and 40,498 respectively, including 2,092, 1,740, and 1,664 employees with disabilities respectively.

Table 2 shows that in 2012, 12.7% of employees with disabilities requested accommodations, and 10.2% had these requests fully or partially granted (column 1). These numbers each went up slightly in 2019 and 2021, so that 15.1% requested accommodations and 12.4% had them granted in 2021 (column 5). These increases between 2012 and 2021 are significant at the p<.10 level (column 7). Among employees without disabilities, the requested and granted accommodations in 2012 were just over half the rates among employees with disabilities (column 2), while these figures went down significantly by 2021 (columns 6 and 8).

Broken down by disability type, granted accommodations were highest among those with cognitive (12.1%) or mobility (13.0%) impairments in 2012 (column 1). This figure increased significantly by 2021 to 19.0% among employees with cognitive impairments, and increased non-significantly to 14.4% among employees with mobility impairments (column 5).

Turning to equipment-based accommodations, 4.2% of employees with disabilities requested such accommodations in 2012 and 3.3% had them granted in full or part (column 1). The numbers also increased slightly (but not significantly) to 4.8% and 4.1% in 2021 (column 5). As with accommodations in general, employees without disabilities saw a significant decline in equipment-based accommodation requests and grants from 2012 to 2021.

The rate of equipment-based accommodations does not vary substantially by disability type. Employees with mobility impairments were the most likely to receive such accommodations in both 2012 (4.0%) and 2021 (5.0%)(columns 1 and 5). The likelihood of such accommodations increased slightly across all disability types, especially among people with cognitive impairments (2.0% in 2012 to 4.4% in 2021). This suggests that technological advances may have particularly benefited people with cognitive impairments.

How do these accommodations vary by occupation? Table 3 presents an occupational breakdown of the percent who were granted accommodations, averaged across all three years. Among employees with disabilities, those doing personal care excluding childcare and home care were the most likely to receive any accommodations (27.3%), followed by those doing health support excluding diagnosis and technicians (23.2%)(column 1). Farming/ranching managers were the least likely to receive any accommodations (0.8%). The accommodation rate was higher among employees with disabilities than among those without disabilities (column 2) in every occupation except for construction managers, food prep excluding cooks, installation/repair, and farming/ranching managers.

Equipment-based accommodations were most likely for employees with disabilities in health support excluding diagnosis and technicians (13.1%), computer/math (12.1%), and administrative assistants (11.0%). Several occupations had no instances of equipment-based accommodations for employees with disabilities: childcare services, laborers/packagers/movers, maids, and farming/forestry/fishing.

Accommodations and employment outcomes

In contrast to prior literature which focuses on assessing accommodations at the individual level, here we use occupation-level measures that reflect the potential availability of accommodations in different occupations, and see how these measures relate to employment outcomes for people with disabilities over the past decade. We assess three outcomes:

1. Disability employment growth: Percentage change in total number of people with disabilities employed in a given occupation, measured as ((year 2 disability employment)/(year 1 disability employment) - 1)*100
2. Disability representation change: Change in percentage of people within an occupation who have a disability, measured as (((year 2 disability employment)/(year 2 total employment)) - ((year 1 disability employment)/(year 1 disability employment)))*100
3. Disability pay gap change: Change in disability pay gap, measured as the difference between the disability coefficients predicting ln(hourly pay) in year 1 and year 2. For each year, ln(hourly pay) was regressed on the control variables listed in Table 1, plus disability interacted with occupational dummies in order to get an occupation-specific disability pay gap in each year.

For all three outcomes, we combined CPS data for all 12 months in the calendar year of the relevant disability supplement (2012, 2019, and 2021). We tested two different occupational coding systems with different levels of detail: one that included 137 occupations which each had at least five employees with disabilities responding to the accommodations question in 2012, and a broader code that included 42 occupations which each had at least 14 employees with disabilities responding to the accommodations question in 2012. The second occupational coding system is used in results presented in Tables 3 and 4, but results were similar between the two coding systems.

As seen in Table 4, occupations in which employees with disabilities had more accommodations in 2012 also had significantly greater disability employment growth in 2012-2019 and 2012-2021 (column 2). There is also a positive correlation between equipment-based accommodations in 2012 and disability employment growth in 2012-2021 (column 3). Both results are consistent with the idea that a higher accommodations rate favored employment growth among people with disabilities.

The above results may simply reflect greater employment growth in general in more accommodating occupations, but we also find a significant positive correlation between the disability accommodations rate in 2012 and the change in disability representation in an occupation. A positive correlation also exists between this outcome and equipment-based correlations, but this is not statistically significant.

A different story emerges with respect to changes in pay gaps. While the accommodations rate in 2012 is positively linked to improvements (i.e., reductions) in the disability pay gap in 2012-2019, the correlation is significantly negative when looking at the 2012-2021 period. It is possible that accommodations help draw in lower-skill workers who contribute to greater disability pay gaps. The pattern indicates that accommodations were linked to greater pay disparities in the 2019-2021 pandemic period, reflecting greater difficulties for workers with disabilities who managed to hang onto their jobs in the pandemic.

Do the potential effects of accommodation availability vary by type of disability? Table 4 reports similar correlations for 2012-2021 changes in employment growth and disability percent in occupation for people with hearing, vision, cognitive, and mobility impairments. As can be seen, the only significant correlation is a positive one, indicating that people with cognitive impairments had greater employment growth in occupations where they received more accommodations in 2012. All of the correlations with equipment-based accommodations, however, do not reach statistical significance.

These data are generally consistent with the idea that disability accommodations help increase employment growth for people with disabilities, and for people with cognitive impairments in particular. To probe the results, we tested whether there were differential effects associated with *changes* in accommodation rates over the 2012-2021 period, or differences between the accommodation rates of people with and without disabilities, but we did not find significant correlations (not reported here).

We recognize there are limitations to using occupation-level data on AT accommodations as a measure of accommodations availability, especially when looking at changes in accommodation rates over time. In particular, technological change varies among occupations, and many new technologies may make jobs more accessible for people with disabilities without the need for special accommodations. For example, many new computer software programs now have accessibility built in so that extra programs or peripherals are not necessary. Requesting accommodations may be stressful and even risky (41), so people with disabilities may gravitate to occupations where no extra equipment or other accommodations are necessary. In addition, employers may be more reluctant to hire people with disabilities in occupations where extra equipment is needed to accommodate their disabilities. Both these employee-driven and employer-driven effects would dampen the correlation between accommodation rates and employment growth.

We are also mindful that our data include the first 16 months of the pandemic (from March 2020 to the survey done in July 2021), and it is possible that the adoption and effects of assistive technologies may be affected by the pandemic recession. In fact we find that the results on disability employment growth are strongest when looking across the entire 2012-2021 period instead of just the 2012-2019 period. This suggests that for the more accommodating occupations in 2012, employers were more prepared and/or willing to retain or rehire people with disabilities in the early stages of the recession in 2020-2021. The use of assistive technologies in the pandemic may be related to the large increase in telework, due both to the development of new technologies to enable telework and to employer willingness to experiment with and accept new methods of completing the work.

V. Example of assistive technology

For a concrete example of a novel assistive technology that has potential to reduce disability-related employment and earnings deficits identified in Table 1, we provide a description of a "soft wearable robot" currently under development. Wearable robots, also referred to as "exoskeletons" or "exosuits," are devices that are designed to support or augment the physical capabilities of the wearer (45). They have shown potential to benefit both able-bodied and disabled users in a variety of scenarios, such as at work (e.g., reducing the risk of injuries in physically demanding jobs), in rehabilitation (accelerating the recovery of physical capabilities), or in daily living (helping individuals with mobility impairments to regain independence)(46–48).

The wearable robot is pictured in Figure 1. It is designed to aid shoulder and arm functions in individuals with residual volitional movement ability, so that the user retains control of the motion, while the device helps to compensate for the effects of gravity (49).

The robot is relatively easy to put on and take off and is worn as a backpack with additional straps around the forearms. The adjustable straps and dimensions of the wearable structure can fit individuals with widely varying body types and sizes. The device has a total weight of 4 kg (9 pounds), with most of the mass being concentrated at the waist level, to minimize the inertial penalty on the wearer. This mass distribution is achieved using cable-driven transmission, which allows the device to deliver assistance to the arms while the actuators (the heaviest components) are located close to the center of mass of the human body. The assistance supports arm elevation in both shoulder abduction and shoulder flexion. The exoskeleton controller detects residual volitional movements of the limbs using motion sensors placed on the wearer's forearms and computes the level of force required to offload the wearer's limbs from the effects of gravity, on the basis of a user-specific calibration.

The robot overcomes the limitations of existing powered rehabilitation and assistive devices, being both portable so that it can be carried around for community use, and capable of providing human-scale forces assistance, which makes it suitable for aid to people with arm weakness as well as to able-bodied individuals. Exoskeletons can be generally divided into passive and powered exoskeletons. Passive exoskeletons, in which the assistive torque is provided by storing energy in elastic elements (e.g., springs, elastic bands), can provide moderate assistance to the shoulder with relatively low weight. However, the fixed assistance profile of passive shoulder exoskeletons causes resistance to the wearer when lowering the arm, thus requiring user energy. Due to smart sensing and control strategies, they offer the opportunity to apply any generic torque profile, being more adaptable to handle varying situations. However, most state-of-the-art powered exoskeletons require a tether to external actuation and power systems in order to comply with the high-torque assistance needs, which compromises their portability and limits their application for community use. Recently, some portable wearable robots have been developed, but they are typically bulky due either to limitations of actuation (e.g., pneumatic actuation relies on heavy air compressor pumps)(51) or to complex designs with excessive mass of motors and transmission (52,53). The bulkiness dominates human dynamics and restricts natural movements leading to unsatisfactory performance of human-robot interaction.

The novel mechatronics design of the shoulder exoskeleton presented here tackles this challenge by using custom high-torque density motors and cable-drive transmission that enable it to significantly reduce mass and impedance of the robot (54). As a result, this design ensures lightweight, fully untethered, highly compliant, and high-bandwidth interaction with humans. Unlike most exoskeletons that are based on robot-initiated control, this device is based on human-initiated control that is synergistic with humans to promote volitional engagement.

With the intuitive assistance strategy of gravity compensation, the wearable robot is designed to be user-friendly, being easy to handle at the first usage without any specific training, which is fundamental to enable true independence of the user. Once the wearer initiates the motion, the robot reacts in real time to support arm elevation in both shoulder abduction and shoulder flexion. Therefore, unloaded from gravity, the user can better leverage any residual capacity to actively control other degrees of freedom, such as shoulder horizontal flexion.

Despite its simplicity, this form of assistance can be very helpful to alleviate cognitive and physical workload during the execution of manipulation tasks, facilitating the restoration of arm functions in subjects with upper-limb impairments. For example, the exoskeleton can augment the wearers' range of motion and assist them in reaching and grasping objects in various directions, even those located at shoulder height or overhead. This ability is extremely useful in certain job-related tasks that involve picking and placing, lifting, or manipulating objects, particularly common in warehouses or retail stores. As such it can reduce fatigue and physical stress.

Additionally, by mitigating the wearer's physical and mental workloads, the exoskeleton might be able to improve other manipulation capabilities not directly targeted by the assistance, such as moving objects across surfaces, pushing and pulling objects horizontally, or using various tools and objects.

The augmentation of these capabilities may address some of the disability-related employment and earnings deficits identified earlier. Table 1 indicates that employment rates are 10.3 percentage points lower among people who have difficulty lifting and carrying 10 pounds, 3.3 points lower among people who have difficulty reaching overhead, and 9.3 points lower among people who have difficulty pushing or pulling large objects. These functional deficits are not associated with lower earnings for those who become employed, but employed people who have difficulty picking up a glass or grasping a pencil have 12.4% lower earnings. A wearable robot such as the one described here has potential to reduce some of these significant employment and earnings deficits.

These potential benefits from reducing these deficits do not, of course, mean that technologies such as these will be readily adopted or accepted by employers. A companion paper in this special issue explores employer reactions to this specific device in an experimental setting, finding that presentation of this device in a hypothetical job interview creates great interest among employers but also concerns about risk, and more enthusiastic language creates greater openness to seeing the positive aspects of this device. In follow-up work we will be interviewing HR and public policymakers to explore the potential of such a device for expanding employment and productivity of people with disabilities, along with employer concerns about costs and other possible barriers to widespread adoption of technologies like this.

VI. Conclusion

There has been an explosion of assistive technologies that can enable people with disabilities to be more productive in the workplace, and help reduce the substantial employment and earnings deficits they continue to face. Our description of a soft wearable robot illustrates how ongoing developments in assistive technology have the potential to increase employability and productivity of people with disabilities.

We find there has been growth among employees with disabilities of both accommodations in general and equipment-based accommodations from 2012 to 2021. Unlike prior studies of accommodations that use individual-level data, we focus on occupation-level accommodations data over the 2012 to 2021 period, examining whether the higher availability of accommodations in certain occupations is linked to employment and earnings growth among people with disabilities in those occupations. We find the occupations with higher rates of all accommodations, and equipment-based accommodations, in 2012 had greater disability employment growth over the 2012-2021 period, but did not have decreases in the disability pay gap (possibly due to greater availability of accommodations drawing lower-skill workers into the occupation).

We have to remain cautious about concluding that there is a causal link. As noted earlier, substantial technological change has occurred over this time period which could increase workplace accessibility without specialized accommodations. People with disabilities may be drawn to occupations where they can perform the work without accommodations. In addition, despite the ADA requirements and greater AT availability, employers may be reluctant to hire people with disabilities in jobs where accommodations are required. The link between accommodations and employment growth may be dampened by both these employee- and employer-driven effects.

As also noted, we are mindful that our data span the first 16 months of the pandemic recession, and the results for disability employment growth are strongest when we include this period. The adoption and effects of assistive technologies may be affected by the state of the labor market—for example, employers may have been more likely to retain accommodated employees in the early stages of the pandemic. Recent evidence on the positive role of telework in the strong employment growth of people with disabilities in 2021-2022 indicates that employers are more willing to make new accommodations in a tight labor market (55,56).

Clearly there is more room for research in the fast-developing world of assistive technologies. It will be valuable not only to look at the effects of specific technologies such as the one described here, but also to examine the institutional, attitudinal, policy, and economic barriers that inhibit adoption of assistive technologies. One of the key factors is who bears the cost of these new technologies—will employers be willing to bear the cost based on expected higher productivity, or will workers or government be required to foot some or all of the bill (e.g., through VR agencies or tax incentives)? Will the costs and other barriers decline significantly as new types of AT become more widely adopted? The ongoing employment and earnings gaps faced by people with disabilities raise the importance of such research.

Declarations

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Tables

Table 1: Disability-related Employment and Pay Gaps

Figures represent regression coefficients (s.e. in parentheses)

Dependent variable:	Employed				Ln(hourly pay)			
Dataset:	ACS		SIPP		ACS		SIPP	
	(1)		(2)		(3)		(4)	
Disability type								
Visual impairment	-0.053**	(0.002)	-0.0477***	(0.0183)	-0.079**	(0.004)	-0.124**	(0.0571)
Hearing impairment	-0.032**	(0.002)	-0.0134	(0.0166)	-0.046**	(0.003)	-0.00517	(0.0425)
Cognitive impairment	-0.289**	(0.001)			-0.193**	(0.003)		
Mobility impairment	-0.343**	(0.001)			-0.139**	(0.003)		
Other limit in dressing or bathing	-0.196**	(0.007)			-0.081**	(0.017)		
Other limit in going outside	-0.359**	(0.003)			-0.185**	(0.008)		
Speech impairment			-0.105***	(0.0257)			-0.133	(0.0853)
Difficulty with physical activities:								
Climbing 10 stairs			-0.0427**	(0.0201)			-0.0551	(0.0446)
Walking 3 blocks			-0.129***	(0.0203)			-0.115**	(0.0505)
Standing for one hour			-0.134***	(0.0192)			0.0238	(0.0386)
Sitting for one hour			0.00474	(0.0179)			0.0152	(0.0457)
Stooping, crouching, or kneeling			-0.0334**	(0.0149)			-0.0586**	(0.0289)
Reaching over head			-0.0333*	(0.0182)			-0.0109	(0.0456)
Lifting and carrying 10 lbs.			-0.103***	(0.0205)			0.0374	(0.0514)
Pick up glass or grasp pencil			-0.0104	(0.0188)			-0.117**	(0.0503)
Pushing or pulling large objects			-0.0926***	(0.0180)			-0.00657	(0.0390)
Mental or cognitive impairment:								
Learning disability			-0.0230	(0.0189)			0.0155	(0.0494)
Alzheimer's, senility, or dementia			-0.104***	(0.0232)			-0.0586	(0.0848)
Intellectual disability			-0.0965***	(0.0365)			-0.536***	(0.149)
Developmental disability			-0.104**	(0.0476)			-0.0943	(0.147)
Other mental/emotional condition			-0.0682***	(0.0183)			-0.120***	(0.0462)
Observations	9,246,283		20,120		8,598,128		18,569	

Columns 1 and 2 are based on linear probability regressions, and columns 3 and 4 are based on Heckman models. All regressions control for education, race/ethnicity, and gender; the ACS regressions also control for gender interacted with marital status, state of residence, and year; the SIPP regressions and the ACS employment regression also control for age, while the ACS pay regression controls for labor market experience. See Tables A-1 and A-2 for fuller results and descriptive statistics.

Table 2: Disability and Non-disability Accommodations, 2012-2021

Figures represent percent of employees who requested or were granted accommodations

	2012			2019			2021			2012-2021 cha
	Disability		No disability	Disability		No disability	Disability		No disability	Disability
	(1)		(2)	(3)		(4)	(5)		(6)	(7)
Any accommodations										
Requested change	12.7%	**	8.6%	14.2%	**	9.2%	15.1%	**	6.8%	2.4%
Granted in full	8.6%	**	5.3%	10.9%	**	6.1%	11.0%	**	4.7%	2.4%
Granted in part	1.7%		1.6%	1.2%		1.5%	1.4%		1.0%	-0.3%
Granted in full or part	10.2%	**	6.9%	12.1%	**	7.6%	12.4%	**	5.7%	2.2%
Granted in full or part if:										
Hearing impairment	7.3%			6.8%			7.8%			0.4%
Vision impairment	7.9%			15.1%	**		7.1%			-0.8%
Cognitive impairment	12.1%	**		14.9%	**		19.0%	**		6.9%
Mobility impairment	13.0%	**		14.7%	**		14.4%	**		1.3%
New or modified equipment										
Requested change	4.2%	**	3.1%	4.7%	**	3.3%	4.8%	**	2.6%	0.6%
Granted in full	2.6%	*	1.9%	3.4%	**	2.1%	4.0%	**	1.8%	1.4%
Granted in part	0.7%		0.7%	0.6%		0.7%	0.2%	**	0.5%	-0.5%
Granted in full or part	3.3%		2.7%	4.0%	**	2.9%	4.1%	**	2.2%	0.9%
Granted in full or part if:										
Hearing impairment	3.4%			3.4%			4.2%	*		0.8%
Vision impairment	3.6%			6.0%	*		4.1%			0.5%
Cognitive impairment	2.0%			3.9%			4.4%	**		2.4%
Mobility impairment	4.0%	*		4.6%	*		5.0%	**		1.0%
Sample size	2,092		52,021	1,740		41,427	1,664		36,834	
Hearing impairment	756			664			572			
Vision impairment	310			238			212			
Cognitive impairment	470			440			494			
Mobility impairment	809			627			581			

* Difference between disability and non-disability samples is significant at p<.10 ** p<.05

^ Change between 2012 and 2021 is significant at p<.10 ^^ p<.05

Table 3: Disability and Non-disability Accommodations, 2012-2021

Percent of employees granted accommodations averaged across 2012-2021, ranked by disability accommodations rate				
	Any accommodations		Eqt. accommodations	
	Disability	No disability	Disability	No disability
	(1)	(2)	(3)	(4)
Total	11.7%	6.8%	3.8%	2.6%
Personal care excl. child & home care	27.3%	4.8%	4.9%	1.9%
Health support excl. diagnosis and technicians	23.2%	7.7%	13.1%	2.3%
Computer/math	22.5%	10.6%	12.1%	4.6%
Admin assistants	20.9%	7.2%	11.0%	2.4%
Social services	20.4%	10.3%	7.8%	3.8%
Education	18.5%	8.2%	4.6%	3.2%
Business operations	18.1%	9.4%	6.7%	3.6%
Scientists	18.0%	10.1%	7.8%	4.8%
Architects/engineers	16.9%	9.3%	7.2%	4.5%
Home or health aides	15.1%	5.4%	2.6%	0.9%
Bus drivers	14.8%	4.2%	0.4%	1.6%
Customer reps	14.6%	7.3%	2.8%	1.8%
Legal	14.6%	10.7%	9.7%	4.5%
Cashiers	14.0%	4.8%	2.6%	0.5%
Misc. managers	13.6%	9.6%	4.1%	4.0%
Health technicians	13.4%	7.9%	5.6%	2.1%
Admin. support excl. admin assistants	13.0%	6.0%	4.5%	2.0%
Health diagnosis	12.9%	8.9%	1.6%	3.1%
Cooks	12.8%	4.9%	1.6%	1.6%
Top executives	11.9%	10.1%	7.5%	4.5%
Arts and entertainment	11.3%	9.7%	3.1%	4.3%
Sales supervisors	11.0%	5.7%	4.9%	1.5%
Financial specialists	11.0%	7.2%	4.1%	2.8%
Protective services	10.0%	6.3%	1.9%	2.4%
Production	9.9%	5.5%	5.7%	2.6%
Retail sales excl. cashiers	9.5%	4.5%	2.4%	0.6%
Receptionists	9.2%	5.4%	0.8%	2.2%
Non-bus vehicle operators	8.6%	4.7%	2.1%	1.9%
Misc. transportation	7.9%	3.9%	1.6%	1.8%
Childcare services	7.9%	3.3%	0.0%	0.3%
Non-retail sales	7.6%	5.6%	1.3%	1.9%
Construction managers	7.2%	8.1%	3.7%	3.7%
Laborers/packagers/movers	6.7%	2.8%	0.0%	1.2%
Automotive	6.2%	5.6%	1.8%	3.1%
Janitors	6.1%	3.7%	1.2%	1.9%
Maintenance excl. janitors	6.0%	3.5%	0.8%	1.8%

Construction/extraction	5.2%	3.4%	1.5%	1.9%
Maids	4.8%	3.3%	0.0%	0.8%
Food prep excl. cooks	3.7%	4.4%	0.5%	0.7%
Farming/forestry/fishing	3.7%	2.8%	0.0%	1.9%
Installation/repair	3.6%	6.7%	2.5%	3.5%
Farm/ranch managers	0.8%	4.4%	0.6%	2.8%

Table 4: Occupation-level Correlations of Accommodations and Employment Outcomes

			Correlation of outcome at left with:					
	Mean	(s.d.)	Accommodation rate among employees with disabilities in base year			Equipment-based accommodation rate among employees with disabilities in base year		
	(1)		(2)			(3)		
All disabilities								
Disability employment growth (percent)								
2012-2019	12.54	(18.99)	0.289	(0.064)	*	0.054	(0.737)	
2019-2021	16.32	(24.85)	0.196	(0.214)		0.110	(0.490)	
2012-2021	3.39	(14.17)	0.448	(0.003)	**	0.314	(0.043)	**
Change in percentage with disability within occupation								
2012-2019	0.12	(0.54)	0.079	(0.621)		-0.114	(0.471)	
2019-2021	0.34	(0.67)	0.210	(0.183)		0.037	(0.816)	
2012-2021	0.22	(0.47)	0.260	(0.096)	*	0.105	(0.507)	
Change in disability pay gap (percent point)								
2012-2019	-2.78	(7.21)	0.290	(0.063)	*	0.086	(0.588)	
2019-2021	2.01	(18.48)	-0.227	(0.148)		-0.210	(0.182)	
2012-2021	4.79	(21.56)	-0.278	(0.074)	*	-0.137	(0.388)	
By disability type								
Disability employment growth (percent), 2012-2021								
Hearing	0.03	(26.22)	-0.204	(0.195)		-0.181	(0.252)	
Vision	10.90	(38.22)	0.240	(0.126)		0.223	(0.156)	
Cognitive	62.79	(65.37)	0.316	(0.041)	**	-0.180	(0.255)	
Mobility	-4.49	(23.67)	0.052	(0.742)		0.049	(0.759)	
Change in percentage with disability within occupation, 2012-2021								
Hearing	-0.09	(0.32)	-0.160	(0.312)		-0.103	(0.516)	
Vision	0.01	(0.17)	0.149	(0.345)		0.088	(0.579)	
Cognitive	0.45	(0.42)	0.082	(0.605)		-0.192	(0.224)	
Mobility	-0.13	(0.32)	0.052	(0.743)		-0.042	(0.791)	
N	42		42			42		
* p<.10 ** p<.05								

P-values in parentheses in columns 2 and 3.

All figures weighted by number of people with disabilities in occupation in 2012.

Figures

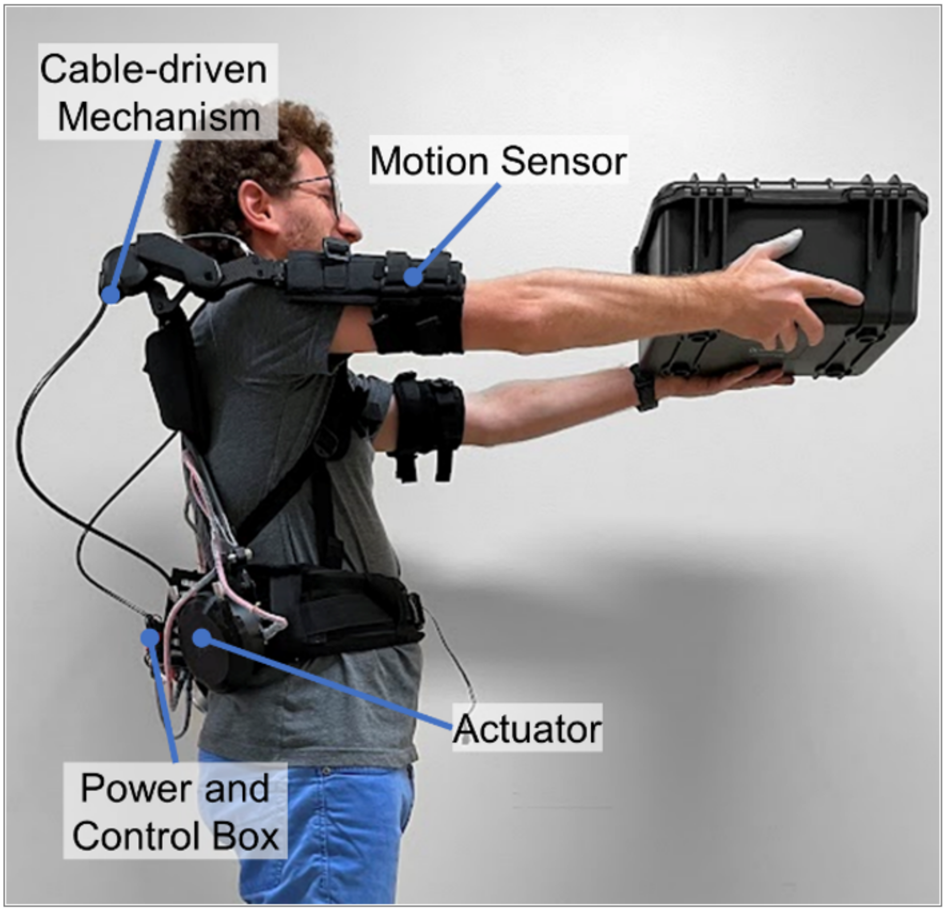

Figure 1

Portable robotic exoskeleton for powered assistance during arms elevation. The robot detects residual volitional movements of the wearer's limbs and provides support to offload the limbs from the effects of gravity, helping to restore arm functions in people with upper-limb impairments.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- TableA1.docx
- TableA2.docx