




# Disability Phenotypes and Job Accommodations Utilization Among People with Physical Disability

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## Abstract

**Purpose** People with disabilities (PWD) are less likely to be employed than those without disabilities. Reasonable job accommodations are an essential factor for ensuring equal access to jobs for PWD. However, use of job accommodation is less than optimal among PWD with various types of disabilities. Sometimes, PWD have co-occurring impairments, which might affect accommodation use. This research aimed to explore disability phenotypes, frequently used accommodations, and employee- and job-related factors associated with the extent of job accommodation use. **Methods** A cross-sectional online survey of PWD was conducted in the Midwest region of the United States. Latent class analyses were used to identify disability phenotypes. Descriptive analysis and stepwise Poisson regression were used to identify factors associated with job accommodation use. **Results** A total of 326 PWD with work experience after acquiring a disability were included in this analysis. We identified three disability phenotypes: (1) Severe disability in cognitive, physical, emotional, communication and visual domains (32%), (2) Moderate cognitive and low physical disability (48%), and (3) High physical disability phenotypes (20%). 80% of PWD received at least one accommodation. Flexible working schedules, telework, and access to a support person in the workplace were the most common accommodations. Employee- (age, disability phenotypes, motor function) and job-related factors (job preparation, self-employment) are associated dependently with accommodation use. **Conclusion** This analysis identifies three disability phenotypes and highlights both employee- and job-related factors associated with accommodations used. It may be beneficial to consider multiple contextual factors, including co-occurring disability, employee- and job-related factors, when assisting people with job accommodations.

**Keywords** Disabilities · Job accommodation · Vocational rehabilitation · Return to work · Employment

## Introduction

Employment is vital for people with disabilities (PWD) as it provides a path to economic self-sufficiency, better health care coverage, and improved quality of life. Furthermore, work is essential to one's identity, confidence, and self-esteem by providing a sense of dignity, purpose, and a chance to fully participate in society [1]. However, PWD are less likely to be employed than those without disabilities. In 2022, the labor force participation rate for PWD was 33.1% compared to 73.8% for those without a disability [2].

Reasonable job accommodations, such as flexible work schedules or modified job duties, are essential for ensuring equal opportunity for PWD to participate in the labor force [3, 4]. Job accommodations allow PWD to perform the essential functions of a job by making changes or adjustments to how a job is performed and to the work

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environment. By using job accommodations, PWD can earn competitive wages and benefits, contribute to their company's success, receive promotions, and advance their careers. Unfortunately, only 25–33% of PWD report using job accommodations in their workplaces [5]. Multilevel risk factors are associated with job accommodation utilization including job-, workplace-, and employee-related factors [4, 6]. Workplace factors such as company size and support from co-workers and supervisors are important [6]. Employee factors, including demographic characteristics and type of disability, are also critical considerations [6]. However, most studies have not comprehensively explored multilevel risk factors in the same statistical model (i.e., job and employee factors).

Research on disability and employment frequently examines disability as a single domain (e.g., physical or cognitive) despite physical disabilities often existing in conjunction with other disabilities [6, 7]. People with multiple coexisting disabilities may require significantly different services and accommodations than individuals with a single disability [7]. It is crucial to assess disability in multiple domains and consider the phenotypes that they may define. In order to address these knowledge gaps, the objectives of this study were to (1) describe disability phenotypes and (2) explore factors associated with the extent of job accommodations by utilizing a comprehensive approach that includes job-, workplace-, and employee-related factors simultaneously in one model.

## Methods

### Study and Survey Design

We designed an online survey in order to collect information about respondents' disabilities, employment situation [8–10], job characteristics [8–10], workplace-related factors [8–12], and job accommodations [9, 10] using published sources. We asked if their monthly earnings exceeded USD 1220, the amount defined as substantial gainful activity by the Social Security Administration for the 2019 [13]. We pilot-tested the survey with 40 PWD and made revisions based on their feedback. We developed the survey before the COVID-19 pandemic and did not aim at measuring PWD's work experiences and employment outcomes during the pandemic. Therefore, we asked participants to answer the questions based on their employment experience before the pandemic. The Institutional Review Board at Northwestern University approved this cross-sectional study (STU002080453).

## Participants and Data Collection

We disseminated the survey to PWD in the Midwest region of the United States from October 2020 to March 2021 through Research Electronic Data Capture (REDCap) hosted at Northwestern University. REDCap is a secure web application for building and managing online databases [14, 15]. The REDCap survey included instructions and a consent form. Eligibility criteria were (1) age at least 18 years, (2) ability to communicate in English, and (3) a physical disability as the primary disability. We defined physical disability as an impairment of physical functioning, mobility, dexterity, or stamina that impedes daily activities. We included a question to assess presence of a brain injury or a neurological condition to assure that people with neurological injuries or disorders were included. Recruitment strategies included inviting former vocational rehabilitation clients from the Shirley Ryan AbilityLab and patients who met eligibility criteria via electronic health records. We used social media, mailings, an invitation on the Shirley Ryan AbilityLab patient portal, and consumer organizations located in Illinois to reach a large audience. We notified disability organizations about the study and asked them to share study information with their members. We contacted eligible individuals two to five times to increase the response rate. For this report, we included participants who reported having work experience after acquiring a disability.

## Measures

### Primary Outcome: Numbers of Job Accommodations Used

Participants reported whether they use job accommodations (Yes/No) including flexible working schedules, telework, allowing a support person on the job, providing equipment or modifying work areas, additional unpaid leave, adjusted or modified tests and training materials, modified policies or workplace rules, work restructuring, and reassigning a vacant position. We asked the participants to select all that apply. We summed the number of job accommodations each participant used. We also asked if they were familiar with services provided by the Job Accommodation Network (JAN); a positive response may indicate greater self-advocacy for accommodations [10].

### Disability Phenotypes and Symptoms Exposure Variables

Participants reported whether their daily lives were affected (Yes/No) by the presence of cognitive (memory, concentration, slow thoughts), physical (mobility, weakness/loss of movement in hand/arm/leg, balance, coordination),

emotional (depression, anxiety, post-traumatic stress disorder), communication (speaking, reading, writing, hearing), and visual perception impairments (left neglect, etc.). We asked the participants to select all that apply. They also reported the presence of chronic pain and fatigue.

### Job and Workplace Characteristics Exposure Variables

We collected information about participants' job titles, industry, company size, and subjective work demands. To estimate participants' objective work demands (physical demands and job preparation), we matched their job titles with the Dictionary of Occupational Titles (DOT) taxonomy [16]. For physical demands, we used DOT classification and categorized jobs into sedentary and non-sedentary jobs (light, medium, heavy, and very heavy) [16]. Job preparation was measured by specific vocational preparation (SVP). SVP is defined as the amount of time required by a worker to learn the techniques, acquire the information, and develop the facility needed for average performance in a specific job [16]. SVP ranges from 1 (short demonstration only) to 9 (over 10 years), with a higher score indicating more job preparation needed. We dichotomized SVP into whether or not the job required considerable or extensive preparation, defined as  $SVP \geq 7$  [17].

## Statistical Analyses

### Define and Describe Disability Phenotypes

We summarized continuous variables using means (SD), count data using median (IQR), and categorical variables using counts (percentages). We used latent class analysis (LCA) to determine the disability phenotypes [18]. We fitted a sequence of LCA models (two- to four-class models) to the data. We selected the optimal number of impairment phenotypes (latent classes) based on the likelihood ratio chi-square ( $LR\chi^2$ ), Akaike Information Criterion (AIC), the Sample Size Adjusted Bayesian Information Criterion (SS Adj. BIC), the entropy index, and the Lo–Mandell–Rubin test, LMR [19–23]. A non-significant  $LR\chi^2$  indicates a good model fit. Lower AIC, BIC, and SS Adj. BIC indicate a better model fit. The entropy index can range from 0 to 1, with values closer to 1 indicating better model fit. A non-significant LMR suggests that the model with one less class should be accepted. We performed LCA using MPlus 8.0 [24].

After developing disability phenotypes, we compared variables between phenotypes using one-way ANOVA for continuous variables, Kruskal–Wallis for count data, and  $\chi^2$  or Fisher's exact tests for categorical variables, as appropriate. We conducted Tukey's honest significance test (HSD) or Bonferroni's post hoc test, as appropriate, for statistically

significant results to determine where differences truly came from.

### Explore Factors Associated with the Extent of Job Accommodations

We used univariable Poisson regression models to evaluate the association of each exposure factor (demographic characteristics, illness and disability-related, and job-related) with the number of job accommodations used. Then, we included all factors in one multivariable Poisson regression model and used backward elimination to evaluate their association with the number of job accommodations used. In all models, we assessed multicollinearity using variance inflation factors, although none was detected (i.e., all variance inflation factors < 10). We used R statistical software for regression analyses with a two-sided  $P < 0.05$  denoting statistical significance and no adjustment for multiple comparisons.

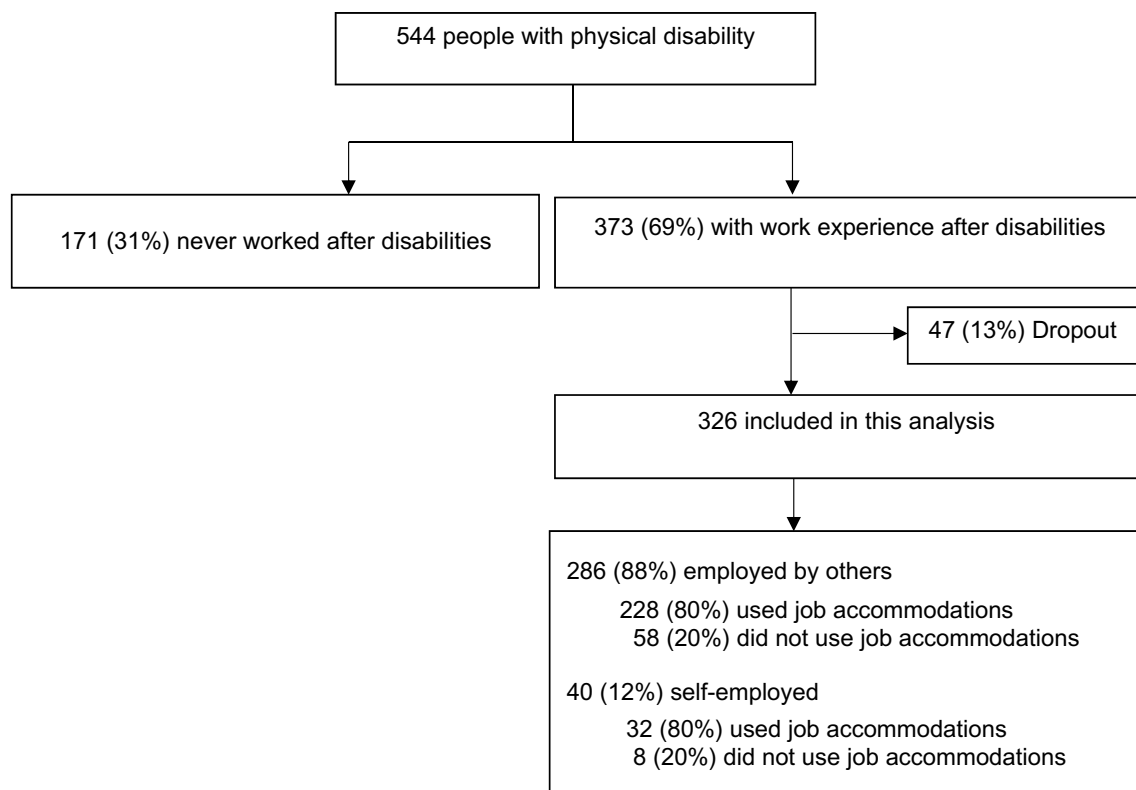
## Results

### Sample Characteristics

Figure 1 shows that 373 participants with work experience after acquiring a disability viewed questions about job accommodations; 326 responded to these questions and define the sample. Table 1 shows that the mean (SD) age was 49 (14) years, 52% of participants had a neurological disorder, and 58% were married or living with a significant other. Participants had a comparable gender distribution (56% female) compared to the US distribution (52% female). However, the sample contained a higher percentage of white respondents than the national distribution (78% vs. 66%) and higher educational attainment (bachelor's degree 73% vs. 16%) [25, 26]. In addition, a higher percentage of respondents worked in health care and social assistance (17% vs. 14%), fewer in manufacturing (5% vs. 10%) and retail (3% vs. 12%), and a higher percentage reporting union membership (15% vs. 10%) than the population of employed persons in the United States [27, 28].

### Functional Impairments and Disability Phenotypes

By selection, physical impairments (80%) were the most common condition reported by our participants, followed by cognitive (47%), emotional (47%), communication (31%), and visual impairments (11%). A total of 207 participants (63%) reported multiple, coexisting functional impairments. LCA identified a three-class model that best fit the data according to the  $LR\chi^2$ , AIC, BIC, SS Adj. BIC, and LMR criteria. Considering the probabilities for each impairment,



**Fig. 1** Flow chart

along with class prevalence, we provide a substantive interpretation of each of the three disability phenotypes: (1) severe disability in all domains (32%), (2) moderate cognitive and low physical disability (48%), and (3) high physical disability (20%). The results of descriptive statistics for each phenotype are shown in Table 1. The latent class profile plot is shown in Fig. 2.

One-way ANOVA revealed that there was a significant difference in age ( $F(2, 323) = [8.7], p < 0.001$ ) and disability duration ( $F(2, 323) = [5.4], p = 0.005$ ) between at least two disability phenotypes (Table 1). Tukey's HSD test for multiple comparisons found that age was significantly younger in the severe disability in all domains group ( $x = 45, SD = 13$ ) than the moderate cognitive and low physical disability groups ( $x = 52, SD = 14; p < 0.001, 95\% CI = [2.97, 11.23]$ ). Disability duration was significantly greater in the moderate cognitive and low physical disability groups ( $x = 13, SD = 15$ ) than the high physical disability group ( $x = 7, SD = 11; p = 0.007, 95\% CI = [1.31, 10.57]$ ).

Chi-Square test of independence revealed that there was a significant difference in gender ( $\chi^2 [df] = 11.2 [2], p = 0.004$ ), used wheelchair (31.9 [2],  $p < 0.001$ ), living alone (8.3 [2],  $p = 0.02$ ), having more than one diagnosis (16.4 [2],  $p < 0.001$ ), primary diagnosis (19.9 [4],  $p = 0.001$ ), pain, (45.3 [2],  $p < 0.001$ ), fatigue (59.6 [2],

$p < 0.001$ ), self-perceived high work demand (45.16 [2],  $p < 0.001$ ), monthly earnings exceeded USD 1220 (11.1 [2],  $p = 0.004$ ), company size (6.8 [2],  $p = 0.03$ ), and return to a full-time job (7.2 [2],  $p = 0.03$ ) between at least two disability phenotypes (Table 1).

Bonferroni's post hoc analyses for multiple comparisons revealed that participants with severe disability in all domains tended to be female (69%  $p = 0.001$ ), live alone (52%,  $p = 0.01$ ), have more than one diagnosis (56%,  $p = 0.002$ ), and have higher pain (64%,  $p < 0.001$ ), fatigue (86%,  $p < 0.001$ ), and self-perceived high work demand (66%,  $p < 0.001$ ) compared to the other disability phenotypes. Furthermore, they were less likely to return to a full-time job (68%,  $p < 0.001$ ) than the two other phenotypes. However, participants with moderate cognitive and low physical disability tended to use wheelchairs (34%,  $p < 0.001$ ). Participants with high physical disability tend to have a single diagnosis (75%,  $p = 0.005$ ), less pain (11%,  $p < 0.001$ ), and fatigue symptoms (28%,  $p < 0.001$ ) than the other two phenotypes. The phenotype groups were similar regarding the number of job accommodations used; however, people with a high physical disability are less likely to receive equipment or modify work areas (20%,  $p = 0.005$ ) than the other two phenotypes (Table 1).

**Table 1** Employee-, Job- and Workplace-related factors, and Job accommodation provision by disability phenotype<sup>‡</sup>

Variable	Total (n = 326)	Severe disability in all domains (n = 104)	High physical disability (n = 64)	Moderate cognitive and low physical disability (n = 158)	p value <sup>‡</sup>
<b>Employee-related factors</b>					
Age, mean (SD) (years)	49 (14)	45 (13) <sup>§</sup>	48 (14)	52 (14) <sup>§</sup>	< 0.001
Female, n (%)	179(56)	69 (69) <sup>¶</sup>	29 (45)	81 (51)	0.004
Race (White), n (%)	252(78)	87 (85)	51 (81)	114 (73)	0.08
Married, living with significant other/partner, n (%)	189 (58)	50 (48) <sup>¶</sup>	45 (70)	94 (60)	0.02
Education (at least bachelor's degree), n (%)	237 (73)	74 (71)	45 (70)	118 (75)	0.73
<b>Diagnosis, n (%)</b>					
Other disorders	61 (20)	22 (22)	12 (22)	27 (18)	0.001
Musculoskeletal disorders	86 (28)	19 (19)	7 (13) <sup>¶</sup>	60 (39) <sup>¶</sup>	
Neurological disorders	162 (52)	59 (59)	36 (66)	67 (44) <sup>¶</sup>	
Have more than one diagnosis, n (%)	125 (38)	55 (56) <sup>¶</sup>	15 (25) <sup>¶</sup>	55 (37)	< 0.001
Time since disability onset (years)	11(13)	10 (12)	7 (11) <sup>§</sup>	13 (15) <sup>§</sup>	0.005
Used wheelchair, n (%)	71 (22)	18 (17)	0 (0) <sup>¶</sup>	53 (34) <sup>¶</sup>	< 0.001
<b>Symptoms, n (%)</b>					
Pain	152 (47)	66 (64) <sup>¶</sup>	7 (11) <sup>¶</sup>	79 (50)	< 0.001
Fatigue	186 (57)	89 (86) <sup>¶</sup>	18 (28) <sup>¶</sup>	79 (50) <sup>¶</sup>	< 0.001
Familiar with the services of the Job Accommodation Network, n (%)	9 (3)	3 (3)	1 (2)	5 (4)	0.76
Ever worked full time after disability, n (%)	249 (76)	71 (68) <sup>¶</sup>	55 (86)	123 (78)	0.03
Monthly earnings exceeded USD 1220, n (%)	251(87)	80 (86)	57 (100) <sup>¶</sup>	114 (83)	0.004
<b>Job- and Workplace-related factors</b>					
<b>Industry, n (%)</b>					
Health care and social assistance	53 (17)	18 (17)	6 (9)	29 (18)	0.3
Educational services	37 (12)	11 (11)	7 (11)	19 (12)	
Professional, scientific and technical services	25 (8)	6 (6)	3 (5)	16 (10)	
Finance and insurance	22 (7)	8 (8)	4(6)	10 (6)	
Information services including technology	22 (7)	7 (7)	6 (9)	9 (6)	
Transportation and warehousing	15 (5)	6 (6)	2 (3)	7 (4)	
Manufacturing wholesale trade	14 (5)	6 (6)	4 (6)	4 (3)	
Public administration (federal, state, local government)	11 (4)	3 (3)	3 (5)	5 (3)	
Retail trade	9 (3)	7 (7)	0 (0)	2 (1)	
Others <sup>‡</sup>	100 (32)	27 (26)	25 (39)	48 (30)	
Company size > 250, n (%)	103 (38)	22 (27) <sup>¶</sup>	20 (39)	61 (45)	0.03
The job required considerable or extensive preparation needed, n (%)	199 (74)	66 (76)	40 (78)	93 (71)	0.52
Sedentary job, n (%)	125 (47)	35 (40)	25 (49)	65 (50)	0.37
Belong to the union, n (%)	45 (15)	19 (20)	11 (19)	15 (11)	0.09
Self-perceived high job demands, n (%)	142 (46)	65 (66) <sup>¶</sup>	28 (46)	49 (33) <sup>¶</sup>	< 0.001
Self-employed, n (%)	40 (12)	11 (11)	7 (11)	22 (14)	0.69
<b>Job accommodation provision</b>					
Number of job accommodations used, medium (IQR)	2 (3)	3 (4)	2 (3)	2 (3)	0.06
<b>Type of job accommodation used, n (%)</b>					
Flexible working schedules	179 (55)	65 (63)	31(48)	83 (53)	0.15
Telework	138 (42)	37 (36)	29 (45)	72 (46)	0.24
Allowing support persons on the job	138 (42)	55 (53)	25 (39)	58 (37)	0.03

**Table 1** (continued)

Variable	Total (n=326)	Severe disability in all domains (n=104)	High physical disability (n=64)	Moderate cognitive and low physical disability (n=158)	p value <sup>ε</sup>
Providing equipment or modifying work area	116 (36)	39 (38)	13 (20) <sup>¶</sup>	64 (41)	0.02
Providing additional unpaid leave	89 (27)	38 (37)	12 (19)	39 (25)	0.03
Modified policies or workplace rules	69 (21)	24 (23)	14 (22)	31 (20)	0.79
Adjusted or modified tests and training materials	57 (18)	25 (24)	12 (19)	20 (13)	0.06
Work restructuring	54 (17)	23 (22)	9 (14)	22 (14)	0.18
Reassigning to a vacant position	31 (10)	10 (10)	6 (9)	15 (10)	0.99

\*Data presented as n (%) unless otherwise noted and may not add to 100% due to rounding variables

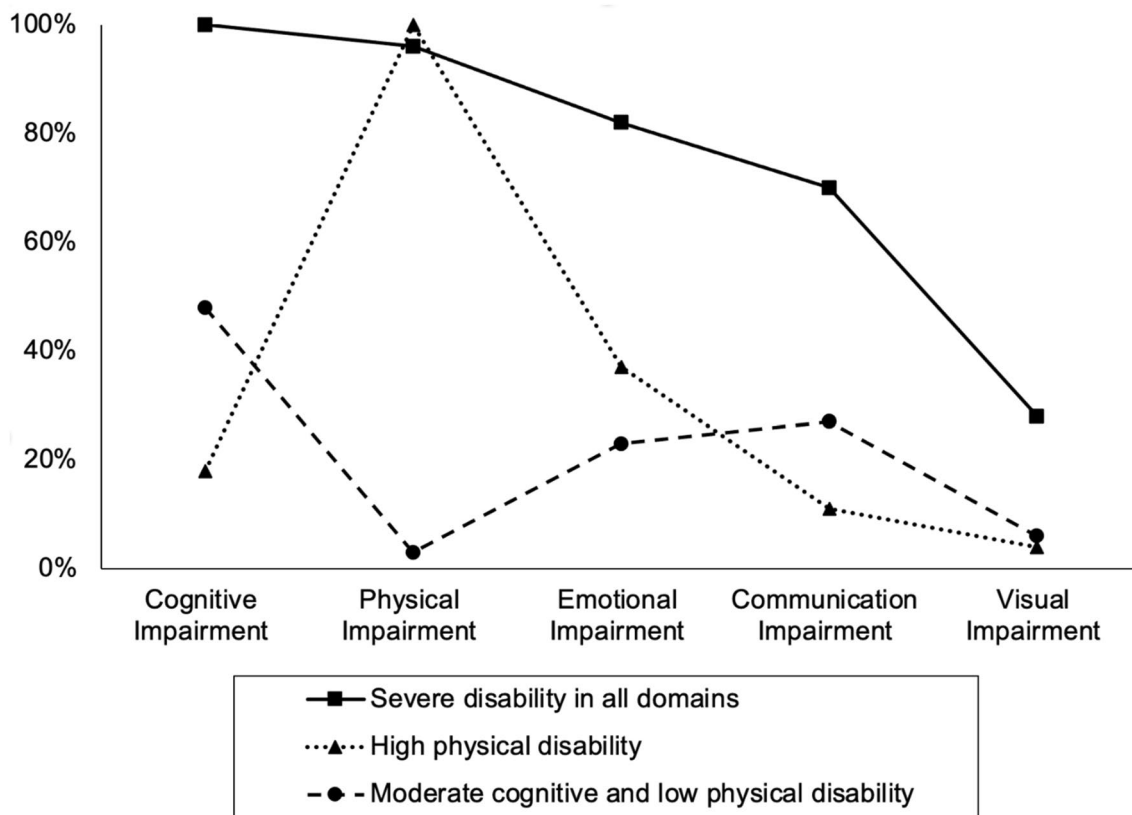
<sup>ε</sup>Calculated by One way ANOVA for continuous variables, Kruskal–Wallis for count data, and  $\chi^2$  or Fisher’s exact tests, as appropriate, for categorical variables.

<sup>¶</sup>Statistically significant result in Bonferroni’s post hoc test

<sup>§</sup> Statistically significant result in Tukey’s honest significance test

<sup>¥</sup>Accommodation and Food Services; Administrative and Support and Waste; Agriculture, Forestry, Fishing, and Hunting; Arts, Entertainment and Recreation; Construction; Management and Remediation Services; Management of Companies and Enterprises; Real Estate Rental and Leasing

<sup>£</sup>Functional impairment phenotypes were constructed using latent class analysis, including emotion, physical, cognitive, communication, visual impairments.



**Fig. 2** Disability phenotypes

## Factors Associated with Job Accommodations

About 80% (n = 261) of participants used at least one job accommodation. The median number (IQR) of accommodations was 2 (3). The most common job accommodations reported were flexible working schedules (55%), telework (42%), and allowing a support person on the job (42%). A greater number of job accommodations was associated with young age, non-white race, more than one diagnosis, using a wheelchair, severe disability in all domains, pain, familiarity with JAN, a sedentary job, earning less than the 2019 substantial gainful activity level, self-perceived high job

demands, and not working full time after disability onset in univariable Poisson regressions (Table 2).

In the multivariable Poisson backward regression model, only age, job preparation, disability phenotype, wheelchair use, and self-employment were associated with the number of job accommodations. Older age (Relative risk [95% CI] 0.99 [0.98, 0.99],  $p=0.02$ ) and a job that requires considerable or extensive preparation (0.78 [0.64, 0.96],  $p=0.02$ ) were associated with a lower number of job accommodations. Respondents with low physical and moderate cognitive disability had a lower number of receiving job accommodations than respondents with high disability in

**Table 2** Associations of the extent of job accommodations with job-, workplace-, and employee-related factors

	Univariable Poisson regression		Multivariable Poisson regression <sup>€</sup>	
	Relative risk (95% CI)	p value	Relative risk (95% CI)	p value
<i>Employee-related factors</i>				
Age, mean (SD) years	0.99 (0.98, 0.99)	<0.001	0.99 (0.98, 0.99)	0.02
Female	1.11 (0.97, 1.27)	0.12		
Race (White)	0.78 (0.67, 0.90)	0.001		
Married, living with significant other/partner	0.89 (0.78, 1.02)	0.09		
Education (at least bachelor's degree)	0.99 (0.86, 1.16)	0.99		
Primary diagnosis	1.00 (0.99, 1.00)	0.23		
Other disorders	Reference			
Musculoskeletal disorders	1.03 (0.85, 1.25)	0.78		
Neurological disorders	0.91 (0.76, 1.09)	0.31		
Have more than one diagnosis	1.42 (1.23, 1.62)	<0.001	1.19 (0.99, 1.42)	0.06
Time since disability onset	1.00 (0.99, 1.01)	0.70		
Used wheelchair	1.49 (1.28, 1.72)	<0.001	1.50 (1.22, 1.83)	<0.001
Disability phenotype <sup>£</sup>				
Severe disability in all domains	Reference		Reference	
High physical disability	0.84 (0.73, 0.97)	0.02	0.87 (0.71, 1.07)	0.18
Moderate cognitive and low physical disability	0.78 (0.64, 0.94)	0.01	0.75 (0.57, 0.99)	0.05
Symptoms				
Pain	1.2 (1.09, 1.42)	0.001		
Fatigue	1.12 (0.97, 1.28)	0.12		
Familiar with the services of the Job Accommodation Network (JAN)	1.46 (1.22, 1.76)	<0.001	1.29 (0.99, 1.42)	0.06
Ever worked full time after the disability	0.86 (0.74, 0.99)	0.04		
Income at or above \$1220 per month (2019)	0.76 (0.63, 0.91)	0.004		
<i>Job- and workplace-related factors</i>				
Company size > 250	0.94 (0.81, 1.10)	0.45		
Job required considerable or extensive preparation	0.86 (0.73, 1.01)	0.06	0.78 (0.64, 0.96)	0.02
Sedentary job	1.24 (1.08, 1.43)	0.003		
Belong to the union	1.14 (0.94, 1.36)	0.18	1.20 (0.94, 1.55)	0.14
Self-perceived high job demands	1.42 (1.24, 1.63)	<0.001	1.19 (0.99, 1.43)	0.07
Self-employed	1.16 (0.96, 1.40)	0.13	1.37 (1.01, 1.86)	0.04

\*Data presented as n (%) unless otherwise noted and may not add to 100% due to rounding

£Functional impairment phenotypes were constructed using latent class analysis, including emotion, cognitive, communication, visual impairments

€Backward stepwise regression model

all domains (0.75 [0.57, 0.99],  $p=0.05$ ). Participants who used a wheelchair (1.5 [1.22, 1.83],  $p<0.001$ ) and were self-employed (1.37 [1.01, 1.86],  $p=0.04$ ) had a greater number of job accommodations than those who did not use a wheelchair and worked for an employer, respectively (Table 2).

## Discussion

This study's sample included 326 PWD with work experience after acquiring a physical disability; 60% reported multiple coexisting impairments. LCA defined three disability phenotypes characterized by (1) Severe disability in all domains (32%), (2) Moderate cognitive and low physical disability (48%), and High physical disability (20%). People with severe disability in all domains tended to be young, female, live alone, have higher pain and fatigue levels, and were less likely to return to a full-time job. This study also revealed that 80% of PWD used at least one job accommodation with a median number of 2 accommodations. The most commonly used accommodations were flexible working schedules, telework, and having a support person on the job. Respondent characteristics associated with use of more job accommodations were younger age, using a wheelchair, severe disability in all domains, having a job that did not require considerable or extensive preparation, and self-employment.

A novel aspect of this study is characterizing disability as multiple, coexisting conditions and defining disability phenotypes in people who have a primary physical disability. This approach was motivated by our systematic review which suggests that co-occurrence of physical, cognitive, behavioral, and sensory impairment is common [6]. In the present study, 60% of the sample have at least two functional impairments, supporting the value of this approach. Consistent with prior studies of PWD and employment, we found that disability type was associated with the extent of job accommodations used [4, 6]. However, by using this approach, we extend our knowledge by showing that the severity of physical and cognitive disability is associated with the extent of job accommodation. Future studies might consider the association between type of disability phenotypes and the type of job accommodation used to inform clinical practice further.

Another strong feature of this study is employing a comprehensive and multi-factorial model of job accommodations. Our findings on job accommodations align with the published literature, which reports that flexible scheduling (20–80%), allowing for telework (6–78%), and providing supportive personnel (12–50%) are common job accommodations [6]. However, in contrast, in the present study, we found that more costly accommodations (i.e., *modifying workplace architecture* and *providing assistive*

*technologies*) were used less frequently than prior studies reported [29–31]. Our study replicates the results of previous research by demonstrating that employee-related factors (e.g., age, disability type, pain) and job-related factors (i.e., job demands and self-employment) are independently associated with the extent of job accommodations. Notably, our findings show that needing and receiving job accommodations results from the interplay between employee, occupational, and contextual factors. The multivariable Poisson regression revealed that both employee-related (age, wheelchair use, disability phenotype) and job-related (job preparation, self-employment) factors were dependently associated with job accommodations. The findings provide a comprehensive view of what job accommodations are used by employees with disabilities. Employing a comprehensive approach that considers multiple contextual factors could support PWDs who would benefit from job accommodations.

Several policy and practice implications emerge from the findings. First, employees must be aware of legislation such as the Americans with Disabilities Act, ADA [32] and its employment provisions, and of resources such as JAN, to request job accommodations. Employees must know of their rights to reasonable accommodations in order to request them. Unrecognized needs for accommodations are likely to be unmet needs [33]. Unrecognized and thus unmet needs may be more common among smaller employers with limited disability experience, and which have limited resources and networks to provide job accommodations. While JAN and the ADA National Network [34] are experts in providing employer education, there may be additional opportunities for outreach to organizations representing attorneys, physicians and rehabilitation counselors who serve employees sustaining occupational injuries.

This study has important strengths, including the sample size and assessing multilevel factors associated with job accommodations. However, the study also has limitations. First, the sample resided primarily in the Midwest region of the United States with internet access. Replication with a nationally representative sample is needed to generalize findings. Second, the retrospective, self-report approach is subject to recall and response bias, and future studies might consider using administrative data to verify self-report. Third, the COVID-19 pandemic dramatically affects the employment situation and job accommodations used by PWD. However, we asked participants to report their work experience and work status right before the pandemic. Thus, findings apply to pre-pandemic situations. Fourth, 80% of our sample reported using at least one accommodation, substantially higher than samples of PWD identified in earlier studies (25–33%). Reflecting the study eligibility criteria, only people with work experience after sustaining a disability participated in this study. Thus, they are not



representative of all PWDs in the Midwest United States and not exactly comparable to earlier studies.

## Conclusion

People with physical disabilities frequently experience co-occurring impairments associated with job accommodations provision. Employee- and job-related factors are simultaneously associated with needing and using job accommodations. It will be beneficial to consider multiple contextual factors, including co-occurring disability and employee- and job-related factors when assisting people who need job accommodations.

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**Data Availability** The datasets generated and analyzed during the current study are not publicly available.

## Declarations

**Conflict of interest** The authors have no relevant financial or non-financial interests to disclose.

**Ethical Approval** This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board of Northwestern University (STU00208453).

**Consent to Publish** Not applicable.

**Informed Consent** Online informed consent was obtained from all individual participants included in the study.

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