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Pain and labor outcomes: A longitudinal study of adults with cerebral palsy in Sweden

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ABSTRACT

Background: Pain is a global health concern with substantial societal costs and limits the activity participation of individuals. The prevalence of pain is estimated to be high among individuals with cerebral palsy (CP).
Objectives: To estimate the association between pain and labor outcomes for adults with CP in Sweden.
Methods: A longitudinal cohort study based on data from Swedish population-based administrative registers of 6899 individuals (53,657 person-years) with CP aged 20–64 years. Individual fixed effects regression models were used to analyze the association between pain and labor outcomes (employment and earnings from employment), as well as potential pathways through which pain might affect employment and earnings.
Results: Pain was associated with adverse outcomes varying across severity, corresponding to a reduction of 7–12% in employment and 2–8% in earnings if employed. Pain might affect employment and earnings through increased likelihood of both sickness leave and early retirement.
Conclusion: Pain management could potentially be important to improve labor outcomes for adults with CP, in addition to improving the quality of life.

Pain is a major global health concern. Estimates from Europe and the United States (US) suggest that the prevalence of chronic pain among adults is approximately 20%.[1,2] Pain has been identified as a leading cause of hospital visits as well as a key contributor to sick leave, with substantial cost to both society and the healthcare sector.[3] However, the consequences of pain on labor and other socioeconomic outcomes have received limited attention in the literature. This may be due to the limited availability of reliable pain data, as well as the fluctuation of pain. In addition, pain has often been considered a symptom of numerous disorders rather than a health condition in itself.

The frequency and intensity of pain differ across underlying health conditions. One group of people with a high prevalence of pain is individuals with cerebral palsy (CP). CP is the most common early-onset lifelong disability and is caused by non-progressive brain damage that occurs before the age of two years.[4] The damage results in motor impairments and subsequent effects on body structures and functions as well as associated impairments.[5] This interacts with environmental and contextual factors such as stigma and discrimination resulting in lower levels of social and labor market participation, as well as earnings,[6–9] educational attainment,[10,11] and quality of life[12,13] compared to the general population. Among adults with CP, the prevalence of chronic pain has been estimated as high as 75% in the Netherlands[14] and 67% in Sweden.[15]

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For individuals with CP, pain has been shown to be associated with a reduction in quality of life,[12,16,17] increase in mental fatigue and a cause of sleep disturbance.[13,18] An association between self-reported pain and functional and social limitations has also been noted,[19,20] although some studies report limited effects.[5] Indications are that the interference of pain on daily activities and sleep increases with increasing age.[15] In addition, pain might also be associated with labor outcomes through several mechanisms; pain might increase healthcare use and disrupt work life of individuals with CP through increased sickness absence or early retirement.

Pain might also constrain the career opportunities of individuals with CP, by forcing individuals to choose jobs with flexible conditions to facilitate regular pain management. Understanding the association between pain and labor market outcomes of individuals with CP might offer insights into the social and economic consequences of pain and improve care provision for adults with motor impairments. Although the literature on the labor market consequences of CP is growing rapidly,[6–8,21] little is known about the extent pain affects labor outcomes and the potential mechanisms through which it happens.

The aims of this study were twofold: (i) to investigate the association between pain and labor outcomes (employment and earnings if employed), and (ii) to explore the association between pain and the use of social welfare systems (long-term sickness absence, unemployment benefits, and early retirement or disability pensions). In the case of earnings from employment, we focus on individuals with an attachment to the labor market.

Materials and methods

Data and sample

This was a longitudinal cohort study using data from Swedish population- based administrative registers. All individuals diagnosed with CP ICD10 code G80 (ICD9: 343) in the National Patient Register (NPR), the Medical Birth Register, and the Swedish CP-Follow up Program and national register (CPUP) between 1990 and 2015 were identified. Information was linked to this population on labor outcomes and social security benefits from the Longitudinal Integrated Database for Health Insurance and Labour Market Studies (LISA), demographics from the Register of the Total Population, health care utilization and medical diagnoses from NPR, and dispensed pain medications from the National Prescribed Drug Register for the years 2006–2015.

We limited our sample to working-aged individuals (20–64 years of age) living in Sweden during the study period. CP is expected to be over-diagnosed in national patient registers as shown by Hollung et al.[22] and we therefore excluded individuals who are considered not to have CP despite an existing diagnosis based on the following criteria: (i) had no CP-diagnosis after the age of three, (ii) acquired a brain injury[1] after the age of 2 years without a CP-diagnosis before the acquired brain damage, (iii) had other diagnoses[2] of the central or peripheral nervous system as well as progressive diseases, muscle disease and metabolic diseases that are incompatible with a CP-diagnosis, and (iv) those who had been excluded in the CPUP register.

The expanded and revised version of the Gross Motor Function Classification System (GMFCS)[23–25] was used to classify CP into mild (GMFCS I-III) or severe (GMFCS IV-V), using information from the CPUP register. However, for a large proportion of our sample, GMFCS information was missing, and in those cases, we classified severity based on CP subtypes. Persons with spastic hemiplegia and ataxic CP are classified as mild. Also, persons with spastic diplegia who at any time received a diagnosis of spastic hemiplegia, and persons with dyskinetic CP were classified as severe except those with a diagnosis of choreoathetoid (G803B), who generally are classified at lower GMFCS levels, and for the purpose of this study, were coded as having mild CP. On the other hand, persons with spastic tetraplegia CP were classified as severe. Persons with dyskinetic CP with a diagnosis of dystonia (G803A or G803X) or unknown tonus/choreoathetoid, and mixed subtypes were considered severe. Those with spastic diplegia without a diagnosis of tonus/choreoathetoid, hemiplegia, or tetraplegia, as well as those with unspecific subtypes could not be classified in terms of severity and were thus excluded from the analyses stratified on severity.

The main outcome variables were employment and earnings from employment. We only included individuals with attachments to the labor market by following previous studies and imposing an earnings threshold[26,27] to exclude individuals who worked very little during a year. A person was defined as employed (yes/no) if the individual had annual earnings from employment and entrepreneurial activities equivalent to at least 100,000 SEK in the 2015 year's price level, corresponding to 3 months average earnings from full-time employment per year. We defined total annual earnings from employment as the sum of total annual gross cash salary and income from entrepreneurial activity. Pain in a specific year was defined as having a pain diagnosis (Table 1) in the National Patient Register (in- and outpatient care) or being dispensed pain-related prescription medication (Table 1) as registered in the Pharmaceutical Register. Our definition of pain in this study includes medication and diagnoses of both CP- and non-CP-related pain. Over-the-counter pain medications without prescription were not included as they are not registered in the Pharmaceutical Register.

Statistical analyses

Employment was defined by a binary variable taking the value one if the individual was employed during the specific year, and zero otherwise. The logarithm of earnings was used to measure relative rather than absolute changes in earnings. We controlled for personal and family characteristics including marital status, presence of children aged 0–3 years, 4–6 years, 7–10 years, and 11–15 years, and region of residence. Educational attainment was included as a categorical variable for mandatory, secondary, and higher education. We accounted for job-related characteristics in the analysis of earnings by controlling for occupational status and industrial affiliation of the workplace.

Based on previous research, the association between pain and labor outcomes was estimated as an individual-level fixed-effects (FE) regression of the form

$$y_{irt} = \alpha + \beta Pain_{irt} + \delta X_{irt} + \omega_t + \kappa_r + \mu_i + \varepsilon_{irt} \quad (1)$$

The dependent variable y_{irt} is the labor market outcome of individual i, in region r in year t. $Pain_{irt}$ is a dummy variable that indicates whether an individual received a pain diagnosis or a dispensed prescription for pain-related medication in a specific year. α is a constant. X_{irt} includes variables that vary over time and δ is a set of coefficients to be estimated. ω_t is a set of year-fixed effects (i.e. dummies for each year 2006–2015) to control for aggregate changes in the economy affecting labor market outcomes over the study period and κ_r is a vector of regional dummies to control for time-invariant differences in regional labor market conditions. μ_i is individual fixed effects, i.e. all time-invariant

[1] ICD10: G00, S061, S062, S063, S067, S068, S069.

[2] ICD10: G60, G61, G62, G71, G72, G834, G95, E71, E72, E74, E75, E76, E830, G114, G12, G31, G37, Q06, Q743.

Table 1
Sources of pain information.

ICD 10 diagnostic codes	Acute pain (R520), Chronic intractable pain (R521), Other chronic pain (R522) Unspecified pain (R529), Headache (R51), Migraine and other headache syndromes (G43-G44), Trigeminal neuralgia (G500), Pain in abdomen (R10) Back (M549), Breast (N644), Chest and throat (R07), Ear (H920), Eye (H571) Joint (M255), Limb (M796), Lumbar region (M545), Pelvic and perineal (R102) Shoulder (M255), Spine (M54), Tongue (K146) and Tooth (K088).
ATC diagnostic codes	Natural opium alkaloids (N02AA), Phenylpiperidine derivatives (N02AB) Oripavine derivatives (N02AE), Opioids in combination with antispasmodics (N02AG) Opioids in combination with non-opioid analgesics (N02AJ), Other opioids (N02AX) Salicylic acid and derivatives (N02BA), Pyrazolones (N02BB), Anilides (N02BE) Other analgesics and antipyretics (N02BG), Selective serotonin (5HT1) Agonists (N02CC), Calcitonin generelated peptide (CGRP) Antagonists (N02CD) Other antimigraine preparations (N02CX) Acetic acid derivatives and related substances (M01AB) Oxicams (M01AC), Propionic acid derivatives (M01AE), Fenamates (M01AG) Other antiinflammatory and antirheumatic agents non-steroids (M01AX) Coxibs (M01AH), Tropical products for joint and muscular pain (M02A), Other muscle relaxants, peripherally acting agents (M03AX) Other centrally acting agents (M03BX).

characteristics (e.g. sex and parental background) that might be associated with both pain and employment/earnings. ε_{irt} is an idiosyncratic error term.

Our main interest is β, the coefficient of $Pain_{irt}$ that is interpreted as the association between pain and employment/earnings. Estimating the association between pain and labor market outcomes using an individual fixed-effects regression allows us to control time-invariant individual characteristics that may influence both pain and labor market outcomes and therefore reduce bias from unobservable characteristics. In order to study if the association between pain and employment/earnings vary across sex and severity of CP, we stratified the sample by sex of the individual and severity and re-estimated equation (1). To investigate potential mechanisms of how pain could affect employment/earnings, we proceeded to re-estimate equation (1) with indicators related to the social welfare system as outcome variables (early retirement, receipt of unemployment benefits, and sickness leave for at least 14 days). As sensitivity analyses, we studied the implications of the 100,000 SEK income threshold in order to be defined as employed by varying the threshold to 0 SEK, 50,000 SEK, and 150,000 SEK.

Ethical approval was granted by Lund Regional Ethical Review Board (dnr: 2018/1000).

Results

A total of 10,256 individuals were identified, of which 2266 were excluded as they did not meet our criteria for CP and 1124 were further excluded from the analysis due to missing information. Our final sample included 6899 individuals (3813 men and 3086 women) with a diagnosis of CP and 53,657 person-years. The characteristics of individuals in our analyses are presented in Table 2, showing that 46% are women, 15% have non-Swedish background (neither parent is Swedish), and 16% of our sample were married or cohabiting, with a higher proportion among women than men.

The prevalence of pain was 38% (Table 2). However, prevalence of pain based on diagnoses was 8% and 35% based on prescribed pain medication. This suggests that individuals were prescribed pain medication without a pain-related diagnosis recorded in the NPR (in- and specialized outpatient care). The prevalence of pain was lower in adults with mild CP compared with severe CP and among men compared to women. Fig. 1 shows the trends in pain prevalence,[3] ranging between 36% and 39% over the study period. For individuals with mild CP, the prevalence of pain was about 30% between 2006 and 2010, and dropped marginally to 28% between 2011 and 2015. For individuals with severe CP, however, pain prevalence increased from 47% in 2006 to 50% in 2012, and has declined marginally since 2013.

The mean employment rate for our sample was 30%, and higher among those with mild CP compared to those with severe CP and higher among men compared to women (Table 2). Employment rate of individuals with CP was relatively stable at 22% between 2006 and 2013, and increased marginally from 2014[4] (Fig. 2).

Employment of individuals with mild CP was stable between 2006 and 2008, and declined in 2009 and 2010. However, the employment of persons with mild CP has increased since 2011, reaching 32% in 2015. For individuals with severe CP, however, employment has been lower over the period compared to 2006.

The effect of pain on employment

Table 3 presents the results of the association between pain and employment of individuals with CP. To facilitate interpretation and align with the results of the earnings estimation below, we present the results for employment in the text in relative terms (i.e., the coefficient of pain divided by the mean of the dependent variable). We found that pain was associated with a 7% (−0.021/0.296) decrease in employment during the study period. Further, we found that the decreases in employment were somewhat smaller for individuals with mild CP (9%) compared to severe CP (12%).[5] Stratified by sex, the association between pain and employment was similar for men and women (7%). Further, pain was associated with a 9% decline in employment for men with mild CP and 15% for severe CP compared to women (8% for mild and 9% for severe CP).

The effect of pain on earnings

In terms of earnings, we found a 3% reduction for individuals with CP due to pain. This is equivalent to SEK 7566 in annual earnings adjusted to 2015 price levels (−0.029 × 252,195.89). The association is larger among those with severe (4%, ≈ SEK 10,783) compared to mild CP (2%; ≈ SEK 5341.36 in 2015 prices) (see Table 4). A larger reduction due to pain was also noted among men (4%, ≈ SEK 10,398) compared to women with CP (2%, ≈ SEK 3948). Pain reduced the earnings of men with mild CP by 4% (≈ SEK 10,003) and severe CP by 7% (≈ SEK 19,226) respectively.

For women, however, no statistically significant effect of pain on earnings was noted when stratifying on severity. The lack of statistical significance is likely attributable to the lack of statistical power when the sample is stratified. The point estimates for the

[3] See Figure A1 in Supplementary Materials for trends in pain by source of pain information.

[4] Trends in employment rates based on the alternative thresholds are presented as Figure A2 in Supplementary Materials.

[5] Note that sample is smaller when stratifying based on severity because not all subtypes are correlated with GMFCS level (see Materials and Methods).

Table 2
Descriptive statistics.

	Full sample			Mild CP			Severe CP		
VARIABLES	Total	Men	Women	Total	Men	Women	Total	Men	Women
Women (%)	45.69			45.93			46.38		
Age (years)	40.82	40.68	40.98	35.42	35.03	35.89	42.29	42.47	42.08
Employed (%)	29.62	32.14	26.62	36.52	41.06	31.18	20.77	22.49	18.78
Pain (%)	38.26	33.35	44.10	30.07	24.65	36.45	49.16	44.27	54.83
Non-Swedish background (%)	14.75	14.65	14.87	15.46	15.94	14.89	16.03	15.53	16.61
Mandatory education (%)	36.94	38.69	34.85	27.45	28.13	26.66	41.99	44.83	38.70
Secondary education (%)	44.85	45.43	44.16	49.62	50.57	48.51	42.91	42.50	43.39
Higher education (%)	18.21	15.88	20.99	22.92	21.30	24.83	15.10	12.67	17.91
Married/Cohabiting (%)	16.14	12.45	20.52	15.59	11.63	20.26	14.78	12.78	17.09
centage with:									
Children 0–3 years (%)	4.24	2.98	5.74	6.12	4.24	8.34	2.59	1.93	3.36
Children 4–6 years (%)	2.80	1.88	3.90	3.52	2.33	4.93	2.00	1.71	2.34
Children 7–10 years (%)	3.33	2.45	4.39	3.75	2.65	5.04	2.95	2.85	3.07
Children 11–15 years (%)	4.89	3.99	5.96	5.81	4.74	7.07	4.73	4.64	4.85
No. individuals	6899	3813	3086	2288	1276	1012	1732	944	788
Observations	53,657	29,142	24,515	16,464	8902	7562	13,919	7464	6455

This table presents descriptive statistics for the sample and calculated as the crude means for the period 2006 to 2015. We indicate rows where the means are percentages as (%). The categorisation of the number of children is based on the data received from Statistics Sweden, the holder of the LISA register.

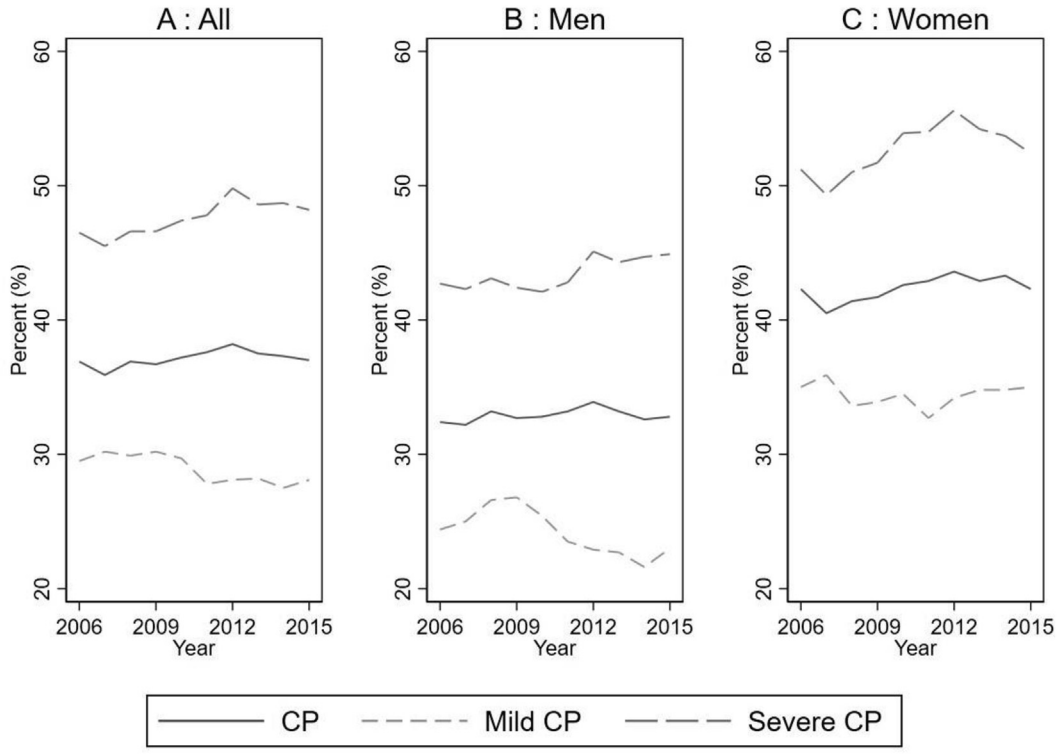

Fig. 1. The figure shows the trends in pain among adults with CP from 2006 to 2015 using both diagnoses and prescribed medication registers. The trends are crude means estimated for each year.

stratified sample for women also indicate that the total estimate for women may be driven by women with severe CP.

Sensitivity analysis

For sensitivity analyses, we alternated the earnings threshold for being considered employed (see Supplementary Materials Tables A1-A6). The association between pain and employment was found to increase with increasing earnings threshold. When no threshold was applied, pain reduced employment by 1.3%. Applying earnings thresholds of 50,000 SEK and 150,000 SEK, respectively, pain was found to reduce employment by 5% and 8% respectively. On the other hand, we found that the association between pain and earnings reduced when the size of the threshold is increased, varying from 9% (no threshold) to 4% (150,000SEK). Our results might therefore reflect that as we increased the threshold, our definition of employment included individuals who are more attached to the labor market. The sensitivity of the results to the earnings thresholds may also reflect the fact that persons with CP may already have lower market attachment[21] that may not fall further due to pain, a situation referred to as a *floor effect*.

Potential mechanisms pain affects labor outcomes

In terms of use of the social insurance system, we found that pain increased the likelihood of sickness leave by 93% (0.080/0.086)

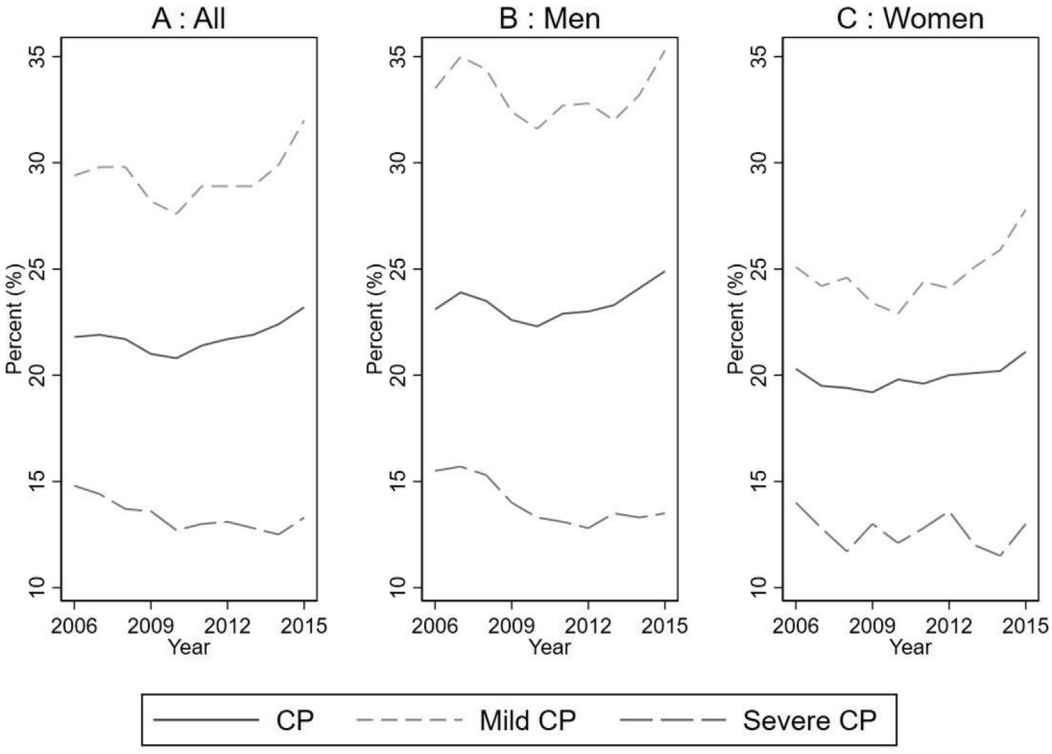

Fig. 2. The figure shows the trends in employment among adults with CP from 2006 to 2015. A person was defined as employed (yes/no) if the individual had an annual income from employment and entrepreneurial activities equivalent to at least 100,000 SEK in 2015 year's price level. The trends are crude means estimated for each year.

Table 3
The effect of pain on employment.

	Total	Mild	Severe
All			
Pain	−0.021***	−0.033***	−0.025***
	(0.003)	(0.007)	(0.005)
Constant	0.311***	0.329***	0.232***
	(0.017)	(0.031)	(0.028)
Observations	53,657	16,464	13,919
R-squared	0.019	0.038	0.026
Mean dep. var.	0.296	0.365	0.208
No. individuals	6899	2288	1732
Men			
Pain	−0.021*** (0.004)	−0.038*** (0.010)	−0.034*** (0.007)
Constant	0.305***	0.394***	0.147***
	(0.022)	(0.042)	(0.037)
Observations	29,142	8902	7464
R-squared	0.019	0.043	0.041
Mean dep. var.	0.321	0.411	0.225
No. individuals	3813	1276	944
Women			
Pain	−0.019*** (0.005)	−0.025** (0.010)	−0.017** (0.008)
Constant	0.310***	0.257***	0.385***
(0.025)	(0.047)	(0.045)	
Observations	24,515	7562	6455
R-squared	0.042	0.058	0.062
Mean dep. var.	0.266	0.312	0.188
Individuals	3086	1012	788

We controlled for educational attainment, marital status and presence of children aged 0–3 years, 4–6 years, 7–10 years, and 11–15 years, occupational status, industry affiliation, year, and region of residence in all regressions. *Mean dependent variable* is the average of the dependent variable (employment) over the period 2006–2015. All regressions were estimated by an individual fixed effects specified in Equation (1). ***p<0.01, **p<0.05, *p<0.1.

Table 4
The effect of pain on earnings.

	Total	Mild	Severe
All			
Pain	−0.029***	−0.021**	−0.044***
	(0.005)	(0.009)	(0.012)
Constant	11.929***	12.205***	12.504***
	(0.288)	(0.118)	(0.129)
Observations	14,220	5240	2629
R-squared	0.200	0.250	0.216
Mean dep. var.	252,195.89	254,350.28	245,069.40
Individuals	2532	1023	461
Men			
Pain	−0.039*** (0.007)	−0.037*** (0.012)	−0.073*** (0.016)
Constant	11.928***	12.316***	12.344***
	(0.290)	(0.131)	(0.138)
Observations	8254	3139	1508
R-squared	0.179	0.247	0.228
Mean dep. var.	266,634.89	270,364.27	263,370.76
Individuals	1429	590	256
Women			
Pain	−0.017**	0.001	−0.015
	(0.008)	(0.014)	(0.017)
Constant	12.409*** (0.095)	12.124*** (0.115)	12.431*** (0.242)
Observations	5966	2101	1121
R-squared	0.262	0.301 2	0.259
Mean dep. var.	232,219.44	230,424.57	220,449.91
Individuals	1103	433	205

We controlled for educational attainment, marital status and presence of children aged 0–3 years, 4–6 years, 7–10 years, and 11–15 years, occupational status, industry affiliation, year, and region of residence in all regressions. *Mean dependent variable* is the average of the dependent variable (annual earnings) over the period 2006–2015. All regressions were estimated by an individual fixed effects specified in Equation (1). ***p<0.01, **p<0.05, *p<0.1.

Table 5
The effect of pain on social welfare benefits.

Variables	(1)	(2)	(3)	(4)
	Sickness	Sickness if employed.	Retirement	Unemployment
All				
Pain	0.080***	0.175***	0.006***	−0.005**
	(0.003)	(0.008)	(0.002)	(0.002)
Constant	0.053***	−0.029	0.658***	0.050***
	(0.016)	(0.072)	(0.010)	(0.011)
Observations	53,657	15,891	53,657	53,657
R-squared	0.018	0.042	0.013	0.006
Mean dep. var.	0.086	0.165	0.640	0.034
No. individuals	6899	2756	6899	6899
Men				
Pain	0.083***	0.182***	0.008***	−0.004
	(0.004)	(0.010)	(0.003)	(0.003)
Constant	0.073***	−0.101	0.609***	0.025*
	(0.020)	(0.087)	(0.014)	(0.014)
Observations	29,142	9365	29,142	29,142
R-squared	0.019	0.050	0.012	0.007
Mean dep. var.	0.075	0.136	0.613	0.034
No. individuals	3813	1572	3813	3813
Women				
Pain	0.077***	0.165***	0.003	−0.006**
	(0.005)	(0.013)	(0.003)	(0.003)
Constant	0.027	−0.003	0.716***	0.072***
	(0.025)	(0.126)	(0.016)	(0.016)
Observations	24,515	6526	24,515	24,515
R-squared	0.021	0.040	0.018	0.010
Mean dep. var.	0.100	0.207	0.672	0.034
No. individuals	3086	1184	3086	3086

We controlled for educational attainment, marital status and presence of children aged 0–3 years, 4–6 years, 7–10 years, and 11–15 years, occupational status, industry affiliation, year, and region of residence in all regressions. *Mean dependent variable* is the average of the dependent variable over the period 2006–2015. All regressions were estimated by an individual fixed effects specified in Equation (1). ***p<0.01, **p<0.05, *p<0.1.

among individuals with CP, compared to those without pain (Table 5). Although it is possible to be on sickness leave while being registered as unemployed in Sweden, individuals who receive the benefits are employed predominantly. We therefore re-estimated the effect of pain on sickness leave conditioned on employment with at least 100,000SEK annual earnings, resulting in a larger association between pain and sickness leave (106%, Table 5, Column 2). Further, we found that pain is marginally associated with an increased likelihood of disability pension (1%) for persons with CP, and reduced the likelihood of unemployment benefits by 15%.

Discussion

This study is one of only a few on the association between pain and labor market outcomes in adults with CP. We found a pain prevalence of 38% based on pain diagnoses and prescribed pain medication dispensed. We find that the prevalence of pain is higher among women than men similar to previous studies.[28,29] The association between pain and employment and earnings vary across severity, with relatively larger effect among persons with severe CP. In relative terms, we found a 7–12% reduction in employment associated with pain, and 2–8% for earnings if employed. The estimate for earnings from employment might be considered a lower bound measure, as individuals who have quit working due to pain are excluded from the analysis. It must also be noted however that it is possible that employment/earnings might be already limited by motor and cognitive impairments, especially among those with severe CP.[5] The sensitivity analysis of our results confirms the negative association between pain and the labor market outcomes of individuals with CP although the association is sensitive to the income threshold applied.

Our estimate of pain prevalence is substantially lower than the prevalence based on self-reported pain from CPUP, even though the trends with higher pain prevalence in women and in those with severe CP are similar.[15] The current study has measured pain based on medical sources, which is expected to explain a large part of the difference in prevalence compared to self-reported pain. Only a small percentage of adults with CP seek medical care for pain[19,30] and therefore the prevalence of pain is likely to be underestimated using administrative data on diagnoses. It is also possible that when individuals with CP do seek care, pain will not be recorded as a diagnosis as other diagnoses are given precedence. However, pain medication has been shown to be a valid proxy for experienced pain among persons with CP.[31]

Thus, it is likely that our sample includes those with more severe pain, requiring medical attention and/or pain prescription. Our sample might exclude those who have had pain the longest and who have long given up on seeking help for their pain as they have found it ineffective in the past. Rovner[28] reports that women are more likely to seek medical care for pain and present pain in more body sites than men. Thus, it is also possible that men may underreport pain in our sample. The difference between men and women reported in this study could potentially be explained by the differences in likelihood to report pain. Further, if men are less likely to report pain, it is possible that the actual magnitudes of associations are larger than those estimated in the current study and the results should be interpreted with this in mind.

Our results are based on the individual fixed effects model, which relies on variation within individuals across time while controlling for time-invariant confounders between individuals. As expected, we find that pain is associated with adverse labor outcomes among persons with CP, similar to prior studies on the labor market consequences of ill health.[11,32,33] Finally, we find that the negative association between pain and employment and earnings of persons with CP may go through absenteeism from work due to

sickness and disability pension. The relationship between pain and receipt of unemployment benefits might reflect the fact that individuals with CP are likely to be outside of the labor force and might be receiving disability pensions instead of unemployment benefits.

The results of the current study also provide evidence of the potential health-related pathways through which CP may affect labor market outcomes. Prior studies have shown a substantial negative association between CP and general labor market outcomes.[6–8] Pain might increase psychological distress and functional impairments[34,35] associated with CP, thereby reducing the well-being and labor market participation of individuals with CP. Pain may also explain the variations in labor market outcomes of individuals with CP. Individuals with CP who experienced pain were found to have increased absence from work due to sickness compared to those without pain. Such disruptions might be expected to negatively affect employment and earnings.

This study contributes to the extensive literature on labor market consequences of disabilities in several ways. First, while most earlier studies have examined the labor market differentials between persons with disabilities and a control group without disabilities, very few have investigated potential differences within the group with disabilities. In this paper, we find that pain, a common secondary condition of CP, contributes to differences in employment and earnings among persons with CP, indicating the importance of pain management and prevention. Further, we explore heterogeneity within the CP population along with severity.

Second, previous studies are generally limited in terms of small sample sizes and use methods that do not account for time-invariant unobserved individual characteristics. The current study contributes by using a large, nationally representative, register-based data sample, and employing an individual fixed effects approach that minimizes the influence of time-invariant unobservable factors that affect both pain and labor market outcomes. Though we do not assume a causal interpretation of our results, the individual fixed-effects estimation may be seen as an improvement over the standard ordinary least squares and logistic regressions in prior studies, as fixed-effect estimation accounts for time-invariant individual characteristics. Third, previous studies have measured pain based on self-reported incidence. The use of administrative registers enables us to obtain information on pain based on diagnoses and prescribed medication. However, this approach is not without its own challenges, and we consider this a compliment to studies using self-reported pain information.

Our results raise questions about access to pain medication for persons with CP in light of recent efforts to constrain access to some types of pain medication in order to address illicit substance use. Further, the expansion of access to recreational drugs may have implications for the pain management options available to persons with CP. These issues are not considered relevant in the Swedish setting as recreational drugs are not legal and access to pain medication requires a prescription by a medical doctor. Sweden has not experienced a crisis of the illicit use of opioid medication. As such, a tightening of access to opioid medications may not affect pain management options for persons with CP since access to these medications are already tightly controlled.

Limitations

Some limitations to this study should be noted. Pain is subjective and there are numerous different types of pain. In this study, a number of different types of pain were collapsed into one pain variable. It would be interesting to specifically delineate the type of pain that interferes with labor market participation in future research. Also, our pain variable captures both CP-related and non-CP-related pain. It will be important in future studies to investigate if the association between pain and labor outcomes differs between CP and non-CP-related pain. Further, our definition of pain does not distinguish between persons with chronic pain and those with infrequent pain. The effect of pain may differ between infrequent and chronic pain among persons with CP, which is left for future studies to explore. CP is associated with several comorbidities and secondary conditions in addition to pain that may in and of themselves interfere with work abilities. Comorbidities and secondary conditions such as cognitive challenges, epilepsy, communication difficulties, and fatigue should be specifically investigated in future studies.

Our classification of CP severity was based on gross motor function levels (GMFCS) and, where missing, CP subtype. Previous studies have found that some CP subtypes are strongly correlated with motor function, although the relationship is not straightforward for all CP subtypes. It is therefore possible that severity in the current study is misclassified for some individuals and the results based on severity should be interpreted with caution. Further, the estimates based on CP severity may be unrepresentative of CP in Sweden as the sample is reduced as it is not possible to assume severity for several CP subtypes. That is, persons with spastic diplegia who did not have a diagnosis of hemiplegia or tetraplegia, and those with unspecific subtypes are to a large extent missing from the analyses stratified on severity. In addition, there are other ways to measure severity of CP as the Manual Ability Classification System (MACS) and Communication Function Classification Systems (CFCS). Our results might therefore be sensitive to the choice of severity measure.

Finally, our estimates are based solely on within-individual variations in pain medication and diagnoses. As such, persons who do not have variations in pain diagnoses and medication are not accounted for. Our results may therefore be conservative estimates of the association between pain and labor market outcomes.

Conclusion

It is well-known that pain associated with CP increases with age and that pain that is not successfully managed tends to become chronic. Pain treatment and management are clearly important to improve quality of life and pain and should be screened from an early age and actively managed throughout the life course. However, our findings also indicate that pain reduction in adults with CP holds promise to enable more individuals to stay active in the labor force. Staying employed could also help maintain social participation and a feeling of belonging. Research continues to show that even individuals with CP who have undergone education and training are still more likely to be unemployed than those who do not have CP.[36] It is important to ensure that individuals with CP who manage to enter the labor market do not have to leave their job due to pain.

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Conflicts of interest

The authors have no conflict of interest to declare.

Availability of data and material

Deidentified individual participant data will not be made available by the authors but are available from the register holders after typical application procedures.

Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dhjo.2023.101479.

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