The Labour Market Consequences of Disability: Types, Severity, Persistence, and Onset.

By Robert Millard*

May 9, 2022

Click Here for Latest Draft of Working Paper

This paper analyzes the vast variation in labour market outcomes across disabilities by representing disability as a bundle of characteristics. Rich with information on the characteristics of a disabling condition, I use the Participation and Activity Limitation Survey to compare the relative importance of each characteristic and their interactions on employment, wages, hours worked, and annual employment income. The set of disability characteristics includes the type of activity limitation, number of limitations, timing of onset, severity, and duration. I find substantial cross-sectional variation in labour supply, wages, and annual earnings across the activity limitations. Severity is most predictive of labour supply, and persistence, or the duration of disability, is predictive of all outcomes. Cognitive types of disabilities are more impact on wages than physical. Lastly, I find the timing of onset to have important implications for wages and annual income. My results are consistent with disabilities that onset by age eighteen, inflicting additional wage penalties through reduced skill accumulation.

*Ph.D. Candidate, The University of Western Ontario. I would like to thank Dr. Christopher Robinson, Dr. Audra Bowlus, Dr. Todd Stinebrickner, and Dr. Nirav Mehta for their supervision of this project and helpful feedback and comments. Also, I would like to thank the faculty at the University of Western Ontario and participants at the 2019 Annual Canadian Economics Association Conference for their feedback and comments.

1 Introduction

Individuals affected by disability are less attached to the labour force, have lower earnings, and experience greater income risk.[1] Disability rates have been rising over the past few decades in much of the developed world.[2] Understanding the variation in labour market outcomes across disabilities is policy relevant, as the increasing prevalence of disability places an increasing burden on public programs (Autor and Duggan 2006). This paper provides insight into this variation of labour market outcomes across disabilities by disaggregating disability into a bundle of characteristics.

Disability results from a variety of medical conditions that can vastly differ in physiology and functional impairment. Representing disability as a bundle of underlying characteristics gives a tractable way to summarize and study a wide range of disabling conditions.[3] I distinguish conditions using measures of severity, its duration or persistence, the type of functional limitation, number of functional limitations, and timing of onset. Using this representation, I compare the relative importance of these characteristics, and their interactions, within a unified framework.

My first contribution is to jointly analyze which disability characteristics are most predictive and impactful on hourly wage, employment, hours worked, and annual earnings. I use the 2001 and 2006 Participation and Activity Limitation Survey (PALS), Canadian cross-sectional datasets with rich measures of the characteristics of disability, in conjunction with labour market outcomes and incomes. Many datasets used for economic research on disability are often designed for non-disabled individuals. Consequently, these data often suffer from small disability sample sizes, especially when conditioning on characteristics. Data with reasonably sized samples of people with disabilities and detail on the characteristics of disability often lack detailed information on the labour market or income.[4] PALS overcomes these data issues and is well suited to analyze the labour market consequences of the disaggregated set of disability characteristics. Moreover, a unified framework alleviates concerns with making comparisons across studies or alternate datasets, which can exacerbate errors due to differences in the measurement of disability or sampling.

[1] Burkhauser et al. 1993, Bound and Burkhauser 1999, Haveman and Wolfe 2000, Meyer and Mok 2019.

[2] Adults aged 25-64 with a disability in Canada have 20% less employment relative to non-disabled adults and the employed earn between 10-30% less annually than workers without a disability. The percentage of Canadians ages 15 and over with a disability rose from 12.4% in 2001 to 22.3% in 2017, and this trend is likely to continue with an aging population. This change is also related to the evolution of the definition of disability and changes in reporting behaviour. For more details on the economic position of Canadians with disabilities see Morris et al. (2017), and Statistics Canada (2001).

[3] This idea is analogous to representing differentiated products as bundles of characteristics as is often done in industrial organization models of demand (Berry, Levinsohn, and Pakes 1995), or modelling human capital as a bundle of skills in labour models (Yamaguchi 2012).

[4] A notable exception is the Health and Retirement Study, which has substantial information on the characteristics of health conditions and labour market outcomes. However, these data focus on individuals over the age of 50.

Disability is measured as a single binary indicator of status in much empirical literature.[5] This approach averages out the impact across all conditions, conflating variation in its effect. More granular representations will capture variation by distinguishing disability based on some notion of the magnitude or frequency of its impact, either categorically or as a continuous index.[6] Moreover, it's often preferable to separate disabilities based on similarity in functional or activity limitations, such as physical or cognitive.[7] Additionally, the implication of when a disability occurs matters when considering the individual's life cycle. For instance, a permanent disability at birth will impact the individual throughout their life, whereas a disability that occurs during retirement will not affect labour market behaviour.[8] A Better understanding of the importance of the characteristics and their correlation structure can inform empirical researchers with limited data on the details of disability. To the best of my knowledge, this paper is the first to study a full set of characteristics in a unified framework.

In these exercises, I find substantial heterogeneity in the effects of disability across the characteristics. This heterogeneity is lost when aggregating the measures of disability over these characteristics. Severity is most important for the intensive and extensive margin of labour supply. Cognitive types and disabilities that are early-onset show the greatest penalties to wages and employment income. This result is consistent with a higher market value to cognitive skills and with early-onset disability having the added effect of impacting human capital production at key periods of development. Persistence has significant implications for all outcomes, motivating the importance of research on the dynamics of the effects of disability.

My second contribution explores the dimension of timing. PALS has a relatively large sample of individuals whose disability onset occurred before age 19, defined early-onset, which has advantages to precision when comparing across this margin.[9] Individuals with an early-onset disability earn approximately 15% less in hourly wages and 22% less in annual employment income relative to late-onset. A disability occurring before the completion of formal education can affect a person's skill development and influence their human capital

[5]For example see Burkhauser et al. (1993), Acemoglu and Angrist (2001), Baldwin and Johnson (2006), Campolieti (2012), Ameri et al. (2018).

[6]For instance, Stern (1989) builds an index using questions on self-reported health and limitation., Low and Pistaferri (2015) distinguish mild and severe disabilities, Charles (2003) partitions those with disabilities based on the chronicity of the disability, Meyer and Mok (2018) partition those with a disability by both chronicity and severity.

[7]For instance, Lundbourg (2014) has medical reports on specific diseases or physiological conditions, and Mori (2016) summarizes conditions as being either physical or cognitive.

[8]Examples of studies about the timing of onset include Charles (2003), Hollenbeck and Kimmel (2008), and Lamichhane et al. (2013).

[9]To my knowledge, Hollenbeck and Kimmel (2008) and Limichhane (2013) are the only studies that include individuals with both early and late onset disabilities. Limichhane collects unique data from Nepal to estimate the determinants of wages. He includes dummy variables for age ranges of onset. He finds the earlier the onset, the less detrimental a disability is to wages. Hollenbeck and Kimmel use US data and separately estimate Mincer style wage regressions for those without disabilities, those whose disability onset before 25, and those whose disability onset after. They find the coefficient on schooling is largest for the late onset individuals. Unfortunately, both studies face severe data limitations in their disabled samples and are not able to explore this dimension further

at this critical period of investment.[10] This ladder effect is reflected in differentials between observationally similar individuals who differ in the timing of onset. I partition my disabled sample into early and late-onset and compare the determinants of wages, hours, and annual employment incomes of each group. I find that cognitive and concurrent are more detrimental to wages for early-onset. Cognitive types have a more significant impact on hours worked for late-onset. Outcomes for individuals with early-onset disabilities improve over time, whereas the negative effects of a disability tend to get worse for late-onset. This suggests that early-onset is better able to adapt to or accommodate their disability.

The remainder of my paper is structured as follows. Section 2 motivates the set of disability characteristics. Section 3 describes the dataset and disability measures used for this analysis. Section 4 explores the difference across and within groups of disabilities as defined by the characteristics, and analyses their joint impact on employment, weekly hours, hourly wages, and employment income. Section 5 partitions my sample into early and late onset and compares the different effect of the other characteristics across these two groups. Section 6 concludes.

2 The Characteristics of a Disability and Why they Matter

Disability impairs functions, limiting the set of productive tasks someone can partake in, thus directly linking to human capital. In a standard framework, an individual's wages are set according to their marginal product, linking human capital to the returns to work. Hence, disability is directly linked to wages, labour supply, and total employment income through its connection to human capital.[11] This intuition is convenient to motivate the relevance of the set of characteristics specified in this analysis.

The severity of a disability represents the magnitude of its impact on human capital. The onset of a more severe disability will cause a greater decline in the stock of human capital and subsequent productivity. The persistence of a disability describes the duration of time a disability has been present. On its own, the more persistent a disability, the longer it affects productivity (i.e. the stock of human capital) and can also have dynamic implications of affecting the accumulation of human capital.[12]

The type of disability describes the functional impairment and kinds of activities that are limited. In

[10] Hollenbeck and Kimmel 2008, Currie 2009, Limichhane 2013, Mori 2016.

[11] For instance, Grossman (2017) models health capital as affecting the amount of productive time, Hanushek and Woessmann (2008) discuss a model of HC inputs that depend on health among other important determinants, and Mori (2016) models productivity as the result complimentary stocks of multidimensional health capital and human capital.

[12] The sign on the effect of persistence can go either way depending on if the disability becomes more or less limiting, or if one can adapt to it. Related studies have found conflicting signs of the effect of persistence depending on its interactions with the other characteristics of disability. For example, see Charles (2003), Lamichhane et al. (2013), Mori (2016), and Meyer and Mok (2019).

the context of multi-dimensional human capital, types of disabilities will differ in the dimensions of human capital that are impacted. For instance, the onset of a physical disability, such as paralyzation below the waist, negatively affects the stock and accumulation of physical capital.[13] Literature on the economic effects of different "types" of health conditions or disabilities find substantial heterogeneity in their impact on outcomes. These studies often find disabilities with a degree of cognitive impairment are more detrimental to economic welfare than physical or sensory disabilities.[14]

Finally, timing refers to the age at which the disability onset occurs. Young people have higher lifetime returns to their human capital and spend more time investing in their human capital (Ben-Porath 1967). This insight suggests an important distinction between a disability that occurs during times of high human capital investment, i.e., during formal schooling, and during times of high earning when education investments are completed. Studies that consider timing typically restrict their sample to include only a sample of individuals whose onset occurred before labor market entry or a sample whose onset occurred after labour market entry.[15]

3 Data: The Participation and Activity Limitation Survey

I use PALS to study the characteristics of disability. PALS is a Canadian repeated cross-sectional survey of individuals flagged for disability in the 2001 or 2006 long-form censuses. It was designed to provide detailed information on the characteristics of disability and the experiences and barriers an individual with a disability faces in daily life. An advantage of PALS is the inclusion of modules on education, the labour market, and census information, which contains various incomes.

3.1 Measuring and Defining Disability

PALS adopts its definition of disability from the International Classification of Functioning (IFC) of the World Health Organization. The IFC defines disability as a multidimensional concept that relates body functions and structures to activities and limitations to these activities, social participation in all aspects of life, and other environmental factors that influence these relationships. PALS emphasizes the characteristics of disability as they relate directly to the activity limitations they induce. The questions on health and limitations are self-reported in PALS.

[13] However, physical limitations can positively affect investment in, and accumulation of, the now relatively more productive cognitive human capital (Mori 2016).

[14] See Case et al. (2005), Lundborg (2014), and Mori (2016).

[15] Charles (2003), Case et al. (2005), Currie (2010), Lundborg (2014), Mori (2016), and Meyer and Mok (2018).

To identify an individual as disabled, PALS uses a 2-stage screening process. The first stage consists of identifying those responding positively to disability screening from the long-form census.[16] This is ultimately how PALS targets its desired population of interest. The second stage involves additional screening questions included in PALS. If an individual is (1) flagged for disability in the census and (2) responds positively to the disability filter questions in PALS or responds positively to the detailed questions on activity limitations in PALS, then are be flagged as disabled.[17]

Using self-reported functional limitations to measure disability is not without its share of criticism, as are all other methods of defining disability.[18] Opponents of using self-reported disability are often concerned with the endogeneity of reporting and overreporting. However, it has been found that self-reported disability is close to exogenous, may actually underrepresent the extent disabled population, and may even underestimate the true impact of disability on relevant labor market outcomes (Stern 1989, Bound and Burkhauser 1999, Burkhauser et al. 2002). Using specific health questions, such as the activity limitation screening questions in PALS, rather than directly asking about disability status can further reduce the concerns associated with self-reports being endogenous (Bound and Burkhauser 1999). The combination of this evidence provides sufficient evidence to validate the use of self-reported disability, as defined by specific questions on functional limitations.

3.2 Measuring the Characteristics of Disability

PALS flags individuals with different types of disabilities based on their responses to a series of questions about limitations to specific activities of daily living. If the respondent reports positively, they are flagged for the respective functional limitation. PALS distinguishes 10 categories of disaggregated functional limitations: Hearing, Seeing, Communication, Mobility, Agility, Pain, Learning, Memory, Developmental, and Psychological. I discard hearing and seeing for my analysis and group the remaining disabilities into either physical or cognitive.[19] Physical disabilities include mobility, agility, and pain limitations. Cognitive

[16] Census questions are; "Does this person have any difficulty hearing, seeing, communicating, walking, climbing stairs, bending, learning or doing any similar activities?" and "Does a physical condition or mental condition or health problem reduce the amount or the kind of activity this person can do? at home? at work or school? in other activities, for example, transportation or leisure?" Responses can be "No", "Yes often", or "Yes sometimes". The individual is flagged if responding positively to any of these questions.

[17] Aggregate disability screening questions are same as the census. A specific activity limitation question could be "How much difficulty do you have hearing what is said in a telephone conversation with at least 3 other people?" The individual is flagged if responding "some difficulty," "a lot of difficulty," or "I cannot hear." The sample of disabled individuals in PALS is therefore necessarily a subset of the sample identified as disabled in the Canadian Long Form Census.

[18] For instance, using insurance receipts to define the disabled has been found to underrepresent the population of individuals who are limited enough in the labor market to be classified as "disabled" (Bound 1989).

[19] Hearing and seeing limitations are sometimes grouped into a "sensory" category. However, I opted to remove this group due to limited sample sizes. Grouping of the other functional limitations is based on a simple correlation analysis.

disabilities include learning, memory, communication, developmental, and psychological limitations. Many disabling conditions cause functional impairments in multiple areas. I define a concurrent group, which consists of individuals flagged for both physical and cognitive limitations, giving me three mutually exclusive groups.

Severity is measured in levels that are derived from the responses to the questions on specific activity limitations.[20] The severity levels are mild, moderate, severe, or very severe. To improve tractability and improve predictive power, I create an indicator equalling one if the reported level is severe or very severe, and zero otherwise.[21]

The measure of persistence is derived from a retrospective question asking at what age the activity limitation began. I construct a continuous variable for the number of years limited, which equals an individual's current age minus the age at which their disability started. Inference on this characteristic tells how conditions may have changed between onset and measurement (e.g., if becoming more or less impactful on outcomes). I also create a binary measure of persistence, which equals one if an individual has been disabled for ten or more years. The cutoff of ten years is based on Meyer and Mok (2019) and Millard (2022), who find the longitudinal change in income and employment following disability onset to be nonlinear and to flattens out by approximately ten years after onset.

Lastly, the timing of onset is derived from the same retrospective question used to measure persistence. The response to this question is used to construct an indicator variable for early-onset. If the age of limitation is reported to occur before age 19, then the individual is flagged as early-onset.

3.3 My Sample

I consider a sample of white individuals aged 25-55 who are not retired. PALS excludes those living on First Nation reserves, in institutional collectives and military bases or vessels. After these restrictions, my sample has 6720 individuals with a disability and a 63,720 observation comparison sample of individuals who are not disabled.[22]

[20] Points are assigned to the responses to questions about specific functional limitations. For example, "completely unable" is assigned 3 points, "a lot of difficulty" is assigned 2 points, "some difficulty" is assigned 1 point and "no difficulty" is assigned zero points. A severity score is built from the points from all questions on the functional limitations associated with a specific type of disability. The levels of severity are derived using this score.

[21] Separating disability into more and less sever is common in related research. For example, Low and Pistaferri (2015)

[22] These counts are rounded to a base 10 as required in the RDC vetting guidelines. PALS was accessed via the Statistics Canada Research and Data Center (RDC) at Western University. The RDC requires all descriptive statistics are rounded and weighted when public-ally reported. For instance, annual employment income, which is used to construct hourly wages, was rounded to multiples of ten. Any output that includes confidential data from the RDC must adhere to these restrictions and be vetted before being approved for public release.

3.4 Descriptive Statistics Across Disability Characteristics

Table 1: Means and Proportion of Covariates by Group.

	Non-Disabled	Disabled	Types			Timing		Persistence		Severity	
			Physical	Cognitive	Concurrent	Late-Onset	Early-Onset	<10 Years	>10 Years	Non-Severe	Severe
Age	40.2	43.4	44.3	38.5	42.6	44.9	38.7	43.2	43.6	43	44.1
	(8.2)	(8.1)	(7.8)	(8.8)	(8.2)	(7.3)	(8.8)	(8.1)	(8.2)	(8.3)	(7.7)
Female	50.8	51.9	50.9	34	56.2	51.8	52.1	52.8	51.3	50.4	54.5
Married	58.3	54.4	61.1	37.5	45.6	60.3	35.6	58.5	51.6	58.2	47.7
High School Dropout	15.7	24.8	20.8	32.3	30.3	22.9	30.7	22.8	26.1	19.7	33.5
High School	24.6	24.1	24.2	20.5	24.5	24.4	23.2	23.2	24.7	25.1	22.5
Post-Secondary	59.7	51.1	55	47.1	45.2	52.7	46	54	49.2	55.2	44.1
Fraction Employed	91.3	72.5	82.7	75.2	55.3	73.4	69.7	78.3	68.7	84.1	52.6
Conditional on Employed											
Weekly Hours	41	38.3	39.6	36.5	35.5	38.7	37.1	39	37.7	39.2	35.8
	(12.8)	(15.1)	(14.6)	(14.4)	(16)	(14.8)	(16)	(13.9)	(15.9)	(14.3)	(16.8)
Hourly Wage	21.6	20.6	21.2	17.9	19.7	21.3	18.2	21.1	20.3	20.3	21.6
	(15.3)	(15.7)	(14.9)	(16)	(17.3)	(15.2)	(17)	(15.3)	(15.9)	(14.2)	(19)
Annual Employment Income	40895.3	33606.7	36555	26510.3	27651.6	35392.2	27608.6	35538.3	32149.4	34895.6	30058.1
	(31265)	(24557.2)	(24809.4)	(23446)	(22722.4)	(24634.3)	(23326.2)	(25289.7)	(23890)	(24552.4)	(24228.4)
Number of Observations[1]	63720	6760	3670	350	2740	5080	1680	2630	4130	3850	2910

Note: Table reports mean of each variable and standard deviations in parentheses where applicable.These summary statistics have been weighted and rounded as required by the RDC. Statistics are weighted to represent the population of all Canadians who fit into my sample criterion.
1. Note: these numbers reflect weighed counts relative to total sample count. Actual counts can not be released under RDC's vetting restrictions. However, actual number of observations for each group are similar in size.

I first compare summary statistics for those with and without a disability, and then analyze the variation within these summary statistics across the characteristics. Table 1. reports the set of demographic variables and labour market outcomes as rows. Demographics include age, sex, marital status, and education.[23] The labour market variables of interest include employment, weekly hours, hourly wages, and annual employment income.[24] The columns report the subgroup conditioned on, and the cells report the mean of the respective demographic or labour market variable for that subgroup.

Individuals with a disability have substantial gaps in their educational attainment relative to non-disabled. They are 9.1 percentage points more likely to drop out of high school and 8.6 percentage points less likely to complete any post-secondary. Only 8.7% of the non-disabled are not employed, 18.8 percentage points less than individuals with a disability. Conditional on employment, the average person with a disability works 2.7 fewer weekly hours, earns $1 less per hour, and brings home $7288 less in annual employment income.

Conditional on disability, columns 3 to 5 contrast the descriptives across types of functional limita-

[23]Education is measured by highest completed certificate. I include 3 categories, where post-secondary includes any completed certificate higher than a high school degree.

[24]Individuals are considered employed if receiving any positive employment income in the respective census year.

tions. Physical disabilities have the smallest gaps in education and labour market outcomes relative to the non-disabled. People with some cognitive impairment are 14.6-16.6 percentage points more likely to drop out of high school and 12.6 to 14.5 percentage points less likely to earn a post-secondary degree relative to non-disabled, depending on physical impairment. Conditional on employment, cognitive disabilities experience the greatest gaps in wages (3.7$/hour) and annual earnings (14,485$/year) relative to non-disabled. Individuals affected by concurrent disabilities, which are characterized by limitations in multiple areas, are the least likely to work. This result is consistent with this group having a smaller set of productive tasks to engage in due to limitations in multiple dimensions.

Columns 6 and 7 partition the disability sample as either late-onset or early-onset. Relative to the non-disabled, the early-onset group is 15 percentage points more likely to drop out of high school and 13.7 percentage points less likely to earn a post-secondary degree. This is consistent with early-onset disabilities impacting the development and returns to productive skills during compulsory schooling and limiting the returns to post-secondary.[25] Consequently, early-onset individuals have much greater discrepancies in hourly wages and annual employment income relative to late-onset, $3.4/hour and $13,287/year less than non-disabled, respectively.

Last, columns 8 and 9 partition disabilities into those present for more or less than ten years, to highlight differences by persistence. The final columns distinguish severe from non-severe disabilities. Labour market outcomes tend to be worse for persistent disabilities, consistent with the negative effects on human capital accumulating over time. Unsurprisingly, more severe disabilities are associated with lower educational attainment, employment, and fewer earnings.

The descriptives in Table 1 highlight large differences in average outcomes across the margins defined by the characteristics. However, there almost certainly exists a correlation structure among the bundle of characteristics. For instance, the self-reported severity of a disability may be related to the presence of multiple limitations or to persistent conditions. To better understand the relationship between characteristics, Table 2 conditions a characteristic in each column and displays the marginal distribution of each other characteristics in rows. Within the disaggregated types of disabilities, physical and concurrent limitations tend to onset late, 84.8% and 66.6%, respectively. Whereas 59.8% of cognitive disabilities are early-onset. 38.7% of concurrent disabilities are severe, which may be due to severity being attributed to having multiple limitations. Almost 80% of people with cognitive limitations have been disabled for more than ten years. Late-onset disabilities are over 60% physical and half of early-onset disabilities are concurrent. Severity is

[25] Education of late onset is interesting as it informs what education levels may put individuals at greater risk to incur a disability in adulthood.

Table 2: Distribution of Characteristics Within Each Other.

	Types			Timing		Persistence		Severity	
	Physical	Cognitve	Concurrent	Late-Onset	Early-Onset	<10 Years	>10 Years	Non-Severe	Severe
Physical	100	0	0	66.1	37.2	69.9	52.1	65	42
Cognitive	0	100	0	2.7	12.8	2.7	6.6	5.7	3.2
Concurrent	0	0	100	31.2	50.1	27.3	41.3	29.3	54.9
Early-Onset	15.2	59.8	33.4	0	100	0.8	39.3	23.2	26.3
Severe	17.9	15.7	38.7	24.4	27.8	24.5	25.7	0	100
>10 Years Disabled	52.9	78.9	69.5	48	98.8	0	100	59.7	61.3

Note: Table reports mean of each variable and standard deviations in parentheses where applicable. These summary statistics have been weighted and rounded according to the requirements of the RDC. Statistics are weighted to represent the population of all Canadians who fit into my sample criterion.

distributed similarly across persistence and early-onset. Severe disabilities tend to be concurrent, whereas non-severe disabilities tend to be physical. Nearly all early-onset disabilities are persistent, and almost all non-persistent disabilities are late-onset, which is due to the construction of these variables.

4 Analysis of Disability Characteristics on Employment, Wages, Hours, and Employment Income

This section estimates models for employment, wages, hours, and annual employment income as functions of the disability characteristics and controls. I linearly project the log of hourly wages, weekly hours, and the log of annual employment income on a full set of interactions of the characteristics to address the underlying correlation within them. I first estimate a specification with the types of disabilities aggregated into a single disability indicator for each dependent variable. I then contrast the findings with estimates from a specification aggregating disability into types of functional limitations. I estimate these models using the entire sample of people with and without disabilities, simplifying the interpretation of the coefficients for the characteristics to be relative to the non-disabled omitted group. The models take the following form,

$$\begin{aligned} Ln(Y_i) =& \beta_1 + \sum_{k=1}^{K} D_i^k \Big(\beta_2^k + \beta_3^k P_i + \beta_4^k S_i + \beta_5^k E_i \\ & + \beta_6^k P_i S_i + \beta_7^k S_i E_i + \beta_8^k P_i E_i + \beta_9^k P_i S_i E_i \Big) + \boldsymbol{\beta_{10}} \boldsymbol{X}_i + c\lambda_i + e_i. \end{aligned}$$

Y_i corresponds to the dependent variable of interest. K=1 for the specification that aggregates types and K=3 otherwise.[26] P_i, S_i, E_i represent the binary measures of persistence, severity, and early-onset, respectively. β_2 captures the average effect of having a disability, or a specific type of limitation, relative to non-disabled. β_3, β_4, and β_5 capture the average additional effect of the disability being persistent, severe, or early-onset, respectively. The coefficients on the interaction terms capture any additional effect that might arise from having two or three characteristics simultaneously.[27] $\boldsymbol{X_i}$ includes controls for cohort and sex in all specifications, and controls for education and labour market experience in some specifications.[28]

Table 3: Probit Estimates of the Effect of the Disability Characteristics on Employment.

Dependent Variable:	Employment
Physical	-0.002
	(-0.0082)
Severe	-0.0273***
	(-0.0105)
Early	0.0027
	(-0.0038)
Both Early and Severe	-0.0145**
	(-0.0069)
Cognitive	-0.0205
	(-0.0129)
Severe	-0.0785***
	(-0.0218)
Early	-0.0085
	(-0.0054)
Both Early and Severe	-0.0042
	(-0.0088)
Concurrent	-0.0229**
	(-0.0097)
Severe	-0.0431***
	(-0.0083)
Early	-0.0036
	(-0.0055)
Both Early and Severe	-0.0181***
	(-0.0038)
R^2	0.1139
N	70440

Note: Standard errors in parentheses. * for P<0.1, ** for P<0.05,*** for P<0.01. See appendix for estimates of control variables.

In some specifications, I control for selection into employment to account for censorship bias resulting from not observing wages for individuals that do not work. The term λ_i represents the inverse of the mill's ratio, derived from a probit estimation on employment, which is the standard Heckman correction procedure (Heckman 1979). The first stage of the probit recovers the predicted probability of employment conditional

[26] $k \in \{1, 2, 3\}$ maps to {physical, cognitive, and concurrent}

[27] For example, the effect of a early severe disability is $\beta_2 + \beta_4 + \beta_5 + \beta_7$.

[28] I include a dummy variable for high school drop out and an dummy variable for any post secondary completion. Hence the omitted group is high school. Labour market experience equals age minus years of school - 6.

on the disability characteristics, various controls, and exclusion restrictions. I control for cohort, sex, and type of disability interacted with early, severity, and the number of years limited. My exclusion restrictions include marital status, number of children, presence of children under 6 years old, dummy variables for receipt of outside sources of income from government assistance or other disability transfers, and the cost of transportation.[29]

The descriptive analysis finds differences in employment rates across the characteristics of disability. Table 3 reports estimates for severity, early-onset, and their interaction across types of function limitations from the first stage model for employment. These variables interact with a continuous measure of the number of years limited.[30] This model also controls for sex, age, and exclusion restrictions.[31] All types of disability have significant negative impacts on employment when they are severe. Also, concurrent disabilities have significant negative penalties for employment. Early-onset significantly affects employment when it is also severe, and the disability has a physical impairment.

Estimates of the disability characteristics from models for wages, hours, and annual employment income are displayed in Table 4. The dependent variable for the first four columns is the log of hourly wage. The second and fourth columns include additional controls and correct for selection.[32] The analysis for hourly wages is motivated by the effect of a disability on productivity, assuming wages are a noisy measure of an individual's underlying productivity. The first two columns pertain to a specification with disability status aggregated across the types of limitations. Disability, regardless of severity, persistence, or timing of onset, comes with 8% percentage less hourly wages.[33] The implied percentage reduction in wages is approximately 55% for individuals affected by an early onset disability, which is amplified when combined with severity or persistence. This is consistent with the early-onset disabilities negatively impacting human capital production at crucial investment times and increasingly throughout working life. There are no substantial differences in the estimates when controlling for experience, education, and selection into employment.

Shifting attention to the third and fourth columns highlights the heterogeneity in the effects of persistence, severity, and timing of onset across the types of functional limitations. Physical disabilities inflict a significant wage penalty. However, the additional effect from the other characteristics is insignificant unless they are

[29]The outside sources of income include disability insurance from the Canadian Pension Plan Disability, from private disability insurance, workers compensations, and provincial social assistance transfers. These programs generally have limitations on employment for beneficiaries, which can result in termination of benefits. To exploit differences in programs between 2001 and 2006, I interact this variable with a dummy for the survey year. The exclusion argument is that receipt of transfer benefits predicts whether someone will be employed or not, but not wages assuming wages reflect productivity.

[30]Using the binary measure of persistence resulted in dropped observations from some cells having no variation in employment.

[31]The full set of estimates from the first stage can be found in Appendix 2.

[32]Estimates for the controls are found in Appendix 2.

[33]This implied percentage is obtained from $exp(\beta) - 1$

Table 4: Linear Projection of the Log of Hourly Wages, Weekly Hours, and Log of Annual Employment Income on Disability Characteristics

Dependent Variable:		Log Hourly Wages				Hours				Log Annual Employment Income			
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Disability		-0.0846**	-0.0718**			-1.1536*	-0.7916			-0.1653***	-0.1249***		
		(-0.0355)	(-0.035)			(-0.5894)	(-0.6015)			(-0.0419)	(-0.0411)		
	Persistent	-0.0686*	-0.051			-1.8247**	-1.3331*			-0.1874***	-0.1333***		
		(-0.0357)	(-0.0386)			(-0.7497)	(-0.7587)			(-0.0375)	(-0.0377)		
	Severe	0.0377	0.0988			-3.4714***	-2.5723***			-0.2026**	-0.0684		
		(-0.0994)	(-0.1207)			(-0.8204)	(-0.8617)			(-0.1023)	(-0.1232)		
	Both Severe and Persistent	-0.0644	-0.0068			-5.9038***	-3.8728***			-0.4244***	-0.2196***		
		(-0.068)	(-0.0729)			(-1.3867)	(-1.4334)			(-0.0865)	(-0.081)		
	Early	-0.7405*	-0.7195*			7.5446	8.0177			-0.8087**	-0.7638*		
		(-0.3938)	(-0.3984)			(-7.7123)	(-7.7597)			(-0.3968)	(-0.3999)		
	Both Early and Persistent	-0.1611***	-0.1431***			-3.0982***	-2.7181***			-0.2686***	-0.2220***		
		(-0.0445)	(-0.043)			(-0.6994)	(-0.7015)			(-0.0508)	(-0.0491)		
	Both Early and Severe	-0.3909***	-0.4571***			0.0566	-0.0058			-0.4938***	-0.5694***		
		(-0.0103)	(-0.0117)			(-0.1665)	(-0.1964)			(-0.0127)	(-0.0141)		
	Early Severe and Persistent	-0.4661***	-0.3673***			-5.1358**	-3.3522			-0.9077***	-0.6701***		
		(-0.1461)	(-0.139)			(-2.0266)	(-2.159)			(-0.1311)	(-0.1315)		
Physical				-0.0957**	-0.0844**			-0.9987	-0.6857			-0.1607***	-0.1244***
				(-0.0403)	(-0.0394)			(-0.6254)	(-0.6362)			(-0.0467)	(-0.0457)
	Persistent			-0.051	-0.0433			-1.1604	-0.8098			-0.1328***	-0.0971**
				(-0.0396)	(-0.0433)			(-0.8704)	(-0.8718)			(-0.0387)	(-0.0382)
	Severe			0.0972	0.1638			-2.9508***	-2.2007**			-0.0224	0.1129
				(-0.1773)	(-0.2162)			(-1.0352)	(-1.1122)			(-0.1553)	(-0.1951)
	Both Severe and Persistent			0.0801	0.1325			-3.7191*	-2.313			-0.2389**	-0.0784
				(-0.0953)	(-0.1096)			(-2.0711)	(-2.1365)			(-0.0998)	(-0.0995)
	Early			-0.7117	-0.7202			4.7277	5.3099			-0.5052	-0.4812
				(-0.5204)	(-0.5454)			(-4.1377)	(-4.4461)			(-0.5319)	(-0.5288)
	Both Early and Persistent			-0.0478	-0.0517			-2.4659***	-2.3932***			-0.1035*	-0.1033
				(-0.0524)	(-0.0523)			(-0.9185)	(-0.9246)			(-0.062)	(-0.0635)
	Both Early and Severe			-0.3913***	-0.4570***			0.0535	0.0116			-0.4945***	-0.5689***
				(-0.0103)	(-0.0117)			(-0.166)	(-0.1949)			(-0.0126)	(-0.0141)
	Early Severe and Persistent			-0.2381	-0.1933			6.9703	7.9645			-0.2055	-0.0854
				(-0.1503)	(-0.1454)			(-5.8039)	(-5.7942)			(-0.2091)	(-0.197)
Cognitive				0.138	0.1274			-3.2071**	-2.9949**			-0.1321	-0.1235
				(-0.1227)	(-0.1154)			(-1.4435)	(-1.4241)			(-0.1844)	(-0.1844)
	Persistent			-0.3820**	-0.3115*			-10.8185***	-10.0785**			-1.2671***	-1.1313***
				(-0.1853)	(-0.1893)			(-4.0937)	(-4.0444)			(-0.31)	(-0.3165)
	Severe			0.1371	0.0476			-4.2244	-2.5035			0.134	0.1581
				(-0.5574)	(-0.5767)			(-10.6859)	(-9.8449)			(-0.3207)	(-0.4039)
	Both Severe and Persistent			-0.3998**	-0.4671***			1.7068	5.059			-0.8188	-0.6536
				(-0.1567)	(-0.1779)			(-10.2019)	(-10.1028)			(-0.7705)	(-0.7958)
	Early			-0.7960***	-0.5406***			7.2070***	6.8586***			-1.3934***	-1.0903***
				(-0.0273)	(-0.0307)			(-0.4564)	(-0.5144)			(-0.0345)	(-0.0373)
	Both Early and Persistent			-0.5644***	-0.5019***			-3.3466**	-2.7760**			-0.6935***	-0.5790***
				(-0.1461)	(-0.1359)			(-1.3795)	(-1.3923)			(-0.1551)	(-0.1411)
	Both Early and Severe			-	-			-	-			-	-
				-	-			-	-			-	-
	Early Severe and Persistent			-0.3533*	-0.2573			-10.6166***	-9.8275***			-0.8095***	-0.6280***
				(-0.2028)	(-0.1711)			(-3.0608)	(-2.7394)			(-0.2413)	(-0.2226)
Concurrent				-0.0731	-0.0603			-1.6373	-1.1923			-0.2092**	-0.1609*
				(-0.0663)	(-0.0677)			(-2.1856)	(-2.1693)			(-0.1005)	(-0.0928)
	Persistent			-0.0954	-0.0554			-3.4284**	-2.5661*			-0.2501***	-0.1483
				(-0.0838)	(-0.0827)			(-1.3318)	(-1.3472)			(-0.0963)	(-0.1016)
	Severe			-0.0206	0.025			-3.9770***	-3.1184**			-0.3795***	-0.2641***
				(-0.0745)	(-0.0789)			(-1.2823)	(-1.2974)			(-0.0933)	(-0.0969)
	Both Severe and Persistent			-0.1786**	-0.1379			-7.6923***	-5.5470***			-0.5712***	-0.3682***
				(-0.0911)	(-0.0897)			(-1.8725)	(-1.8594)			(-0.1318)	(-0.1244)
	Early			-0.799	-0.7321			13.3918	13.5773			-1.4198***	-1.3522**
				(-0.5726)	(-0.5162)			(-20.614)	(-20.6227)			(-0.521)	(-0.5762)
	Both Early and Persistent			-0.1543**	-0.1242*			-4.3825***	-3.5798**			-0.3662***	-0.2733***
				(-0.0692)	(-0.0672)			(-1.4952)	(-1.4886)			(-0.0814)	(-0.0763)
	Both Early and Severe			-	-			-	-			-	-
				-	-			-	-			-	-
	Early Severe and Persistent			-0.5334***	-0.4361**			-7.2622***	-5.4247**			-1.0835***	-0.8365***
				(-0.1949)	(-0.1866)			(-2.2076)	(-2.3595)			(-0.1624)	(-0.1645)
Additional controls		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Inverse Mills		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
R^2		0.026	0.073	0.027	0.074	0.094	0.095	0.095	0.096	0.084	0.131	0.086	0.133

Note: Standard errors in parentheses. * for P<0.1, ** for P<0.05,*** for P<0.01. See appendix for estimates on control variables.

early-onset and persistent. Cognitive disabilities have substantial negative wages penalties when persistent or early, 20% and 50% respectively. Penalties are amplified when early and severe, resulting in 80 to 85% lower wages. The large decline in average wages for those with cognitive disabilities is consistent with Mori (2016) and Yamaguchi (2012), who find cognitive skills to be priced higher by the labour market. The wage

penalties for early-onset cognitive disabilities are the largest across all characteristics for all types. Concurrent disabilities only matter when they are persistent and either early, severe, or both. This heterogeneity in the effects of the types of disabilities is lost when using an aggregated measure of disability.

Columns five to eight show the same progression of models with the number of hours worked per week as the dependent variable. The specification with aggregated disability status finds workers with a disability work one hour less per week on average. The difference in hours worked when a disability is persistent or severe declines by 1 and 3 hours, respectively. Early disabilities only significantly affect hours when they are also persistent. Persistent and severe disabilities result in the most substantial decline of hours worked, an additional 6 hours less per week. Columns 7 and 8 find that physical disabilities reduce the number of hours worked when severe or both early and severe. Cognitive disability shows 3 fewer hours worked a week, plus 10 fewer when persistent. Unlike wages, early-onset cognitive disabilities result in more hours worked per week. This positive relation is offset when the cognitive disability is early-onset and severe. Concurrent disabilities decrease the number of hours worked only when persistent or severe, and the estimated decline doubles when both severe and persistent (approximately 15 hours less). The magnitude of impact for most characteristics is reduced when correcting for selection into employment.

The final four columns report estimates from models for the log of annual employment income. The effect of disability characteristics on annual employment income is similar to the models for wages but of greater magnitude. Annual employment income combines the effect of disability on both the price and supply of labour. Again, early-onset disabilities come with substantial penalties, resulting in almost 60% lower annual earnings. The penalties jump to 71-89% when combined with persistence, severity, or both. The final two columns again show cognitive disabilities as very impactful when persistent or early-onset. Physical disabilities significantly reduce annual employment income by 11% and have additional penalties when severe. Concurrent types show significant penalties to annual employment income even when not persistent. Otherwise, the magnitude of its effect is similar to cognitive types.

The main takeaway from the statistical analysis of the disability characteristics on wages, hours, and employment income suggests it is important to consider them jointly (when possible) to avoid confounding their effects. Aggregating disabilities across the different types of limitations masks substantial heterogeneity in the ways disability affects these outcomes. The impact of an early-onset disability on hourly wages and annual employment income is considerable.

5 Early, Late, and the Indirect Effect of a Disability

The previous analysis above suggests the distinction between early and late onset disability has large and significant implications for wages and employment income. As briefly discussed in the introduction, this partition based on timing is economically meaningful in the context of human capital. The impact of a disability following onset can be thought of as two effects. The first effect is the direct loss of ability from the condition or drop in the stock of human capital, which I call the direct effect. The onset of a disability may also affect one's productivity indirectly by impacting the development of productive skills, which I call the indirect effect. Education is one of the most important times of human capital investment, so an early-onset disability may also impact human capital through impacting education investment, which was seen to be lower in Table 1.

Separating the sample with disabilities into early and late-onset is useful when considering the indirect effect of a disability. The earnings of both groups will reflect the direct effect of disability. However, when controlling for years limited, the earnings of the early group will also reflect the indirect effect on educational attainment. The difference in wages between early and late-onset disability, which I define as the "early-late gap", measures an upper bound to is part of the indirect effect of a disability. For the final analysis, I discard the non-disabled control group and partition the remaining sample into early and late-onset. I estimate and compare models for hours, wages and employment income for each group, $g \in \{early, late\}$. The models for each dependent variable take the form,

$$y_i = \beta_0^g + \beta_1^g \boldsymbol{X_i} + \beta_2^g \boldsymbol{T_i} + \beta_3^g S_i + \beta_4^g P_i + e_i. \tag{1}$$

The estimates on the other dimensions of disability capture their average effect. I omit physical disabilities, thus $\boldsymbol{T_i}$ includes cognitive and concurrent disabilities. Severity, S_i, is the same measure as above and P is a continuous measure of the number of years limited. $\boldsymbol{X_i}$ controls for cohort, sex, education, and experience.[34] Table 5 shows the results of these regressions for the log of hourly wages, weekly hours, and the log of annual employment income.

First, the estimated R-Squared for early relative to late for each model. The model for wages and employment income explains 19.1% in the variation of wages for early-onset and only 4.7% for late. Similarly, the model for annual employment income accounts for 22.6% of the variation for early and only 13.2% for late. The disability characteristics and other covariates can better explain the variation in wages for those

[34]There was no meaningful difference in these results when controlling for selection into employment.

Table 5. Comparing estimates between Early and Late. Dependent Variable: Ln(Hourly Wage)

Dependent Variable		Ln(Hourly Wage)		Weekly Hours		Ln(Annual Employment Income)	
		Early	Late	Early	Late	Early	Late
Education							
	Post Secondary	0.329***	0.163***	0.610	2.140**	0.309***	0.231***
		(0.083)	(0.058)	(1.609)	(0.914)	(0.109)	(0.065)
	Dropout	-0.157**	0.045	-2.042	2.205	-0.254*	-0.002
		(0.096)	(0.089)	(2.024)	(1.438)	(0.130)	(0.090)
Experience		0.077**	0.012	-0.120	0.091	0.080**	0.030
		(0.035)	(0.017)	(0.42)	(0.280)	(0.038)	(0.022)
Experience^2		-0.002***	-3.3E-4	0.005	-0.003	2.39E-3**	-7.30E-4*
		(0.001)	(3.3E-5)	(0.008)	(0.006)	(0.001)	(4.2E-4)
type							
	Cognitive	-0.345**	-0.028	-3.954**	-5.606***	-0.541***	-0.483**
		(0.113)	(0.116)	(1.987)	(1.975)	(0.128)	(0.188)
	Concurrent	-0.144*	-0.084	-4.67**	-1.844*	-0.435***	-0.191***
		(0.087)	(0.061)	(2.151)	(1.014)	(0.100)	(0.070)
Severe		-0.182*	0.118	0.136	-2.479	-0.380***	-0.045
		(0.107)	(0.074)	(2.449)	(0.978)	(0.120)	(0.078)
# of Years Limited		0.008	0.000379	0.038	-0.059	0.015**	-0.004
		(0.005)	(0.004)	(0.099)	(0.064)	(0.007)	(0.004)
Female		-0.085	-0.266***	-7.037***	-8.811***	-0.437***	-0.586***
		(0.082)	(0.047)	(1.340)	(0.799)	(0.096)	(0.051)
Cohort							
	60's	-0.115	-0.096	1.396	0.861	-0.145	-0.058
		(0.158)	(0.085)	(2.145)	(1.221)	(0.195)	(0.092)
	70's	-0.252	-0.118	4.661	0.297	0.017	-0.162
		(0.235)	(0.138)	(3.831)	(2.398)	(0.259)	(0.160)
	80's	-0.277	-0.334	3.948	3.903	-0.007	-0.200
		(0.284)	(0.243)	(5.318)	(3.864)	(0.322)	(0.289)
Intercept		2.114***	2.811***	39.781***	42.877***	9.377***	10.224***
		(0.367)	(0.266)	(6.330)	(4.208)	(0.446)	(0.319)
R^2		0.191	0.047	0.073	0.113	0.226	0.132

Note: Standard errors in parentheses. * for P<0.1, ** for P<0.05, *** for P<0.01.

with early-onset disabilities than for late-onset.

The intercept for the log of hourly wages suggest the omitted group earns approximately twice as much when their disability onset occurs late compared to early.[35] Cognitive and concurrent disabilities inflict large wage penalties for early-onset and are not significantly different than physical for late. Cognitive and concurrent types are estimated to have a significant negative penalty to earnings of 29% and 13%, respectively. The effect of disability on wages gets progressively worse for later onset. It is insignificant for early-onset, consistent with this group being better able to accommodate or adapt to their disability over time. The estimates for experience also suggest this finding.

Columns 3 and 4 compare estimates for the weekly number of hours worked. The intercept indicates the omitted group of later-onset individuals work longer in a week than the early-onset. The average effect of cognitive disabilities is worse for late-onset, and the average effect of concurrent disabilities is worse for

[35]The omitted group is non-severe physically disabled males with a high school degree and no experience born in the 50s

early-onset. Severity and the number of years limited are not predictive of the number of weekly hours worked for either group. Post-secondary schooling has a significant positive impact for late-onset. Disabled females incur a larger hours penalty for late, which is similar to the findings in the wage model. Finally, the R^2 of both models suggests that this set of predictors do not account for very much of the variation in the number of hours worked.

Finally, the last two columns are for the log of annual employment income. As expected, the average annual employment income for early-onset is less than that of late for the omitted group. Similar to earnings, the effects of cognitive and concurrent disabilities are largest for early, and the penalty for cognitive is larger than the penalty for concurrent. Severity has a negative and significant impact on employment income for early but is not significant for late.[36] The measure of persistence significantly predicts annual employment income for early. This is consistent with the ability to adapt to the disability or compensate for it. Post-secondary schooling provides positive gains to annual employment income for both early and late and is larger for early. However, the difference in the gain is smaller than that of hourly wages and weekly hours. The effect of cognitive disabilities now substantially overcomes the gain from schooling. Early incurs a large penalty from high school dropout. Experience is significant and beneficial for early, which is similar to the findings from wages.

6 Conclusion

This paper explores the joint implications of accounting for a rich bundle of disability characteristics on employment, hours worked, wages, and employment income. My findings suggest there is considerable variation in the impact of the characteristics on these outcomes. Disaggregating disability into types of functional limitations is important to account for the heterogeneity of disabilities. The distinction between early and late-onset disability is significant for wages and employment income. The effects of disability on wages for those with early-onset disabilities are consistent with the disability adversely impacting skills development. Severity is more relevant for the intensive and extensive margins of labour supply. Persistence has important effects on all outcomes, motivating the importance of research on the dynamics of the effects of disability.

A better understanding of the effects of the characteristics and their correlation to each other can help inform empirical researchers with limited data on the details of disability. Awareness of what traits

[36] As annual employment income combines wages and hours, this suggests that although severity impacts the number of weekly hours worked for late, it does not impact this measure of labor market welfare. Severity impacts wage for early, and it also negatively affects this measure of economic welfare in the labor market.

of disability correlate with each other and which drive outcomes can offer a better intuition into studies on the effects of disability. Moreover, this intuition can help inform policymakers to better target individuals bearing the greatest burden of their condition.

7 References

Acemoglu, Daron, and Joshua D. Angrist. "Consequences of Employment Protection? The Case of the Americans with Disabilities Act." Journal of Political Economy 109, no. 5 (2001): 915-57.

Ameri, Mason, Lisa Schur, Meera Adya, F. Scott Bentley, Patrick McKay, and Douglas Kruse. "The disability employment puzzle: a field experiment on employer hiring behavior." ILR Review (2015).

David, H., and Mark G. Duggan. "The growth in the social security disability rolls: a fiscal crisis unfolding." Journal of Economic perspectives 20, no. 3 (2006): 71-96.

Baldwin, Marjorie L., and William G. Johnson. "A critical review of studies of discrimination against workers with disabilities." Handbook on the economics of discrimination (2006): 119-160.

Ben-Porath, Yoram. "The Production of Human Capital and the Life Cycle of Earnings." Journal of Political Economy 75, no. 4 (1967): 352-65.

Berry, Steven, James Levinsohn, and Ariel Pakes. "Automobile prices in market equilibrium." Econometrica: Journal of the Econometric Society (1995): 841-890.

Bound, John. "The Health and Earnings of Rejected Disability Insurance Applicants." The American Economic Review 79, no. 3 (1989): 482-503.

Bound, John and Burkhauser, Richard. "Chapter 51 Economic analysis of transfer programs targeted on people with disabilities. Handbook of Labor Economics." 3. (1999): 3417-3528.

Bound, John and Stinebrickner, Todd and Waidmann, Timothy. "Health, economic resources and the work decisions of older men," Journal of Econometrics 156, no. 1 (2010): 106-129. Elsevier.

Burkhauser, R, Haveman, R. and B Wolfe. "How People with Disabilities Fare When Public Policies Change," Journal of Policy Analysis and Management 12, no. 2 , (1993): 429-433.

Campoleiti 2012

Case, Anne, Fertig, Angela and Paxson, Christina. "The lasting impact of childhood health and circumstance," Journal of Health Economics 24, no. 2, (2005): 365-389.

Charles, Kerwin Kofi. "The Longitudinal Structure of Earnings Losses among Work-Limited Disabled Workers." The Journal of Human Resources 38, no. 3 (2003): 618-46.

Conti, Gabriella, James Heckman, and Sergio Urzua. "The Education-Health Gradient." American Economic Review 100, no. 2, (2010): 234-38.

Cunha, Flavio, and James Heckman. "The Technology of Skill Formation." American Economic Review, 97 no. 2, (2007): 31-47.

Currie, Janet and Enrico Moretti. "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings." Quarterly Journal of Economics VCXVIII, 4 (2003): 1495 1532.

Currie, Janet "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development," Journal of Economic Literature 47, (2009): 87–117.

Currie, Janet, Mark Stabile, Phongsack Manivong, and Leslie L. Roos. "Child Health and Young Adult Outcomes." The Journal of Human Resources 45, no. 3 (2010): 517-48.

Dean, D. , Pepper, J. , Schmidt, R. and Stern, S. "The effects of vocational rehabilitation for people with cogntivie impairments." International Economic Review 56 (2015): 399-426.

Fortin, Nicole, Thomas Lemieux, and Sergio Firpo. "Decomposition methods in economics." In Handbook of labor economics 4, (2011): 1-102.

French, Eric, and Jae Song. "The Effect of Disability Insurance Receipt on Labor Supply." American Economic Journal: Economic Policy 6, no. 2 (2014): 291-337.

Grossman, Michael. "Education and Non market Outcomes." In Handbook of the Economics of Education 1, ed. Eric Hanushek and Finis Welch, (2006): 577-633. Amsterdam: Elsevier.

Haveman, Robert and Wolfe, Barbra. "The economics of disability and disability policy in Robert Haveman and Barbara Wolfe (eds.)," Handbook of Health Economics, 1, (2000). Elsevier.

Heckman, James J. "Sample selection bias as a specification error." Econometrica: Journal of the econometric society (1979): 153-161.

Hollenbeck, Kevin and Kimmel, Jean. "Differences in the Returns to Education for Males by Disability Status and Age of Disability Onset," Southern Economic Journal 74, no. 3, (2008): 707-724.

Jann, Ben. "The Blinder-Oaxaca decomposition for linear regression models." The Stata Journal 8, no. 4 (2008): 453-479.

Lamichhane, Kamal and Sawada, Yasuyuki. "Disability and returns to education in a developing country," Economics of Education Review 37, (2013): 85-94. Elsevier.

Low, Hamish, and Luigi Pistaferri. "Disability Insurance and the Dynamics of the Incentive Insurance Trade-Off." The American Economic Review 105, no. 10 (2015): 2986-3029.

Lundborg, Petter, Nilsson, Anton and Rooth, Dan-Olof. "Adolescent health and adult labor market outcomes," Journal of Health Economics, 37. C, (2014): 25-40.

Maestas, Nicole, Kathleen J. Mullen, and Alexander Strand. "Does disability insurance receipt discourage work? Using examiner assignment to estimate causal effects of SSDI receipt." American Economic Review v103(5), (2013): 1797-1829.

Meyer, Bruce and Mok, Wallace K. C. "Disability, Earnings, Income and Consumption," Journal of Public Economics, (2018).

Mori, Hiroaki, "Essays on Human Capital Complementarities" (2016). Electronic Thesis and Dissertation Repository. 3898. https://ir.lib.uwo.ca/etd/3898.

Morris, Fawcett, Brisebois, and Hughes. "A demographic, employment and income profile of Canadians with disabilities aged 15 and over, 2017." Statistics Canada, 2017.

Statistics Canada, "A Profile of Disability in Canada, 2001." Statistics Canda Report, (2001).

Stephens, Melvin. "The Long-Run Consumption Effects of Earnings Shocks." The Review of Economics

and Statistics 83, no. 1 (2001): 28-36.

Stern, Steven. "Measuring the Effect of Disability on Labor Force Participation." The Journal of Human Resources 24, no. 3 (1989): 361-95.

Von Wachter, Till, Jae Song, and Joyce Manchester. "Trends in Employment and Earnings of Allowed and Rejected Applicants to the Social Security Disability Insurance Program." American Economic Review 101, no. 7 (2011): 3308-29.

Yamaguchi, Shintaro. "Tasks and Heterogeneous Human Capital." Journal of Labor Economics 30, no. 1 (2012): 1-53.

Appendix

A1. Census filter questions and example of specific questions on activity limitation in PALS

Disability Screening Filter in Long form Census: 1. Do you have any difficulty heading, seeing, communicating, walking, climbing stairs, bending, learning or doing any similar activities?

- Yes, sometime
- Yes, often
- No

2a. Does a physical condition or mental condition or health problem reduce the amount or kind of activity you can do at home?

- Yes, sometime
- Yes, often
- No

2b. Does a physical condition or mental condition or health problem reduce the amount or kind of activity you can do at home?

- Yes, sometime
- Yes, often
- No

2c. Does a physical condition or mental condition or health problem reduce the amount or kind of activity you can do in other activities, for example, transportation or leisure?

- Yes, sometime
- Yes, often
- No

Questions for activity limitation associated with hearing disability in PALS:

- With your hearing aid(s), how much difficulty do you have hearing what is said in a conversation with one other person?
- With your hearing aid(s), how much difficulty do you have hearing what is said in a conversation with at least three other people?
- With your hearing aid(s), how much difficulty do you have hearing what is said in a telephone conversation?
- How much difficulty do you have hearing what is said in a telephone conversation with one other person?
- How much difficulty do you have hearing what is said in a telephone conversation with at least three other people?
- How much difficulty do you have hearing what is said in a telephone conversation?
- Which of the following best describes your ability to hear?

If respondents answered "some difficulty", "a lot of difficulty", or "I cannot hear" then they were flagged as having a hearing limitation.

A2. Additional Estimates from Probit and Linear Projection Models

Table 5: Table 3. Probit estimates of controls and exclusion restrictions for effects of the disability characteristics on employment

Dependent Variable:	Employment
Age	0.0609***
	(-0.0217)
Age^2	-0.0010***
	(-0.0002)
Married	0.1981***
	(-0.0241)
Number of Kids	-0.0308***
	(-0.011)
Presence of Children under 6	-0.2839***
	(-0.0419)
Sex	-0.5794***
	(-0.0217)
Born in 60s	-0.1509***
	(-0.0434)
Born in 70s	-0.1782**
	(-0.0823)
Born in 80s	-0.1096
Survey = 2001, Outside income = 1	-0.1968*
	(-0.1128)
Survey = 2006, Outside income = 0	0.1080***
	(-0.0271)
Survey = 2006, Outside income = 1	-1.5071***
	(-0.0752)
Transport Costs	0.0634**
	(-0.0268)
Intercept	0.9934**
	(-0.4746)

Table 6: Linear Projection of the Log of Hourly Wages, Weekly Hours, and Log of Annual Employment Income on Disability Characteristics

Dependent Variable:	Log Hourly Wages				Hours					Log Annual Employment Income			
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Sex	-0.1632***	-0.1632***	-0.1668***	-0.1708***	-7.7547***	-7.7559***	-7.0387***	-0.1708***	-0.4288***	-0.4286***	-0.3872***	-0.3941***	
	-0.009	-0.009	-0.013	-0.0131	-0.1459	-0.1458	-0.2047	-0.0131	-0.0105	-0.0104	-0.0156	-0.0154	
Born in 60s	-0.0482***	-0.0481***	-0.0875***	-0.0877***	0.4176**	0.4222**	0.4058	-0.0877***	-0.0517***	-0.0516***	-0.1005***	-0.1015***	
	-0.0106	-0.0105	-0.016	-0.0158	-0.1702	-0.1702	-0.2644	-0.0158	-0.012	-0.0119	-0.0179	-0.0176	
Born in 70s	-0.1585***	-0.1579***	-0.1933***	-0.1937***	0.0347	0.0423	0.2431	-0.1937***	-0.2237***	-0.2228***	-0.2559***	-0.2571***	
	-0.0114	-0.0114	-0.0238	-0.0237	-0.183	-0.1823	-0.4007	-0.0237	-0.0137	-0.0137	-0.0278	-0.0276	
Born in 80s	-0.3310***	-0.3305***	-0.3341***	-0.3345***	-1.8818***	-1.8671***	-1.5663**	-0.3345***	-0.4548***	-0.4533***	-0.4460***	-0.4463***	
	-0.0278	-0.0278	-0.0382	-0.0381	-0.4636	-0.4633	-0.6448	-0.0381	-0.035	-0.035	-0.0459	-0.0458	
Post-Secondary Certificate			0.2529***	0.2525***			0.5049***	0.2525***			0.2873***	0.2865***	
			-0.0107	-0.0107			-0.1855	-0.0107			-0.0126	-0.0126	
High School Dropout			-0.1491***	-0.1485***			0.4400*	-0.1485***			-0.2033***	-0.2020***	
			-0.0151	-0.015			-0.2492	-0.015			-0.0167	-0.0166	
Experience			0.0103***	0.0102***			0.0609	0.0102***			0.0154***	0.0154***	
			-0.003	-0.003			-0.0496	-0.003			-0.0036	-0.0035	
Experience^2			-0.0252***	-0.0252***			-0.0994	-0.0252***			-0.0351***	-0.0355***	
			-0.0068	-0.0068			-0.1064	-0.0068			-0.0078	-0.0078	
Inverse Mills Ratio			-0.1029	-0.0739			-4.9548***	-0.0739			-0.4485***	-0.3979***	
			-0.0685	-0.0682			-0.9813	-0.0682			-0.0845	-0.0828	
Intercept	2.9908***	2.9906***	2.8102***	2.8096***	44.6634***	44.6601***	43.9541***	2.8096***	10.6190***	10.6186***	10.4075***	10.4062***	

Note: Standard errors in parentheses. * for P<0.1, ** for P<0.05,*** for P<0.01. See appendix for estimates on control variables.