The Effects of a Disability on Labor Market Performance: The Case of Epilepsy*

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I. Introduction

In 1985, 14% of the civilian non-institutional population in the U.S., reported they had an activity limitation.[1] Having a disability is therefore not an uncommon event, yet there are relatively few empirical studies which examine the effect of a disability on labor market performance.[2] This study examines educational attainment, probability of employment, and wages for one group of disabled individuals: people with epilepsy.

To determine the impact of a disability on labor market performance two issues seem particularly relevant. First, it is important to control for the severity of a health limitation because the effects of a disorder may not be uniform across levels of impairment. Second, while having a disability and the severity of the disability are exogenous to the individual, measuring the wage effects of activity limitations can be greatly affected by the employment and educational choices disabled individuals make.

Since many disabilities have varying degrees of severity, it may be seriously misleading to simply include a dichotomous variable to control for the effect of having a disability. Wages and the probability of employment are expected to be decreasing functions of severity. Capturing the average severity effect through a dichotomous variable may mask important differences across individuals. More importantly, the effect of a disability on some labor market phenomena may not be uniform across all levels of severity. For example, it is not necessarily the case that increases in the severity of a disability affect the marginal costs and benefits of schooling equally. While a more severe disability reduces market wages and increases the incentives to attend school, it may also reduce the amount of human capital acquired per year of schooling and decrease incentives to attend school, *ceteris paribus*. The effect of severity on the number of years of education is

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1. Based on the Nation Health Interview Survey. Table #194 from the 1990 Statistical Abstract of the U.S.

2. See however Bartel and Taubman [1], Johnson and Lambrinos [5], Lambrinos [6], Leonard [7], Mitchell and Butler [8], and Mitchell and Burkhauser [9].

therefore an empirical question. Including only a dummy variable for a disability in an education regression would not allow for possible differences in the effects of severity on human capital acquisition.

Second, individual choices depend not only on the severity of the limitation, but also on unobservable factors such as the individual's motivation or ability to cope with the disorder. Modelling the effect of severity on the choices of educational attainment and employment are particularly important for the estimation of a wage equation. In particular, the degree of severity is expected to impact the choice of whether or not to work. The OLS estimates of the effect of a disability on wages from a sample of working individuals suffers from selection bias; working persons with a disability do not comprise a random sample of people with a disability. People whose disorder is the most severe are less likely to work than people whose disorder only slightly affects their functioning. Therefore, those who have the most severe forms of a disability who still choose to work may be even more motivated than those with mild forms of a disorder. Accounting for selection bias is expected to increase the estimated impact of severity on earnings. The importance of correcting for selection bias when estimating the wages of those with a disability was noted by Mitchell and Butler [8], though the authors do not focus on the effect of selection bias on the coefficient estimate on severity in their wage equation. Mitchell and Butler estimated an annual earnings equation for those with arthritis and, although they never found that the severity of arthritis significantly affected the annual earnings of those with the disorder, accounting for selection bias increased the point estimate on the effect of severity of arthritis sixteen fold.

The estimated effect of the severity of a disability on earnings may be further increased if the endogeneity of education is modeled. The level of education is generally assumed to be a predetermined variable in a wage regression. However, if the severity of a disability affects the level of education, to determine the full effects of severity on earnings, the indirect effect of severity through educational attainment should be taken into account.

To obtain estimates of the effects of a disability on labor market performance, samples of people with epilepsy and a control group were collected from the Regional Epilepsy and Burn Clinics, respectively, at Harborview Medical Center in Seattle, Washington. Because disabilities are quite varied in their impact on individual functioning, a narrowly defined group of disabled individuals was chosen in order to obtain a reasonable measure of the severity of the disability. Epilepsy was chosen not only because approximately 1–2% of the population have the disorder, but also because of the tremendous variation in the severity of this disability. This variation provides a more powerful test of the importance of severity on labor market performance because it is more likely that the effects of severity can be statistically distinguished from the effects of simply having the disorder. Importantly, the medical community has developed a measure of the severity of a seizure disorder. In this study a summary measure of severity based upon this medical measure is developed.

This data set contains actual measures of labor market experience and tenure on the job, parent's education, significant other's income, and the number of children less than six years old. It is particularly important in studies of the disabled to have measures of actual experience and tenure because the standard potential experience variable, age−education−6, may be a poor proxy for actual time spent in the labor market. In addition, determining who has epilepsy and the severity of their disorder was not based on self-reported information, but rather was determined from the individual's medical chart. Two different control groups, patients at the Burn clinic and individuals in Washington State who participated in the 1986 Current Population Survey (CPS), were used in the empirical analysis. While the CPS is missing several key explanatory variables, results based on the CPS are used as a benchmark for the results found using the Burn control sample.

The paper is organized as follows. First, the measurement of the severity of a seizure disorder for the individuals in this study is described. Then data collection methods, a description of the samples used in the hypothesis tests, and summary statistics are presented. The effects of seizure severity on education regressions, employment probits, and wage equations are estimated and presented in the next section. The estimated effects of seizure severity are compared across an OLS wage regression, a selection bias corrected wage regression, and the selectivity corrected wage equation when accounting for the endogeneity of education. The assumption of equal effects of severity by sex is tested. Finally, conclusions are drawn.

II. The Measure of Seizure Severity

The measure of seizure severity used in this study is an individual's predicted score on the Halstead-Reitan Neuropsychological Test Battery, where the prediction is based upon the individual's seizure characteristics. The Halstead-Reitan test battery is the standard tool used by the medical community, both in terms of patient management and in terms of measuring research outcomes, to assess the functional capacity of individuals with epilepsy. The high cost of administering the test battery precluded testing the individuals in this study directly. As an alternative, a sample of 787 people with epilepsy collected by Dr. Carl Dodrill, a neuropsychologist at Harborview Medical Center was used to derive a prediction equation. The Halstead-Reitan test battery score was regressed on the seizure characteristics for the Dodrill sample of 787 people with epilepsy. Since the same seizure characteristics were collected for the people with epilepsy in this study's sample, it was possible to compute a predicted Halstead-Reitan test score. Comparisons of seizure characteristic means between the Dodrill sample and the sample of people with epilepsy used in this analysis and the coefficient estimates of the prediction equation are presented in Appendices 1 and 2.

Seizure characteristics explain about 15 percent of the individual variation in Halstead-Reitan test scores. Thus the variation in predicted severity for the people with epilepsy in my sample is much less than the variation in measured severity obtained if the test battery had been administered directly. Nonetheless, any variation in severity is an improvement over a dichotomous representation of epilepsy. Given the relatively small amount of test score variation which is explained by seizure characteristics, it seems more reasonable to assume that the predicted Halstead score appropriately assigns individuals into low, medium, and high impairment categories as opposed to providing a complete rank ordering of individuals with respect to the severity of their impairment. An advantage to using categories of impairment as opposed to including the predicted Halstead score as a regressor directly is that no particular functional form is imposed upon the effects of severity on the dependent variables. Hence three dichotomous categories for severity are used in the analysis: an individual receives a one for *LOW-EPI* if their predicted Halstead score is less than .3, a one for *MED-EPI* if their predicted Halstead score is greater than or equal

3. The endpoints approximate the lowest quartile of predicted Halstead scores for the *LOW-EPI*, the second and third quartiles for *MED-EPI*, and the highest quartile for *HIGH-EPI*. For all regressions I tried using a dichotomous variable for each of the quartiles separately as dependent variables. I was never able to reject the equality of the second and third quartile.

to .3 but less than .5, and a one for *HIGH-EPI* if their predicted score is greater than or equal to .5.[3] All regressions were also estimated using a continuous *HALSTEAD* severity measure and a dichotomous variable for having epilepsy.[4] Results were, in general, invariant to the choice of specification except in the wage equation where multicollinearity between the dichotomous epilepsy variable and the continuous severity measure precluded determining the impact of severity separately from simply having the disorder.

III. The Data

The surveys for this study were administered by the author and her associates over the period 1 May 1986 to 1 May 1987. Usable data on 160 people with epilepsy between the ages of 21 and 64 were collected at the Harborview Medical Center's Regional Epilepsy Clinic in Seattle, Washington.[5] Two different control groups of people between the ages of 21 and 64 were used. 118 people were interviewed by the author, using the same survey instrument and methodology as was used for the people with epilepsy, from the Harborview Medical Center's Regional Burn Clinic. For comparison purposes, data for 2464 Washington State residents from the 1986 Current Population Survey (CPS) were also used. Blacks were excluded from the analysis because there was only one black individual in the epilepsy sample.

Two sets of data were obtained for the sample of people with epilepsy. Seizure-related information for the construction of the severity variable was obtained from the individual's medical chart. Demographic and work related data for the employment, education, and wage equations were obtained through interviews with new and returning patients.[6] In addition to standard variables, general experience (months on jobs other than the current job), tenure (months in the current job), parent's education, spouse's earnings, and whether the individual has a disability other than epilepsy were collected.[7] Since it is possible to conceal a seizure disorder, individuals were asked whether or not they had informed their employer.

In an effort to reduce interview bias, another regional clinic at Harborview Medical Center was chosen as a control group: the Burn Clinic.[8] Individuals who were burned, or the parents of children who were burned, were asked to provide information about the job they had prior to being burned (or their current job if their child was burned). To control for the possibility that the sample is composed of a greater number of people receiving a compensating wage differential for

4. No predicted Halstead-Reitan test score could be estimated for the control group because they had no seizure characteristics. However, the average score on the Halstead-Reitan battery for Dodrill's control group was .25. Therefore, .25 was subtracted from the predicted test battery score for the people with epilepsy in the sample and the control group all received a score of zero.

5. 47 people with epilepsy were not used in the analysis because they were either students (21), had pseudoseizures (10), came to the epilepsy center for vocational rehabilitation (10), were working in sheltered workshops (3), or had bad data (3). For the people with epilepsy, selection into the sample depends primarily upon the severity of their seizures. However, since severity of epilepsy is not a choice variable, this selection rule—as long as a wide range of seizure severities are observed in the sample—will not introduce selection bias into the estimated equations.

6. Data collection questionnaires are available from the author upon request.

7. The measure of general experience was missing for 53 unemployed people with epilepsy and was therefore imputed.

8. The Burn Clinic was chosen because it is a regional clinic as is the Epilepsy Center. As opposed to other clinics at Harborview (which generally serves a low income population), individuals attend the regional clinics with less regard to financial status. Collecting the control group in a face-to-face interview and in a hospital setting, as was the epilepsy sample, is expected to reduce interview bias.

Table I. Variable Definitions

1.	*HALSTEAD*	the measure of seizure severity: Predicted Halstead-Reitan neuropsychological test score
2.	*EPILEPSY*	= 1 if the individual has epilepsy; = 0 otherwise.
3.	*LOW-EPI*	= 1 if *HALSTEAD* is less than .3 and *EPILEPSY* = 1; = 0 otherwise
4.	*MED-EPI*	= 1 if *HALSTEAD* is greater than or equal to .3 and less than .5; = 0 otherwise
5.	*HIGH-EPI*	= 1 if *HALSTEAD* is greater than or equal to .5; = 0 otherwise
6.	*AGE*	in years.
7.	*AGE2*	*AGE* squared
8.	*EDMOM*	mother's number of years of education
9.	*EDMOM2*	*EDMOM* squared
10.	*EDDAD*	father's number of years of education.
11.	*EDDAD2*	*EDDAD* squared
12.	*DISABL*	= 1 if the person has a disability other than epilepsy, = 0 otherwise.
13.	*FEMALE*	= 1 if a female; = 0 otherwise.
14.	*ED*	number of years of education completed.
15.	*SINGLE*	= 0 if married, = 1 if single, separated, divorced, widowed, or other.
16.	*WAGES*	natural log of hourly earnings. If the individual earned a salary, divisions using *WEEKS* and *HOURS* were used to derive *WAGES*.
17.	*WORK*	= 1 if individual is employed, = 0 otherwise
18.	*HOURS*	the number of hours worked last week.
19.	*KIDS*	number of children less than six years old, living with or supported by individual.
20.	*EXPER*	number of months in jobs, other than current job, since finishing school (was predicted for 53 unemployed people with epilepsy)
21.	*EXPER2*	*EXPER* squared.
22.	*TENURE*	the number of months of employment in the current job.
23.	*TENURE2*	*TENURE* squared.
24.	*FULEXP*	*TENURE* + *EXPER*
25.	*SOINC*	significant other's hourly wage.
26.	*UNION*	= 1 if the person is a union member, = 0 if person is not a union member.
27.	*GOVT*	= 1 if the person has a government job, = 0 otherwise.
28.	*SELF*	= 1 if the person is self employed, = 0 otherwise.
29.	*JOBBURN*	= 1 if the burned individual received the burn on the job, = 0 otherwise.
30.	*MOM*	= 1 if have a child under six years old and are a woman, = 0 otherwise.
31.	*LAMBDA*	the inverse of the Mill's ratio: Heckman's selection bias correction term

the differential risk of being burned, information on whether the individual was burned on the job was collected.

A sample of individuals from Washington State was obtained from the 1986 Current Population Survey (CPS) to use in the hypothesis tests as well. The CPS data set does not contain information on tenure, previous labor market experience, disability other than epilepsy, parent's education, spouses' earnings, or whether the individual has epilepsy. However, the data set is frequently used in empirical studies of labor market performance and is a large sample collected on a probability basis. The tradeoffs between the better control variables for the estimation of wage, education, and participation equations in the burn control sample and using the large, well-known sample from the CPS were assessed by generating CPS-like variables in the burn sample and comparing the results to those found using the CPS. The results are qualitatively similar. For the remainder of this paper, the Burn control sample results will be presented though results using the CPS sample will always be discussed.[9]

9. Results using the CPS data and the burn control sample with CPS-like variables are available from the author.

Table II. Sample Means (Standard Deviations in Parentheses)

FULL SAMPLE:

Variable	Epilepsy (N = 160)		Burn (N = 118)	
AGE (years)	33.74	(9.40)	34.47	(10.10)
FEMALE (%)	.51	(.50)	.37	(.49)
ED (years)	13.16	(2.20)	13.13	(2.23)
KIDS (number)	.25	(.56)	.59	(1.00)
SINGLE (%)	.64	(.48)	.49	(.50)
DISABL (%)	.16	(.37)	.08	(.28)
FULEXP (Months)	91.77	(85.03)	91.93	(96.30)
SOINC (log hourly)	2.83	(6.13)	4.51	(9.18)
MOM (%)	.12	(.32)	.15	(.36)
HALSTEAD	.39	(.15)	0.0	
LOW-EPI	.178	(.384)	0.0	
MED-EPI	.578	(.497)	0.0	
HIGH-EPI	.244	(.498)	0.0	

WORKERS ONLY:

Variable	Epilepsy (N = 70)		Burn (N = 92)	
WAGES (log hourly)	2.02	(.47)	2.24	(.55)
TENURE (Months)	52.93	(58.70)	46.12	(57.80)
EXPER (Months)	70.46	(83.07)	98.38	(101.40)
UNION (%)	.23	(.42)	.22	(.41)
GOVT (%)	.17	(.38)	.04	(.18)
SELF (%)	.09	(.28)	.1	(.30)
JOBBURN (%)	0.0		.36	(.48)
HALSTEAD	.36	(.15)	0.0	
LOW-EPI	.400	(.493)	0.0	
MED-EPI	.443	(.500)	0.0	
HIGH-EPI	.157	(.367)	0.0	

The variables used in the empirical analysis are defined in Table I. Sample means and standard deviations for the people with epilepsy and the burn control sample are presented in Table II.

IV. Results

Education Regression

One of the major factors affecting the costs of acquiring an additional year of schooling is foregone earnings. The severity of epilepsy, to the extent that it reduces marginal productivity (or increases discrimination), will reduce market wages. Lower market wages imply lower costs to attending school and, *ceteris paribus,* would lead an individual to choose more schooling. However, severity of the disorder is also likely to affect the amount of human capital acquired per year of schooling and hence the benefits from spending another year in school. The effect of epilepsy severity on years of education will depend upon the relative shifts of marginal costs and marginal benefits.

Both the people with epilepsy and the control group acquired approximately 13 years of

Table III. Education Regression

Variable	Coefficient	Std. Error	Mean
ED			13.146
LOW-EPI	.952**	.362	.158
MED-EPI	−.043	.289	.299
HIGH-EPI	−.494	.407	.119
EDMOM	−.511	.361	12.246
EDMOM2	.027*	.014	155.392
EDDAD	−.280*	.160	12.100
EDDAD2	.017**	.007	158.221
AGE	.311**	.077	34.047
AGE2	−.004**	.001	1253.176
FEMALE	.097	.243	.450
DISABL	−.727**	.364	.129
CONSTANT	9.799**	2.572	1.000
Number of Obs.		278.	
Adj. R-square		.2040	

*Significant at the 10% level
**Significant at the 5% level

education on average. Parent's education, parent's education squared, age, age squared, sex, and presence of a disability other than epilepsy are used to explain the number of years of education in addition to the three categories of impairment. The results are presented in Table III. The most striking results are on the seizure severity categories. At low levels of impairment, people with epilepsy acquire significantly more education than the control group—approximately an additional year. This suggests that there are relatively large returns to the acquisition of additional human capital compared to the loss of earnings for people who are only slightly impaired by their epilepsy. However, for the more impaired, this finding is completely reversed: not only it is not worthwhile to acquire additional human capital, the people with the most severe epilepsy acquire on average half a year of education less than the control group, though this difference was not statistically significant. (However, the least impaired people with epilepsy acquire about 1.45 more years of education than the most impaired, and this difference is significant at the 1% level.)

Though there are no controls for parent's education, essentially the same result was found when using the CPS control group—except results were more statistically significant: the least impaired people with epilepsy acquire significantly more education than the control group—approximately three quarters of a year; the most impaired people with epilepsy acquired significantly less education than the control group—approximately one year.

Using either control sample, there is no significant difference found between the people with epilepsy and the control groups if a dichotomous variable for epilepsy only is used in the education equation. The dichotomous representation for a disability, at least for people with epilepsy, masks not only significant differences in educational attainment between the disabled at different levels of severity but also significant differences between the disabled and control groups.

Employment Probit

To the extent that the probability of employment is affected by seizure severity, estimating the impact of a seizure disorder in a wage equation on the selected sample of working people with

Table IV. Employment Probit

Variable	Coefficient	Std. Error	Mean
WORK			.583
LOW-EPI	−.479*	.274	.158
MED-EPI	−1.074**	.232	.299
HIGH-EPI	−.882**	.321	.119
ED	.041	.046	13.146
AGE	−.090**	.016	34.047
FEMALE	.138	.218	.450
KIDS	.092	.175	.394
SOINC	−.019	.013	3.539
MOM	−1.100**	.398	.133
SINGLE	−.332	.236	.576
DISABL	−.146	.277	.129
FULEXP	.017**	.004	106.975
FULEXP2/1000	.014	.009	20.517
CONSTANT	2.154**	.747	1.000
Number of Obs.		278.	
Log Likelihood		−121.834	

*Significant at the 10% level
**Significant at the 5% level

epilepsy will be affected by selection bias. Seizure severity may reduce the probability of employment by raising the reservation wage, either by affecting the utility of leisure or by increasing the probability of obtaining disability insurance. Epilepsy may also reduce market wages through reduced productivity or, possibly, increased discrimination. The employment rates in the burn and the CPS control samples are similar: 72% and 78% respectively. The epilepsy sample has similar mean values of age and education, but has more women than the control groups. The greater percentage of women in the epilepsy sample explains, in part, the far lower employment rate, 43.8%, for this group.

To examine the effect of seizure severity on the probability of employment more systematically a probit model was estimated. The dependent variable, *WORK*, is one if the individual is currently employed and equals zero otherwise.[10] In addition to standard controls and the severity categories in the probit, spouse's income and total months of actual labor market experience (*TENURE*+*EXPER*) are included as regressors. Education is also included as an explanatory variable in the probit. The probit estimates are consistent assuming the error in the education equation is uncorrelated with the error in the probit.[11] The results for the employment probit are presented in Table IV. The effects of severity on the probability of employment are large and significant. At any level of severity, people with epilepsy are significantly less likely to be employed than the control group. The least impaired are significantly more likely to be employed than people with average epilepsy severity. Those with the highest severity are not significantly less likely to

10. In this study unemployment and out of the labor force are not treated as distinct labor market states.

11. The probit results appear to be robust to the assumption of uncorrelated errors across the education regression and the employment probit. The probit was estimated using predicted education, based on the education regression, instead of actual years of education. The probit was also estimated without education, but including all the exogenous variables from the education regression. The effects of these alternative specifications of education on the point estimates for the impairment categories were negligible.

be employed than the low severity individuals. In addition, the point estimate on *HIGH-EPI* is smaller in magnitude than the estimate on *MED-EPI*.[12] Because of the nonlinearity of the probit specification, the effect of severity on the probability of employment depends upon the levels of the other exogenous variables. Consider a single woman without children, with a high school education, who has no disability and who has the average number of months of experience for women (107 months). Given these observed characteristics, the predicted probability of being employed is about .918. If the same women had the lowest level of seizure severity, the probability of employment is .819. If instead she had average severity, the probability of being employed would drop to .625. If she had the most severe epilepsy, the probability of employment would be .695.

The estimated effects of seizure severity on the probability of being employed using the CPS control sample were quite similar. The regressors in the probit were the three severity categories, sex, marital status, the presence of a child less than six years old, years of education, potential experience (*AGE−ED−6*), potential experience squared as well as interactions between the potential experience variables, education, and children less than six years old and sex. For a single female with a high school education, no children, potential experience of 18 years, and no epilepsy the probability of being employed is .755. If instead the same women had the mildest epilepsy, the probability of employment falls to .58. Again, the most impaired are slightly more likely to be employed than those with average severity: the probability of being employed is .33 and .36 for persons with average and most severe epilepsy respectively.

Wage Regressions

In the employment probits it was found that people with epilepsy at all levels of severity are significantly less likely to work than people without the disorder. In addition, those with average seizure severity are significantly less likely to work than those whose disorder is less impairing. These results suggest that the people whose epilepsy is more impairing but who still choose to work may be those who are particularly motivated, have the highest tastes for work, or are the most able to cope with their disorder. As a result, while increasing severity is expected to reduce marginal productivity and hence wages, increasing severity is also expected to be associated with higher levels of unmeasured characteristics which are expected to increase wages. The estimated effects of seizure severity in a wage equation not corrected for selection bias would therefore be downward biased.

To test this hypothesis, OLS wage equations are estimated first. The dependent variable for all the wage regressions is the log of hourly wages. For ease of interpretation, estimated coefficients have been converted into dollar equivalents. The results are presented in Table V. Each of the three severity levels significantly reduces hourly wages. The average control group individual is estimated to earn $10.49 an hour. If that same individual had the lowest seizure severity, then

12. It is possible that once knowing an individual's actual labor market history (in terms of *EXPER* and *TENURE*), there is much less to be learned by knowing seizure severity. For example, consider a severely impaired individual who has many months of labor market experience. Conditional on the level of severity, the fact that the individual is clearly attached to the labor market, as measured by the many months of labor market experience, is probably a very good predictor of whether or not the disabled individual is currently employed. This would suggest that labor market experience is capturing tastes for work or ability to cope with the disability. To test this hypothesis, *AGE−ED−6* was used instead of *FULEXP* in the probit. While the point estimates on *HIGH-EPI* increased in magnitude—to −1.077 (.283), the point estimate was still less than *MED-EPI*−1.154 (.206) and the equality of the two coefficients could not be rejected. In the regressions which use all CPS-like variables however, the hypothesis is supported.

Table V. Wage Regression Not Controlling for Selection Bias

Variable	Coefficient	Std. Error	Mean
WAGES			2.142
LOW-EPI	−.272**	.103	.173
MED-EPI	−.250**	.100	.191
HIGH-EPI	−.305**	.152	.068
ED	.065**	.016	13.323
TENURE	.006**	.002	49.062
TENURE2/1000	−.015**	.007	5.762
EXPER	.002*	.001	86.315
EXPER2/1000	−.005	.003	16.351
JOBBURN	.082	.103	.204
FEMALE	−.058	.079	.358
DISABL	−.029	.135	.080
UNION	.234**	.091	.222
GOVT	.151	.129	.093
SELF	.109	.128	.093
CONSTANT	1.021**	.222	1.000
Number of Obs.		162	
Adj. R-square		.3295	
Mean Squared Error		.4305	

*Significant at the 10% level
**Significant at the 5% level

wages decline to $7.99 per hour. At the median seizure severity, wages are $8.17 per hour. If the individual had the most severe seizures, then earnings per hour are $7.73. Therefore, in the OLS wage regression, simply having epilepsy reduces wages by approximately $2.50 per hour. Increasing epilepsy severity from the mildest to the most severe forms only reduces earnings by an additional $.26 per hour.

Table VI presents the wage equation corrected for selection bias using Heckman's technique [3; 4]. There is significant selection bias for working people with epilepsy in the wage equation; the marginal significance level for the selectivity term is about 10.25%. (This corroborates the findings of Mitchell and Butler [8] for men with arthritis). More importantly, accounting for selection bias has a substantial impact on the estimated effects of severity on earnings. The point estimates of the wage effects of epilepsy increase in absolute value at all levels of severity. The difference in the point estimates on the severity categories between the OLS and selection bias corrected wage equations increases as the severity of the disorder increases. The average control individual is estimated to earn $10.69 per hour. A similar person with the mildest form of epilepsy earns $8.02 per hour, with average epilepsy severity earns $7.61, and with the most severe epilepsy earns $6.92 per hour. While the difference in mean earnings between the most and least impaired individuals with epilepsy is not statistically significant, the point estimate of the difference is $1.10—which is over four times the estimated differential in the OLS wage regression.[13]

13. The results comparing the OLS wage equation with the selection bias corrected wage equation using the CPS control group are as follows. People with epilepsy earn on average $2.21 less per hour than the CPS control group. While the inverse of the Mill's ratio was insignificantly positive, the estimated impact of seizure severity increased when controlling for selectivity in the wage equation. When selectivity is not controlled for the point estimates (standard errors in

Table VI. Wage Regression Controlling for Selection Bias

Variable	Coefficient	Std. Error	Mean
WAGES			2.142
LOW-EPI	−.287**	.098	.173
MED-EPI	−.340**	.109	.191
HIGH-EPI	−.434**	.162	.068
ED	.063**	.015	13.323
TENURE	.007**	.002	49.062
TENURE2/1000	−.017**	.007	5.762
EXPER	.002**	.001	86.315
EXPER2/1000	−.005*	.003	16.351
JOBBURN	.072	.099	.204
FEMALE	−.086	.077	.358
DISABL	−.094	.132	.080
UNION	.213**	.086	.222
GOVT	.122	.122	.093
SELF	.088	.123	.093
LAMBDA	.200	.123	.417
CONSTANT	.939**	.217	1.000
Number of Obs.		162	
Adj. *R*-square		.3353	
Mean Squared Error		.4096	

*Significant at the 10% level
**Significant at the 5% level

V. Generalizations

Endogenous Education

It is possible to further examine the effect of seizure severity on wages by taking into account the effect of seizure severity on education. Education has a large, positive effect on earnings. People whose disability is not particularly impairing were found to choose additional education. When estimating the effects of severity on earnings above, people with disabilities and the control group are compared at the same levels of education, despite the fact that a similar disabled individual with low severity would have acquired more education than the control individual. As a result, wages would be higher for the low severity disabled group if the endogeneity of education was taken into account.

The indirect effect of seizure severity upon earnings through the impact on years of education can be examined using the following recursive model:

$$ED = \alpha_0 + \alpha_1 LOW\text{-}EPI + \alpha_2 MED\text{-}EPI + \alpha_3 HIGH\text{-}EPI + \sum_i \alpha_i Z_i + \varepsilon$$

$$\text{Ln}\, W = \beta_0 + \beta_1 ED + \beta_2 LOW\text{-}EPI + \beta_3 MED\text{-}EPI + \beta_4 HIGH\text{-}EPI + \sum_i \beta_i X_i + v,$$

parentheses) are *LOW-EPI*−.222 (.083), *MED-EPI*−.125 (.077), and *HIGH-EPI*−.183 (.129). Correcting for selectivity, the estimated impacts of severity increased to *LOW-EPI*−.294 (.108), *MED-EPI*−.343 (.221), and *HIGH-EPI*−.395 (.239). Again, the largest changes in the point estimates when accounting for selectivity were for those at higher levels of impairment.

Table VII. The Wage Effects of Epilepsy: Accounting for Selectivity and Endogenous Education

	OLS	Selection Bias Corrected (SBC)	SBC & Endogenous Education
*CONTROLS**	$10.49	$10.69	$10.69
LOW-EPI	$7.99	$8.02	$8.52
MED-EPI	$8.17	$7.61	$7.59
HIGH-EPI	$7.73	$6.92	$6.71
Estimated (Marginal) Wage Penalty for Having Most Severe Epilepsy:			
	$.26	$1.10	$1.81

*The average wage for the control group was found by subtracting off (β_1 *LOW-EPI* + β_2 *MED-EPI* + β_3 *HIGH-EPI*) from average log wages, where the severity levels were evaluated at their sample means.

where *ED* is years of education, Ln W is the log of hourly wages, and X and Z are vectors of variables affecting earnings and schooling respectively. The total change in the log of wages with respect to, say, *LOW-EPI* is $[\beta_2 + \beta_1(\alpha_1)]$. The selection bias corrected wage equation parameter estimates presented in Table VI are used to compute the effect of severity on wages through education. Because people who have the mildest forms of epilepsy acquire additional education, mean hourly wages for this group are estimated to be $8.52 which is fifty cents higher than when education effects are ignored. For people with the median severity of epilepsy mean earnings are about $7.59. However, accounting for the significantly lower educational attainment of the most severly impaired implies that the average wage for this group is only $6.71. Including the effects of both selectivity and endogenous educational attainment, the estimated differential in hourly wages between the most and the least severely impaired people with epilepsy is $1.80.

The consequences of accounting for selectivity and endogenous education on the estimated effect of seizure severity on hourly wages are summarized in Table VII. In summary, in the OLS wage regression there is a large drop in earnings for simply having epilepsy with only a slight additional penalty for having the most severe form of the disorder. However, accounting for the highly selected sample of people with severe epilepsy who choose to work increased the estimated wage penalty for having severe epilepsy by 423% and only slightly increased the estimated wage differential between the least impaired people with epilepsy and the control group. The wage differential between the least and the most impaired people with epilepsy is further increased when the effect of seizure severity on the choice of years of education is considered. The 63% widening of the wage differential occurred primarily because the least impaired choose an additional year of schooling which increases their earnings by fifty cents. The full loss in earnings (i.e., correcting for selection bias and endogenous education), from having the least severe epilepsy is therefore estimated to be $2.17 per hour while having the most severe epilepsy reduces hourly wages by $3.98.

Severity Interacted with Sex

A possible concern is that the effect of epilepsy has been assumed equal for men and women. To test this hypothesis, the education regression, employment probits, and OLS and selection bias corrected wage regressions were estimated when the severity categories are interacted with sex.[14] In the education and both wage regressions, using either the burn or CPS control groups, the

14. Because of sample size considerations it was not possible to estimate separate regressions for men and women.

hypothesis of equal effects of epilepsy for men and women can not be rejected. However, the effects of seizure severity on the probability of being employed, using either control group, are significantly different for men and women.[15]

Using the burn control sample, epilepsy is a much greater employment deterrent for men than for women. The hypothesis that there is no effect of epilepsy on the probability a woman is employed can not be rejected. Using the CPS control sample, seizure severity is a significant employment deterrent for both women and men. While the CPS is a much larger sample than the burn control group, the CPS does not have good proxies for experience. Since $AGE-ED-6$ may be a worse proxy for the experience of women than men, allowing for differences by sex may be particularly important for the CPS control sample. To test this hypothesis, an employment probit with sex interactions and CPS-like variables was estimated using the burn control sample. A significant effect of epilepsy is found for women using the burn control group if CPS-like variables are used.

Given the assumption of equal effects of epilepsy on the probability of employment for men and women is rejected, the effect of correcting for selection bias in the restricted wage equation was examined when estimating *LAMBDA* from the probit with sex interactions. Qualitatively the results are the same as when the interactions are not included in the employment probit. Using the burn control sample, the estimated marginal penalty to having the most severe epilepsy is sixty-seven cents compared to the estimate of \$1.10 reported in Table VII.[16] Using the CPS control group, the estimated marginal penalty for having the most severe epilepsy is \$2.28 compared to the estimate of sixty-five cents when sex interactions are not included in the probit.[17]

Allowing for differences in the effect of epilepsy by sex is especially important in data sets with poor proxies for experience. There is evidence that, controlling for actual labor market experience, severity is not a factor in determining women's employment. Given the small cell sizes using the burn control sample however, further analysis on sex differences in the effects of a disability on the probability of being employed seems warranted.

VI. Conclusions

By examining a single disorder, epilepsy, this study is able to develop a measure of the severity of a disability and assign the disabled sample into least, average, and most severely impaired groups. Even this relatively simple distinction between people with epilepsy illustrated several important considerations for determining the effects of a disability on labor market performance.

First, it is important to obtain measures of the severity of a disorder even though it may be quite costly to do so. Not surprisingly, the impact of a health limitation is quite different de-

15. The effect of severity on the probability of employment (standard errors in parentheses):

	BURN CONTROLS		CPS CONTROLS	
	MEN	WOMEN	MEN	WOMEN
LOW-EPI	−.907 (.400)	.010 (.382)	−.737 (.298)	−.194 (.289)
MED-EPI	−1.752 (.340)	−.312 (.339)	−1.503 (.213)	−.583 (.214)
HIGH-EPI	−1.327 (.477)	−.391 (.438)	−.886 (.339)	−1.040 (.335)

16. The estimated coefficients and standard errors in the burn control wage regression corrected for selection bias are: *LOW-EPI*−.278 (.098), *MED-EPI*−.289 (.107), *HIGH-EPI*−.366 (.163).

17. The estimated coefficients and standard errors in the CPS control wage regression corrected for selection bias are: *LOW-EPI*−.052 (.142), *MED-EPI*−.240 (.146), *HIGH-EPI*−.325 (.167).

pending upon the level of severity. In fact, as in the case of educational attainment, the effect of severity need not be monotonic. Such differences are masked if only the presence of a disorder is used to explain labor market phenomena.

Second, seizure severity is a substantial determinant of the number of years of education an individual acquires. People with epilepsy whose disorder is the least severe choose an additional year of school compared to the control group and an additional year and one half compared to the people with epilepsy whose seizures are the most impairing.

Seizure severity has a significant negative impact on the probability of employment, especially for men. Since the sample of people with epilepsy who choose to work is nonrandom with respect to severity, selectivity is an issue when estimating a wage equation on a sample of working individuals.

Finally, the wage effects of simply having epilepsy are large and the estimated wage penalty across severity types is magnified when taking account of selectivity and, to a lesser extent, endogenous education. The full effect on earnings, i.e., correcting for selection bias and endogenous education, to having even the most mild epilepsy is estimated to be $2.17 per hour while having the most severe epilepsy reduces hourly wages by $3.98.

The results from this study suggest that the effects of the severity of the disability may be important in analyzing the impact of education, training, and rehabilitation programs for the disabled. Because the effects of the severity of a disability are likely to be specific to each disorder, additional empirical work on the effects of disabilities on labor market performance are required before public policy prescriptions for improving the welfare of the disabled can be made.

Appendix I. Means of the Seizure Data

VARIABLE NAME	FAMULARI SAMPLE	DODRILL SAMPLE
HALSTEAD	.636*	.546
ANTI-EPILEPTIC DRUGS (AED):		
NUMBER (NUMAED)	1.532	1.877
MG/KG #1	10.630	6.908
MG/KG ALL TYPES	16.127	13.891
SEDATING #1 (%)	.058	.060
AED STABILIZED (%)	.520	.812
YEARS AED	18.005	11.098
ONSET (years)	14.705	13.830
NOSEIZ (years)	.377	1.261
WISEIZ (years)	18.555	11.290
DURATN (years)	18.933	14.935
PRECIPITATING FACTORS:		
HAS PF:SLEEP (%)	.094	.194
HAS PF:FATIGUE (%)	.269	.455
HAS PF:EMOTION (%)	.485	.638
HAS PF:ALCOHOL (%)	.082	.179
HAS PF:MENSES (%)	.123	.227
HAS PF:OTHER (%)	.205	.254
HAS ANY PF (%)	.655	.860
ETIOLOGY KNOWN (%)	.550	.498
HAS AURA (%)	.480	.648
HAD STATUS (%)	.152	.264
HAS FAMILY HISTORY (%)	.269	.276

Appendix I. Continued

VARIABLE NAME	FAMULARI SAMPLE	DODRILL SAMPLE
FREQ SEIZURES #1	10.892	12.308
FREQ SEIZURES #2	1.643	.878
FREQ ALL SEIZURE TYPES	13.492	14.061
AGE	33.637	28.738
EDUCATION	13.267	11.604
SAMPLE SIZE	171	787

*For the Famulari sample, *HALSTEAD* is the predicted score.

Appendix II. Regression of Halstead-Reitan Neuropsychological Test Battery Scores on Seizure Characteristics, Dodrill Sample

VARIABLE	COEFFICIENT	STANDARD ERROR
DURATION	.007211	(.00168)**
ONSET	.004275	(.00123)**
ETIOLOGY	.032654	(.02146)
FAMHIST	.016129	(.02377)
PFSLEEP	−.021333	(.02769)
PFFATIGUE	−.034013	(.02312)
PFEMOTION	.037759	(.02656)
PFALCOHOL	−.029043	(.02898)
PFMENSES	.040550	(.02677)
PFOTHER	−.002839	(.02521)
FREQ1	.000070	(.00131)
FREQ2	−.017422	(.02002)
AURA	−.070057	(.02223)**
STATUS	−.023189	(.02376)
NOSEIZ	−.012449	(.00427)**
TOTAL	.000250	(.00099)
WISEIZ	.005740	(.00223)**
YRSAED	−.001274	(.00210)
HASPF	−.034813	(.03882)
AED1	.004461	(.00551)
SEDATN1	.018616	(.05227)
SNUM1	.000024	(.00027)
SNUM2	.005492	(.00473)
MGKG1	−.006209	(.00302)**
NUMAED	.018035	(.01657)
MGKGALL	.003026	(.00128)**
MEDSTABL	.005146	(.02701)
SEIZ1	.008815	(.00816)
SEIZ2	.004618	(.00532)
CONSTANT	.301930	(.07192)**
R^2		.1460
SAMPLE SIZE		787

**Significant at the 5% level or better

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