

Chronic conditions in adults with cerebral palsy.

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Running Title: Chronic Conditions in Cerebral Palsy

Word Count: 639

Revision Data: 08/10/2015

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Introduction

Adults with cerebral palsy (CP) represent a growing population whose health status and healthcare needs are poorly understood.¹ Mortality records reveal that death due to ischemic heart disease and cancer is higher among adults with CP;² however, there have been no national surveillance efforts to track disease risk in this population. We examined estimates of chronic conditions in a population-representative sample of adults with CP.

Methods

We used the Full Year Consolidated and Medical Conditions files for 9 years of the Medical Expenditure Panel Survey (MEPS) (2002-2010). MEPS is an ongoing, nationally representative survey of the U.S. civilian, non-institutionalized population, conducted annually by the Agency for Healthcare Research and Quality.³ Data are collected by interviews, with a single respondent for the household, with a mean response rates of 60%. The survey has been reviewed and approved by the Westat IRB, established under a multi-project assurance granted by the Office for Protection from Research Risks; the requirement for informed consent was waived. Adjustments were made for the complex survey design of MEPS. Adults were identified as participants with congenital or infantile CP if an ICD-9-CM Diagnosis Code of 343 was associated with an office-based, hospital outpatient, or emergency department visit, a hospital inpatient stay, or a prescription medication.

Age-adjusted prevalence rates for 8 chronic conditions were evaluated in adults with and without CP, a subset of the priority condition section defined by the US Department of Health and Human Services workgroup, selected to reflect lifestyle-related behaviors: diabetes, asthma, hypertension, other heart conditions (including cardiovascular disease, heart attack, angina, and other cardiovascular conditions), stroke, emphysema, joint pain, and arthritis. For each, a logistic regression model was fitted, adjusting for age, sex, weight status, race/ethnicity, marital status, education, income, type of health insurance, physical and

mental health, physical activity, disability, metropolitan statistical area, and geographical location. All analyses were completed using Stata, version 13 (StataCorp LP), with 2-sided 95% confidence intervals to determine significance.

Results

Of the 207,615 adults included, 1,015 had CP. Participants with and without CP differed on many characteristics, including age (58.2 vs 45.4 years), sex (65.9% vs 51.7% male) and race (92.7% vs 69.0% white) (Table 1).

Age-adjusted prevalence of all chronic conditions were significantly greater among adults with vs without CP, including diabetes (9.2% vs. 6.3%), asthma (20.7% vs. 9.4%), hypertension (30.0% vs. 22.1%) and other heart conditions (15.1% vs. 9.1%), stroke (4.6% vs. 2.3%), emphysema (3.8% vs. 1.4%), joint pain (43.6% vs. 28.0%), and arthritis (31.4% vs. 17.4%) (all: $p < 0.001$). Adjusted odds ratios were significantly different for all conditions except diabetes and ranged from 1.32 (95% CI, 1.04-1.67) for hypertension to 2.03 (95% CI, 1.39-2.97) for emphysema. Age, sex, weight, physical disability, overall health and physical activity were also associated with chronic conditions (Table 2).

Discussion

In this population-based sample, adults with CP had significantly higher odds of chronic diseases compared with adults without CP-raising important questions about preventable health complications in this population.

Accelerated functional losses are a concern in the aging CP population. A large percentage of individuals who were once mobile eventually stop ambulating, due to fatigue, inefficiency of gait, and/or muscle and joint pain.⁴ The current findings demonstrated that level of mobility impairment was strongly associated with chronic conditions.

This study was limited by the inability to determine cause-effect relationships between CP and chronic conditions; reliance on self-report data from a household member;

and a borderline acceptable (60%) response rate. The sample of adults with CP may not be entirely representative of the total population of adults with CP. Approximately half of adults with CP reported having a minor or no disability, suggesting that the group was particularly high functioning. Future efforts are needed to better understand the healthcare utilization associated with chronic conditions for persons with CP and to characterize the relationship between mobility impairments, sedentary lifestyles and chronic conditions.

Acknowledgement:

Drs. Mark Peterson and Elham Mahmoudi had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Funding Sources

Dr. Peterson is funded by the National Institutes of Health (1KO1HD074706).

Role of the Sponsors: The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Disclosures

The authors report no conflicts of interest.

References

1. Peterson MD, Gordon PM, Hurvitz EA. Chronic disease risk among adults with cerebral palsy: the role of premature sarcopenia, obesity and sedentary behaviour. *Obesity reviews* : 2013;14(2):171-182.
2. Strauss D, Cable W, Shavelle R. Causes of excess mortality in cerebral palsy. *Dev Med Child Neurol*. Sep 1999;41(9):580-585.
3. Cohen JW, Monheit AC, Beauregard KM, et al. The Medical Expenditure Panel Survey: a national health information resource. *Inquiry: a journal of medical care organization, provision and financing*. 1997;33(4):373.
4. Murphy K, Molnar G, Lankasky K. Employment and social issues in adults with cerebral palsy. *Archives of Physical Medicine and Rehabilitation*. 2000;81:807-811.

Table 1: Characteristics of Adults with and without Cerebral Palsy, Ages 18 and Over.

	Without CP (n=206,600)		With CP (n=1,015)		Difference
	Weighted Percentage	95% CI	Weighted Percentage	95% CI	<i>p</i> -value
Independent Variables:					
Age, years*	45.38	45.07-45.58	58.19	56.93-59.57	<0.001
Male, % *	51.7	51.4-52.0	65.9	61.6-70.3	<0.001
Weight Status by BMI Category, %					
Underweight (BMI <18.5 kg/m ²)	1.7	1.6-1.8	2.0	0.7-2.9	0.861
Normal Weight (BMI 18.5-24.9 kg/m ²)	34.4	34.0-34.9	25.4	21.9-29.0	<0.001
Overweight (BMI 25-29.9 kg/m ²)	34.2	33.8-34.5	31.2	27.7-34.8	0.114
Obese (BMI>30 kg/m ²)	29.7	29.3-30.1	41.4	37.2-45.6	<0.001
Physical Disability Status					
Minor or No Disability	82.0	81.5-82.4	48.7	44.3-53.3	<0.001
Moderate Physical Disability	4.9	4.7-5.1	8.9	6.7-11.1	<0.001
Severe Physical Disability	11.3	10.9-11.6	40.6	36.4-44.8	<0.001
Race/ethnicity, %					
Non-Hispanic White*	69.0	67.8-70.1	92.7	90.7-94.7	<0.001
Non-Hispanic Black*	11.3	10.6-12.0	2.5	1.5-3.7	<0.001
Hispanic or Mexican American*	13.2	12.4-14.1	2.4	1.5-3.3	<0.001
Other Race*	6.5	6.0-7.0	2.3	0.9-3.7	<0.001
Type of Insurance, %					
Any private insurance	70.4	69.7-71.1	68.0	63.9-72.1	0.199
Public insurance only*	14.9	14.5-15.5	28.4	24.9-32.3	<0.001
No insurance*	14.6	14.1-15.1	3.4	1.9-4.9	<0.001
Geographic Region, %					
Northeast*	18.7	17.8-19.7	13.4	9.9-17.0	0.003
Midwest	22.2	21.0-23.3	26.3	22.3-30.3	0.063
South	36.2	34.9-37.6	38.1	33.5-42.7	0.359
West	22.9	21.6-24.1	22.1	18.3-25.9	0.736
MSA, % *	83.1	81.7-84.6	76.1	71.7-80.5	0.002
Good Health, % *	87.1	86.7-87.4	65.5	61.6-69.4	<0.001
Good Mental Health, % *	92.8	92.6-93.1	80.2	77.1-83.2	<0.001
Regular Physical Activity (≥3 Days Per Week)	57.7	57.1-58.3	39.0	35.2-42.7	<0.001
Smoker	20.4	20.0-20.9	19.7	16.4-23.1	0.695

Table 1 Continued

	Without CP (n=206,600)		With CP (n=1,015)		Difference
	Weighted Percentage	95% CI	Weighted Percentage	95% CI	p-value
Dependent Variables: Age-Adjusted Prevalence, %					
Diabetes*	6.3	6.1-6.5	9.2	7.4-11.1	<0.001
Asthma*	9.4	9.1-9.7	20.7	17.3-24.2	<0.001
Hypertension*	22.1	21.8-22.4	30.0	26.1-33.5	<0.001
Other Heart Conditions*	9.1	8.9-9.3	15.1	12.9-17.4	<0.001
Stroke*	2.3	2.2-2.4	4.6	3.5-5.7	<0.001
Emphysema*	1.4	1.3-1.5	3.8	2.6-4.9	<0.001
Joint pain*	28.0	27.5-28.5	43.6	39.4-47.7	<0.001
Arthritis*	17.4	17.1-17.7	31.4	28.3-34.5	<0.001

Note: The variables listed are the explanatory variables in the estimated regression models. For all analyses we adjusted data for the clustered and stratified survey design of MEPS, and weighted all estimates using the supplied weight by the Agency for Healthcare Research and Quality (AHRQ).

Note: For race/ethnicity, we considered individuals of any race claiming to be of Hispanic origin as Hispanic or Mexican American. Others were classified as Non-Hispanic black, Non-Hispanic white, or other race, by their responses to the question about race.

Note: Variable-specific nonresponse rates generally ranged from 0-3%. Several variables, including body mass index (BMI), physical disability, physical activity participation, and smoking status showed nonresponse rates in the 5–15% range. For these and all other independent variables, we used a multiple imputation technique to estimate missing values. Five complete sets of data were created to allow for re-estimation of regression models, as well as re-estimation of prevalence of chronic conditions for each complete set of data. Thereafter, average estimates were used in order to incorporate the uncertainty of the missing data into the standard errors. After controlling for missing data and cases with non-positive weights, the final sample sizes for each regression model ranged between 199,048 and 201,801 individuals.

Note: There were no significant differences between adults with CP compared to adults without CP for weighted percentages of marital status, highest levels of education, household income status, or smoking status.

Source: Data comes from the household and condition files of the 2002-2010 Medical Expenditure Panel Survey.

Table 2. Estimates of diabetes, hypertension, other heart conditions, stroke, asthma, emphysema, joint pain, arthritis, and various select covariates for adults with cerebral palsy as compared to adults without cerebral palsy.

^a Variables	Diabetes <i>n</i> = 200,935		Hypertension <i>n</i> = 199,567		Other Heart Conditions <i>n</i> = 199,639	
	Odds Ratio	95% CI	Odds Ratio	95% CI	Odds Ratio	95% CI
Cerebral Palsy	1.18	0.92-1.51	1.32	1.04-1.67	1.40	1.12-1.76
<i>^bCerebral Palsy: Unadjusted Analyses</i>	2.63	2.09-3.31	3.13	2.56-3.83	3.37	2.75-4.14
Age	1.05	1.04-1.05	1.07	1.06-1.07	1.05	1.04-1.05
Sex (Reference: Male)	0.81	0.76-0.86	0.85	0.82-0.88	0.78	0.74-0.81
Weight Status by BMI Category (Reference: Normal Weight)						
Underweight (BMI <18.5 kg/m ²)	0.32	0.24-0.43	0.59	0.49-0.70	0.96	0.81-1.15
Overweight (BMI 25-29.9 kg/m ²)	1.86	1.73-2.01	1.86	1.78-1.94	1.04	0.99-1.10
Obese (BMI >30 kg/m ²)	4.37	4.05-4.71	3.76	3.59-3.94	1.28	1.21-1.36
Physical Disability Status (Reference: Minor or No Disability)						
Moderate Physical Disability	1.45	1.32-1.60	1.42	1.33-1.52	1.61	1.47-1.77
Severe Physical Disability	1.59	1.48-1.71	1.49	1.42-1.57	1.91	1.79-2.03
Self-Rated Health (Reference: Poor Health)	0.39	0.37-0.42	0.51	0.49-0.54	0.44	0.41-0.47
Self-Rated Mental Health (Reference: Poor Mental Health)	1.04	0.97-1.12	0.98	0.93-1.05	1.00	0.93-1.07
Regular Physical Activity (Reference: <3 Days Per Week)	0.86	0.82-0.90	0.91	0.88-0.94	0.98	0.94-1.02
Smoking Status (Reference: Non-Smoker)	0.95	0.88-1.02	1.04	0.99-1.09	1.02	0.97-1.08

Abbreviations: CI-Confidence Interval; BMI-Body Mass Index; HS-High School; MSA-Metropolitan Statistical Area

^aAll results are multivariable adjusted except as noted. In addition, all models are adjusted for numerous sociodemographic covariates including education, income level, marital status, race and ethnicity, type of health insurance, metropolitan statistical area, and geographic location.

^bUnadjusted (i.e., univariate) ORs and 95% CIs for the association between CP and each chronic disease outcome.

Table 2 Continued

^a Variables	Stroke <i>n</i> = 199,771		Asthma <i>n</i> = 201,801		Emphysema <i>n</i> = 199,794	
	Odds Ratio	95% CI	Odds Ratio	95% CI	Odds Ratio	95% CI
Cerebral Palsy	1.59	1.18-2.15	1.65	1.31-2.07	2.03	1.39-2.97
^b <i>Cerebral Palsy: Unadjusted Analyses</i>	4.08	3.08-5.41	2.41	1.94-2.99	5.30	3.71-7.57
Age	1.06	1.05-1.06	0.99	0.98-0.99	1.05	1.04-1.05
Sex (Reference: Male)	0.84	0.77-0.92	1.53	1.45-1.60	0.64	0.57-0.72
Weight Status by BMI Category (Reference: Normal Weight)						
Underweight (BMI <18.5 kg/m ²)	1.12	0.87-1.44	0.97	0.80-1.16	2.05	1.56-2.70
Overweight (BMI 25-29.9 kg/m ²)	1.06	0.96-1.17	1.26	1.19-1.34	0.85	0.74-0.99
Obese (BMI >30 kg/m ²)	1.07	0.96-1.18	1.59	1.50-1.69	0.98	0.85-1.13
Physical Disability Status (Reference: Minor or No Disability)						
Moderate Physical Disability	1.74	1.51-2.01	1.67	1.53-1.83	1.87	1.54-2.26
Severe Physical Disability	2.96	2.68-3.26	1.97	1.82-2.12	2.68	2.33-3.07
Self-Rated Health (Reference: Poor Health)	0.54	0.49-0.59	0.56	0.52-0.60	0.43	0.39-0.48
Self-Rated Mental Health (Reference: Poor Mental Health)	0.67	0.61-0.73	0.89	0.82-0.97	1.00	0.88-1.14
Regular Physical Activity (Reference: <3 Days Per Week)	0.90	0.83-0.98	1.01	0.97-1.06	0.80	0.72-0.89
Smoking Status (Reference: Non-Smoker)	1.19	1.07-1.32	1.07	1.01-1.14	3.71	3.31-4.15

Abbreviations: CI-Confidence Interval; BMI-Body Mass Index; HS-High School; MSA-Metropolitan Statistical Area

^aAll results are multivariable adjusted except as noted. In addition, all models are adjusted for numerous sociodemographic covariates including education, income level, marital status, race and ethnicity, type of health insurance, metropolitan statistical area, and geographic location.

^bUnadjusted (i.e., univariate) ORs and 95% CIs for the association between CP and each chronic disease outcome.

Table 2 Continued

^a Variables	Joint Pain <i>n</i> = 199,048		Arthritis <i>n</i> = 199,366	
	Odds Ratio	95% CI	Odds Ratio	95% CI
Cerebral Palsy	1.35	1.10-1.66	1.71	1.38-2.11
<i>^bCerebral Palsy: Unadjusted Analyses</i>	<i>3.40</i>	<i>2.83-4.08</i>	<i>4.87</i>	<i>4.06-5.85</i>
Age	1.03	1.02-1.03	1.06	1.05-1.06
Sex (Reference: Male)	1.14	1.11-1.17	1.68	1.62-1.75
Weight Status by BMI Category (Reference: Normal Weight)				
Underweight (BMI <18.5 kg/m ²)	0.69	0.61-0.78	0.68	0.57-0.81
Overweight (BMI 25-29.9 kg/m ²)	1.28	1.24-1.33	1.46	1.40-1.54
Obese (BMI >30 kg/m ²)	1.73	1.66-1.80	2.10	2.00-2.21
Physical Disability Status (Reference: Minor or No Disability)				
Moderate Physical Disability	4.11	3.84-4.39	3.26	3.04-3.51
Severe Physical Disability	4.21	3.97-4.45	4.27	4.03-4.53
Self-Rated Health (Reference: Poor Health)	0.56	0.54-0.59	0.58	0.55-0.61
Self-Rated Mental Health (Reference: Poor Mental Health)	0.81	0.77-0.86	0.90	0.83-0.96
Regular Physical Activity (Reference: <3 Days Per Week)	1.14	1.10-1.18	1.13	1.08-1.17
Smoking Status (Reference: Non-Smoker)	1.24	1.20-1.29	1.23	1.17-1.29

Abbreviations: CI-Confidence Interval; BMI-Body Mass Index; HS-High School; MSA-Metropolitan Statistical Area

^aAll results are multivariable adjusted except as noted. In addition, all models are adjusted for numerous sociodemographic covariates including education, income level, marital status, race and ethnicity, type of health insurance, metropolitan statistical area, and geographic location.

^bUnadjusted (i.e., univariate) ORs and 95% CIs for the association between CP and each chronic disease outcome.