Published in final edited form as:

Ann Intern Med. 2019 September 03; 171(5): 328–333. doi:10.7326/M18-3420.

Prevalence of mental health disorders among adults with cerebral palsy: A cross-sectional analysis

Daniel G. Whitney, PhD[1,2,3], **Seth A. Warschausky, PhD**[1], **Sophia Ng, MPH, PhD**[3], **Edward A. Hurvitz, MD**[1], **Neil S. Kamdar, MA**[3,4,5,6], **Mark D. Peterson, PhD, MS**[1,3]

[1]Department of Physical Medicine and Rehabilitation, Michigan Medicine, University of Michigan, Ann Arbor, MI, USA

[2]University of Michigan Depression Center, University of Michigan, Ann Arbor, MI, USA

[3]Institute for Healthcare Policy and Innovation, University of Michigan, Ann Arbor, MI, USA

[4]Department of Obstetrics and Gynecology, University of Michigan, Ann Arbor, MI, USA

[5]Department of Surgery, University of Michigan, Ann Arbor, MI, USA

[6]Department of Emergency Medicine, University of Michigan, Ann Arbor, MI, USA

Abstract

Background: Individuals with cerebral palsy (CP) have increased risk for secondary chronic conditions during childhood, including mental health disorders; yet, little is known about how these disorders affect adults with CP.

Objective: To determine the prevalence of mental health disorders among adults with CP, compared to adults without CP.

Design: Cross-sectional.

Setting: 2016 Optum Clinformatics® Data Mart.

Patients: 8.7 million adults (including 7,348 adults with CP).

Measurements: Other neurodevelopmental comorbid conditions (intellectual disabilities, autism spectrum disorders, epilepsy) and 37 mental health disorders (as 6 categories) were identified based on diagnosis codes. Direct age-standardized prevalence of mental health disorder categories was estimated by sex for patients with CP alone, patients with CP and neurodevelopmental disorders, and patients without CP.

Results: Male patients with CP alone had higher age-standardized prevalence compared to male patients without CP for schizophrenic disorders (2.8% [95%CI: 2.2%, 3.4%] vs. 0.7%), mood affective disorders (19.5% [95%CI: 18.0%, 21.0%] vs. 8.1%), anxiety disorders (19.5%

Corresponding author: Mark D. Peterson, PhD, MS, Department of Physical Medicine and Rehabilitation, Michigan Medicine, University of Michigan, Ann Arbor, MI, Phone: 734-936-7175, Fax: 734-615-1770, mdpeterz@med.umich.edu.

Protocol: not available

Statistical Code: Available to interested readers by contacting Dr. Peterson at mdpeterz@umich.edu

Data: not available

[95%CI: 18.0%, 21.0%] vs. 11.1%), disorders of adult personality/behavior (1.2% [95%CI: 0.8%, 1.6%] vs. 0.3%), and alcohol and/or opioid related disorders (4.7% [95%CI: 3.9%, 5.5%] vs. 3.0%). The same pattern was observed for females. Male and female patients with CP and neurodevelopmental disorders had similar or higher age-standardized prevalence of the 6 mental health disorder categories compared to male and female patients with CP alone, except for the lower prevalence of alcohol and/or opioid related disorders for male patients.

Limitations: Single claims code was used to define cohort of interest. Severity of CP was not available.

Conclusion: Adults with CP have an elevated prevalence of mental health disorders compared to adults without CP, which may be more pronounced for some mental health disorders among patients with comorbid neurodevelopmental disorders.

Introduction

Cerebral palsy (CP) is the most common physical disability of childhood (1), and represents a heterogeneous group of movement disorders with a range of motor impairment severities. CP is associated with several developmental comorbidities (e.g., communication impairment) and always involves the potential for restriction in activities of daily living. The adult CP population is expanding due to increased survival rates (2) and stable or marginally increased global prevalence of the condition (3) over recent decades. Children and adolescents with CP experience an array of health-and function-related problems affecting neuromuscular (4), musculoskeletal (5, 6), and other physiologic systems (7); these health and functional problems may increase in severity as they transition into and throughout adulthood (8–11). Consequently, individuals with CP are at increased risk of developing chronic, noncommunicable diseases at younger ages and in more severe forms as compared to the general population (9, 10, 12, 13). Despite being considered a neurological syndrome caused by a non-progressive brain injury or malformation, the hallmark features of CP represent a highly progressive phenotype of “early aging” (14–16).

Mental health disorders are among the leading contributors to the overall global and national burden of disease in children, adolescents, and adults (17, 18). Mental health disorders that arise during childhood can impede healthful transition into adulthood (19), and are associated with adverse health outcomes as adults (19, 20). To date, there is a general lack of clinical awareness and resources for mental health disorders for individuals with CP. Nevertheless, recent work suggests that children (21, 22) and adults (23–25) with CP may have a higher risk for mental health disorders compared to individuals without CP. However, these studies were performed outside of the U.S., had small samples sizes, and in most cases, used questionnaires not designed for individuals with disabilities. Therefore, there is a need to describe the prevalence of physician-diagnosed mental health disorders in a broader sample of individuals with CP. Notably, the association between CP and mental health disorders may be influenced by comorbid neurodevelopmental conditions. The prevalence of intellectual disabilities, autism spectrum disorders, and epilepsy among individuals with CP has been reported as 45% (26), 6.9%, and 41% (27), respectively, and these conditions are themselves associated with mental health disorders (28–30).

Thus, the primary objective of this study was to determine the prevalence of mental health disorders among patients with CP alone, patients with CP and neurodevelopmental disorders, and patients without CP. We hypothesized that patients with CP will have a higher prevalence of all mental health disorders compared to patients without CP, which would be more pronounced among patients with comorbid neurodevelopmental disorders.

Methods

Data source

The Clinformatics® Data Mart Database (OptumInsight™, Eden Prairie, MN, USA) is a nationwide, de-identified insurance claims database of 79 million beneficiaries from a single private payer from 2001 to 2017. This administrative database contains information about all beneficiaries with both medical and pharmacy coverage. All inpatient and outpatient services, emergency room visits, and outpatient pharmacy prescription fills are included in this dataset throughout their enrollment. The University of Michigan Institutional Review Board approved this study as exempt.

Sample selection

The study period for this analysis was January 1 to December 31, 2016. All individuals 18 years of age and older that had 12 months of continuous enrollment in 2016 were potentially eligible for this analysis. Individuals were excluded if they did not have an inpatient, outpatient, or emergency room visit reporting a diagnostic code while enrolled in 2016 to eliminate risk of bias as we were unable to identify any diagnoses. Individuals were excluded if they had missing data on sex since the results are stratified by sex. This analysis used inpatient, outpatient, and emergency room visits, but not pharmacy claims, to identify eligible participants and diagnoses.

Identification of Patients with Cerebral Palsy, Neurodevelopment Disorders, and Mental Health Disorders

The diagnosis of CP was identified based on a single encounter (i.e., inpatient, outpatient, or emergency room visit) that included one of the pertinent International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10) codes for CP (in any position) (see Appendix 1 for list of codes). Neurodevelopmental disorders were identified based on a single encounter (i.e., inpatient, outpatient, or emergency room visit) that used one of the pertinent ICD-10 codes (in any position) for intellectual disabilities, autism spectrum disorders, or epilepsy. We created a binary variable to indicate the presence or absence of neurodevelopmental conditions in all patients. Thus, the final sample was categorized as patients with CP alone, patients with CP and neurodevelopmental disorders, and patients without CP.

Mental Health Disorders

Physician-diagnosed mental health disorders were also identified based on a single encounter (i.e., inpatient, outpatient, or emergency room visit) that included at least one of pertinent ICD-10 codes (in any position) (see Appendix 1 for list). The 37 mental health conditions and their variations (e.g., severity, episodic/recurrent, unspecified) on this list of

codes were grouped into six categories: (1) schizophrenia, schizotypal, delusional, and other non-mood psychotic disorders (8 disorders); (2) mood affective disorders (6 disorders); (3) anxiety, dissociative, stress-related, somatoform, and other nonpsychotic mental disorders (7 disorders); (4) behavioral syndromes associated with physiological disturbances and physical factors (e.g., eating disorders, puerperal psychosis; 7 disorders); (5) disorders of adult personality and behavior (7 disorders); and (6) alcohol or opioid related disorders (2 disorders).

Statistical analysis

Sociodemographic variables included age, sex, ethnic group, education level, and household annual income. We performed direct age-standardization for females and males for each of the six mental health disorder categories for each group (i.e., CP alone, CP and neurodevelopmental disorders, without CP), using the 2016 U.S. adult population as a standard population. We used the U.S. Census Bureau table on age and sex composition in the United States for 2016 (31) with eighteen 5-year age brackets. In order to make use of this table, it was assumed that age was evenly distributed within the 15–19 year age bracket. Therefore, since 6.8% of U.S. males were 15–19 years old, it was assumed that 2.72% males were 18–19 years old (6.8% × (2/5)). Similarly, since 6.3% of U.S. females were 15–19, it was assumed that 2.64% females were 18–19 years old (6.6% × (2/5)).

Direct age-standardization method was applied (32). Age specific outcome prevalence was estimated using the study population. The study population prevalence rates were then applied to the 2016 U.S. adult population by age brackets. This procedure was repeated for each group (i.e., CP alone, CP and neurodevelopmental disorders, without CP). We calculated 95% binomial confidence intervals for the prevalence estimates as the sample proportion plus and minus the margin of error using a z-value of 1.96.

In addition to the primary analyses, we performed a sensitivity analysis to determine age-standardized prevalence estimates of mental health disorders, but with the requirement of including only those with at least two claims during the enrollment year for each mental health disorder category. All variables were summarized as mean (SD) or percentage. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Role of the Funding Source

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

Results

Of the 10.3 million adults with 12 months of continuous enrollment in 2016, 1.6 million members (15.1%) were excluded because they did not have an inpatient, outpatient, or emergency room visit while enrolled in 2016. Another 991 (<0.01%) individuals were excluded because of missing data on sex. The final sample comprised 8.7 million individuals. Overall, the prevalence of CP was 0.84 per 1,000 for the entire sample. The prevalence of neurodevelopmental comorbidities among the entire sample for adults with

vs. without CP was 13.5% (95%CI: 12.7, 14.3) vs. 0.1% for intellectual disabilities, 2.3% (95%CI: 2.0, 2.7) vs. 0.1% for autism spectrum disorders, and 24.3% (95% CI: 23.3, 25.3) vs. 1.1% for epilepsy, respectively. Descriptive characteristics of patients with CP alone (n=5,052), patients with CP and neurodevelopmental disorders (n=2,296), and patients without CP (n=8.7 million) are presented in Table 1.

Age-standardized prevalence of mental health disorder categories stratified by group and sex is presented in Table 2. Female and male patients with CP had higher prevalence of all mental health disorder categories (e.g., anxiety disorders: female 28.6% [95%CI: 26.8, 30.4] vs. 18.0%; men 19.5% [95%CI: 18.0, 21.0] vs. 11.1%) compared to patients without CP, except for behavioral syndromes associated with physiological disturbances and physical factors (female: 2.0% [95%CI: 1.5, 2.5] vs. 1.8%; men: 2.1% [95%CI: 1.5, 2.7] vs. 1.7%). Female and male patients with CP and neurodevelopmental disorders had similar or higher prevalence of all mental health disorder categories compared to patients with CP alone (e.g., schizophrenic disorders: female 7.3% [95%CI: 5.8, 8.8] vs. 3.2% [95%CI: 2.5, 3.9]; men 6.5% [95%CI: 5.1, 7.9] vs. 2.8% [95%CI: 2.2, 3.4]), except for the lower prevalence of alcohol and/or opioid related disorders for male patients (2.4% [95%CI: 1.5, 3.3] vs. 4.7% [95%CI: 3.9, 5.5]).

The results of the sensitivity analysis requiring two or more claims on different days for each mental health disorder category are presented in Appendix Table 2. Interpretations were largely unchanged. Briefly, female and male patients with CP had higher prevalence of all mental health disorder categories (e.g., mood effective disorders: female 20.6% [95%CI: 19.0, 22.2] vs. 9.1%; men 13.1% [95%CI: 11.8, 14.4] vs. 5.2%) compared to patients without CP, except again for behavioral syndromes associated with physiological disturbances and physical factors (female: 1.2% [95%CI: 0.8, 1.6] vs. 0.8%; men: 0.6% [95%CI: 0.3, 0.9] vs. 0.6%), as well as alcohol and/or opioid related disorders for females (1.5% [95%CI: 1.0, 2.0] vs. 1.0%). Female and male patients with CP and neurodevelopmental disorders had similar or higher prevalence of all mental health disorder categories compared to patients with CP alone.

Conclusions

We found a higher prevalence of a variety of mental health disorders among adults with CP compared to adults without CP. The prevalence of several mental health disorder categories was also higher among patients with CP who also had comorbid neurodevelopmental disorders, except for alcohol and/or opioid related disorders among male patients. This is a critical finding, because mental health disorders are a primary contributor to the burden of disease in adults (17) and children (18) in general, and can be prevented or treated if adequate clinical screening is established.

Noncommunicable diseases and multimorbidity are increasingly burdensome with the expansion of the aging population. In the U.S., care coordination and healthcare access are woefully insufficient in meeting the complex healthcare needs of individuals with pediatric-onset disabilities (including CP) across the lifespan (33–36). This can lead to missed opportunities to properly diagnose and treat preventable noncommunicable diseases,

such as mental health disorders. Even prior to the 4th decade of life, young adults with CP exhibit a higher prevalence of chronic diseases and a multimorbidity profile that is more than four times higher than adults without CP (10). Further, this morbidity profile (10, 12) gets worse with older age (9).

To date, there is a paucity of information pertaining to prevalence estimates of mental health disorders among individuals with CP. A few studies have recently addressed this gap in the literature by showing that children, adolescents (21, 22), and adults (23–25) with CP have higher prevalence of mental health disorders or symptoms of mental health disorders compared to the general population. However, most of these findings were derived using instruments (e.g., surveys, questionnaires) rather than medical diagnoses (e.g., ICD-10 codes). Since the instruments used were not designed for use among individuals with disabilities, the results may be more reflective of the general problems experienced by this population, rather than actual mental health conditions (21). For example, problems with sleep, pain, and other symptoms of CP, as well as medication side effects, may increase symptomatology of adverse mental health functioning; although, mental health disorders may also lead to problems with sleep and exacerbate pain. Nevertheless, individuals with CP are at a heightened risk for developing mental health disorders due to a variety of factors that may be directly associated with CP (e.g., communication impairment), or as a resulting sequela of their condition (e.g., morbidity profile, pain, low fitness levels). Ultimately, these factors may independently or synergistically impair physical, emotional, social, and mental functioning and participation throughout the lifespan in this population.

Comorbid neurodevelopmental conditions, such as intellectual disabilities, autism spectrum disorders, and epilepsy may be associated with the development of mental health disorders among the CP population. This is because these conditions are each associated with a higher prevalence of mental health disorders (28–30), due to a variety of physical and social factors affecting independence, social integration, and transition towards adulthood (28, 37–41). A recent study of over 3,000 individuals with CP found that comorbid neurodevelopmental conditions were associated with an overall greater medical complexity (26). In the current study, we accounted for neurodevelopmental disorders by stratifying the CP group by the presence of these conditions. We found that adults with CP alone had higher prevalence of many mental health disorder categories that were medically diagnosed, compared to a representative-sample of adults without CP. We also found that comorbidity of neurodevelopmental disorders was associated with a similar or elevated prevalence of mental health disorders, except for alcohol and/or opioid related disorders among male patients.

A major strength of this study is the large sample of adults with CP. It can be challenging to gather data on clinical sub-populations, and very little is known about health outcomes among individuals with CP as they age into and throughout their adult years. Another strength of this study is the number of mental health disorders that were investigated. Our comprehensive assessment of medically-diagnosed mental health disorder profiles among individuals with CP throughout the adult lifespan may prompt the development of improved screening strategies and identification of at-risk individuals for mental health disorders.

Our study also has several limitations that should be acknowledged. First, the overall sample may represent a healthier segment of the U.S. population, as evidenced by the low prevalence of neurodevelopmental comorbidities among the CP and non-CP samples. Further, the sample with CP may not be entirely representative of the U.S. population of adults with CP, as further evidenced by a lower than expected prevalence. We were unable to determine the severity of CP through claims-based data. However, we suspect that our sample may be more reflective of a healthier segment of the CP population (42), because they had to be enrolled in private insurance, either by purchasing their own insurance, or by being covered through employment or marriage to someone who had private insurance. Individuals with more severe forms of CP may be more likely to be on federally-subsidized health insurance, Medicare, or Medicaid state-sponsored programs. Therefore, results and comparisons to adults without CP are likely conservative estimates, and the true extent of mental health disorder prevalence may be underestimated in this study. Second, administrative claims data may be prone to inaccurate coding of medical diagnoses, such as CP or mental health disorders, and we used a single claim to identify beneficiaries with CP, neurodevelopmental disorders, or mental health disorders, which may have an effect on our prevalence estimates. While validation studies have shown that using >1 claim for a medical condition improves the ability to identify beneficiaries with that medical condition (43, 44), single claim-based algorithms have been reported to have moderate-to-high positive predictive value (~80%) or specificity (up to 96%) (43, 45, 46); however, the accuracy of identifying medical conditions using claims data depends on the number of years for the study period (45) and the medical condition examined (43, 45–47). To address this concern, we performed a sensitivity analysis which required two different claims during the enrollment year for each mental health disorder, and although the prevalence estimates were reduced for both adults with and without CP, the magnitude of difference between groups and interpretations remained largely unchanged. Moreover, our definition for mental health conditions did not include medication data, which might have also helped to reduce the possibility of “rule out” diagnoses. Finally, we were unable to determine or account for the pathological etiologies of the CP diagnoses (e.g., extent of white matter damage). It is possible that the extent, severity, and compensatory mechanisms for recovery from the initial brain damage leading to CP, and the resulting aging sequela of the central nervous damage, may interfere with mental health processing and development. Future studies are needed to disentangle the pathological features of CP with the development of mental health disorders in this population.

In conclusion, adults with CP have an elevated age-adjusted prevalence of a variety of mental health disorders compared to the general adult population of privately insured beneficiaries without CP. These findings were more pronounced in cases where neurodevelopmental disorders were comorbid with CP. Individuals with CP frequently utilize healthcare services as part of their routine clinical care. Therefore, increasing clinical awareness of the mental health disorders and risks among adults with CP, improving clinical screening strategies, and developing efficient referral resources for mental health care services may help reduce the burden of mental health disorders in this population.

Acknowledgments:

The authors would like to acknowledge Dr. Kevin Dombkowski for his expertise and guidance throughout this work.

Funding source:

This research was developed in part under a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR #90RTHF0001–01–00).

Appendix Table 1.: Diagnostic codes for all conditions and mental health disorders using the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10) codes.

GROUP	ICD-10 codes
Cerebral palsy	G80.0–.4 G80.8 G80.9
NEURODEVELOPMENTAL COMORBIDITIES	
Intellectual disabilities	F70–73 F78 F79
Autism spectrum disorders	F84.0 F84.3 F84.5 F84.8 F84.9
Epilepsy	G40.001 G40.009 G40.011 G40.019 G40.101 G40.109 G40.111 G40.119 G40.201 G40.209 G40.211 G40.219 G40.301 G40.309 G40.311 G40.319 G40.A01 G40.A09 G40.A11 G40.A19 G40.B01 G40.B09 G40.B11 G40.B19 G40.401 G40.409 G40.411 G40.419 G40.501 G40.509 G40.801–.804 G40.811–.814 G40.821–.824 G40.89 G40.901 G40.909 G40.911 G40.919
OUTCOME MEASURES	
"Schizophrenia, schizotypal disorder, delusional, and other non-mood psychotic disorders"	
Schizophrenia	F20.0–.3 F20.5 F20.81 F20.89 F20.9
Schizotypal disorder	F21
Delusional disorder	F22
Brief psychotic disorder	F23
Shared psychotic disorder	F24
Schizoaffective disorders	F25.0 F25.1 F25.8 F25.9
Other psychotic disorder not due to a substance or known physiological condition	F28
Unspecified psychosis not due to a substance or known physiological condition	F29
"Mood affective disorders"	
Manic episode	F30.1–.4 F30.10–.13 F30.8 F30.9
Bipolar disorder	F31.0 F31.10–.13 F31.2 F31.30–.32 F31.4–.5 F31.60–.64 F31.70–.78 F31.81 F31.89 F31.9
Major depressive disorder, single episode	F32.0–.5 F32.81 F32.89 F32.9
Major depressive disorder, recurrent	F33.0–.3 F33.40–.42 F33.8 F33.9
Persistent mood [affective] disorders	F34.0 F34.1 F34.81 F34.89 F34.9
Unspecified mood [affective] disorders	F39
"Anxiety, dissociative, stress-related, somatoform and other nonpsychotic mental disorders"	

GROUP	ICD-10 codes
Phobic anxiety disorders	F40.00–.02 F40.10 F40.11 F40.210 F40.218 F40.220 F40.228 F40.230–.233 F40.240–.243 F40.248 F40.290 F40.291 F40.298 F40.8 F40.9
Other anxiety disorders	F41.0 F41.1 F41.3 F41.8 F41.9
Obsessive-compulsive disorder	F42.2–.4 F42.8 F42.9
Reaction to severe stress, and adjustment disorders	F43.0 F43.10–.12 F43.20–.25 F43.29 F43.8 F43.9
Dissociative and conversion disorders	F44.0–.2 F44.4–.8 F44.81 F44.89 F44.9
Somatoform disorders	F45.0 F45.1 F45.20–.22 F45.29 F45.41 F45.42 F45.8 F45.9
Other nonpsychotic mental disorders	F48.1 F48.2 F48.8 F48.9
“Behavioral syndromes associated with physiological disturbances and physical factors”	
Eating disorders	F50.00–.02 F50.2 F50.81 F50.82 F50.89 F50.9
Sleep disorders not due to a substance or known physiological condition	F51.01–.05 F51.09 F51.11–.13 F51.19 F51.3–.5 F51.8 F51.9
Sexual dysfunction not due to a substance or known physiological condition	F52.1 F52.21 F52.22 F52.31 F52.32 F52.4–.6 F52.8 F52.9
Puerperal psychosis	F53
Psychological and behavioral factors associated with disorders or disease classified elsewhere	F54
Abuse of non-psychoactive substances	F55.0–.4 F55.8
Unspecified behavioral syndrome associated with physiological disturbances and physical factors	F59
“Disorders of adults personality and behavior”	
Specific personality disorders	F60.0–.7 F60.81 F60.89 F60.9
Impulse disorders	F63.0–.3 F63.81 F63.89 F63.9
Gender identity disorders	F64.0–.2 F64.8 F64.9
Other disorders of adults personality and behavior	F68.8
Unspecified disorder of adults personality and behavior	F69
“Alcohol or opioid related disorders”	
Alcohol related disorders	F10.10 F10.11 F10.120 F10.121 F10.129 F10.14 F10.150 F10.151 F10.159 F10.180–.182 F10.188 F10.19 F10.20 F10.21 F10.220 F10.221 F10.229 F10.230–.232 F10.239 F10.24 F10.250 F10.251 F10.259 F10.26 F10.27 F10.280–.282 F10.288 F10.29 F10.920 F10.921 F10.929 F10.94 F10.950 F10.951 F10.959 F10.96 F10.97 F10.980–.982 F10.988 F10.99
Opioid related disorders	F11.10 F11.11 F11.120–.122 F11.129 F11.14 F11.150 F11.151 F11.159 F11.181 F11.182 F11.188 F11.19 F11.20 F11.21 F11.220–.222 F11.229 F11.23 F11.24 F11.250 F11.251 F11.259 F11.281 F11.282 F11.288 F11.29 F11.90 F11.920–.922 F11.929 F11.93 F11.94 F11.950 F11.951 F11.959 F11.981 F11.982 F11.988 F11.99

Appendix Table 2.: Age-standardized prevalence of mental health disorder categories for study participants. Mental health disorder categories were identified by at least two claims on different days.

	Females			Males		
	CP alone	CP + ND disorder	Without CP	CP alone	CP + ND disorder	Without CP
	% (95% CI)	% (95% CI)	%	% (95% CI)	% (95% CI)	%
Schizophrenia, schizotypal disorder, delusional, and other non-mood psychotic disorders	2.3 (1.7, 2.9)	4.8 (3.5, 6.1)	0.4	2.1 (1.5, 2.7)	4.0 (2.9, 5.1)	0.5
Mood affective disorders	20.6 (19.0, 22.2)	23.6 (21.1, 26.1)	9.1	13.1 (11.8, 14.4)	18.1 (15.9, 20.3)	5.2
Anxiety, dissociative, stress-related, somatoform and other nonpsychotic mental disorders	19.2 (17.7, 20.7)	21.2 (18.8, 23.6)	11.0	13.4 (12.1, 14.7)	15.5 (13.4, 17.6)	6.7
Behavioral syndromes associated with physiological disturbances and physical factors	1.2 (0.8, 1.6)	1.3 (0.6, 2.0)	0.8	0.6 (0.3, 0.9)	0.6 (0.2, 1.0)	0.6
Disorders of adult personality and behavior	0.7 (0.4, 1.0)	2.7 (1.7, 3.7)	0.2	0.7 (0.4, 1.0)	2.7 (1.8, 3.6)	0.2
Alcohol and/or opioid related disorders	1.5 (1.0, 2.0)	1.2 (0.6, 1.8)	1.0	2.9 (2.2, 3.6)	1.8 (1.0, 2.6)	1.8

CP, cerebral palsy; ND, neurodevelopmental; CI, confidence interval.

References

1. Oskoui M, Coutinho F, Dykeman J, Jette N, Pringsheim T. An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. Dev Med Child Neurol. 2013;55(6):509–19. [PubMed: 23346889]
2. Brooks JC, Strauss DJ, Shavelle RM, Tran LM, Rosenbloom L, Wu YW. Recent trends in cerebral palsy survival. Part I: period and cohort effects. Dev Med Child Neurol. 2014;56(11):1059–64. [PubMed: 24966011]
3. Boyle CA, Boulet S, Schieve LA, Cohen RA, Blumberg SJ, Yeargin-Allsopp M, et al. Trends in the prevalence of developmental disabilities in US children, 1997–2008. Pediatrics. 2011;127(6):1034–42. [PubMed: 21606152]
4. Stackhouse SK, Binder-Macleod SA, Lee SC. Voluntary muscle activation, contractile properties, and fatigability in children with and without cerebral palsy. Muscle & nerve. 2005;31(5):594–601. [PubMed: 15779003]
5. Whitney DG, Singh H, Miller F, Barbe MF, Slade JM, Pohlig RT, et al. Cortical bone deficit and fat infiltration of bone marrow and skeletal muscle in ambulatory children with mild spastic cerebral palsy. Bone. 2017;94:90–7. [PubMed: 27732905]
6. Johnson DL, Miller F, Subramanian P, Modlesky CM. Adipose tissue infiltration of skeletal muscle in children with cerebral palsy. J Pediatr. 2009;154(5):715–20. [PubMed: 19111321]

7. Whitney DG, Miller F, Pohlig RT, Modlesky CM. BMI does not capture the high fat mass index and low fat-free mass index in children with cerebral palsy and proposed statistical models that improve this accuracy. Int J Obes (Lond). 2019;43(1):82–90. [PubMed: 30181652]
8. Day SM, Wu YW, Strauss DJ, Shavelle RM, Reynolds RJ. Change in ambulatory ability of adolescents and young adults with cerebral palsy. Dev Med Child Neurol. 2007;49(9):647–53. [PubMed: 17718819]
9. Whitney DG, Hurvitz EA, Devlin MJ, Caird MS, French ZP, Ellenberg EC, et al. Age trajectories of musculoskeletal morbidities in adults with cerebral palsy. Bone. 2018;114:285–91. [PubMed: 29981509]
10. Whitney DG, Hurvitz EA, Ryan JM, Devlin MJ, Caird MS, French ZP, et al. Noncommunicable disease and multimorbidity in young adults with cerebral palsy. Clin Epidemiol. 2018;10:511–9. [PubMed: 29750055]
11. Shin YK, Yoon YK, Chung KB, Rhee Y, Cho SR. Patients with non-ambulatory cerebral palsy have higher sclerostin levels and lower bone mineral density than patients with ambulatory cerebral palsy. Bone. 2017;103:302–7. [PubMed: 28720522]
12. Cremer N, Hurvitz EA, Peterson MD. Multimorbidity in Middle-Aged Adults with Cerebral Palsy. Am J Med. 2017;130(6):744 e9–e15.
13. Peterson MD, Kamdar N, Hurvitz EA. Age-related trends in cardiometabolic disease among adults with cerebral palsy. Dev Med Child Neurol. 2019;61(4):484–9. [PubMed: 29704244]
14. Peterson MD, Gordon PM, Hurvitz EA. Chronic disease risk among adults with cerebral palsy: the role of premature sarcopoenia, obesity and sedentary behaviour. Obes Rev. 2013;14(2):171–82. [PubMed: 23094988]
15. Peterson MD, Gordon PM, Hurvitz EA, Burant CF. Secondary muscle pathology and metabolic dysregulation in adults with cerebral palsy. Am J Physiol Endocrinol Metab. 2012;303(9):E1085–93. [PubMed: 22912367]
16. Verschuren O, Smorenburg ARP, Luiking Y, Bell K, Barber L, Peterson MD. Determinants of muscle preservation in individuals with cerebral palsy across the lifespan: a narrative review of the literature. J Cachexia Sarcopenia Muscle. 2018;9(3):453–64. [PubMed: 29392922]
17. Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet. 2013;382(9904):1575–86. [PubMed: 23993280]
18. Kyu HH, Pinho C, Wagner JA, Brown JC, Bertozzi-Villa A, Charlson FJ, et al. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. JAMA Pediatr. 2016;170(3):267–87. [PubMed: 26810619]
19. Pine DS, Cohen P, Gurley D, Brook J, Ma Y. The risk for early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. Arch Gen Psychiatry. 1998;55(1):56–64. [PubMed: 9435761]
20. Jacobson NC, Newman MG. Anxiety and depression as bidirectional risk factors for one another: A meta-analysis of longitudinal studies. Psychol Bull. 2017;143(11):1155–200. [PubMed: 28805400]
21. Downs J, Blackmore AM, Epstein A, Skoss R, Langdon K, Jacoby P, et al. The prevalence of mental health disorders and symptoms in children and adolescents with cerebral palsy: a systematic review and meta-analysis. Dev Med Child Neurol. 2018;60(1):30–8. [PubMed: 28914445]
22. Whitney DG, Warschausky SA, Peterson MD. Mental health disorders and physical risk factors in children with cerebral palsy: a cross-sectional study. Dev Med Child Neurol. 2019;61(5):579–85. [PubMed: 30362114]
23. Van Der Slot WM, Nieuwenhuijsen C, Van Den Berg-Emons RJ, Bergen MP, Hilberink SR, Stam HJ, et al. Chronic pain, fatigue, and depressive symptoms in adults with spastic bilateral cerebral palsy. Dev Med Child Neurol. 2012;54(9):836–42. [PubMed: 22809436]
24. Weber P, Bolli P, Heimgartner N, Merlo P, Zehnder T, Katterer C. Behavioral and emotional problems in children and adults with cerebral palsy. Eur J Paediatr Neurol. 2016;20(2):270–4. [PubMed: 26748599]

25. Smith KJ, Peterson MD, O'Connell NE, Victor C, Liverani S, Anokye N, et al. Risk of Depression and Anxiety in Adults With Cerebral Palsy. JAMA Neurol. 2018.
26. Reid SM, Meehan EM, Arnup SJ, Reddihough DS. Intellectual disability in cerebral palsy: a population-based retrospective study. Dev Med Child Neurol. 2018;60(7):687–94. [PubMed: 29667705]
27. Christensen D, Van Naarden Braun K, Doernberg NS, Maenner MJ, Arneson CL, Durkin MS, et al. Prevalence of cerebral palsy, co-occurring autism spectrum disorders, and motor functioning - Autism and Developmental Disabilities Monitoring Network, USA, 2008. Dev Med Child Neurol. 2014;56(1):59–65. [PubMed: 24117446]
28. Austin KL, Hunter M, Gallagher E, Campbell LE. Depression and anxiety symptoms during the transition to early adulthood for people with intellectual disabilities. J Intellect Disabil Res. 2018;62(5):407–21. [PubMed: 29473259]
29. Simonoff E, Pickles A, Charman T, Chandler S, Loucas T, Baird G. Psychiatric disorders in children with autism spectrum disorders: prevalence, comorbidity, and associated factors in a population-derived sample. J Am Acad Child Adolesc Psychiatry. 2008;47(8):921–9. [PubMed: 18645422]
30. Kanner AM, Schachter SC, Barry JJ, Hesdorffer DC, Mula M, Trimble M, et al. Depression and epilepsy: epidemiologic and neurobiologic perspectives that may explain their high comorbid occurrence. Epilepsy Behav. 2012;24(2):156–68. [PubMed: 22632406]
31. United States Census Bureau (2018, August 9, 2018). "Age and Sex Composition in the United States: 2016." Retrieved February 21, 2019, from https://www.census.gov/data/tables/2016/demo/age-and-sex/2016-age-sex-composition.html.
32. National Center for Health Statistics (2014). "Age Standardization and Population Counts." Retrieved February 21, 2019, from https://www.cdc.gov/nchs/tutorials/NHANES/NHANESAnalyses/agestandardization/age_standardization_intro.htm.
33. Ahmedani BK, Hock RM. Health care access and treatment for children with co-morbid autism and psychiatric conditions. Soc Psychiatry Psychiatr Epidemiol. 2012;47(11):1807–14. [PubMed: 22322982]
34. Vohra R, Madhavan S, Sambamoorthi U, St Peter C. Access to services, quality of care, and family impact for children with autism, other developmental disabilities, and other mental health conditions. Autism. 2014;18(7):815–26. [PubMed: 24353274]
35. Aisen ML, Kerkovich D, Mast J, Mulroy S, Wren TA, Kay RM, et al. Cerebral palsy: clinical care and neurological rehabilitation. Lancet Neurol. 2011;10(9):844–52. [PubMed: 21849165]
36. Berry JG, Berry SD. Caring for Patients With Neurological Impairment: Conversations Between a Pediatrician and Geriatrician. JAMA Pediatr. 2018;172(9):795–6. [PubMed: 29971353]
37. Hinckson EA, Curtis A. Measuring physical activity in children and youth living with intellectual disabilities: a systematic review. Res Dev Disabil. 2013;34(1):72–86. [PubMed: 22940161]
38. Bassell JL, Phan H, Leu R, Kronk R, Visootsak J. Sleep profiles in children with Down syndrome. Am J Med Genet A. 2015;167A(8):1830–5. [PubMed: 26105013]
39. Breau LM, Camfield CS. Pain disrupts sleep in children and youth with intellectual and developmental disabilities. Res Dev Disabil. 2011;32(6):2829–40. [PubMed: 21664797]
40. Woodmansee C, Hahne A, Imms C, Shields N. Comparing participation in physical recreation activities between children with disability and children with typical development: A secondary analysis of matched data. Res Dev Disabil. 2016;49–50:268–76.
41. Shields N, King M, Corbett M, Imms C. Is participation among children with intellectual disabilities in outside school activities similar to their typically developing peers? A systematic review. Dev Neurorehabil. 2014;17(1):64–71. [PubMed: 24087974]
42. Whitney DG, Alford AI, Devlin MJ, Caird MS, Hurvitz EA, Peterson MD. Adults With Cerebral Palsy Have Higher Prevalence of Fracture Compared With Adults Without Cerebral Palsy Independent of Osteoporosis and Cardiometabolic Diseases. J Bone Miner Res. 2019.
43. Reeves S, Garcia E, Kleyn M, Housey M, Stottlemyer R, Lyon-Callo S, et al. Identifying sickle cell disease cases using administrative claims. Acad Pediatr. 2014;14(5 Suppl):S61–7. [PubMed: 24882379]

44. Kerr EA, McGlynn EA, Van Vorst KA, Wickstrom SL. Measuring antidepressant prescribing practice in a health care system using administrative data: implications for quality measurement and improvement. Jt Comm J Qual Improv. 2000;26(4):203–16. [PubMed: 10749005]

45. Leslie WD, Lix LM, Yogendran MS. Validation of a case definition for osteoporosis disease surveillance. Osteoporos Int. 2011;22(1):37–46. [PubMed: 20458577]

46. Doktorchik C, Patten S, Eastwood C, Peng M, Chen G, Beck CA, et al. Validation of a case definition for depression in administrative data against primary chart data as a reference standard. BMC Psychiatry. 2019;19(1):9. [PubMed: 30616546]

47. Noyes K, Liu H, Lyness JM, Friedman B. Medicare beneficiaries with depression: comparing diagnoses in claims data with the results of screening. Psychiatr Serv. 2011;62(10):1159–66. [PubMed: 21969642]

Table 1.

Descriptive characteristics of study participants.

	CP alone	CP + ND disorder	Without CP
Sample size, n	5,052	2,296	8,732,455
Age, mean (SD)	52.5 (18.0)	43.9 (17.1)	55.2 (18.6)
Sex, %			
Female	49.6	48.2	55.3
Male	50.4	51.8	44.7
Ethnicity, %			
White	57.2	56.7	55.9
Black	11.6	11.8	8.0
Hispanic	7.8	9.4	9.0
Asian	1.6	2.1	3.8
Unknown/missing	21.9	20.1	23.3
Education, %			
Less than high school	0.5	0.5	0.5
High school diploma	32.0	32.4	25.3
More than high school	62.8	63.1	69.6
Unknown/missing	4.8	4.1	4.6
Household annual income, %			
<$40K	26.0	21.6	16.8
$40K to 59.9K	12.1	10.2	11.7
$60K to 99.9K	17.2	14.1	21.4
≥$100K	16.7	17.8	28.2
Unknown/missing	28.0	36.3	22.0
Comorbidities, %			
Intellectual disabilities	0.0	43.2	0.1
Autism spectrum disorders	0.0	7.3	0.1
Epilepsy	0.0	77.8	1.1

CP, cerebral palsy; ND, neurodevelopmental; SD, standard deviation.

Table 2.

Age-standardized prevalence of mental health disorder categories for study participants.

	Females			Males		
	CP alone	CP + ND disorder	Without CP	CP alone	CP + ND disorder	Without CP
	% (95% CI)	% (95% CI)	%	% (95% CI)	% (95% CI)	%
Schizophrenia, schizotypal disorder, delusional, and other non-mood psychotic disorders	3.2 (2.5, 3.9)	7.3 (5.8, 8.8)	0.6	2.8 (2.2, 3.4)	6.5 (5.1, 7.9)	0.7
Mood affective disorders	28.6 (26.8, 30.4)	28.8 (26.1, 31.5)	14.3	19.5 (18.0, 21.0)	23.3 (20.9, 25.7)	8.1
Anxiety, dissociative, stress-related, somatoform and other nonpsychotic mental disorders	28.6 (26.8, 30.4)	29.6 (26.9, 32.3)	18.0	19.5 (18.0, 21.0)	21.7 (19.4, 24.0)	11.1
Behavioral syndromes associated with physiological disturbances and physical factors	2.0 (1.5, 2.5)	1.7 (0.9, 2.5)	1.8	2.1 (1.5, 2.7)	2.1 (1.3, 2.9)	1.7
Disorders of adult personality and behavior	1.2 (0.8, 1.6)	4.4 (3.2, 5.6)	0.4	1.2 (0.8, 1.6)	4.1 (3.0, 5.2)	0.3
Alcohol and/or opioid related disorders	2.8 (2.2, 3.4)	2.2 (1.3, 3.1)	1.8	4.7 (3.9, 5.5)	2.4 (1.5, 3.3)	3.0

CP, cerebral palsy; ND, neurodevelopmental; CI, confidence interval.