HHS Public Access

Author manuscript

Dev Med Child Neurol. Author manuscript; available in PMC 2015 March 06.

Published in final edited form as:

Dev Med Child Neurol. 2014 January ; 56(1): 59–65. doi:10.1111/dmcn.12268.

Prevalence of cerebral palsy, co-occurring autism spectrum disorders, and motor functioning – Autism and Developmental Disabilities Monitoring Network, USA, 2008

DEBORAH CHRISTENSEN[1], **KIM VAN NAARDEN BRAUN**[1], **NANCY S DOERNBERG**[1], **MATTHEW J MAENNER**[2,3], **CARRIE L ARNESON**[2], **MAUREEN S DURKIN**[2,3], **RUTH E BENEDICT**[2,4], **RUSSELL S KIRBY**[5], **MARTHA S WINGATE**[6], **ROBERT FITZGERALD**[7], and **MARSHALYN YEARGIN-ALLSOPP**[1]

[1]Division of Birth Defects and Developmental Disabilities, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention, Atlanta, GA

[2]Waisman Center, University of Wisconsin–Madison, Madison, WI

[3]Department of Population Health Sciences, University of Wisconsin– Madison, Madison, WI

[4]Occupational Therapy Program, Department of Kinesiology, University of Wisconsin–Madison, Madison, WI

[5]Department of Community and Family Health, College of Public Health, University of South Florida, Tampa, FL

[6]Department of Health Care Organization and Policy, School of Public Health, University of Alabama at Birmingham, Birmingham, AL

[7]Department of Psychiatry, Washington University in St. Louis, St. Louis, MO, USA

Abstract

AIM—The aim of this study was to report the prevalence and characteristics of children with cerebral palsy (CP).

METHOD—Children with CP (*n*=451) were ascertained by the Autism and Developmental Disabilities Monitoring (ADDM) Network, a population-based, record-review surveillance system monitoring CP in four areas of the USA. Prevalence was calculated as the number of children with CP among all 8-year-old children residing in these areas in 2008. Motor function was categorized by Gross Motor Function Classification System level and walking ability. Co-occurring autism spectrum disorders (ASD) and epilepsy were ascertained using ADDM Network surveillance methodology.

© 2013 Mac Keith Press

Correspondence to Dr Deborah Christensen, Division of Birth Defects and Developmental Disabilities, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention, 1600 Clifton Road NE, MS E-86, Atlanta, GA 30333, USA. dqc3@cdc.gov.

DISCLAIMER: The findings and conclusions in this study are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

RESULTS—The period prevalence of CP for 2008 was 3.1 per 1000 8-year-old children (95% confidence interval 2.8–3.4). Approximately 58% of children walked independently. Co-occurring ASD frequency was 6.9% and was higher (18.4%) among children with non-spastic CP, particularly hypotonic CP. Co-occurring epilepsy frequency was 41% overall, did not differ by ASD status or CP subtype, and was highest (67%) among children with limited or no walking ability.

INTERPRETATION—The prevalence of CP in childhood from US surveillance data has remained relatively constant, in the range of 3.1 to 3.6 per 1000, since 1996. The higher frequency of ASD in non-spastic than in spastic subtypes of CP calls for closer examination.

The definition of cerebral palsy (CP) was revised in 2006 to acknowledge that ‘the motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy, and by secondary musculoskeletal problems’.[1] However, few data from the USA are available regarding the co-occurrence of behaviorally defined conditions such as autism spectrum disorders (ASD), which are reported to be more frequent among children with CP than in the general population.[2–4] Co-occurring behavioral conditions may contribute to limitations in a child’s ability to perform daily activities and in community participation. Population-based information on conditions co-occurring with CP can help communities plan and provide appropriate services for children and may also provide clues as to shared risk factors or etiologic pathways.

The Autism and Developmental Disabilities Monitoring (ADDM) Network is a multisite, collaborative program funded by the Centers for Disease Control and Prevention to conduct ongoing, population-based surveillance for developmental disabilities, including CP and ASD, among 8-year-old children in areas of the USA. Data from the ADDM Network were used to address the following study goals: (1) to estimate the prevalence of CP among 8-year-old children in 2008 at the four ADDM Network sites that currently monitor CP and (2) to describe the demographic characteristics, subtype, gross motor function, and frequency of co-occurring ASD and epilepsy among children with CP.

METHOD

In 2008, the ADDM Network monitored CP in areas of northern and central Alabama; metropolitan Atlanta, Georgia; metropolitan St. Louis, Missouri; and southeastern Wisconsin. Each surveillance site met applicable local institutional review board and privacy and confidentiality requirements. Children were eligible for ascertainment if they were born in 2000 and their parents or guardians resided in site-specific surveillance areas at any time during 2008. The ADDM CP Network included a total population of 147 112 8-year-old children in 2008, constituting approximately 4% of the US population of 8-year-olds. The overall distribution by race/ethnicity group was as follows: 56.7% white non-Hispanic, 28.5% black non-Hispanic, 4.9% Hispanic, 3.8% Asian/Pacific islander non-Hispanic, and 0.4% American Indian/native Alaskan non-Hispanic. Georgia had a higher proportion of black non-Hispanic children (41.0%) than Alabama (25.4%), Missouri (24.0%), and Wisconsin (16.9%). The proportion of Hispanic children was similar across study sites.

Children with CP were identified at multiple data sources in the community that educate, diagnose, treat, and provide services to children with developmental disabilities. Trained abstractors screened records for a confirmed or suspected CP diagnosis or descriptions of physical findings consistent with CP documented by qualified professionals, which included physicians, physical therapists, occupational therapists, nurse practitioners, physician assistants, and clinical nurse specialists. If these criteria were met, the following data were abstracted from each record: demographics, diagnostic summaries, descriptions of physical findings and gross motor function, and information on co-occurring conditions. Trained clinicians reviewed abstracted evaluations from all data sources to determine if the child met the surveillance CP case definition at or after 2 years of age. Common protocols were used for abstraction and clinician review at all sites. Additional details on the clinician review process were described previously.[5] Children with CP attributed to an event occurring after the postneonatal period (>28d after birth) were included (*n*=28, 6.2%).

Information on epilepsy and ASD was systematically collected by all four sites; data on cognitive and sensory impairments were collected systematically only in Georgia. For ASD, a child’s record was abstracted if there was documentation of a confirmed or suspected diagnosis of an ASD (autistic disorder; pervasive developmental disorder not otherwise specified; or Asperger disorder), if the child had a special education autism eligibility, or if the record included descriptions of behaviors consistent with the Diagnostic and Statistical Manual, Fourth Edition, Text Revision[6] criteria for an ASD. Final determination of ASD was done independently of determination of CP by a team of ASD clinician reviewers. ASD status did not require a previous ASD classification by a community provider, defined for analytic purposes as the presence of an ASD diagnosis, autism special education eligibility, or 299.0, 299.8, or 299.9 International Classification of Diseases, Ninth Revision billing codes. A child was classified as having co-occurring epilepsy if an evaluation by a physician documented a confirmed diagnosis of epilepsy or an epilepsy syndrome, or described two or more unprovoked, non-febrile seizures that occurred more than 24 hours apart.[7] Additional details on the ADDM Network methodology are published elsewhere.[8]

Clinician reviewers assigned children with CP a Gross Motor Function Classification System (GMFCS)[9] level based on abstracted descriptions of gross motor function at or after the age of 4 years, with an emphasis on sitting, transferring, and mobility. Walking ability was also determined. [10] Walking ability for children with an assigned GMFCS level was categorized as follows: levels I and II were classified as ‘walks independently’; level III, ‘walks with handheld mobility device’; and levels IV and V, ‘limited or no walking ability’. For some children (*n*=28, 6.2%) there was sufficient information to assign a level of walking ability but not a GMFCS level. A GMFCS level or walking ability category was not assigned for 114 children (25.3%) owing to insufficient documentation of gross motor function in the source records.

Initial interrater reliability for CP clinician review was established among reviewers to a minimum standard of 90% agreement on CP case status. Ongoing reliability was evaluated in a blinded, random 10% sample of abstracted records, scored independently by two reviewers. The average interrater agreement was 96% (kappa=0.92) for final CP case status of children. Not all records for children could be located, and the percentage missing varied across study sites. We estimated that the increase in CP prevalence if missing records had been found would range from 1.5% in Missouri to 8.2% in Alabama.

The overall prevalence of CP was calculated, with the numerator being the sum of the number of 8-year-old children who met the surveillance case definition for CP across the four ADDM CP Network sites in 2008, and the denominator being the number of 8-year-old children residing in the four surveillance areas according to the National Center for Health Statistics Vintage 2009 bridged-race postcensal population estimates for 2008.[11] Prevalence estimates were stratified by surveillance site, sex, and race/ethnicity group. Poisson approximation to the binomial distribution was used to calculate 95% confidence intervals (CIs).[12] Pearson χ^2 tests were used to examine differences in the prevalence and characteristics of children with CP by surveillance area, CP subtype, and co-occurring ASD; exact tests were used when the number in any cell was less than five. A p-value of <0.05 was considered significant. We performed multiple imputation to account for the one-quarter of children whose walking ability could not be classified from the information in the records. Our imputation model included CP subtype, indicators for co-occurring intellectual disability, epilepsy, age at earliest known CP diagnosis, age at most recent known CP evaluation, number of evaluations, race/ethnicity group, sex, and surveillance site. A detailed description of these imputation methods was previously published.[13] Imputation was performed using the SAS-callable IVE-ware, and used 10 iterations and 10 multiples.

RESULTS

Among the four sites, 451 children met the ADDM Network CP case definition (Table I). The overall period prevalence was 3.1 per 1000 (95% CI 2.8–3.4), and was significantly higher in Georgia compared with Missouri and Wisconsin ($p<0.01$). Prevalence was higher for males than females (prevalence ratio 1.5:1; 95% CI 1.2–1.8), higher for black non-Hispanic children than for white non-Hispanic children (prevalence ratio 1.5:1; 95% CI 1.2–1.8), and similar for Hispanic children compared with White non-Hispanic children (prevalence ratio 0.9:1; 95% CI 0.6–1.3).

The majority of children (77.4%) had spastic CP (63.6% bilateral, 36.4% unilateral), 8.4% had non-spastic CP, and 14.2% had other CP subtypes (8.4% mixed CP subtype; 5.8% CP not otherwise specified) (Table II). The proportion of children with non-spastic CP was highest in Georgia (13.9%), including a relatively high number of children with hypotonic CP (n=19, or 76% of the 25 total children with hypotonic CP across all sites; data not shown in table). Nearly all children with CP had a previous diagnosis of CP in their records, ranging from 100% in Georgia to 95.5% in Wisconsin. The frequency of co-occurring ASD was 6.9% (95% CI 4.9–9.6%) and approximately 71% of children with CP and co-occurring ASD had a previous ASD classification by a community professional documented in their records, compared with 74% of children with ASD without CP (p=0.69) in these four study sites. The overall frequency of co-occurring epilepsy was 41% and did not differ by ASD status.

The frequency of co-occurring ASD varied by CP subtype: 6.0% among children with spastic CP; 18.4% among children with non-spastic CP; and 4.7% among children with other CP (p=0.02 for overall difference) (Table III). Hypotonic CP accounted for a larger proportion of non-spastic CP among children with ASD (n=6, 19.4%) compared with those without ASD (n=19, 4.5%; p=0.001). The frequency of co-occurring epilepsy did not vary by CP subtype. Data on GMFCS level or walking ability were available for 74.7% of children with CP; availability varied by study site (Alabama, 80.5%; Georgia, 67.8%; Missouri, 67.2%; Wisconsin, 86.5%; p=0.002 for overall difference). The distribution of walking ability and GMFCS differed by CP subtype (Table III). Overall, 58.2% of children walked independently, 11.3% walked using a hand-held mobility device, and 30.6% had limited or no walking ability. Nearly all children with unilateral spastic CP walked independently (96.6%) compared with less than half of those with bilateral spastic CP (45.4%). The distribution of walking ability was similar across study sites (data not shown). The distribution of walking ability when missing values were imputed was similar to the distribution using observed data (Table III).

Compared with children without co-occurring ASD, those with co-occurring ASD had a higher frequency of non-spastic CP (7.4% vs 22.6%), and lower frequencies of spastic CP (78.1% vs 67.7%) and mixed/not otherwise specified CP (14.5% vs 9.7%) (p=0.01 for overall difference) (Table IV). Among children with non-spastic CP, hypotonic CP was the most common subtype for children with and without ASD. Of children with co-occurring ASD, 73.9% were independent walkers compared with 57.0% of those without ASD. When we grouped children by walking ability (data not shown in table), the frequency of epilepsy increased, particularly for children with limited or no walking (34.2% for independent walkers, 34.2% for those walking with a hand-held mobility device, and 68.0% for those with limited or no walking ability; p<0.001).

DISCUSSION

In addition to providing the most recent CP prevalence estimates, this is the first US, population-based study to provide details on the co-occurrence of CP and ASD. Our finding that 6.9% (95% CI 4.9–9.6%) of children with CP had co-occurring ASD suggests that the frequency of ASD is elevated in children with CP compared with the estimated ASD population prevalence of approximately 1%.[14] Co-occurring ASD was more frequent among children with non-spastic CP, particularly hypotonic CP.

Two previous studies have performed direct screening for ASD among children with CP; in a population-based study, Nordin and Gillberg[3] reported that 4 of 38 children with CP also had ASD. In a clinical series of 126 children with CP, Kilincaslan and Mukaddes[2] found an ASD prevalence of 15% (95% CI 8.7–21.4%). Previous records-based studies have reported ASD frequencies ranging from 5%[15] to 8%.[4] It is not surprising that records-based studies, which depend on the documentation of ASD diagnoses or descriptions of behaviors consistent with ASD, find a lower frequency of co-occurring ASD compared with studies that performed systematic ASD screening and diagnosis. In our study, 71% of children with CP and co-occurring ASD had a previous ASD classification or diagnosis by a community professional in their records, similar to the percentage for children with ASD who did not have CP in these four study sites. The remaining 29% met the ASD surveillance case definition but did not have a previous ASD classification in their records. This may reflect difficulty in distinguishing sensory and communication problems associated with CP from behaviors related to ASD. Diagnostic instruments that can identify ASD and other behavioral disorders in the presence of other disabilities are needed. This is particularly relevant given the recommendation of the American Academy of Pediatrics for universal ASD screening[16] to help ensure that children receive appropriate diagnosis and access to services.

The association of co-occurring ASD with non-spastic CP is consistent with findings from the ADDM Network in 2006.[4] In both 2006 and the current study, this finding was a result of a higher frequency of ASD among children with hypotonic CP. The only other study[2] to report CP subtype among children with co-occurring ASD reported a higher frequency of ASD among children with mixed CP compared with spastic CP in a clinical sample of children with spastic, dyskinetic, or mixed CP; hypotonic and ataxic CP were excluded. Hypotonic CP is a diagnostic category excluded by some[17] but not all[18] CP surveillance programs. For comparison, if hypotonic CP was excluded from our analysis, the frequency of co-occurring ASD would be 5.9% and not different by CP subtype. Hypotonia and other motor impairments are common among children with ASD[19] and further research may be needed to clarify the patterns of motor dysfunction that are common to ASD and CP or specific to one or the other. In addition, studies that include neuroimaging findings may provide insight into the etiology for children with CP and co-occurring ASD or other neuropsychiatric disorders.

The CP period prevalence of 3.1 per 1000 8-year-old children found in this study is similar to estimates from other population-based studies using children (rather than live births) as the denominator. CP prevalence was significantly higher in Georgia, particularly hypotonic CP. If hypotonic CP was excluded, CP prevalence would be 2.9 per 1000 (95% CI 2.6–3.2) overall and Georgia prevalence would be similar to the other sites. Nevertheless, the higher estimate is consistent with data from the National Health Interview Survey, which found a CP period prevalence, based on parental reporting of a CP diagnosis, of 3.9 per 1000 children in a nationally representative sample of US children aged 3 to 17 years.[20] In general, period prevalence estimates from the USA have been higher than birth prevalence estimates from Europe and Australia.[17,18] However, caution is necessary when making comparisons between prevalence estimates derived from live births and those from census counts of children during a specified time.[21] Migration patterns may affect both types of prevalence estimates[22] but should not affect estimates from nationally representative studies such as the National Health Interview Survey.

Our data are limited to information in children’s records to determine surveillance participant status and describe gross motor function and co-occurring disorders. Across all surveillance sites, about 25% of children with CP did not have sufficient information on gross motor function to enable classification by walking ability. However, imputed data on motor function were similar to observed data, as reported in a previous study using ADDM surveillance data.[13] Another limitation is that sufficient information on cognitive and sensory impairments was not available from the surveillance system for inclusion in this report.

There are several strengths to our surveillance method. First, CP prevalence is estimated for children living in a specific area during a specific surveillance year. This makes the numerator and denominator comparable with respect to the influences of survival and migration between birth and age of ascertainment. Second, active surveillance for other developmental disabilities provides a fuller picture of the characteristics of children with CP and can suggest areas for further research. Third, we estimate the prevalence of CP in children at an age that is particularly relevant for needs assessments related to treatment, education, and community participation as well as for ascertaining co-occurring conditions that may not be recognized until several years after birth.

In summary, the 2008 ADDM CP Network prevalence was 3.1 per 1000, or 1 in 323 8-year-old children. This is not significantly different from the prevalence reported in previous surveillance years.[4,5,23] Nearly 7% of children with CP had co-occurring ASD; interestingly, the prevalence of ASD among children with CP has not increased during a time of substantial increase in ASD prevalence in the general population. Reasons for an elevated frequency of ASD among children with CP are not known, but overlap in behavioral and motor findings may indicate common risk factors or etiologies. Continued monitoring of ASD among children with CP in the ADDM Network is important to examine whether this stability continues. Diagnostic instruments that can identify behavioral disorders in children with multiple disabilities are needed to ensure that children can be identified early and receive services and supports. Continued population-based surveillance of the prevalence and characteristics of CP can inform planning for treatments and services that help children with CP achieve optimal development.

Acknowledgments

The ADDM CP Network is indebted to the project staff at each site (project coordinators, clinician reviewers, data abstractors, epidemiologists, and programmers) and to the hospitals, clinics, diagnostic centers, health care providers, state public health and rehabilitation agencies, and public school special education programs whose participation made this study possible.

ABBREVIATIONS

ADDM	Autism and Developmental Disabilities Monitoring
ASD	Autism spectrum disorders

References

1. Rosenbaum P, Paneth N, Leviton A, et al. A report: the definition and classification of cerebral palsy April 2006. Dev Med Child Neurol. 2007; 109:8–14.
2. Kilincaslan A, Mukaddes NM. Pervasive developmental disorders in individuals with cerebral palsy. Dev Med Child Neurol. 2009; 51:289–94. [PubMed: 19335564]
3. Nordin V, Gillberg C. Autism spectrum disorders in children with physical or mental disability or both. I: clinical and epidemiological aspects. Dev Med Child Neurol. 1996; 38:297–313. [PubMed: 8641535]
4. Kirby RS, Wingate MS, Van Naarden Braun K, et al. Prevalence and functioning of children with cerebral palsy in four areas of the United States in 2006: a report from the Autism and Developmental Disabilities Monitoring Network. Res Dev Disabil. 2011; 32:462–9. [PubMed: 21273041]

5. Yeargin-Allsopp M, Van Naarden Braun K, Doernberg NS, Benedict RE, Kirby RS, Durkin MS. Prevalence of cerebral palsy in 8-year-old children in three areas of the United States in 2002: a multisite collaboration. Pediatrics. 2008; 121:547–54. [PubMed: 18310204]
6. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4. Washington, DC: American Psychiatric Association; 1994.
7. Commission on Epidemiology and Prognosis & International League Against Epilepsy. Guidelines for epidemiologic studies on epilepsy. Epilepsia. 1993; 34:592–6. [PubMed: 8330566]
8. Yeargin-Allsopp M, Rice C, Karapurkar T, Doernberg N, Boyle C, Murphy C. Prevalence of autism in a US metropolitan area. JAMA. 2003; 289:49–55. [PubMed: 12503976]
9. Palisano RJ, Rosenbaum P, Bartlett D, Livingston MH. Content validity of the expanded and revised Gross Motor Function Classification System. Dev Med Child Neurol. 2008; 50:744–50. [PubMed: 18834387]
10. Beckung E, Hagberg G, Uldall P, Cans C. Surveillance of Cerebral Palsy in Europe. Probability of walking in children with cerebral palsy in Europe. Pediatrics. 2008; 121:e187–92. [PubMed: 18070932]
11. National Center for Health Statistics. Postcensal Estimates of the Resident Population of the United States for July 1, 2000–July 1, 2010, by Year, County, Age, Bridged Race, Hispanic Origin, and Sex (Vintage 2009). Hyattsville, MD: National Center for Health Statistics; 2010.
12. Selvin, S. Statistical power and sample-size calculations. In: Selvin, S., editor. Statistical Analyses of Epidemiologic Data. 2. New York: Oxford University Press; 1996. p. 95-100.
13. Maenner MJ, Benedict RE, Arneson CL, et al. Children with cerebral palsy: racial disparities in functional limitations. Epidemiology. 2012; 23:35–43. [PubMed: 22081059]
14. Centers for Disease Control and Prevention. Prevalence of autism spectrum disorders – Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008. MMWR Surveill Summ. 2012; 61:1–19.
15. Himmelmann K, Uvebrant P. Function and neuroimaging in cerebral palsy: a population-based study. Dev Med Child Neurol. 2011; 53:516–21. [PubMed: 21574988]
16. Council on Children With Disabilities, Section on Developmental Behavioral Pediatrics, Bright Futures Steering Committee, Medical Home Initiatives for Children With Special Needs Project Advisory Committee. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. Pediatrics. 2006; 118:405–20. [PubMed: 16818591]
17. Surveillance of Cerebral Palsy in Europe. Prevalence and characteristics of children with cerebral palsy in Europe. Dev Med Child Neurol. 2002; 44:633–40. [PubMed: 12227618]
18. Australian Cerebral Palsy Register Group. Report of the Australian Cerebral Palsy Register: Birth Years 1993–2003. Dec. 2009
19. Fournier KA, Hass CJ, Naik SK, Lodha N, Cauraugh JH. Motor Coordination in autism spectrum disorders: a synthesis and meta-analysis. J Autism Dev Disord. 2010; 40:1227–40. [PubMed: 20195737]
20. Boyle CA, Boulet S, Schieve LA, et al. Trends in the prevalence of developmental disabilities in US children, 1997–2008. Pediatrics. 2011; 127:1034–42. [PubMed: 21606152]
21. Day SM. Do we know what the prevalence of cerebral palsy is? Dev Med Child Neurol. 2011; 53:876–7. [PubMed: 21838815]
22. Van Naarden Braun K, Maenner MJ, Christensen D, et al. Role of migration and choice of denominator on prevalence of cerebral palsy. Dev Med Child Neurol. 2013; 55:520–6. [PubMed: 23506432]
23. Arneson CL, Durkin MS, Benedict RE, et al. Brief report: prevalence of cerebral palsy – Autism and Developmental Disabilities Monitoring Network, three sites, United States, 2004. Disabil Health J. 2009; 2:45–8. [PubMed: 21122742]

What this paper adds

- The overall period prevalence of CP among 8-year-old children in four US surveillance sites in 2008 was 3.1 per 1000, similar to previous estimates.
- The frequency of ASD among children with CP was 6.9% overall and higher (18.4%) among children with non-spastic CP, particularly hypotonic CP.
- The frequency of co-occurring epilepsy was 41.5% and did not differ by ASD status or CP subtype but was higher in children with limited or no walking ability.

Table I

Demographic characteristics of cerebral palsy prevalence estimates (per 1000 8-year-old children) by site; Autism and Developmental Disabilities Monitoring Network, surveillance year 2008

	Alabama	**Georgia**	**Missouri**	**Wisconsin**	**All sites**
Total number 8year-olds with cerebral palsy	118	180	64	89	451
Total 8-year-olds in surveillance area[a]	36 566	50 427	25 668	34 451	147 112
Total prevalence[b] (95% CI), individuals per 1000	3.2 (2.7–3.9)	3.6 (3.1–4.1)[c]	2.5 (2.0–3.2)	2.6 (2.1–3.2)	3.1 (2.8–3.4)
Sex-specific prevalence (95% CI), individuals per 1000					
Male	4.0 (3.2–5.0)	4.3 (3.6–5.2)	3.2 (2.4–4.3)	2.6 (1.9–3.4)	3.6 (3.2–4.1)
Female	2.4 (1.8–3.2)	2.8 (2.2–3.6)	1.8 (1.2–2.7)	2.6 (1.9–3.5)	2.5 (2.1–2.9)
Male:female prevalence ratio	1.7:1 (1.2:1–2.5: 1)	1.5:1 (1.1:1–2.0:1)	1.7:1 (1.0:1–2.9:1)	1.0:1 (0.6:1–1.5:1)	1.5:1 (1.2:1–1.8:1)
Race-specific prevalence (95% CI), individuals per 1000					
White, non-Hispanic	2.9 (2.3–3.7)	3.2 (2.4–4.1)	2.3 (1.7–3.1)	2.2 (1.7–2,9)	2.7 (2.3–3.0)
Black, non-Hispanic	4.1 (3.0–5.6)	4.1 (3.3–5.1)	2.1 (1.2–3.6)	4.5 (3.0–6.6)	3.9 (3.3–4.5)
Hispanic	3.3 (1.6–7.0)	2.5 (1.6–3.9)	1.1 (0.2–8.0)	2.1 (1.1–3.9)	2.4 (1.8–3.4)
American Indian/Alaska Native, non-Hispanic	6.5 (0.9–46.1)	–	–	–	1.7 (0.2–12.0)
Asian/Pacific-Islander, non-Hispanic	–	2.0 (0.9–4.5)	1.2 (0.2–8.7)	–	1.3 (0.6–2.7)

[a] Denominator data were obtained from National Center on Health Statistics' Vintage 2009 bridged-race postcensal population estimates for 2008.

[b] All children are included in the total regardless of race/ethnicity group as well as children for whom race/ethnicity group is unknown (n=21). Because of the lack of an appropriate denominator, multi-racial or other race/ethnicity categories are not presented.

[c] p=0.39 for Georgia versus Alabama; p=0.01 for Georgia versus Missouri; p=0.01 for Georgia versus Wisconsin.

Table II

Cerebral palsy subtypes, previous cerebral palsy diagnosis, and co-occurring conditions by site; Autism and Developmental Disabilities Monitoring Network, surveillance year 2008

	Alabama, *n* (%)	**Georgia, *n* (%)**	**Missouri, *n* (%)**	**Wisconsin, *n* (%)**	**All sites, *n* (%)**
Total	118	180	64	89	451
Spastic	103 (87.3)[a]	129 (71.7)	50 (78.1)	67 (75.3)	349 (77.4)
Unilateral spastic[b]	42 (35.6)	46 (25.6)	12 (18.8)	27 (30.3)	127 (28.2)[c]
Bilateral spastic[d]	61 (51.7)	83 (46.1)	38 (59.4)	40 (44.9)	222 (49.2)
Non-spastic[e]	4 (3.4)	25 (13.9)[f]	3 (4.7)	6 (6.7)	38 (8.4)
Mixed/not otherwise specified[g]	11 (9.3)	26 (14.4)	11 (17.2)	16 (18.0)	64 (14.2)[h]
Previous diagnosis of cerebral palsy	117 (99.2)	180 (100.0)[i]	62 (96.9)	85 (95.5)	444 (98.4)
Co-occurring epilepsy	49 (41.5)	74 (41.1)	25 (39.1)	37 (41.6)	185 (41.0)[j]

[a] *p*=0.002 for Alabama versus Georgia; *p*=0.11 for Alabama versus Missouri; *p*=0.03 for Alabama versus Wisconsin.

[b] Includes spastic mono-plegia, spastic hemiplegia, and unilateral spastic cerebral palsy not otherwise specified.

[c] *p*=0.20 for difference in unilateral versus bilateral spastic cerebral palsy by study site.

[d] Includes spastic diplegia, spastic quadriplegia, spastic triplegia, and bilateral spastic cerebral palsy not otherwise specified.

[e] Includes dyskinetic, ataxic, hypotonic, and dyskinetic-ataxic cerebral palsy.

[f] *p*=0.002 for Georgia versus Alabama; *p*=0.05 for Georgia versus Missouri; *p*=0.04 for Georgia versus Wisconsin.

[g] Includes spastic–ataxic, spastic–dyskinetic, mixed cerebral palsy not otherwise specified, and cerebral palsy not otherwise specified.

[h] *p*=0.21 for overall difference by study site.

[i] *p*=0.22 for Georgia versus Alabama; *p*=0.02 for Georgia versus Missouri; *p*=0.004 for Georgia versus Wisconsin.

[j] *p*=0.99 for overall difference by study site.

Table III

Co-occurring developmental disabilities and gross motor function among 8-year-old children with cerebral palsy by subtype; Autism and Developmental Disabilities Monitoring Network, surveillance year 2008

	Total (*n*=451), *n* (%)	**All spastic (*n*=349), *n* (%)**	**Spastic unilateral[a] (*n*=127), *n* (%)**	**Spastic bilateral[b] (*n*=222), *n* (%)**	**Non spastic[c] (*n*=38), *n* (%)**	**Mixed/not otherwise specified[d] (*n*=64), *n* (%)**
Co-occurring autism spectrum disorders	31 (6.9)[e]	21 (6.0)	7 (5.5)	14 (6.3)	7 (18.4)	3 (4.7)
Co-occurring epilepsy	185 (41.0)[f]	140 (40.1)	42 (33.1)	98 (44.1)	13 (34.2)	32 (50.0)
GMFCS data available	309 (68.5)[g]	249 (71.3)	79 (61.4)	170 (76.6)	25 (65.8)	35 (54.7)
GMFCS level						
I	125 (40.4)	112 (45.0)	68 (85.9)	44 (25.9)	9 (36.0)	4 (11.4)
II	47 (15.2)	35 (14.1)	8 (10.3)	27 (15.9)	4 (16.0)	8 (22.8)
III	38 (12.3)	29 (11.6)	3 (3.9)	26 (15.3)	6 (24.0)	3 (8.6)
IV	52 (16.8)	36 (14.5)	0	36 (21.2)	2 (8.0)	14 (40.0)
V	47 (15.2)	37 (14.9)	0	37 (21.8)	4 (16.0)	6 (17.1)
Walking ability data available	337 (74.7)[h]	273 (78.2)	88 (68.5)	185 (83.3)	25 (65.9)	39 (60.9)
Walking ability (observed data only)						
Walks independently	196 (58.2)[i]	169 (61.9)	85 (96.6)	84 (45.4)	13 (52.0)	14 (35.9)
Uses hand-held mobility device	38 (11.3)	29 (10.6)	3 (3.5)	26 (14.1)	6 (24.0)	3 (7.7)
Limited or no walking	103 (30.6)	75 (27.4)	0	75 (40.5)	6 (24.0)	22 (56.4)
Walking ability (including imputed data for missing values)						
Walks independently	274 (60.8)	222 (63.6)	114 (89.8)	108 (48.6)	21 (55.3)	32 (50.0)
Uses hand-held mobility device	50 (11.1)	37 (10.6)	6 (4.7)	31 (14.0)	9 (23.7)	6 (9.4)
Limited or no walking	127 (28.2)	90 (25.8)	7 (5.5)	83 (37.4)	8 (21.0)	27 (42.2)

[a] Includes spastic monoplegia and spastic hemiplegia.

[b] Includes spastic diplegia, spastic quadriplegia, and spastic triplegia.

[c] Includes dyskinetic, ataxic, hypotonic, and dyskinetic–ataxic.

[d] Includes spastic–ataxic, spastic–dyskinetic, and cerebral palsy not otherwise specified.

[e] p=0.02 for overall difference in co-occurring ASD frequency by cerebral palsy subtype (spastic, non-spastic, other).

[f] p=0.22 for overall difference in co-occurring epilepsy frequency by cerebral palsy subtype (spastic, non-spastic, other).

[g] p=0.03 for overall difference in availability of Gross Motor Function Classification System (GMFCS) data by cerebral palsy subtype (spastic, non-spastic, other).

[h] p=0.01 for overall difference in availability of walking ability data by cerebral palsy subtype (spastic, non-spastic, other).

[i] p=0.001 for overall difference in three-level observed walking ability categories by cerebral palsy subtypes (spastic, non-spastic, other).

Table IV

Demographic characteristics and clinical features of children with cerebral palsy with and without co-occurring autism spectrum disorders; Autism and Developmental Disabilities Monitoring Network, surveillance year 2008

Characteristic	**Total cerebral palsy (*n*=451), *n* (%)**	**Cerebral palsy with co-occurring autism spectrum disorders (*n*=31), *n* (%)**	**Cerebral palsy without co-occurring autism spectrum disorders (*n*=420), *n* (%)**	***p*-value**
Sex				
Male	274 (60.8)	21 (67.7)	253 (60.2)	0.41
Ethnic group				
Black non-Hispanic	162 (37.7)	11 (35.5)	151 (37.8)	0.31 (excluding missing)
White non-Hispanic	222 (51.6)	19 (61.3)	203 (50.9)	
Other	46 (10.7)	1 (3.2)	45 (11.3)	
Missing	21	0	21	
Cerebral palsy subtype				
Spastic[a]	349 (77.4)	21 (67.7)	328 (78.1)	0.02 (spastic, non-spastic, mixed, not otherwise specified)
Unilateral	127 (28.2)	7 (33.3)	120 (28.6)	
Bilateral[b]	222 (49.2)	14 (66.7)	208 (49.5)	
Non-spastic[c]	38 (8.4)	7 (22.6)	31 (7.4)	
Ataxic/dyskinetic	13 (2.9)	1 (3.2)	12 (2.9)	
Hypotonic	25 (5.5)	6 (19.4)	19 (4.5)	
Mixed/not otherwise specified[d]	64 (14.2)	3 (9.7)	61 (14.5)	
Co-occurring epilepsy	185 (41.0)	13 (41.9)	172 (41.0)	0.91
Walking ability (observed data only)				
Walks independently	196 (58.2)	17 (73.9)	179 (57.0)	0.29 (excluding missing)
Uses handheld device	38 (11.3)	2 (7.8)	36 (11.5)	
Limited/no walking	103 (30.6)	4 (17.4)	99 (31.5)	
Missing	114	8	106	

[a] Includes spastic monoplegia and spastic hemiplegia.

[b] Includes spastic diplegia, spastic quadriplegia, and spastic triplegia.

[c] Includes dyski-netic, ataxic, hypotonic, and dyskinetic–ataxic.

[d] Includes spastic–ataxic, spastic–dyskinetic, and cerebral palsy not otherwise specified.