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# Trends in the Prevalence of Developmental Disabilities in US Children, 1997–2008



**WHAT'S KNOWN ON THIS SUBJECT:** US data on the changes in the prevalence of developmental disabilities are scarce. Although there are a few studies on individual disabilities, data examining the impact of the full range of developmental disabilities are unavailable.



**WHAT THIS STUDY ADDS:** Developmental disabilities make a significant contribution to overall childhood health. We show the health disparities that exist for specific populations and how selected conditions have increased over the past 10 years.

## abstract

**OBJECTIVE:** To fill gaps in crucial data needed for health and educational planning, we determined the prevalence of developmental disabilities in US children and in selected populations for a recent 12-year period.

**PARTICIPANTS AND METHODS:** We used data on children aged 3 to 17 years from the 1997–2008 National Health Interview Surveys, which are ongoing nationally representative samples of US households. Parent-reported diagnoses of the following were included: attention deficit hyperactivity disorder; intellectual disability; cerebral palsy; autism; seizures; stuttering or stammering; moderate to profound hearing loss; blindness; learning disorders; and/or other developmental delays.

**RESULTS:** Boys had a higher prevalence overall and for a number of select disabilities compared with girls. Hispanic children had the lowest prevalence for a number of disabilities compared with non-Hispanic white and black children. Low income and public health insurance were associated with a higher prevalence of many disabilities. Prevalence of any developmental disability increased from 12.84% to 15.04% over 12 years. **Autism, attention deficit hyperactivity disorder, and other developmental delays increased**, whereas hearing loss showed a significant decline. These trends were found in all of the sociodemographic subgroups, except for autism in non-Hispanic black children.

**CONCLUSIONS:** Developmental disabilities are common and were reported in ~1 in 6 children in the United States in 2006–2008. The number of children with select developmental disabilities (autism, attention deficit hyperactivity disorder, and other developmental delays) has increased, requiring more health and education services. Additional study of the influence of risk-factor shifts, changes in acceptance, and benefits of early services is needed. *Pediatrics* 2011;127:1034–1042

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### KEY WORDS

developmental disabilities, prevalence, autism, attention deficit hyperactivity disorder

### ABBREVIATIONS

NHIS—National Health Interview Survey

ADHD—attention deficit hyperactivity disorder

All authors made substantial intellectual contributions to the study, including the conception and design, acquisition of data, analysis, and interpretation. All authors participated actively in the drafting and revising of the manuscript. Finally, all authors approved the final version that was submitted for publication. Dr Coleen A. Boyle had full access to all the data and takes responsibility for the integrity of the data and accuracy of the data analysis and contributed to the study design and concept, analysis and interpretation of the data, drafting of the manuscript, critical review of the manuscript, and statistical analysis. Dr Sheree Boulet contributed to the study design and concept, acquisition of the data, analysis and interpretation of the data, and critical review of the manuscript. Dr Laura Schieve contributed to the study design and concept, analysis and interpretation of the data, drafting of the manuscript, and critical review of the manuscript. Dr Robin A. Cohen contributed to the acquisition of the data and analysis and interpretation of the data. Dr Stephen J. Blumberg contributed to the analysis and interpretation of the data, drafting of the manuscript, and critical review of the manuscript. Dr Marshalyn Yeargin-Allsopp contributed to the analysis and interpretation of the data, drafting of the manuscript, and critical review of the manuscript. Dr Susanna Visser contributed to the analysis and interpretation of the data, drafting of the manuscript, and critical review of the manuscript. Dr Michael D. Kogan contributed to the analysis and interpretation of the data, drafting of the manuscript, and critical review of the manuscript.

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Data on the prevalence of developmental disabilities have been used to describe the importance of these health problems and to assess the educational, medical, and social support needs for children with developmental disabilities and their families. Estimates of the prevalence of developmental disabilities in US children on the basis of the 1988 National Health Interview Survey (NHIS) indicated that 16.8% of children younger than 18 years of age had lifelong conditions arising in early childhood as a result of cognitive or physical impairment or a combination of the 2.<sup>1</sup> Findings from more recent surveys that used a more restrictive definition of developmental disabilities suggested that 13.2% of children had 1 or more developmental disabilities during 1997–2005 and 1.6% had 3 or more developmental disabilities.<sup>2</sup> These studies also documented the considerable impact of the disorders as measured by higher rates of health and special-education service use for children with developmental disabilities compared with children without developmental disabilities.

A number of factors may have influenced the prevalence of developmental disabilities over the past 10 to 15 years, including improved survival of the growing number of children born preterm or with birth defects or genetic disorders, such as spina bifida and Down syndrome,<sup>3</sup> whose improved survival may be offset by a disproportionate burden of neurologic and other impairments.<sup>4,5</sup> Other trends and medical practice changes that might contribute to a reduction of developmental disabilities in the population include increases in prenatal diagnosis and therapeutic abortion, older maternal age, new infant vaccines, and the expansion of newborn screening.<sup>6,7</sup> Finally, increased awareness and improved diagnosis, particularly for conditions with a behavioral phenotype, such as autism or attention

deficit hyperactivity disorder (ADHD), may have contributed to changes over time.

Since 1997, the NHIS has routinely included questions on a broad array of developmental disabilities among children younger than 18 years of age. This survey, with population-based annual samples and consistent verbiage in individual disability condition questions, is ideal for monitoring trends in prevalence over time. We used data for a 12-year time period (1997–2008) to examine (1) the national prevalence of developmental disabilities according to major demographic and socioeconomic characteristics and (2) changes in the prevalence of developmental disabilities over time.

## PARTICIPANTS AND METHODS

We used the Family Core and Sample Child Components of the NHIS from 1997 to 2008. The NHIS is an ongoing annual survey, conducted by the Centers for Disease Control and Prevention, National Center for Health Statistics, that uses a multistage probability sample to estimate the prevalence of a number of health conditions in the civilian noninstitutionalized population of the United States.<sup>8,9</sup> Demographic and health data on family members

are obtained through an in-person interview with a knowledgeable adult family member. For the Sample Child component, more detailed data are obtained for 1 randomly selected child younger than 18 years of age. For more than 90% of the children included in the NHIS Sample Child component, the knowledgeable adult interviewed was a parent or legal guardian.

The current analysis was limited to children aged 3 to 17 years (total 1997–2008 unweighted sample size: 119 367). Children younger than 3 years of age were excluded because many developmental disabilities are not recognized or diagnosed before that age. The average household response rate for the NHIS was 88.3% (range of annual rates: 84.9–91.8%); the average conditional response rate for the sample child component was 91.2% (range: 85.6–93.7%).

The specific conditions assessed were as follows: ADHD; cerebral palsy; autism; seizures; stammering or stuttering; mental retardation; moderate to profound hearing loss; blindness; learning disorders; and other developmental delays (see Table 1 for the survey questions). The same set of questions were asked over the 11 survey years; the ex-

**TABLE 1** The NHIS Questions on Developmental Disabilities, 1997–2008

Condition	Survey Question
ADHD/attention deficit disorder (ADD), <sup>a</sup> autism, cerebral palsy, mental retardation, <sup>b</sup> and other developmental delay	"Has a doctor or health professional ever told you that [survey child] had any of the following conditions?"
Seizures and stuttering or stammering	"During the past 12 months, has [survey child] had any of the following conditions?"
Moderate to profound hearing loss	"Which statement best describes [survey child's] hearing without a hearing aid: good, a little trouble, a lot of trouble, or deaf?" <sup>c</sup>
Blindness	"Is [survey child] blind or unable to see at all?"
Learning disability	"Has a representative from the school of a health professional ever told you that [survey child] has a learning disability?"

<sup>a</sup> NHIS shifted from asking about ADD in 1997–1999 to asking about ADD and ADHD in 2000 and later.

<sup>b</sup> Referred to as intellectual disability in the text and tables.

<sup>c</sup> Categories were revised in 2008 to the following: excellent; good; a little trouble; moderate trouble; a lot of trouble; and deaf. Moderate to profound hearing loss included the categories of deaf and a lot of trouble hearing for 1997–2007 and moderate trouble, a lot of trouble, and deaf for 2008.

ception was an expansion of the hearing-loss categories in 2008 (see Table 1 for details). Although the NHIS questionnaire used the term “mental retardation,” to be more closely aligned to currently accepted terminology, we refer to this condition as “intellectual disability.”<sup>10</sup> The time frame for the majority of the questions refers to whether the child was “ever” diagnosed with the condition; for seizures and stuttering or stammering the reference period was the “past 12 months,” and moderate to profound hearing loss and blindness referred to the current status of the child. A child was considered to currently have a condition if there was an affirmative response, regardless of the time frame of the questions. There was substantial collinearity between learning disabilities and intellectual disabilities, and we therefore report learning disabilities as a consequence of the intellectual disability rather than a co-occurring condition. That is, children with reported intellectual disabilities and learning disabilities were only included in the intellectual disability category.

We examined the prevalence of any parent-reported developmental disabilities and of each individual developmental disability for the 12-year period combined and assessed how the estimates varied by a number of demographic and socioeconomic characteristics, including the child’s age; gender and race/ethnicity; mother’s education; total family income level from all sources, including supplemental security income (with income defined relative to the federal poverty level); and health insurance status (any public, private-only, no health insurance reported). Children covered by both private insurance and the state’s Medicaid programs are included under “any public.” We also assessed secular trends for each disability over 4 3-year

time intervals (1997–1999; 2000–2002; 2003–2005; and 2006–2008). For the disabilities with statistically significant temporal trends, we conducted additional analyses to determine whether trends were uniform within the demographic and socioeconomic subgroups. Income stratification in this report is based on both reported and imputed income.<sup>11</sup>

Prevalence estimates were weighted using NHIS weights to represent the US noninstitutionalized population of children. Variance estimates were produced using Sudaan software to account for the complex NHIS sample design.  $\chi^2$  Tests were used to determine whether the prevalence estimates differed among the various groups being compared. Wald-F tests were used to assess linear trends over the 4-calendar-year time periods. All associations and differences described in the text were statistically significant at the  $P < .05$  level. Human subject review was not required for this analysis of publicly available data.

## RESULTS

### Prevalence and Demographic Characteristics

The prevalence of any developmental disability in 1997–2008 was 13.87% and ranged from 0.13% for blindness to 6.69% for ADHD and 7.66% for learning disabilities (Table 2). In general, there was higher prevalence in older children for conditions likely to be first recognized or confirmed in the school years, including ADHD and learning disabilities. Little change across age groups was noted for cerebral palsy, moderate to profound hearing loss, and other developmental delays. There was a lower prevalence in older children for stuttering or stammering. Hispanic children had a lower prevalence of several disorders relative to non-Hispanic white and black children, including ADHD and learning

disabilities; the prevalence of other developmental delays was higher only in comparison to non-Hispanic white children. Stuttering or stammering was reported more often in non-Hispanic black children than non-Hispanic white children. **Boys had twice the prevalence of any developmental disability and excess prevalence for ADHD, autism, learning disabilities, stuttering or stammering, and other developmental delays, specifically.**

There was a nearly twofold higher prevalence of any reported developmental disability among children insured by Medicaid relative to those insured by private insurance, and this pattern was statistically significant for ADHD, learning disabilities, intellectual disabilities, seizures, stuttering or stammering, and other developmental delays. Family incomes below the federal poverty level were associated with a higher prevalence of parent-reported developmental disabilities overall and learning disabilities, intellectual disabilities, stuttering or stammering, and other developmental delays, specifically. Lower maternal education (ie, any attainment less than a college degree) was associated with a higher prevalence of any developmental disabilities, learning disabilities, and stuttering or stammering.

### Time Trends

For all developmental disabilities combined, there was a small, but statistically significant, linear increase in the prevalence over the 4 time periods, from 12.84% in 1997–1999 to 15.04% in 2006–2008 (Table 3). **Of the individual disorders, ADHD and autism showed significant and successive increases over time.** Other developmental delays, a catch-all category, also showed significant increases over the time period, but the increase was observed only between the most recent 2 intervals (from 2003–2005 to 2006–2008).

ADHD, because of its considerably higher prevalence, was chiefly responsible for the upward trend in the overall prevalence of developmental disabilities, with a 33% increase in prevalence from 1997–1999 to 2006–2008. **Autism, however, showed, by far, the largest relative increase, with nearly a fourfold change from a prevalence of 0.19% in 1997–1999 to 0.74% in 2006–2008.** Moderate to profound hearing loss was the only disorder to decline in prevalence, showing a 31% decrease from 1997–1999 to 2006–2008.

Although the magnitude of the change varied somewhat among the various descriptive factors (Table 4), in general, we observed upward trends in the parent-reported prevalence of ADHD and autism and a decrease for moderate to profound hearing loss. One exception was race/ethnicity and autism, with a lack of a significant increase in non-Hispanic black children.

## DISCUSSION

Developmental disabilities affect a significant proportion of children in the United States. We found that 15% of children aged 3 to 17 years, or nearly 10 million children in 2006–2008, had a developmental disability on the basis of parent report. The 17% increase in prevalence over the 12-year period represents ~1.8 million more children with developmental disabilities in 2006–2008 than a decade earlier.

It is difficult to corroborate the overall prevalence reported in this study because of the lack of comparable studies using a similar grouping of conditions. In comparing the prevalence for individual disorders, however, we find good agreement for some of the prevalence estimates. A comparable high prevalence of ADHD recently was reported from the 2003–2007 National Survey of Children's Health, using a similar set of parent-reported survey questions.<sup>12</sup> Prevalence rates for au-

**TABLE 2** Prevalence of Developmental Disabilities in Children Aged 3 to 17 Years, by Selected Demographic and Socioeconomic Factors, NHIS, 1997–2008

Condition	Total %		Age, %		Race and Ethnicity, %		Gender, %		Maternal Education, %			Poverty Level, %		Health Insurance Coverage, %		
	3–10	11–17	Non-Hispanic White	Non-Hispanic Black	Hispanic	Boys	Girls	Less Than High School	High School/Some College	College Graduate or Higher	<200%	≥200%	Private	Medicaid or CHIP	Uninsured	
Any developmental disability	13.87	11.78	14.99	14.77	10.65 <sup>d,e</sup>	18.04 <sup>c</sup>	9.50	13.89	14.78	10.88 <sup>g,h</sup>	16.08	12.42 <sup>j</sup>	12.10	20.28 <sup>k</sup>	11.61	
ADHD	6.69	4.72	7.82	6.30	3.87 <sup>d,e</sup>	9.51 <sup>c</sup>	3.73	5.46	7.26 <sup>i</sup>	5.35	7.20	6.36	6.01	9.55 <sup>k</sup>	4.97 <sup>i</sup>	
<b>Autism</b>	0.47	0.56	0.52	0.41	0.32	<b>0.74<sup>c</sup></b>	<b>0.19</b>	0.25	0.50	0.61	0.44	0.49	0.45	0.67	0.19	
Blind/unable to see at all	0.13	0.10	0.12	0.13	0.15	0.16	0.10	0.16	0.13	0.07	0.16	0.11	0.10	0.17	0.17	
Cerebral palsy <sup>a</sup>	0.39	0.36	0.39	0.36	0.33	0.36	0.37	0.33	0.35	0.42	0.41	0.34	0.61	0.60	0.33	
Moderate to profound hearing loss	0.45	0.44	0.51	0.41	0.32	0.54	0.35	0.56	0.50	0.28	0.64	0.32	0.34	0.77	0.44	
Learning disabilities	7.66	5.07	7.58	7.62	5.50 <sup>d,e</sup>	8.97 <sup>c</sup>	5.01	8.06	7.50	4.85 <sup>g,h</sup>	8.57	6.03 <sup>j</sup>	5.94	10.87 <sup>k</sup>	6.16 <sup>i</sup>	
Intellectual disabilities <sup>b</sup>	0.71	0.59	0.62	1.06	0.70	0.78	0.63	0.93	0.70	0.48	1.03	0.50 <sup>j</sup>	0.44	1.68 <sup>k</sup>	0.38 <sup>i</sup>	
Seizures in the past 12 months	0.67	0.72	0.66	0.91	0.61	0.73	0.62	0.73	0.75	0.45	0.91	0.52	0.49	1.31 <sup>k</sup>	0.46 <sup>i</sup>	
Stuttered or stammered in the past 12 months	1.60	1.99	1.27	2.63 <sup>f</sup>	1.96	2.25 <sup>a</sup>	0.91	2.57	1.59	0.96 <sup>g,h</sup>	2.40	1.07 <sup>j</sup>	1.08	3.09 <sup>k</sup>	1.64 <sup>i</sup>	
Other developmental delay	3.65	3.86	3.97	3.62	2.64 <sup>d</sup>	4.64 <sup>c</sup>	2.61	3.19	3.91	3.32	4.39	3.16 <sup>j</sup>	3.03	6.06 <sup>k</sup>	2.42 <sup>i</sup>	

<sup>a</sup> We excluded cerebral palsy from the analysis for 2004–2007 because of the high likelihood of interviewer error arising from a questionnaire change in 2004.

<sup>b</sup> The survey question asked about mental retardation, but we refer to the condition as intellectual disability.

<sup>c</sup>  $P < .05$ , ages 3–10 vs 11–17 years.

<sup>d</sup>  $P < .05$ , non-Hispanic white versus Hispanic.

<sup>e</sup>  $P < .05$ , non-Hispanic black versus Hispanic.

<sup>f</sup>  $P < .05$ , non-Hispanic white versus non-Hispanic black.

<sup>g</sup>  $P < .05$ , less than high school versus college graduate.

<sup>h</sup>  $P < .05$ , high school versus college graduate.

<sup>i</sup>  $P < .05$ , less than high school versus high school graduate.

<sup>j</sup>  $P < .05$ , <200% versus ≥200% poverty level.

<sup>k</sup>  $P < .05$ , private insurance versus Medicaid.

<sup>l</sup>  $P < .05$ , Medicaid versus uninsured.

**TABLE 3** Trends in Prevalence of Specific Developmental Disabilities in Children Aged 3 to 17 Years, NHIS, 1997–2008

Disability	<i>n</i> (Unweighted)	All Years, %	1997–1999, %	2000–2002, %	2003–2005, %	2006–2008, %	Percent Change 1997–1999 versus 2006–2008 <sup>c</sup>
Any developmental disability	15956	13.87	12.84	13.70	13.88	15.04	17.1 <sup>d</sup>
ADHD	7652	6.69	5.69	6.71	6.77	7.57	33.0 <sup>d</sup>
Autism	537	0.47	0.19	0.35	0.59	0.74	289.5 <sup>d</sup>
Blind/unable to see at all	160	0.13	0.11	0.15	0.12	0.13	18.2
Cerebral palsy	305	0.39	0.39	0.43	<sup>b</sup>	<sup>b</sup>	<sup>b</sup>
Moderate to profound hearing loss	533	0.45	0.55	0.44	0.42	0.38	30.9
Learning disability	8154	7.04	6.86	7.24	6.82	7.24	5.5
Intellectual disability <sup>a</sup>	868	0.71	0.68	0.73	0.75	0.67	−1.5
Seizures, past 12 months	792	0.67	0.66	0.65	0.66	0.72	9.1
Stuttered or stammered, past 12 months	1924	1.60	1.63	1.40	1.69	1.68	3.1
Other developmental delay	3978	3.65	3.40	3.28	3.67	4.24	24.7 <sup>d</sup>

Source: Centers for Disease Control and Prevention, National Center for Health Statistics, NHIS.

<sup>a</sup> Survey question asked about mental retardation, but we refer to the condition as intellectual disability.

<sup>b</sup> We excluded cerebral palsy from the analysis for 2004–2007 because of the high likelihood of interviewer error arising from a questionnaire change in 2004.

<sup>c</sup> Percent change between 1997–1999 and 2006–2008.

<sup>d</sup> Test of linear trend over 4 time periods,  $P < .05$ .

tism, cerebral palsy, seizures, blindness, and stuttering or stammering are comparable with those from several population-based prevalence studies using varied study methods.<sup>13–18</sup> This is particularly relevant for seizures, where the nomenclature, as endorsed by the International League Against Epilepsy, for recurrent seizures is epilepsy and not seizures or seizure disorder.<sup>18</sup> The prevalence of moderate to profound hearing loss was considerably higher, whereas the prevalence of intellectual disabilities was ~50% lower than findings from a population-based surveillance program that requires auditory test results for moderate to profound hearing loss and cognitive test results for intellectual disabilities.<sup>17</sup> A number of factors may have influenced these discordant findings, including a more restrictive case definition in the records-based surveillance program for moderate to profound hearing loss (ie, bilateral measured loss of 40 dB or greater) than that used in the NHIS analysis. In the case of intellectual disabilities, and particularly mild intellectual disabilities, because testing often is done in the context of educational placement, the parent or

guardian may never have been told that their child's test results suggested functioning in the intellectual disabilities range. Also, since 1997, federal law has allowed for state and local education agencies to extend the use of the less-specific "developmental delay" category up to 9 years of age, enabling many children to not require a more specific education classification, such as intellectual disability.<sup>19</sup> Some of these children may have been identified in the NHIS by the question "other developmental delay," as suggested by the high and increasing prevalence for this category.<sup>20</sup> Although it is not clear what specific functional problems children with other developmental delays have, Boulet et al<sup>2</sup> showed that 76% have a co-occurring developmental disability and that learning disabilities and ADHD were the most frequent co-occurring conditions.

The 17% increase in all developmental disabilities over the 12 years was caused in large part by shifts in the prevalence of ADHD and autism. Increases in autism during the mid-1990s to late 1990s and continuing through the late 2000s have been noted in a number of studies<sup>14,19,21–23</sup>

using varying definitions of autism and study designs, ranging from administrative educational and service system data to retrospective studies of successive birth cohorts of children. Although data on trends in ADHD are less available, they support a similar increase.<sup>23,24</sup> A Danish study<sup>23</sup> reported that trends in the birth cohort prevalence of several neuropsychiatric disorders, including autism and hyperkinetic disorder (*International Classification of Diseases 10 Revision* classification that is closely aligned with the hyperactivity component of ADHD) increased significantly for children born in 1990 through 1999. A US-based study<sup>24</sup> reported significant increases in the prevalence of office-based visits for ADHD during 1991–1998. Finally, an upward trend in prevalence, using US education data, was found for the "other health impaired" education category, which, since 1991, is the education category used for children with ADHD.<sup>19,25</sup> Decreases in the prevalence of moderate to profound hearing loss over the 12-year period have not been reported previously. Trend data from service records over a shorter time frame showed little to no change.<sup>17</sup> Nationally, the number of infants identi-

fied with congenital moderate to profound hearing loss from state newborn-screening programs has increased dramatically with the expansion of universal screening<sup>26</sup>; however, it is unlikely that this program would have impacted the prevalence for this survey. The lower prevalence of moderate to profound hearing loss from the NHIS was limited to 2006–2008; in 2008, there was a modification in the moderate to profound hearing loss categories, which makes it difficult to determine whether this lower trend continues. More data are needed to better understand this finding.

Factors responsible for increases in autism and ADHD are numerous. Availability of services and in how the service system classifies children with behavioral disorders has progressed as we learn more about the advantages of earlier interventions. Improvements in clinical, parental, and societal recognition of and screening for these disorders have occurred. For example, we have national campaigns to increase awareness of autism,<sup>27</sup> and the American Academy of Pediatrics has incorporated ongoing monitoring of a child's development as a practice recommendation for pediatricians in 2007.<sup>28</sup> Another contributing factor may be the efficacy of medications and behavioral treatments for ADHD.<sup>29</sup> There also has been an increase in the prevalence of known prenatal risk factors for these conditions. Examples include increases in the prevalence of preterm birth and the recognition of the full range of potential adverse developmental consequences of late preterm birth,<sup>4,5</sup> shifts toward older parental age, and increases in the prevalence of assisted reproductive technologies and possibly other hormonal infertility treatments and the consequent increase in multiple births, each of which is associated

**TABLE 4** Prevalence of ADHD, Autism, and Moderate to Profound Hearing Loss in Children Ages 3 to 17 years, by Select Characteristics and Time Period, NHIS, 1997–2008

Characteristics	ADHD, %		Autism, %		Percentage change 1997–1999 versus 2006–2008		Moderate to Profound Hearing Loss, %		Percentage Change 1997–1999 versus 2006–2008					
	1997–1999	2000–2002	2003–2005	2006–2008	1997–1999	2006–2008	1997–1999	2000–2002		2003–2005	2006–2008			
Age, y														
3–10	4.16	4.80	4.74	5.19	0.27	0.40	0.72	0.87	222.2	0.54	0.43	0.45	0.34	–37.04
11–17	7.51	8.90	8.98	10.24	0.11	0.31	0.45	0.59	436.4	0.57	0.46	0.37	0.43	–24.56
Gender														
Male	8.43	9.55	9.44	10.59	0.31	0.58	0.94	1.12	261.3	0.65	0.57	0.52	0.42	–35.38
Female	2.83	3.73	3.96	4.39	0.07	0.11	0.22	0.34	385.7	0.45	0.31	0.30	0.35	–22.22
Race/ethnicity														
Non Hispanic white	6.74	7.95	7.80	8.89	0.16	0.36	0.74	0.88	450.0 <sup>a</sup>	0.64	0.45	0.50	0.44	–31.25
Non Hispanic black	4.40	6.08	6.86	7.81	0.33	0.36	0.51	0.44	33.3	0.39	0.49	0.40	0.35 <sup>c</sup>	–10.26
Hispanic	3.13	3.65	4.10	4.39	0.17	0.25	0.32	0.47	176.5 <sup>a</sup>	0.37	0.40	0.20	0.32	–13.51
Mother's education:														
Less than high school	5.08	5.42	5.89	5.44	0.19	0.16	0.33	0.33	73.7	0.68	0.57	0.47	0.51	–25.00
High school/some college	6.07	7.27	7.33	8.43	0.16	0.37	0.62	0.85	431.3	0.62	0.50	0.49	0.37	–40.32
College or greater	4.51	5.47	5.15	6.09	0.27	0.49	0.73	0.88	225.9	0.31	0.24	0.24 <sup>c</sup>	0.32	3.23
% of poverty level														
<20%	6.05	6.98	7.13	8.54	0.22	0.35	0.48	0.69	213.6	0.84	0.71	0.55	0.47	–44.05
≥200%	5.45	6.55	6.53	6.89	0.17	0.35	0.65	0.78	358.8	0.36	0.28	0.32	0.32	–11.11
Health insurance														
Private	5.23	6.18	6.25	6.46	0.16	0.31	0.63	0.73	356.3	0.41	0.34	0.31	0.31	–24.39
Medicaid or CHIP	8.81	9.40	8.88	10.64	0.36	0.59	0.59	0.94	161.1	1.29	0.86	0.62	0.55	–57.36
Uninsured	4.33	5.03	5.50	5.17	19.4	0.22 <sup>c</sup>	0.26 <sup>c</sup>	0.20 <sup>c</sup>	<sup>d</sup>	0.44	0.32 <sup>c</sup>	0.61 <sup>c</sup>	0.41 <sup>c</sup>	–7.3

<sup>a</sup> Test of linear trend over 4 time periods,  $P < .05$ .

<sup>b</sup> Estimates with an SE of higher than 50% are not shown.

<sup>c</sup> Estimates have a relative SE of more than 30% and less than or equal to 50% and should be used with caution because they do not meet the standards of reliability or precision.

<sup>d</sup> Not calculated because of imprecise estimates.

with adverse developmental outcomes.<sup>30</sup> Finally, given that the shift in developmental disability prevalence over time seems to be focused on conditions that are based on an emotional or behavioral phenotype, a societal shift in the acceptance and destigmatization of such conditions in young children also may play a role.<sup>31</sup>

Several of our findings regarding the descriptive characteristics of children with developmental disabilities were noteworthy. Others studies have reported lower prevalence estimates for autism and ADHD in Hispanics,<sup>12,14,32,33</sup> although findings from more recent studies suggest that the gaps may be closing.<sup>13</sup> Rather than these patterns reflecting true differences, they are more likely the result of language barriers, lack of access to services, and health insurance coverage. **The pre-dominance of boys with developmental disabilities also was remarkable. Although the increased gender ratio for selected developmental disabilities is well described, this study showed the pattern present for nearly all developmental disabilities.** Some of this is certainly biological, such as X-linked genetic disorders that result in intellectual disabilities and other functional limitations. Others have described a cultural factor related to greater incentive for case finding in boys compared with girls.<sup>34</sup> Alternatively, there may be gender-specific presentations of some of the disorders, particularly for conditions with an exclusively behavior phenotype (ADHD and autism) that favor the identification of boys over girls. ADHD is a good example, in that girls tend to exhibit less of the impulsivity associated with the disorder and therefore maybe be less likely to come to clinical attention.<sup>35</sup> Regarding socioeconomic inequities, public health insurance coverage

seemed to be associated with a higher prevalence of developmental disabilities; low family income and low maternal education had similar but less significant impacts. Larson and Halfon<sup>36</sup> showed a similar inverse socioeconomic gradient with family income and the prevalence of ADHD, learning disabilities, and speech problems but not autism. Some of the impact with public insurance is likely reflecting eligibility for Medicaid for children with disabilities.

The strengths of the NHIS are important to highlight. The survey has a nationally representative sample that allows for generalizability to the US population of 3- to 17-year-old children. The same set of questions was asked of parents in each survey year. As a consequence, this is the only study able to examine, in detail, trends in these disorders. The response rate for the NHIS remained at exemplary high levels over the 11 years, despite the challenges of door-to-door surveys, limiting our concerns about the bias resulting from selectivity and nonresponse.

Limitations also are important to consider. Parent report of medical conditions is not without error. Inaccurate reporting can result from parental distress and the stigma associated with some of the conditions; the questions may be misunderstood or there may be variations in professional terminology used for developmental disabilities; for example, autism can be referred to by more broad or umbrella terms, such as autism spectrum disorders. Also, specific terms fall out of accepted use (mental retardation versus intellectual disability and seizure disorder versus epilepsy). A few studies<sup>33,37,38</sup> have examined the validity of parent report for selected developmental disabilities. Some, but not all,

of the conditions seem to have high validity (see Boulet et al<sup>2</sup> for more detail.) Ongoing survey research is needed to maintain the validity of the survey questions, while balancing the benefits of historical information to compare overtime. Finally, although we assumed that many of these conditions are chronic, in fact, a condition may resolve to the point where parents or health care providers may no longer consider the child as having the disorder. Recent evidence<sup>13,39</sup> of this was found for autism, and a longitudinal study showed considerable changes in diagnoses over time for children with physical and emotional or behavior diagnoses. Finally, some children included in the stuttering or stammering or seizures categories may have had transient conditions, resulting in an overestimation of the prevalence of these conditions.

## CONCLUSIONS

We found that the number of children with developmental disabilities has increased over the decade. These findings have a direct bearing on the need for health, education, and social services, including the need for more specialized health services (mental health services, medical specialists, therapists, and allied health professionals). Also, the consequent burden on families and caregivers will need to be considered. Finally, more detailed study of the influence of risk factor shifts, changes in acceptance, and benefits of early services is needed to better understand why these shifts have occurred.

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## REFERENCES

- Boyle CA, Decoufle P, Yeargin-Allsopp M. Prevalence and health impact of developmental disabilities in US children. *Pediatrics*. 1994;93(3):399–403
- Boulet SL, Boyle CA, Schieve LA. Health care use and health and functional impact of developmental disabilities among US children, 1997–2005. *Arch Pediatr Adolesc Med*. 2009;163(1):19–26
- Shin M, Besser LM, Kucik JE, Lu C, Siffel C, Correa A. Prevalence of Down syndrome among children and adults in 10 regions in the United States. *Pediatrics*. 2009;124(6):1565–1571
- Boulet SL, Schieve LA, Boyle CA. Birth weight and health and developmental outcomes in US children, 1997–2005. *Matern Child Health J*. 2009[Epub ahead of print]
- Petrini JR, Dias T, McCormick MC, Massolo ML, Green NS, Escobar GJ. Increased risk of adverse neurological development for late preterm infants. *J Pediatr*. 2009;154(2):169–176
- Brosco JP, Mattingly M, Sanders LM. Impact of specific medical interventions on reducing the prevalence of mental retardation. *Arch Pediatr Adolesc Med*. 2006;160(3):302–309
- Wilcken B, Haas M, Joy P, et al. Expanded newborn screening: outcome in screened and un-screened patients at age 6 years. *Pediatrics*. 2009;124(2). Available at: [www.pediatrics.org/cgi/content/full/124/2/e241](http://www.pediatrics.org/cgi/content/full/124/2/e241)
- National Center for Health Statistics, National Health Interview Survey. About the National Health Interview Survey [article online], 2009. Available at: [www.cdc.gov/nchs/nhis/about\\_nhis.htm#sample\\_design](http://www.cdc.gov/nchs/nhis/about_nhis.htm#sample_design) Accessed April 22, 2011
- National Center for Health Statistics. National Health Interview Survey: research for the 1995–2004 redesign. *Vital Health Stat*. 1999;(126):1–119
- Schalock RL, Luckasson RA, Shogren KA. Perspectives: the renaming of mental retardation: understanding the change to the term intellectual disability. *Intellectual Dev Disabilities*. 2007;45(2):116–124
- Schenker N, Raghunathan TE, Chiu PL, Makuc D, Zhang G, Cohen AJ. Multiple imputation of family income and personal earnings in the National Health Interview Survey: methods and examples [article online], 2009. National Center for Health Statistics, Atlanta, GA. Available at: [www.cdc.gov/nchs/data/nhis/tecdoc3.pdf](http://www.cdc.gov/nchs/data/nhis/tecdoc3.pdf) Accessed April 22, 2011
- Centers for Disease Control and Prevention. Increasing prevalence of parent-reported attention-deficit/hyperactivity disorder among children: United States, 2003–2007. *MMWR* 2010;59(44):1439–1443
- Kogan MD, Blumberg SJ, Schieve LA, et al. The prevalence of parent-reported diagnosis of autism spectrum disorder among children in the United States, 2007. *Pediatrics*. 2009;124(5):1395–1403
- Autism and Other Developmental Disabilities Monitoring Network. Prevalence of autism spectrum disorders: Autism and Developmental Disabilities Monitoring Network, United States, 2006. *MMWR*. 2009;58(SS-10):2–21
- Yeargin-Allsopp M, Van Naarden-Braun K, Doernberg N, Benedict R, Kirby R, Durkin M. Prevalence of cerebral palsy in 8-year-old children in three areas of the United States in 2002: a multisite collaboration. *Pediatrics*. 2008;121(3):547–554
- Murphy CC, Trevathan E, Yeargin-Allsopp M. Prevalence of epilepsy and epileptic seizures in 10-year-old children: results from the Metropolitan Atlanta Developmental Disabilities Study. *Epilepsia*. 1995;36(9):866–872
- Karapurkar-Bhasin, T, Brocksen S, Avchen RN, Van Naarden-Braun K. Prevalence of four developmental disabilities among children age 8 years: Metropolitan Atlanta Developmental Disabilities Surveillance Program, 1996 and 2000. *MMWR*. 2006;55(SS01):1–9
- International League Against Epilepsy. Revised terminology and concepts for organization of the epilepsies: report of the Commission on Classification and Terminology [article online], 2009. Available at: [www.ilae-epilepsy.org/visitors/centre/ctf/ctfoverview.cfm](http://www.ilae-epilepsy.org/visitors/centre/ctf/ctfoverview.cfm) Accessed April 22, 2011
- Newschaffer CJ, Falb, MD, Gurney JG. National autism prevalence trends from United States special education data. *Pediatrics*. 115(3). [www.pediatrics.org/cgi/content/full/115/3/e277](http://www.pediatrics.org/cgi/content/full/115/3/e277)
- Larson SA, Lakin KC, Doljanac D. (2005). Problems in defining mental retardation and developmental disability: using the National Health Interview Survey [article online], 2005. Vol 7, No 1. DD Data Brief, University of Minnesota-Minneapolis, Institute on Community Integration. Available at: <http://rtc.umn.edu/docs/dddb7-1.pdf>. Accessed April 22, 2011
- Gurney JG, Fritz MS, Ness KK, Sievers P, Newschaffer CJ, Shapiro EG. Analysis of prevalence trends of autism spectrum disorder in Minnesota. *Arch Pediatr Adolesc Med*. 2003;157(7):622–627
- Schechter R, Grether JK. Continuing increases in autism reported to California's developmental services system: Mercury in retrograde. *Arch Gen Psychiatry*. 2008;65(1):15–16
- Atladóttir HO, Parner ET, Schendel D, Dalsgaard S, Thomsen PH, Thorsen P. Time trends in reported diagnoses of childhood neuropsychiatric disorders. *Arch Pediatr Adolesc Med*. 2007;161(2):193–198
- Robinson LM, Skaer TL, Sclar DA, Galin RS. Is attention deficit hyperactivity disorder increasing among girls in the US? *CNS Drugs*. 2002;16(2):129–137
- US Department of Education, Office of Special Education Programs. Clarification of policy to address the needs of children with ADD within general and/or special education [article online], 1999. Available at: [www.ed.gov/policy/speced/leg/idea/brief6.html?esp=0](http://www.ed.gov/policy/speced/leg/idea/brief6.html?esp=0). Accessed April 22, 2011
- Gaffney M, Eichwald J, Grosse SD, Mason CA. Identifying infants with hearing loss: United States, 1999–2007. *MMWR*. 2010;59(8):220–223
- Daniel KL, Prue C, Taylor MK, Thomas J, Scales M. 'Learn the Signs. Act Early': a campaign to help every child reach his or her full potential. *Public Health Reports*. 2009;123 (Suppl 1):e11–e16
- American Academy of Pediatrics Council on Children with Disabilities. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. *Pediatrics*. 2006;118(1):405–420
- MTA Cooperative Group. National Institute of Mental Health multimodal treatment study of ADHD: 24-month outcomes of treatment strategies for attention-deficit/hyperactivity disorder. *Pediatrics*. 2004;113(4):754–761
- Schieve LA, Devine O, Boyle CA, Petrini JR, Warner L. Estimation of the contribution of non-assisted reproductive technology ovulation stimulation fertility treatments in US singleton and multiple births. *Am J Epidemiol*. 2009;170(11):1396–1407 Dec 1
- Grinker RR, Yeargin-Allsopp M, Boyle C. Culture and autism spectrum disorders: the impact on prevalence and recognition. In: Amaral D, Geschwin D, Dawson G, Eds. *Autism Spectrum Disorders*. New York, NY: Oxford University Press, In press
- Froehlich TE, Lanphear BP, Epstein JN, Barbaresi WJ, Katusic SK, Kahn RS. Prevalence, recognition, and treatment of attention-deficit/hyperactivity disorder. *Arch Pediatr Adolesc Med*. 2007;161(9):857–864

33. Schieve LA, Rice C, Boyle C, Visser SN. Mental health in the United States: parental report of diagnosed autism in children aged 4–17 years: United States, 2003–2004. *MMWR*. 2006;55(17):481–486
34. Rowland AS, Lesesne CA, Abramowitz AJ. The epidemiology of attention-deficit/hyperactivity disorder (ADHD): a public health view. *Ment Retard Dev Disabil Res Rev*. 2002;8(3):162–70
35. deHaas PA. Attention styles and peer relationships of hyperactive and normal boys and girls. *J Abnorm Child Psychol*. 1986; 14(3):457–467
36. Larson K, Halfon N. Family income gradients in the health and health care access of US children. *Matern Child Health J*. 2010; 14(3): 332–342
37. Ackland MJ, Wade RQ. Health status of Victorian special school children. *J Paediatr Child Health*. 1995;31(5): 423–427
38. Miller JE, Gaboda D, Davis D. Early childhood illness: comparability of maternal reports and medical records. *Vital Health Stat 2*. 2001;(131):1–10
39. Van Cleave J, Gortmaker SL, Perrin JM. Dynamic of obesity and chronic health conditions among children and youth. *JAMA*. 2010;303(7):623–630

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