



# A Cross-Sectional Study of 0.6 Million Children with Attention-Deficit/Hyperactivity Disorder in the United States

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## Abstract

Attention-deficit hyperactivity disorder (ADHD) is an increasingly recognized chronic neurodevelopmental disorder. This work aims at studying the prevalence and clinical characteristics of children with ADHD in the United States in the period between 2009 and 2018. Data from the National Health Interview Survey were analyzed by univariate and multivariate statistics to assess the role of socioeconomic factors in the development of ADHD. It has been studied 615,608 children, 51.2% male and 48.7% female. The prevalence of ADHD was 9.13%, with males predominating over females. The number of children with ADHD increased from 2009 to 2018 by 14.8%. As specified by multiple logistic regression analysis, males (odds ratio [OR] 2.38) who have neither mother nor father (OR 1.76) are twice as likely to have ADHD compared with their peers. In addition, family income (OR 1.40) and parent's education (OR 1.12) were significantly associated with ADHD. It has been highlighted the significance of deprivation of both family and financial comfort as primary indicators for ADHD in children. Moreover, children with ADHD were more likely to be males in the age group of 12 to 17.

## Keywords

- ▶ ADHD
- ▶ prognostic factors
- ▶ socioeconomic factors

## Introduction

Attention-deficit hyperactivity disorder (ADHD) is a chronic neurodevelopmental disorder in which children cannot handle their behavior due to difficulty in processing neural stimuli, followed by high activity levels.<sup>1</sup> Inattention, impulsivity, and hyperactivity are some of the symptoms that the child is faced with.<sup>2–4</sup> The prevalence of ADHD ranges from 1 to 20% among children and adolescents worldwide.<sup>5–9</sup> The knowledge of the prevalence of ADHD among children is of paramount importance for further response scheduling, resource allocation, training, and research.<sup>10</sup>

Low socioeconomic status (SES) has been linked not only to poor physical health but also to impaired mental health in childhood.<sup>11–19</sup> In particular, children from low socioeconomic backgrounds are 1.18 to 3.34 times more likely to have mental health problems than their peers.<sup>19</sup> The association between ADHD and SES appears to be complex because

symptoms are associated with interactions between genes and the environment during development.<sup>20</sup> Other proposed factors that could be involved include maternal mental health,<sup>21</sup> substance abuse,<sup>22</sup> as well as the parent's involvement in the upbringing of their child.<sup>23</sup>

It is of utmost importance to acknowledge the seriousness of ADHD in children, and the knowledge of underlying factors that lead children to ADHD. For this purpose, this work studied ADHD in the United States during the period 2009 to 2018 with the aim to find statistically significant socioeconomic indicators for this type of disorder.

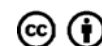
## Methods

The data used in this work originate from the National Health Interview Survey (NHIS) data set<sup>24</sup> and cover the period 2009 to 2018. The target population for NHIS is the civilian

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noninstitutionalized population of the United States. NHIS data are collected through personal household interviews. The main objective of NHIS is to monitor the health of the U.S. population through the collection and analysis of data on a broad range of health topics. Each year, a representative sample of households across the country is selected for NHIS using a multistage cluster sample design. Trained interviewers from the U.S. Census Bureau visit each selected household and administer the NHIS in person. To identify children with ADHD, each household was asked to answer the question: “Has a doctor or other health professional ever told you that [child’s name] had ADHD or attention deficit disorder?” Statistical methods were chi-square test for categorical variables and one-way analysis of variance for continuous variables to check the hypothesis that the prevalence of ADHD was not associated with socioeconomic characteristics (gender, age, race, origin, parent’s education, family income, poverty status, health insurance coverage, current health status, family structure, place of residence, and region). Factors associated with ADHD were identified by multiple logistic regression analysis. Children with ADHD (case group) were compared with a matched cohort of children without this condition (control group). Factors associated with ADHD were represented using the odds ratio (OR) and 95% confidence intervals, and a *p*-value of < 0.05 was considered statistically significant. Particularly, the OR has been used to compare the relative odds of occurrence of the outcome of interest (children with ADHD), given exposure to the variable of interest (specific socioeconomic characteristics of children).<sup>25</sup> The study was performed using IBM SPSS 25 software package for Windows.

All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Results**

Participants of this study were 615,608, 51.2% males and 48.7% females. Moreover, 13.5% of the participants were 0 to 4 years old, 46.5% of them were 5 to 11 years old, and finally, 40.1% of them were 12 to 17 years old. The number of children and adolescents with ADHD was 56,252. As shown in ► **Table 1**, ADHD was more frequent in males, in the age group of 12 to 17 years, and in Caucasians. Most children with ADHD had parents with high education—more than a high school diploma (69.2%)—and excellent or very good health status (72.1%). Moreover, most families whose children have ADHD were not poor (51.4%), with a family income of \$35,000 or more (38.4%) and private health insurance coverage (47.5%). Finally, most children with ADHD had both mother and father as family structure (57.5%) and live in southern U.S. (43.1%), in large metropolitan areas with a population size of one million or more (47.3%).

Most children in the control group were females, in the age group of 5 to 11, and Caucasians. Most children of the control group had parents with high education—more than a high school diploma (69.5%)—and excellent or very good health status (84.5%). Moreover, most families from the control group were not poor (57.8%), with a family income of \$35,000 or more (41.4%) and private health insurance coverage (55.9%). Finally, most children from the control group had both mother

**Table 1** Chi-square and one-way ANOVA test

Characteristics of children with ADHD: United States 2009–2018		Children with ADHD	Percentages	<i>p</i> -Value
Gender				< 0.05
	Male	39,308	69.9%	
	Female	16,944	30.1%	
Age				< 0.05
	3–4	1,228	2.2%	
	5–11	24,280	43.2%	
	12–17	30,746	54.7%	
Race				< 0.05
	White	42,627	81.4%	
	Black or African American	9,104	17.4%	
	Asian	627	1.2%	
Origin				< 0.05
	Hispanic or Latino	8,491	8.1%	
	Mexican or Mexican American	4,930	4.7%	
	Not Hispanic or Latino	47,762	45.4%	
	White, single race	35,315	33.6%	
	Black or African American, single race	8,598	8.2%	

**Table 1** (Continued)

Characteristics of children with ADHD: United States 2009–2018		Children with ADHD	Percentages	p-Value
Parent's education				< 0.05
	Less than a high school diploma	5,333	10.1%	
	High school diploma	10,972	20.7%	
	More than a high school diploma	36,603	69.2%	
Family income				< 0.05
	Less than \$35,000	19,888	23.1%	
	\$35,000 or more	33,065	38.4%	
	\$35,000–\$49,999	6,438	7.5%	
	\$50,000–\$74,999	8,078	9.4%	
	\$75,000–\$99,999	5,411	6.3%	
	\$100,000 or more	13,137	15.3%	
Poverty status				< 0.05
	Poor	13,522	25.1%	
	Near poor	12,677	23.5%	
	Not poor	27,666	51.4%	
Health insurance coverage				< 0.05
	Private	26,593	47.5%	
	Medicaid	25,535	45.6%	
	Other coverage	1,671	3.0%	
	Uninsured	2,238	4.0%	
Current health status				< 0.05
	Excellent or very good	40,552	72.1%	
	Good	12,670	22.5%	
	Fair or poor	3,034	5.4%	
Family structure				< 0.05
	Mother and father	32,334	57.5%	
	Mother, no father	18,239	32.4%	
	Father, no mother	2,418	4.3%	
	Neither mother nor father	3,262	5.8%	
Place of residence				< 0.05
MSA (metropolitan statistical area)	Large MSA (population size 1 million or more)	26,611	47.3%	
	Small MSA (less than 1 million)	19,578	34.8%	
	Not in MSA	10,064	17.9%	
Region				< 0.05
	Northeast	9,023	16.0%	
	Midwest	14,123	25.1%	
	South	24,242	43.1%	
	West	8,869	15.8%	

Abbreviations: ADHD, attention-deficit hyperactivity disorder; ANOVA, analysis of variance.

and father as family structure (69.5%) and they live south (36.4%), in a large metropolitan statistical area with a population size of one million or more (58.0%).

► **Table 2** represents the multiple logistic regression analysis with the ORs with the aim of finding predictors for

ADHD. As can be seen in ► **Table 2**, all prognostic factors were statistically significant ( $p < 0.05$ ). Based on multiple logistic regressions, children who were more likely to have ADHD were black or African Americans (OR 5.4), males (OR 2.38), and in the age group of 12 to 17 (OR 1.0), with parents having

**Table 2** Statistically significant predictors of ADHD in children using multivariate logistic regression

Socioeconomic characteristics of children: United States 2009–2018		Patients	Controls	Odds ratio (95%CI)	p-Value
Gender					< 0.05
	Male	39,308	276,048	2.38 (2.33–2.42)	
	Female	16,944	283,308	1.0 (ref)	
Age					< 0.05
	3–4	1,228	82,016	0.10 (0.10–0.11)	
	5–11	24,280	262,956	0.65 (0.64–0.66)	
	12–17	30,746	216,951	1.0 (ref)	
Race					< 0.05
	White	42,627	416,541	4.98 (4.6–5.4)	
	Black or African American	9,104	82,076	5.4 (4.98–5.86)	
	Asian	627	30,557	1.0 (ref)	
Origin					< 0.05
	Hispanic or Latino	8,491	138,513	0.54 (0.52–0.56)	
	Mexican or Mexican American	4,930	94,190	0.46 (0.44–0.48)	
	Not Hispanic or Latino	47,762	423,414	1.0 (0.97–1.0)	
	White single race	35,315	293,397	1.01 (1.04–1.09)	
	Black or African American, single race	8,598	76,337	1.0 (ref)	
Parent's education					< 0.05
	Less than a high school diploma	5,333	65,515	0.83 (0.81–0.86)	
	High school diploma	10,972	100,341	1.12(1.10–1.15)	
	More than a high school diploma	36,603	377,321	1.0 (ref)	
Family income					< 0.05
	Less than \$35,000	19,888	152,705	1.4 (1.4–1.5)	
	\$35,000 or more	33,065	365,674	1.02 (1.00–1.04)	
	\$35,000–\$49,999	6,438	63,897	1.14 (1.10–1.17)	
	\$50,000–\$74,999	8,078	87,394	1.04 (1.01–1.07)	
	\$75,000–\$99,999	5,411	65,711	0.93 (0.90–0.96)	
	\$100,000 or more	13,137	148,677	1.0 (ref)	
Poverty status					< 0.05
	Poor	13,522	103,020	1.45 (1.42–1.48)	
	Near poor	12,677	120,095	1.16 (1.14–1.19)	
	Not poor	27,666	305,974	1.0 (ref)	
Health insurance coverage					< 0.05
	Private	26,593	313,087	1.4 (1.3–1.4)	
	Medicaid	25,535	194,357	2.2 (2.1–2.3)	
	Other coverage	1,671	14,770	1.89 (1.77–2.0)	
	Uninsured	2,238	37,480	1.0 (ref)	
Current health status					< 0.05
	Excellent or very good	40,552	474,701	0.26 (0.25–0.27)	
	Good	12,670	77,857	0.49 (0.47–0.52)	
	Fair or poor	3,034	9,266	1.0 (ref)	

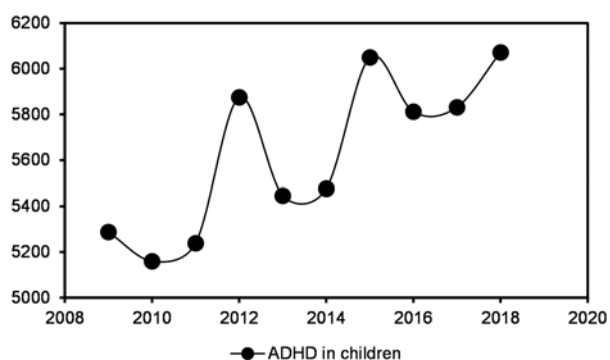
**Table 2** (Continued)

Socioeconomic characteristics of children: United States 2009–2018		Patients	Controls	Odds ratio (95%CI)	p-Value
Family structure					< 0.05
	Neither mother nor father	3,262	17,000	1.76 (1.66–1.86)	
	Mother, no father	18,239	132,207	0.76 (0.72–0.79)	
	Father, no mother	2,418	22,208	1.26 (1.21–1.32)	
	Mother and father	32,334	390,514	1.0 (ref)	
Place of residence					< 0.05
MSA (metropolitan statistical area)	Large MSA (population size 1 million or more)	26,611	311,997	0.6 (0.58–0.61)	
	Small MSA (less than 1 million)	19,578	155,337	0.9 (0.86–0.91)	
	Not in MSA	10,064	70,927	1.0 (ref)	
Region					< 0.05
	Northeast	9,023	91,913	1.54 (1.5–1.6)	
	Midwest	14,123	125,650	1.77 (1.72–1.82)	
	South	24,242	204,506	1.86 (1.82–1.91)	
	West	8,869	139,856	1.0 (ref)	

Abbreviations: ADHD, attention-deficit hyperactivity disorder; CI, confidence interval.

“high school diploma” as education status (OR 1.12). Moreover, children whose parents had a family income less than \$35,000 (OR 1.4) and Medicaid health insurance coverage (OR 2.2) were twofold more likely to have ADHD. In addition, poor children (OR 1.62), with “fair or poor” current health status (OR 1.00), who live south (OR 1.86), “not in a metropolitan statistical area” (OR 1.00), were more likely to have ADHD. Finally, children who had neither mother nor father were also more likely to have ADHD (OR 1.76).

► **Fig. 1** represents the trend in ADHD in children during the years 2009 to 2018 in the United States. The number of children with ADHD increased from 2009 to 2018 by 14.8%. Moreover, the prevalence of ADHD in this decade was 9.13%. ► **Fig. 2** represents the prognostic factors with the ORs for ADHD. As can be seen, ethnicity ranks first, followed by gender, health insurance coverage, region, and family structure.



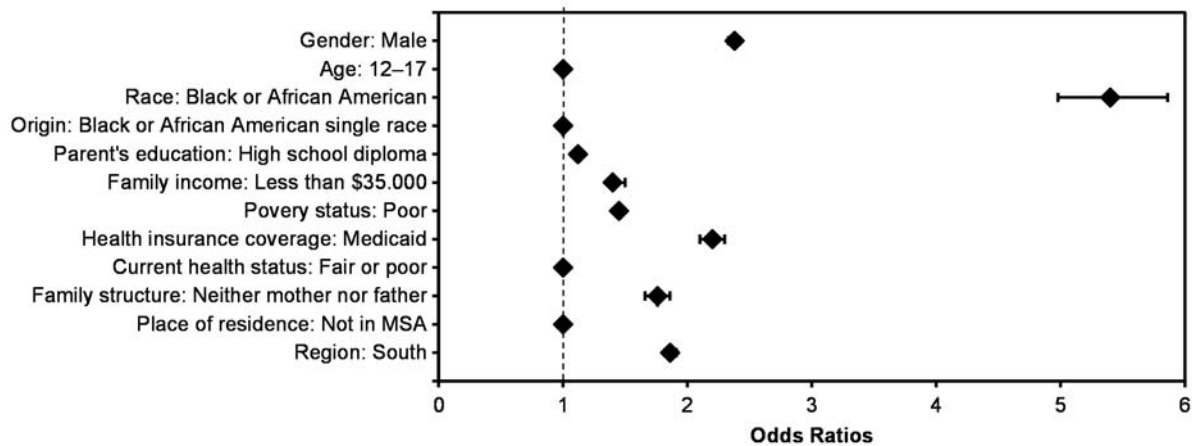
**Fig. 1** Trend in attention-deficit hyperactivity disorder (ADHD) during the years 2009 to 2018 in the United States.

## Discussion

The number of children diagnosed with ADHD in the United States during the years 2009 to 2018 increased at an alarming rate of 14.8%. Children who had neither mother nor father were twice as likely to have ADHD. This can be explained by the fact that the lack of parents reflects problems in the psychopathology of the child. These results are in agreement with prior studies, in which ADHD was linked to the lack of parent’s involvement in the upbringing of their child.<sup>26</sup>

Additionally, family income and poverty status play a key role in the occurrence of this type of disorder. Children living in a poor financial situation and low SES were more likely to have ADHD. The results of this study are in agreement with prior studies, in which it has been reported that although ADHD is highly heritable, symptoms are associated with interactions between genes and the environment during development such as low SES and chaos (household disorganization).<sup>27</sup> It has also been found that socioeconomic disadvantage was associated with emotional and conduct problems in children but neither home environment nor parenting attenuated this association, indicating the decisive role of SES in the child’s psychopathology.<sup>28</sup>

The importance of this study lies in the interaction between multiple socioeconomic variables and ADHD, which reflects the complexity and multidimensional nature of deprivation, as well as the various roles of these dimensions during the course of life, which in turn reflects the longest gestation period for ADHD. Deprivation has been linked to stress, which in turn influences human behavior and health. More specifically, stressors in early life are responsible for the production of cortisol, a hormone that peaks in response



**Fig. 2** Prognostic factors with the odds ratios for attention-deficit hyperactivity disorder (ADHD).

to stressful experiences, and has not only immunological effects but also social and behavioral consequences.<sup>29,30</sup>

One limitation of the present study is that data were collected through personal household interviews. Nondisclosure of a characteristic of the child by participants is possible due to memory and/or social bias. Another limitation of the study is that multiple logistic regression analysis does not establish causality between variables.

## Conclusion

The results of this work explain the significance of deprivation (of family and financial comfort) as the main prognostic factor for ADHD. Moreover, children with ADHD are more likely to be black or African American, males in the age group of 12 to 17.

### Conflict of Interest

None declared.

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