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Attention-Deficit/Hyperactivity Disorder and obesity in US males and females, age 8–15 years: National Health and Nutrition Examination Survey 2001–2004

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Abstract

Objective—To investigate how associations between Attention-Deficit/Hyperactivity Disorder (ADHD) and obesity differ by gender and medication use in a nationally representative sample of US youth in which height and weight were measured.

Methods—Youth age 8–15 (n=3,050) studied in the National Health and Nutrition Examination Survey 2001–2004. Obesity defined as 95th percentile of US BMI-for-age reference. ADHD determined by asking parents if child had been diagnosed and using the Diagnostic Interview Schedule for Children IV. Gender-stratified multivariable logistic regression was used to estimate odds of obesity for youth with ADHD (medicated and unmedicated) relative to youth without ADHD.

Results—Males with ADHD who were medicated had lower odds of obesity compared to males without ADHD (adjusted OR = 0.42, 95% CI = 0.23 – 0.78). Unmedicated males with ADHD were as likely as males without ADHD to be obese (adjusted OR = 1.02, 95% CI = 0.43 – 2.42). The odds of obesity for females taking medication for ADHD did not differ statistically from those of females without ADHD (adjusted OR = 1.21, 95% CI = 0.52 – 2.81). Females with ADHD not taking medication had odds of obesity 1.54 times those of females without ADHD; however, the 95% CI (0.79–2.98) was wide and not statistically significant at $p = 0.05$.

Conclusions—Associations between ADHD and obesity are influenced by treatment of ADHD with medication and may differ by gender. Youth with ADHD who are not treated with medication are as or more likely than youth without ADHD to be obese.

Keywords

adolescent; Attention-Deficit/Hyperactivity Disorder (ADHD); gender differences; National Health and Nutrition Examination Survey (NHANES); obesity

INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) and obesity are two common conditions that increase physical and/or mental health risks for youth in the United States.^{1–3} ADHD

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can cause functional impairment by virtue of difficulties in disinhibition, working memory, planning, and sustained attention.^{4, 5} A growing but relatively recent literature has documented a link between ADHD and obesity.^{6, 7} Evidence that individuals with ADHD may have an elevated risk for obesity comes from studies of adults^{8, 9} and youth, in both clinical^{10–13} and population-based settings.^{14–17}

That ADHD would be associated with higher risk for obesity has seemed counterintuitive given that many youth with ADHD have symptoms of hyperactivity. In one of the first investigations of these associations, Holtkamp et al. studied 97 German boys with ADHD to evaluate the hypothesis that they would have a *lower* prevalence of obesity than boys in the general population, but found instead that it was higher.¹¹ Similarly, many clinical samples of children and adolescents in the US and other countries have reported that obesity is at least as common among youth with ADHD as compared to youth in the population overall.^{6, 10, 12, 13} Several large population studies have also observed a modest association between obesity and ADHD.^{14–17} Two analyses of the National Survey of Children's Health (NSCH) 2003, a large telephone survey conducted with parents of US children, found that youth with ADHD who were not treated with medication were at higher risk of obesity than their non-ADHD counterparts,^{15, 17} and that the strength of this association may be stronger among females than males.¹⁵ In a national study of German youth in which height and weight were measured and ADHD was assessed using a structured diagnostic interview, Erhart et al found that ADHD was more prevalent among obese youth compared to non-obese youth.¹⁴

A number of potential mechanisms, some behavioral and others physiologic, have been hypothesized to account for these associations. From a behavioral perspective, ADHD could potentially increase risk for obesity through deficits in self-regulation and increased impulsivity. These characteristics may contribute to externally-cued eating, eating in the absence of hunger, or binge eating, which evidence suggests are associated with obesity.^{9, 14, 18} Factors such as under-arousal and hypoactivity, associated with the inattentive subtype of ADHD, may contribute to reduced energy expenditure, increased sedentary behavior, or poor sleep.^{15, 19, 20} Some evidence suggests that obese adolescents with sleep problems are more likely to have symptoms of ADHD.^{19, 21} Physiologically, ADHD and obesity may both be associated with hypo-dopaminergic function in the brain. Some research has shown that dysfunction of the dopamine receptor gene DRD2 gives rise to a “reward deficiency syndrome” that is associated with increased risk taking, substance abuse, and eating pathology.²² Overeating may be an attempt at self-medication given that palatable, energy-dense food is also known to activate dopamine pathways.⁷ It is well-established that eating-pathology is more common among females,²³ and this appears to be true as well for females with ADHD.²⁴ Accordingly, we hypothesized that for females with ADHD the risk for obesity might be higher than for males. However, these mechanisms are not fully understood, and are further complicated by the appetite suppressing effect of stimulant medication that is often used to treat ADHD symptomatology.²⁵

To date, only a few studies have investigated possible gender differences in associations between ADHD and obesity, and findings have been mixed.^{14, 15, 26} In the NSCH, Kim et al found that for both boys and girls, obesity was more prevalent among youth with ADHD who were not medicated, compared to youth who did not have ADHD. They also reported that the strength of the association (as represented by the adjusted odds for obesity) was greater for females than for males.¹⁵ Although gender differences were not tested statistically, stratified analyses presented by Erhart et al. in a population-based study of German youth (7–17 years), suggested similar associations between males and females.¹⁴ Another analysis of German youth found that associations between ADHD and obesity were strongest for adolescent females.²⁶

Utilizing nationally representative data from the US National Health and Nutrition Examination Survey (NHANES) 2001–04, we build upon what is understood about ADHD/obesity associations in population studies of youth by examining gender differences. The strengths of these data include direct measurement of height and weight and comprehensive assessment of ADHD using a structured diagnostic interview as well as parent-report. In this report we present analyses of data from NHANES 2001–2004 investigating: 1) the relationship of ADHD to obesity among US youth age 8–15 years; 2) the influence of medication treatment on the association; and 3) how the association may differ based on gender.

METHODS

We analyzed data for youth aged 8–15 years from the 2001–2002 and 2003–2004 waves of the National Health and Nutrition Examination Surveys (NHANES).^{27, 28} These are the most-recent waves of NHANES in which the mental health of youth was assessed using a structured diagnostic interview administered to parents.²⁹ In this report, we use ‘parent’ to refer to a youth’s primary caregiver, whether parent or guardian. NHANES is representative of the civilian non-institutionalized US population and a probability sample is selected using a complex, multistage, stratified, clustered design.³⁰ The response rate for youth in the 2001–2002, and 2003–2004 waves was approximately 85%.³¹ Participants in NHANES are examined and interviewed in a mobile examination center. Our analyses utilize survey weights that adjust for non-response, unequal selection probabilities, and under coverage of the target population.³⁰ NHANES restricts access to data on the mental health status of youth to researchers who have received approval from the National Center for Health Statistics (NCHS) Research Data Center and requires that researchers access restricted-use data through a secure system which they administer.³² Data collection for NHANES was approved by the NCHS Ethics Review Board. Analysis of restricted-use data through the NCHS Research Data Center is approved by the NCHS Ethics Review Board.³² The institutional review board of the Ohio State University determined that our analysis did not require additional review.

Main Predictor - ADHD

We defined ADHD status of youth by combining information available from the structured diagnostic interview, parent report, and medication use. The National Institute of Mental Health Diagnostic Interview Schedule for Children IV (DISC-IV) is a diagnostic interview that can be administered by lay interviewers to assess the presence of past-year symptoms consistent with DSM-IV diagnostic criteria for mental disorders in children and adolescents.²⁹ In NHANES the DISC-IV was administered to parents by telephone;²⁹ youth were considered to have ADHD based on the DISC-IV if they met diagnostic criteria as determined by an algorithm developed by the DISC Group at the Division of Child and Adolescent Psychiatry, Columbia University.³³ The reliability and validity of the DISC-IV have been established.³⁴ The DISC-IV is intended to diagnose the presence of mental disorders and therefore focuses on current and recent symptoms. Treatment for ADHD, particularly with medication, can ameliorate symptoms, and thus youth who are being treated for ADHD may not be identified as having ADHD based on the DISC-IV.¹ To address this concern, we also used parent-report to identify youth who have been previously diagnosed with ADHD. During a separate component of NHANES, parents were asked in a face-to-face interview, “Has a doctor or health professional ever told you that [Sample person (SP)] had attention deficit disorder?” Youth were considered to be positive for ADHD by parent-report if their parent responded affirmatively to this question. Use of medication to treat ADHD symptoms was based on parent response to the DISC-IV survey question, “In the past year, has [he, she] taken medication for being overactive, being

hyperactive, or having trouble paying attention?” We categorized youth as “ADHD-medicated” if this question was answered affirmatively. If youth were not taking medication for ADHD, we categorized them as “ADHD-not medicated” if they were identified as having ADHD either based on the DISC-IV or parent-report. All other youth were categorized as not having ADHD (“No ADHD”).

Outcome - Obesity

Height and weight of youth were measured at the NHANES mobile examination center using standardized protocols and calibrated instrumentation.³⁵ Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Gender-specific BMI-for-age percentiles were calculated based on the 2000 US growth reference³⁶ and we classified as obese those youth whose BMI-for-age was $\geq 95^{\text{th}}$ percentile.³⁷

Covariates

Sociodemographic characteristics and potentially confounding variables included in our analyses were: age, gender, race/ethnicity, poverty-income-ratio (PIR), prenatal maternal smoking status, birth weight, health insurance status, major depressive disorder (MDD), and conduct disorder. MDD and conduct disorder were assessed using the DISC-IV.^{33, 34} Age was calculated from birth date and interview date, and was dichotomized for descriptive analyses as children (8–11 years) and adolescents (12–15 years). Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, and other race/ethnicity. Poverty-income-ratio (PIR), the ratio of reported income to the poverty threshold appropriate for household size, was categorized as: < 1.00 , $1-1.85$, $1.86-3.50$, and > 3.50 . Birth weight was categorized as low (< 5.5 lbs) and normal (≥ 5.5 lbs). Prenatal maternal smoking status was defined in response to the survey question “Did [SP NAME’s] biological mother smoke at any time while she was pregnant with [him/her]?” Health insurance status was based on response to the question “Is [SP] covered by health insurance or some other kind of health care plan?”

Statistical Analysis

Data from the 2001–02 and 2003–04 waves of NHANES were combined according to NCHS guidelines.³⁰ Our analyses were restricted to youth aged 8 to 15 years who had data available on ADHD and weight status. All analyses were conducted using SAS statistical software, version 9.0 (SAS Institute Inc, Cary, North Carolina) via the NCHS Research Data Center remote ANDRE system.³² Sample weights were applied such that estimates are representative of US youth ages 8 to 15 years in 2001–04; variance estimates and statistical testing account for the complex survey design.³⁸ We tabulated associations between descriptive characteristics, obesity status and ADHD category (ADHD-medicated, ADHD-unmedicated, No ADHD) using the design-corrected Rao-Scott Chi-square test to assess statistical significance of differences. Multivariable logistic regression models were used to estimate the odds (95% confidence-interval [CI]) of obesity for youth with ADHD who were medicated and for youth with ADHD who were not medicated each relative to youth without ADHD. We present analyses for youth overall, as well as analyses stratified by gender; unadjusted odds ratios (OR) and ORs adjusted for age (as a continuous variable), race/ethnicity, PIR, low birth weight, MDD and conduct disorder are presented. These covariates were selected because of their association with ADHD and/or obesity. Prenatal maternal smoking status and health insurance were not included in our adjusted models to avoid multicollinearity.

RESULTS

Of the 3907 youth aged 8–15 years who participated in NHANES 2001–2004, 3739 (96%) had measured height and weight. Six hundred and eighty nine (689) youth were excluded from our analyses because they did not have complete data on ADHD. The 689 youth excluded for missing information on ADHD did not differ statistically significantly from youth included in our analytic sample ($n=3050$) relative to gender ($p=0.19$) or the prevalence of obesity ($p=0.22$). However, youth who were excluded from the analytic sample due to missing data tended to be younger (mean age 11.7 years vs. 12.1 years, $p = 0.04$), poorer (mean PIR 2.09 vs. 2.57, $p < 0.001$), and more likely to belong to a minority racial/ethnic group (53.2% vs. 62.8% non-Hispanic white, $p = 0.02$) compared to those in the analytic sample.

Characteristics of the sample and population are presented in Table 1. Overall, 40.5% of youth were in families that had a PIR at or below 185% of the poverty level, but most youth were covered by health insurance. The prevalence (95% CI) of obesity (BMI-for-age 95th percentile) for US youth ages 8–15 years in 2001–04 was 18.1% (15.5 – 20.6). As has been reported elsewhere,² the prevalence of obesity differed in the population relative to racial/ethnic group. High PIR was associated with lower obesity prevalence, and maternal smoking during pregnancy was associated with a higher prevalence of obesity. The prevalence of obesity among the 2% of youth with MDD was much higher than among youth who did not have MDD (34.7% vs. 17.7%, $p=0.01$).

Overall, 412 youth (15.6%) were classified as having ADHD; of these, 94 were identified by both the DISC-IV and parent-report, and 124 were identified by the DISC-IV only. Twice as many males compared to females had ADHD (20.3% vs. 10.5%, Table 1). The prevalence of ADHD was also higher for youth whose mothers smoked during pregnancy compared to youth whose mothers did not. Youth with MDD or conduct disorder were much more likely than youth without these comorbid disorders to have ADHD (Table 1).

One-hundred and eighty-five youth (7.4%) were taking medication for ADHD symptoms and 11.7% of these youth were obese (Table 1). Taking medication for ADHD was associated with a lower prevalence of obesity in comparison to all other youth ($p = 0.04$, data not shown); youth with ADHD who were not medicated ($n=227$) had a somewhat higher prevalence of obesity than youth without ADHD (21.6% vs. 18.3%) but this difference did not reach statistical significance ($p=0.15$) (Table 1). In logistic regression analyses combining males and females, the adjusted odds of obesity among youth medicated for ADHD were 0.62 (95 % CI = 0.35 – 1.08) times that for youth without ADHD. The adjusted odds of obesity among youth with ADHD who were not medicated were 1.18 (95 % CI = 0.70 – 2.00) times that for youth who did not have ADHD.

Stratified by gender, males with ADHD who were medicated were less likely than males without ADHD to be obese (adjusted OR = 0.42, 95% CI = 0.23 – 0.78) (Table 2). Males with ADHD who were not medicated were as likely as males without ADHD to be obese (adjusted OR = 1.02, 95% CI = 0.43 – 2.42). The odds of obesity for females taking medication for ADHD did not differ statistically from those of females without ADHD (adjusted OR = 1.21, 95% CI = 0.52 – 2.81). Females with ADHD who were not medicated had adjusted odds of obesity 1.54 times those for females without ADHD; however, the confidence interval was wide and ranged from a somewhat protective association (lower bound of 95% CI = 0.79) to a quite strong association (upper bound of 95% CI = 2.98).

DISCUSSION

We found that the prevalence of obesity among youth with ADHD who were not medicated was as high or higher than youth without ADHD, and that these associations may differ for males and females. Although not statistically significant at an alpha level of 0.05, females with ADHD who were not medicated had odds of obesity that were 50% higher than those of females without ADHD. For both males and females with ADHD the prevalence of obesity was lower among youth treated with medication and this was strongly so for males. Our analyses are representative of US youth aged 8–15 years in 2001–2004 and utilize anthropometric measurements to assess obesity and a structured diagnostic interview, medication-use, and parent-report to assess ADHD.

Our results from NHANES, particularly in females, are consistent with evidence suggesting ADHD may increase risk for obesity.^{9, 14, 15, 17} In analyses of >60,000 youth studied in the NSCH 2003, unmedicated US youth aged 5 to 17 years with ADHD had odds of obesity 1.51 times those of youth who did not have ADHD.¹⁷ Also in NSCH 2003, gender-stratified analyses by Kim et al. found that the odds of obesity for females (6 to 17 years) with unmedicated ADHD were 1.85 times those of females without ADHD, whereas the odds ratio for males was 1.42.¹⁵ NSCH 2003 is a nationally representative cross-sectional study of US youth. Parents (or guardians) of children under age 18 years are interviewed by telephone, and the parent or guardian most knowledgeable about the child's health is asked to respond to a series of interview questions that take approximately 25 minutes to administer.³⁹ Weight status is based on parent-report of the youth's height and weight. The accuracy with which parents can estimate their growing child's height and weight is uncertain, but particularly for young children error is likely.⁴⁰ The large sample size of the NSCH results in greater precision in estimates as compared to NHANES, but NHANES has a higher response rate than NSCH and its methodology may be less subject to measurement error.^{28, 39} Our analyses of youth studied in NHANES 2001–2004 complement what is known about the associations between ADHD and obesity from analyses of NSCH 2003.^{15, 17} Both NSCH and NHANES are nationally representative, but anthropometric measurements are taken directly in NHANES, reducing the potential for misclassification of youth's weight status. In addition, NHANES administered a DSM-IV structured diagnostic interview to determine the mental health status of children and adolescents. We found, as did Froehlich et al.,¹ that among youth who met diagnostic criteria for ADHD by the DISC-IV, approximately half were reported by their parent to have been previously diagnosed with ADHD.

We chose to combine information from the DISC-IV and parent-report to identify youth with ADHD. This combined method includes youth with current or past-year symptoms that would qualify them for an ADHD diagnosis but who have not been previously diagnosed. It also includes youth who have been diagnosed with ADHD but whose symptoms have been effectively managed through treatment. As a result, the overall prevalence estimate of 15.6% that we report, which includes current and previously diagnosed ADHD, is higher than prevalence estimates based only on the DISC-IV¹ or only on parent-report.¹⁷

In these analyses we have investigated the influence of medication-use and gender on the association between ADHD and obesity. Although for both males and females the prevalence of obesity among youth who are medicated for ADHD is lower than the prevalence for youth with ADHD who are not taking medication, the strength of this association is stronger for males. Males treated with medication for ADHD were less than half as likely as males without ADHD to be obese (9.2% vs. 19.3%), and this estimate was not sensitive to adjustment for covariates. Among females with ADHD, the prevalence of

obesity in those who were medicated was lower than for those who were not, but the difference was less pronounced than for the males (17.8% vs. 24.0%).

There is some evidence that the association of ADHD with obesity may depend upon gender. In our analyses, males with unmedicated ADHD had a similar prevalence of obesity to males without ADHD (20.3% vs. 19.3%, adjusted OR=1.02), whereas females with unmedicated ADHD were more likely to be obese than females without ADHD (24.0% vs. 17.3%, adjusted OR=1.54). These results are not conclusive given the wide confidence intervals, but they suggest that ADHD may be differently associated with obesity in male and female youth. Analyses of German youth also support the possibility of gender differences in associations between ADHD and obesity.²⁶ In their gender-stratified analyses of NCHS 2003, Kim et al. found that although the prevalence of obesity was higher for males than females overall, the odds of obesity associated with having ADHD and being unmedicated compared to not having ADHD were higher for females than for males.¹⁵ This may be related to the higher prevalence of the inattentive subtype of ADHD observed in females versus the hyperactive-impulsive subtype which is more prevalent among males.⁴¹ Persons with the inattentive type of ADHD are often described as “hypoactive”, potentially contributing to reduced energy expenditure.²⁰ As has been suggested previously, the association between ADHD and obesity may be a result of genetic and environmental influences (e.g., prenatal maternal smoking) and/or dopamine insufficiency.²² As reviewed by Davis,⁷ both obesity and ADHD have been found to be associated with impulsivity and deficits in self-regulation. How these and other factors manifest differently in females and males warrants further investigation.

Our study has a number of limitations. As a cross-sectional study, it does not permit conclusions to be drawn about temporality or causality. We analyzed data from the most recent waves (2001–04) of NHANES in which youth ADHD was assessed using a structured diagnostic interview; it is possible that associations between ADHD and obesity in the US adolescent population have changed. We categorized youth reported by their parent to have taken medication during the past year “for being overactive, being hyperactive, or having trouble paying attention” as ADHD-medicated. This group includes 20 youth who were not reported by their parent to have been diagnosed with ADHD and who did not meet diagnostic criteria for ADHD on the DISC-IV. We did not investigate the type(s) of medication that youth with ADHD were taking, although the most commonly prescribed medications for ADHD in youth are stimulants.^{25, 42} Also, the age at which children were diagnosed with ADHD or began taking medication for ADHD is not known; some children who either recently began taking medication or recently stopped could have been misclassified. It is possible that males might receive medication for ADHD at an earlier age than females which could explain why the difference in obesity prevalence between medicated and unmedicated youth with ADHD was larger for males than females. Although the precision of our estimates was limited by the clustered survey design, and particularly among females, the sample size, the magnitude of the association we observed between ADHD and obesity for unmedicated females (OR = 1.54) is meaningful and supports the need for further study. Perhaps because ADHD is more prevalent among males than females,⁴ few studies of the association of ADHD with obesity have focused on gender differences. Future research examining the unique risk factors that females with ADHD experience may broaden our understanding of the complex interactions between ADHD and weight status.

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HCMB participated in the design and conception of the research, analyzed the data, and drafted the manuscript. CC participated in the conception and design of the research, interpretation of data, and revision of the manuscript. SEA supervised the design and conception of the research, led the analysis and interpretation of data, drafted portions of the manuscript and critically revised the manuscript. All authors approved the final version of the submitted manuscript.

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Abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
NSCH	National Survey of Children's Health
NHANES	National Health and Nutrition Examination Survey
NCHS	National Center for Health Statistics
DISC IV	Diagnostic Interview Schedule for Children IV
SP	sample person
BMI	body mass index
PIR	poverty-income-ratio
MDD	major depressive disorder
CI	confidence-interval
OR	odds ratio

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What is already known about this subject

- Youth with ADHD may be at increased risk for obesity
- Medications used to treat ADHD can affect weight
- Few studies have investigated possible gender differences in associations between ADHD and obesity

What this study adds

- Nationally representative of US youth aged 8 – 15 years
- Height and weight were measured, and ADHD assessed by structured-diagnostic interview and parent-report
- Associations between ADHD and obesity are reported for males and females to enable gender comparisons

Table 1

Characteristics of US youths 8–15 years of age in relation to prevalence of obesity and attention deficit hyperactivity disorder (ADHD) in NHANES 2001–04.

Characteristic	Sample n ^a	Prevalence (95% CI) ^a	Obesity ^b Prevalence (95% CI)	P value ^c	ADHD ^d Prevalence (95% CI)	P value ^e
Age						
Children (8–11 yrs)	1144	47.8 (45.2 – 50.5)	19.1 (15.5 – 22.7)	0.32	15.8 (13.4 – 18.2)	0.87
Adolescents (12–15 yrs)	1906	52.2 (49.5 – 54.8)	17.1 (14.3 – 20.0)		15.4 (11.7 – 19.0)	
Gender						
Male	1501	51.4 (49.4 – 53.5)	18.4 (14.8 – 22.0)	0.74	20.3 (17.7 – 23.0)	< 0.001
Female	1549	48.6 (46.5 – 50.6)	17.7 (14.7 – 20.7)		10.5 (8.3 – 12.7)	
Racial/ethnic group						
Non-Hispanic white	898	62.8 (57.6 – 68.0)	16.5 (12.9 – 20.0)	0.03	17.1 (14.2 – 20.0)	0.10
Non-Hispanic black	1014	14.5 (11.2 – 17.8)	23.8 (20.8 – 26.9)		16.4 (14.6 – 18.2)	
Mexican American	918	11.7 (8.6 – 14.8)	20.7 (18.2 – 23.2)		9.5 (7.2 – 11.8)	
Other Hispanic	114	5.8 (2.7 – 8.9)	18.3 (9.5 – 27.2)		12.5 (4.1 – 20.8)	
Other race/ethnicity	106	5.1 (3.6 – 6.7)	15.0 (6.9 – 23.1)		12.3 (1.8 – 22.7)	
Poverty-income ratio (PIR)^e						
< 1.00	863	20.4 (17.6 – 23.2)	20.8 (16.6 – 25.0)	0.02	18.5 (14.4 – 22.6)	0.27
1.00 – 1.85	703	20.1 (18.0 – 22.3)	18.9 (13.9 – 23.8)		16.7 (12.8 – 20.6)	
1.86 – 3.50	720	27.9 (24.8 – 30.9)	20.3 (16.2 – 24.4)		15.1 (10.6 – 19.7)	
> 3.50	649	31.5 (27.4 – 35.7)	13.5 (9.7 – 17.3)		13.4 (10.5 – 16.3)	
Prenatal maternal smoking status^e						
Smoker	465	19.0 (16.4 – 21.7)	22.2 (17.0 – 27.4)	0.01	25.2 (19.4 – 31.0)	< 0.001
Non-smoker	2552	81.0 (78.3 – 83.7)	17.2 (14.9 – 19.6)		13.0 (11.1 – 14.9)	
Birth weight^e						
5.5 lbs	2755	93.0 (92.1 – 93.9)	18.4 (15.9 – 20.9)	0.26	15.2 (13.0 – 17.3)	0.14
< 5.5 lbs	264	7.0 (6.1 – 7.9)	14.3 (7.3 – 21.2)		21.2 (13.3 – 29.2)	
Health insurance^e						
Yes	2552	87.9 (85.2 – 90.6)	17.6 (14.8 – 20.5)	0.29	16.5 (14.8 – 18.5)	0.008
No	466	12.1 (8.4 – 14.8)	20.3 (15.8 – 24.8)		9.2 (5.2 – 13.2)	
Major Depressive Disorder^e						

Characteristic	Sample n ^a	Prevalence (95% CI) ^a	Obesity ^b Prevalence (95% CI)	P value ^c	ADHD ^d Prevalence (95% CI)	P value ^e
Yes	72	2.0 (1.1 – 2.8)	34.7 (17.9 – 51.4)	0.01	41.9 (27.5 – 56.3)	< 0.001
No	2972	98.0 (97.2 – 98.9)	17.7 (15.1 – 20.2)		15.0 (13.0 – 17.1)	
Conduct disorder^e						
Yes	68	2.1 (1.4 – 2.8)	11.0 (2.2 – 19.7)	0.21	49.4 (32.6 – 66.3)	< 0.001
No	2981	97.9 (97.2 – 98.6)	18.2 (15.6 – 20.9)		14.8 (13.0 – 16.6)	
ADHD^f						
ADHD, medicated ^g	185	7.4 (5.9 – 8.9)	11.7 (5.4 – 18.0)	0.15	N/A	N/A
ADHD, not medicated	227	8.2 (7.0 – 9.3)	21.6 (11.5 – 29.7)			
No ADHD	2638	84.4 (82.6 – 86.2)	18.3 (15.5 – 21.0)			

ADHD, Attention Deficit/Hyperactivity Disorder; PIR, poverty-income ratio; MDD, Major Depressive Disorder

^aN is unweighted number of participants; prevalence estimates weighted to be representative of US youth aged 8–15 years 2001–2004; 95 % confidence intervals (CI) account for complex sample design

^bObesity defined as gender-specific BMI-for-age 95th percentile of the CDC growth charts.

^cP-value from Rao-Scott design-corrected chi-square test

^dIncludes youth with ADHD who were medicated and who were not medicated; ADHD identified by DISC-IV or parent-report.

^e115 participants in analytic sample missing information on PIR, 33 missing information on maternal smoking status, 31 for birthweight, 32 for health insurance, 6 for MDD, and 1 for conduct disorder.

^fADHD, medicated = youth taking medication to treat ADHD; ADHD, not medicated = youth who were positive for ADHD by DISC-IV or by parent-report and who were not taking ADHD medication; No ADHD = all other youth.

^gIncludes 20 youth who were reported as taking medication in the past year to treat symptoms of hyperactivity or inattention but were not positive for ADHD by DISC-IV or parent-report.

Association between ADHD with and without medication use in relation to obesity prevalence for male and female youth ages 8–15 years in NHANES 2001–04.

Table 2

Gender	ADHD ^a	Sample n ^b	Obesity ^c Prevalence (95% CI)	P value ^d	Unadjusted odds ratio (95% CI)	Adjusted ^e odds ratio (95% CI)
Males (n=1501)	ADHD, medicated	132	9.2 (3.6–14.6)	0.17	0.42 (0.24–0.74) [*]	0.42 (0.23–0.78) [*]
	ADHD, not medicated	143	20.3 (6.8–33.8)		1.06 (0.44–2.54)	1.02 (0.43–2.42)
	No ADHD	1226	19.3 (15.3–23.4)		1 (referent)	1 (referent)
Females (n=1549)	ADHD, medicated	53	17.8 (4.23 – 31.4)	0.46	1.04 (0.45–2.40)	1.21 (0.52–2.81)
	ADHD, not medicated	84	24.0 (12.6 – 35.2)		1.51 (0.81–2.80)	1.54 (0.79–2.98)
	No ADHD	1412	17.3 (14.3 – 20.3)		1 (referent)	1 (referent)

^{*} Indicates statistical significance, P<0.05

^a ADHD, medicated = youth taking medication to treat ADHD; ADHD, not medicated = youth who were positive for ADHD by DISC-IV or by parent-report and who were not taking ADHD medication; No ADHD = all other youth.

^b N is unweighted number of participants; prevalence estimates are weighted to be representative of US youth aged 8–15 years during 2001–2004; 95% confidence intervals (CI) account for complex sample design

^c Obesity defined as gender-specific BMI-for-age 95th percentile of the CDC growth charts.

^d P-value from Rao-Scott design-corrected chi-square test

^e Odds ratio and 95% CI adjusted for age, race/ethnicity, PIR, birth weight, major depressive disorder, and conduct disorder