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**Overweight in Children and Adolescents in Relation to Attention-Deficit/Hyperactivity Disorder: Results From a National Sample**

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The authors have indicated they have no financial relationships relevant to this article to disclose.

<table>
<thead>
<tr>
<th>What’s Known on This Subject</th>
<th>What This Study Adds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous research exploring the relationship between ADD/ADHD and childhood obesity has been conducted mainly on clinical samples and may not be generalizable to the general US population of children and adolescents.</td>
<td>In a large, nationally representative sample, youth with ADD/ADHD not currently medicated had ~1.5 times the odds of being overweight, and those currently medicated had ~1.6 times the odds of being underweight compared to youth without ADD/ADHD.</td>
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**ABSTRACT**

**OBJECTIVE.** As the prevalence of childhood obesity increases, identifying groups of children who are at increased risk of overweight is important. The current study estimated the prevalence of overweight in children and adolescents in relation to attention-deficit/hyperactivity disorder and medication use.

**PATIENTS AND METHODS.** This study was a cross-sectional analysis of 62,887 children and adolescents aged 5 to 17 years from the 2003–2004 National Survey of Children’s Health, a nationally representative sample of children and adolescents in the United States. Attention-deficit disorder/attention-deficit/hyperactivity disorder was determined by response to the question “Has a doctor or health professional ever told you that your child has attention-deficit disorder or attention-deficit/hyperactive disorder, that is, ADD or ADHD?” Children and adolescents were classified as underweight, normal weight, at risk of overweight, or overweight according to BMI for age and gender.

**RESULTS.** After adjustment for age, gender, race/ethnicity, socioeconomic status, and depression/anxiety, children and adolescents with attention-deficit disorder/attention-deficit/hyperactivity disorder not currently using medication had ~1.5 times the odds of being overweight, and children and adolescents currently medicated for attention-deficit disorder/attention-deficit/hyperactivity disorder had ~1.6 times the odds of being underweight compared with children and adolescents without either diagnosis.

**CONCLUSIONS.** This study provides heightened awareness for pediatric providers about the relationship between attention-deficit disorder/attention-deficit/hyperactivity disorder, medication use, and weight status. Future work is needed to better understand the longitudinal and pharmacologic factors that influence the relationship between attention-deficit disorder/attention-deficit/hyperactivity disorder and weight status in children and adolescents. *Pediatrics* 2008;122:e1–e6

In the United States, the prevalence of overweight among children aged 6 to 11 years has risen dramatically in the past few decades; in 1980, 7% were overweight, and that number rose to 16% in 2002.1 Over the same time period, the prevalence of overweight among adolescents more than tripled, from 5% to 16%.1 Childhood overweight has negative consequences for physical and mental health. Relative to their normal-weight peers, overweight children and adolescents are at an elevated risk for many disorders and conditions including hypertension, dyslipidemia, high cholesterol levels, metabolic syndrome, diabetes, nonalcoholic fatty liver disease, reproductive problems, bone and joint problems, and sleep apnea.1-3 Overweight children and adolescents are also at increased risk for lower self-esteem, compromised peer relationships, and problems at school, including poorer attendance and performance.1,2,4-5

Understanding which groups of children are at increased risk for being overweight may help pediatricians and parents prevent the development of obesity. Children with attention-deficit/hyperactivity disorder (ADHD) may be 1 such risk group. Attention-deficit disorder (ADD)/ADHD is characterized by persistent patterns of inattention...
and/or hyperactivity-impulsivity that cause impairment in at least 2 settings (eg, school and home).6 It has been suggested that the impulsivity and poor behavioral regulation often found in youth with ADD/ADHD may lead to the development of eating patterns that put youth at increased risk for obesity.7 Because weight loss and decreased appetite are known adverse effects of the common stimulant medications used to treat children and adolescents with ADD/ADHD,8,9 we expected that medication use would be associated with underweight. Previous research exploring the relationship between ADD/ADHD and childhood obesity has been conducted mainly on clinical samples and may not be generalizable to the general US population of children and adolescents.10-13 Using the National Survey of Children’s Health (NSCH), a large nationally representative sample, we estimated the extent to which children and adolescents with ADD/ADHD are at increased risk of being overweight and the extent to which treatment with stimulant medications alters this association.

PATIENTS AND METHODS
The Maternal and Child Health Bureau and the National Center for Health Statistics sponsored the NSCH to produce national and state-level prevalence estimates of a variety of physical, emotional, and behavioral indicators of children’s health and information about the child’s family context and neighborhood.14 Because the public-use data set contains no personally identifiable information, the Brown University institutional review board determined that this study did not require review.

NSCH used the State and Local Area Integrated Telephone Survey (SLAITs) program for the sampling and data collection.14 The sampling frame was identical to that of the National Immunization Study.14 Briefly, trained interviewers called telephone numbers at random to identify households with ≥1 child under the age of 18. In each eligible household, interviewers randomly selected 1 child and interviewed the adult in the household who knew the most about the child’s health and well-being. Interviewers completed a total of 102,353 interviews in English or Spanish from January 2003 to July 2004.

Because the clinical criteria for making a diagnosis of ADHD require that the child experience impairment in at least 2 settings, such as home and school,6 and studies examining children seeking treatment for ADHD have reported a youngest age of seeking treatment of ~4 years,15 we restricted our sample to children and adolescents aged 5 to 17 years. After exclusion because of ineligible age (n = 28,089) or missing BMI (n = 5264), ADD/ADHD (n = 281), ADD/ADHD medication use (n = 26), depression or anxiety (n = 123), race/ethnicity (n = 635), or household income (n = 5048) information, our analytic sample consisted of 62,887 children and adolescents.

Trained interviewers asked parents or guardian respondents a series of questions regarding the physical, emotional, and behavioral health of their child and about access to health care, parental health, and neighborhood characteristics.14 Interviewers asked respondents, “Has a doctor or health professional ever told you that your child has attention-deficit disorder or attention-deficit/hyperactive disorder, that is, ADD or ADHD?” Other large population-based surveys have used this question to assess diagnosis of ADD/ADHD in children and adolescents.16,17 Respondents who reported that their child had ADD or ADHD were asked, “Is your child currently taking medication for ADD or ADHD?” Parents or guardians answered the questions, “How tall is your child now?” and “How much does your child weigh now?”; BMI was calculated from the answers as weight in kilograms divided by height in meters squared. The Centers for Disease Control and Prevention created gender- and age-specific growth charts that are used for children and adolescents aged 2 to 20 years.18 A child with a BMI in the <5th percentile for gender and age is considered underweight, in the >5th and <85th percentile for gender and age is considered normal weight, in the ≥85th to <95th percentile is considered at risk for overweight, and in the ≥95th percentile is considered overweight.18-20 We used the preencoded variable in the NSCH data set that classified children into BMI classes according to the Centers for Disease Control and Prevention growth charts.

All analyses of the NSCH data used SUDAAN,21 which produces variance estimates for complex survey designs. The public-use NSCH data set provided the sampling weights used in these analyses. These weights consist of a base sampling weight and adjustment for multiple telephone lines per household and for nonresponse.14 The weights are poststratified so that the sum of weights for each state equals the number of children in that state as estimated by the July 2003 US census.14 First, we compared the characteristics of children and adolescents according to ADD/ADHD and medication use. Next, we used polytomous logistic regression models to estimate odds ratios (ORs) and 95% confidence intervals (CIs) to compare the odds of being underweight, at risk for overweight, or overweight with being of normal weight. In polytomous logistic regression the outcome takes 1 of ≥3 categories, and models are simultaneously fit by using maximum likelihood to estimate ORs for each group compared with a common reference group.22 We calculated crude ORs and 95% CIs of underweight, at risk of overweight, and overweight versus normal weight among children and adolescents with ADD/ADHD compared with those without ADD/ADHD.

Finally, we used polytomous logistic regression models to control for confounding. The final model included all covariates whose inclusion changed the estimate of the OR for ADD/ADHD by ≥10%. We evaluated the following variables for confounding: race/ethnicity, low socioeconomic status (SES), gender, age, and depression or anxiety. Known risk factors for childhood overweight include nonwhite race/ethnicity and low SES.19,20,23-26 To ensure the confidentiality of the participants, the NSCH collapsed responses to the question about the child’s race into white only, African American or black only, other race, and multiple race.14 The NSCH coded race and Hispanic/Latino origin separately.14 In our study, race/ethnicity was coded as non-Hispanic white, non-His-
panic black, Hispanic, or multiracial/other race. In addition to being a risk factor for overweight, low SES has been associated with diagnosis of ADD/ADHD.27 Interviewers asked respondents about household income.14 Income to household size was compared with the Department of Health and Human Services federal poverty guidelines.15 We dichotomized SES into “low SES” and “not low SES” by using a cutoff of <200% of the federal poverty level.16 Diagnosis of ADD/ADHD is more common among boys8,16,28,29 and older children.6,16 To allow for nonlinearity, we entered age as both a linear and quadratic term. However, because of a lack of significance, we did not include the quadratic term in the final model. Because depression and anxiety are common comorbidities of ADD/ADHD28,30 and depression is a risk factor for the development of obesity among adolescents,31 we evaluated depression/anxiety as a potential confounder. Interviewers asked respondents whether a doctor or health professional had ever told them that their child had depression or anxiety problems.

Because a number of otherwise-eligible participants (n = 5683) did not provide information on their race/ethnicity and/or household income, we duplicated the analysis including indicator variables in the models representing missing race/ethnicity and missing SES. After this study was conducted, the Centers for Disease Control and Prevention published a multiple imputation of the missing household-poverty-level variable.32 We repeated our analysis by using this imputed data set. Although these methods prevented the loss of participants caused by item nonresponse, the results were not materially different from the complete case analysis. Therefore, for ease of interpretation, we present the analysis of the 62,887 youth who had valid responses for all variables of interest.

RESULTS
The prevalence of ADD/ADHD among children and adolescents was estimated to be 8.8% (95% CI: 8.4%–9.2%). A little more than half of the children and adolescents with ADD/ADHD were taking medication for ADD/ADHD (57.2% [95% CI: 54.9%–59.4%]). Compared with children and adolescents without ADD/ADHD, the youth with ADD/ADHD were more likely to be male, to be non-Hispanic white, and to have low SES (Table 1). The children and adolescents with ADD/ADHD were ~9 times as likely to report depression/anxiety as those without ADD/ADHD (28.0% vs 3.1%). A little more than half of the children and adolescents (56.7% [95% CI: 56.0%–57.4%]) were of normal weight, 6.7% (95% CI: 6.4%–7.1%) were underweight, 15.6% (95% CI: 15.1%–16.1%) were at risk of overweight, and 21.0% (95% CI: 20.4%–21.6%) were overweight. At the crude level, the children and adolescents with ADD/ADHD who were not taking medication at the time had increased odds of overweight (OR: 1.35 [95% CI: 1.12–1.62]), and those who were taking medication for ADD/ADHD at the time had increased odds of underweight (OR: 1.48 [95% CI: 1.20–1.81]) relative to the children and adolescents without ADD/ADHD (Table 2).

We found that ADD/ADHD and medication use were associated with weight status in the children and adolescents independent of the effect of gender, age, race/ethnicity, SES, or depression or anxiety. Children and adolescents with ADD/ADHD who were not using medications at the time had 1.5 times the odds for overweight (Table 2) compared with the children and adolescents without ADD/ADHD. The children and adolescents with ADD/ADHD tended to have increased odds of being at risk for overweight (OR: 1.13; Table 2). Compared with the children and adolescents without ADD/ADHD, those with ADD/ADHD who were taking medications had ~1.6 times the odds of being underweight (Table 2). Those who were taking medications for ADD/ADHD were not at increased odds for being either at risk of overweight or overweight.

DISCUSSION
We found that children and adolescents with ADD/ADHD who do not currently take medications are at increased risk for being overweight and that children and adolescents who currently take medication for ADD/ADHD are more likely to be underweight than children and adolescents without ADD/ADHD. Our finding that unmedicated children and adolescents with ADD/ADHD are more likely to be overweight is in accordance with previous research that linked overweight and ADD/ADHD.7,10,11,17,33,34 Because weight loss and reduced appetite are known adverse effects of common stimulant medications used to treat ADD/ADHD,8,9 the finding that the children and adolescents on medication for ADD/ADHD were more likely to be underweight was expected. However, we were unable to explore medication use further, because the NSCH did not obtain information about the type and timing of medication use.

From these findings, we suggest a possible mechanism by which ADD/ADHD and medication use may influence weight status in children and adolescents. It has been suggested that the impulsivity and poor behavioral regulation often found in youth with ADD/ADHD...
may lead to the development of eating patterns that put youth at increased risk for obesity. In addition, youth with ADD/ADHD, especially those who are not taking medications for the condition, may spend more time watching television or playing computer or video games.

This study has several strengths. Our results are generalizable to children and adolescents across the United States. Previous research included children and adolescents from tertiary clinics for children with developmental or psychiatric disorders or inpatient units for children and adolescents with eating disorders or weight problems, included only boys, or were conducted in other countries (eg, Germany, Israel, Spain, and China). Our sample was drawn from the general population of the United States, thus minimizing the selection biases of clinical samples. In addition, we explored medication use and distinguished between underweight and normal weight. Our results confirm previous research on the prevalence and correlates of childhood obesity. Our prevalence estimates of 15% at risk of overweight and 20% overweight among youth aged 5 to 17 years are similar to prevalence estimates based on measured height and weight. Non-Hispanic black and Hispanic youth and those who had low SES were more likely to be at risk of overweight or overweight compared with non-Hispanic white youth and youth with higher SES. Our findings also agree with literature that linked depression and the development of childhood overweight.

The limitations of this study relate primarily to limitations in the NSCH. Because of the cross-sectional nature of the NSCH, we cannot determine the temporal relationship between ADD/ADHD and weight status. The NSCH calculated BMI by using height and weight reported by the parent/guardian respondent, which may be less accurate than measured height and weight. The NSCH and other large population-based surveys assessed ADD/ADHD by asking parent/guardian respondents whether a doctor or health professional had ever told them that their child had ADD/ADHD rather than conducting standardized clinical interviews with each respondent. We estimated the national prevalence of ADD/ADHD among 5- to 17-year-olds to be 8.8%, which is similar to estimates from population-based surveys that assessed ADD/ADHD by using clinical interviews. Although the majority of medications prescribed for children and adolescents with ADD/ADHD are stimulants, we were unable to explore the effect of type or dosing of medication or medication history on weight status.

### CONCLUSIONS

Both the management of ADD/ADHD and the prevention of childhood obesity are important topics in the field of pediatric research and health care. This study pro-

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**TABLE 2** Results From Polytomous Logistic Regression: Weight Status in Children and Adolescents in Relation to Diagnosis of ADD/ADHD and Medication Use

<table>
<thead>
<tr>
<th></th>
<th>Underweight OR (95% CI)</th>
<th>At Risk of Overweight OR (95% CI)</th>
<th>Overweight OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD/ADHD (unadjusted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD/ADHD, not currently medicated</td>
<td>0.92 (0.65–1.28)</td>
<td>1.08 (0.88–1.32)</td>
<td>1.35 (1.12–1.62)</td>
</tr>
<tr>
<td>ADD/ADHD, currently medicated</td>
<td>1.48 (1.20–1.81)</td>
<td>0.95 (0.81–1.12)</td>
<td>1.02 (0.86–1.20)</td>
</tr>
<tr>
<td>No ADD/ADHD (Referent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD/ADHD (adjusted)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD/ADHD, not currently medicated</td>
<td>1.25 (0.89–1.75)</td>
<td>1.13 (0.92–1.39)</td>
<td>1.51 (1.24–1.86)</td>
</tr>
<tr>
<td>ADD/ADHD, currently medicated</td>
<td>1.63 (1.30–2.04)</td>
<td>0.92 (0.77–1.09)</td>
<td>0.94 (0.78–1.13)</td>
</tr>
<tr>
<td>No ADD/ADHD (Referent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.26 (1.12–1.41)</td>
<td>1.22 (1.13–1.33)</td>
<td>1.57 (1.45–1.70)</td>
</tr>
<tr>
<td>Female (Referent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.83 (0.82–0.85)</td>
<td>0.93 (0.92–0.94)</td>
<td>0.82 (0.81–0.83)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>1.29 (1.08–1.54)</td>
<td>1.42 (1.26–1.61)</td>
<td>2.53 (2.26–2.82)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.19 (0.98–1.44)</td>
<td>1.32 (1.14–1.51)</td>
<td>1.75 (1.54–1.99)</td>
</tr>
<tr>
<td>Multiracial/other race</td>
<td>1.38 (1.05–1.80)</td>
<td>1.11 (0.91–1.36)</td>
<td>1.18 (0.98–1.42)</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>(Referent)</td>
<td>(Referent)</td>
<td>(Referent)</td>
</tr>
<tr>
<td>SESc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low SES</td>
<td>1.22 (1.07–1.39)</td>
<td>1.28 (1.17–1.40)</td>
<td>1.69 (1.55–1.83)</td>
</tr>
<tr>
<td>Not low SES (Referent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression or anxiety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.80 (0.59–1.07)</td>
<td>1.11 (0.92–1.33)</td>
<td>1.48 (1.23–1.77)</td>
</tr>
<tr>
<td>No (Referent)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The reference group is children and adolescents of normal weight as determined by BMI for age and gender.

* ORs were adjusted for all other variables in the regression.

1 OR for children 1 year older.

Low SES was defined as <200% of the federal poverty line according to Department of Health and Human Services guidelines.

vides heightened awareness for pediatric providers that children and adolescents with ADD/ADHD who are not currently taking medication may be at increased risk for overweight compared with children and adolescents without ADD/ADHD. In light of these findings, children and adolescents with ADD/ADHD should be monitored for overweight and underweight/weight loss. By monitoring weight status of these youth, clinicians will be better prepared to prevent the development of childhood obesity and the negative physical health and psychosocial consequences. Future work is needed to better understand the longitudinal and pharmacologic factors that influence the relationship between ADD/ADHD and weight status in children and adolescents.

ACKNOWLEDGMENT

We are grateful to Karen L. Schneider, PhD, for assistance with SUDAAN.

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