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Prevalence of Enuresis and Its Association With Attention-Deficit/Hyperactivity Disorder Among U.S. Children: Results From a Nationally Representative Study

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Abstract

Objective—There are no published nationally representative prevalence estimates of enuresis among children in the United States using standardized diagnostic criteria. This study sets out to describe the prevalence, demographic correlates, comorbidities, and service patterns for enuresis in a representative sample of U.S. children.

Method—The diagnosis of enuresis was derived from parent-reported data for “enuresis, nocturnal” collected using the computerized version of the Diagnostic Interview Schedule for Children (C-DISC 4.0) from a nationally representative sample of 8- to 11-year-old children ($n = 1,136$) who participated in the 2001–2004 National Health and Nutrition Examination Surveys.

Results—The overall 12-month prevalence of enuresis was 4.45%. The prevalence in boys (6.21%) was significantly greater than that in girls (2.51%). Enuresis was more common at younger ages and among black youth. Attention-deficit/hyperactivity disorder (ADHD) was strongly associated with enuresis (odds ratio 2.88; 95% confidence interval 1.26–6.57). Only 36% of the enuretic children had received health services for enuresis.

Conclusions—Enuresis is a common condition among children in the United States. Few families seek treatment for enuresis despite the potential for adverse effects on emotional health. Child health care professionals should routinely screen for enuresis and its effects on the emotional health of the child and the family. Assessment of ADHD should routinely include evaluation for enuresis and vice versa. Research on the explanations for the association between enuresis and ADHD is indicated.

Keywords

enuresis; prevalence; health care use; comorbidities; ADHD

Enuresis is a distressing condition that involves repeated voiding of urine into clothes or bedclothes that persists beyond the normative age of maturation of urinary control. The prevalence estimates of enuresis are highly variable,^{1–19} with a range of 3.8%¹⁹ to 24%.⁵ The

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disparate estimates can be accounted for primarily by the differences in the definitions of enuresis in the *International Classification of Diseases and Related Health Problems-Tenth Edition (ICD-10)*,²⁰ the *DSM-IV*,²¹ and the International Children's Continence Society (ICCS).²² The *DSM-III*²³ and *ICD-10* require a bed-wetting frequency of twice per month in the past 3 months for children ages 5 and 6 years and once per month in the past 3 months for children ages 7 years or older, whereas the *DSM-IV* requires a bed-wetting frequency of twice per week for 3 consecutive months or the presence of clinically significant distress or impairment, irrespective of the age of the child. Higher rates of enuresis were observed in population-based epidemiological studies that applied the less stringent *DSM-III* criteria^{3,4} or *ICD-10* criteria.^{9,10} In addition to different diagnostic criteria, differences in the age range and ethnicity of children and reference periods for prevalence rates (e.g., point prevalence versus 12-month prevalence), as well as cultural differences, may also account for the widely varying prevalence estimates of enuresis published worldwide.

There is a striking lack of data on the prevalence of enuresis in U.S. children. The only study of a nationally representative sample found that 10.1% of children wet the bed at least once during the previous 12 months.² An earlier study of children representative of the population in six U.S. cities estimated that 14% wet their bed, with almost half of the enuretic children wetting as often as once per week.¹³ Another study, which followed a birth cohort of 857 Baltimore children for 12 years, reported a 19% prevalence of nighttime wetting at age 8 years and 8% at 12 years.¹⁷ However, none of these studies used structured clinical interviews or formal diagnostic criteria. More recently, a 3-to 7-year prospective study of a community sample in North Carolina yielded a prevalence rate of 5.11% for *DSM-III-R*-defined enuresis¹⁴ and, at a later date, 3.8% for *DSM-IV*-defined enuresis.¹⁵

Enuresis is approximately twice as common in boys as in girls,^{1,5-7,10,14,16,19} and most studies have shown decreasing prevalence with increasing age,^{1-8,10-12,18,19} stabilizing at approximately 2% in adulthood.²⁴ Other risk factors and correlates of enuresis include family history of enuresis,^{1,5,11,25,26} lower socioeconomic status,^{5,19} and black race.^{14,17,27}

Determining the prevalence and sociodemographic correlates of enuresis in U.S. children is critical, given the distress and impairment associated with this disorder, especially among children older than 7 years. Enuresis has been associated with poor self-image,²⁸ diminished achievement in school,⁷ and an increase in the time spent by families compensating, both financially and personally, for the symptoms.²⁹ This article examines the prevalence and correlates of enuresis in a large nationally representative survey of the United States using the National Institute of Mental Health Diagnostic Interview Schedule for Children, version 4 (DISC-IV).³⁰ Information gained from this analysis will help inform studies of etiology as well as aid in the development of targeted and effective preventive programs.

METHOD

Subjects

The National Health and Nutrition Examination Survey (NHANES) is a large nationally representative study of U.S. noninstitutionalized civilians conducted by the National Center for Health Statistics to examine the health status of U.S. children and adults. Participants were identified through a complex, stratified, multistage probability cluster design that oversampled low-income people, African Americans, and Mexican Americans. A total of 1,512 children ages 8 to 11 years participated in the 2001–2004 NHANES surveys, with data regarding *DSM-IV* "elimination disorders" available for 1,155 children (76% of total). The analytic sample of 1,136 children consisted of children who also had data available for six other *DSM-IV* disorders (75% of total). There were no significant sex and age differences between the respondents and nonrespondents. However, respondents were more likely to be wealthier (poverty index ratio

[PIR] ≥ 1 , 76.2% versus 66.3%) and non-Hispanic white (62.0% versus 49.0%). Detailed NHANES survey operations manuals are available on the NHANES Web site (<http://www.cdc.gov/nchs/nhanes.htm>).

Measures

The DISC-IV is a structured diagnostic interview designed for use by lay interviewers to assess psychiatric disorders of children and adolescents.³⁰ Responses to the DISC-IV questions can be used to elicit the diagnostic criteria specified in the *DSM-IV*.²¹ Seven of the 34 diagnostic assessment sections contained in the computerized version of the DISC-IV interview (C-DISC 4.0) were included in the 2001–2004 NHANES, including “elimination disorders,” attention-deficit/hyperactivity disorder (ADHD), generalized anxiety disorder, conduct disorder (CD), eating disorders, major depressive/dysthymic disorder (MDD), and panic disorder. Initial evaluations were conducted at the NHANES Mobile Examination Center (MEC) where parents provided informed consent for conducting interviews and medical evaluations of their children.

The DISC-IV modules consist of youth-informant interviews administered in person to children and adolescents ages 8 to 19 years (generalized anxiety disorder, panic disorder, eating disorders, and MDD) or a parent-informant interview administered to a parent or caregiver about their child ages 8 to 11 years (elimination disorders) or 8 to 15 years (ADHD, CD, eating disorders, and MDD). Only eating disorders and MDD were assessed by both a youth- and parent-informant interview. The parent-informant interview was conducted via telephone within 4 to 28 days after the child’s MEC evaluation.

Assessment of Enuresis

The DISC-IV elimination disorders module collected information on the symptoms, frequency, age of onset, impairment, and service use associated with nocturnal enuresis, diurnal enuresis, and encopresis within the past 30 days, the past 12 months, and lifetime. This study focuses on the 12-month prevalence, correlates, and comorbidity of nocturnal enuresis. Whereas the *DSM-IV* definition of enuresis includes nocturnal as well as diurnal symptoms, the ICCS now considers enuresis to be synonymous with (intermittent) nocturnal incontinence and has recommended that the term *diurnal enuresis* be avoided.²² Although the present study is based on data gathered using the DISC-IV nocturnal enuresis module, we have deleted the term *nocturnal* in referring to enuresis based on recommendations of the ICCS. To acquire a diagnosis of enuresis in this study, the child had to fulfill the following criteria: repeated voiding of urine into bed, whether involuntary or intentional; the behavior is clinically significant as manifested by either a frequency of twice per week for at least 3 consecutive months or the presence of clinically significant distress or impairment in social, academic, or other important areas of functioning; chronological age is at least 5 years; and the behavior is not due exclusively to the direct physiological effect of a substance (e.g., a diuretic) or a general medical condition (e.g., diabetes, spina bifida, a seizure disorder).

A parent-informant interview was administered by trained lay interviewers via telephone to a parent or caregiver who was asked questions about the child. The mother was the preferred respondent. However, if the child did not live with the mother, the information was collected from the adult caregiver with whom he or she had lived in the past year. The interview was conducted by English-Spanish bilingual interviewers. No proxy respondents or translators were used in situations when the respondent could not self-report. Children who met *DSM-IV* criteria for enuresis during any 3-month period during the past 12 months were included in counting the “12-month prevalence of enuresis.” A copy of the interview used to assess “elimination disorders” in the NHANES study may be obtained from the corresponding author.

Service Use

The “nocturnal enuresis” section of the DISC-IV “elimination disorders” module asks parents the following question as it applies to their child: “In the past 12 months, has he/she seen someone at a hospital or a clinic or at their office because he/she wets the bed at night?” A positive answer on this question was taken to indicate “health service use” for enuresis in the past year. A positive answer to another question, “In the last year, has [he/she] taken any medicine for bed-wetting?” was taken to indicate medication use for enuresis. Parents were not specifically asked if the child was given any herbal medications or dietary supplements.

The *DSM-IV* allows for “clinically significant distress or impairment” to be substituted for a frequency of “twice a week for at least 3 consecutive months.” It does not specify a minimum frequency of “repeated voiding into clothes or bedclothes” at which the presence of clinically significant distress or impairment will suffice for diagnosis. In this study, we set a minimum frequency of once per month for at least 3 months, resulting in significant distress or impairment. Significant distress or impairment was defined as at least an intermediate rating, which corresponded to the answers “some of the time” or “bad” to six questions about extent of distress or impairment. Because questions addressing impairment are limited to the previous 12-month period, only information on the prevalence, correlates, and comorbidity of 12-month enuresis will be discussed.

Covariates

Additional predictors considered in these analyses include age, sex, race/ethnicity, and socioeconomic status as assessed by the PIR. The PIR is the ratio of the reported household income to the poverty threshold appropriate for household size, as determined by the Bureau of the Census. We categorized PIR into two groups: PIR less than 1.00 and PIR greater than or equal to 1.00. Values of PIR less than 1.00 were defined as below poverty level. Child race/ethnicity was designated by a parent or caregiver and included the following categories: non-Hispanic black, Mexican American, other Hispanic, non-Hispanic white, and other (including multiracial). Because of small numbers, the “other Hispanic,” “Mexican American,” and “other” groups were combined into a single “Hispanic/Other” category.

Data Analysis

To account for the complex survey design, we applied sample weights and design variables in all analyses as recommended by the National Center for Health Statistics guidelines. The sample weights are inversely proportional to the probability of selection and were calculated according to the base probabilities of selection, adjusted for nonresponse, and poststratified to match population control totals. The weights can be interpreted as the number of individuals in the target population that each sample participant is estimated to represent. A 4-year weight variable was calculated by using one half of the 2-year MEC weight in NHANES 2001–2002 and one half of the 2-year MEC weight in NHANES 2003–2004. Analyses were performed using SUDAAN statistical software (version 9; Research Triangle Park, NC), which uses Taylor series linearization methods to account for the multistage NHANES sampling design.

Descriptive statistics on the 12-month prevalence of enuresis are given for the sample overall and across demographic groups. We used Wald χ^2 tests to assess bivariate associations between the demographic predictor variables and a past-year diagnosis of enuresis. Multivariate logistic regression was performed to assess the association of demographic factors with enuresis. A second set of logistic regression models examined the association of enuresis and health services use while adjusting for the effects of sex, age, race/ethnicity, and PIR. The final set of adjusted logistic regression models examined the association of enuresis with the remaining six childhood diagnoses.

RESULTS

The prevalence of enuresis and ADHD and the demographic correlates of the 1,136 children administered the complete DISC-IV in the 2001–2004 NHANES are displayed in Table 1. The 12-month prevalence of enuresis in this sample is 4.45%. The prevalence of enuresis was higher in male subjects as compared with female subjects (odds ratio [OR] 2.69; 95% confidence interval [CI] 1.37–5.26), and black children as compared with white children (OR 2.02; 95% CI 1.03–3.98; Table 2). Children 8 years of age were significantly more likely to have the diagnosis of enuresis as compared with those 11 years of age (OR 2.63; 95% CI 1.30–5.31). Only approximately one third of the children with enuresis (35.99%, SE 7.49) in this study are reported to have used health care for this condition in the past year. Only 7.32% (SE 3.09) of the children with enuresis received medications for treatment of this condition in the past year. Among children with enuresis, those who were comorbid for ADHD were less likely than those without ADHD to have received health services for enuresis in the past year (OR 0.21; 95% CI 0.05–0.97; not shown in tables). Age, sex, race/ethnicity, and poverty were not associated with the likelihood of receiving treatment in the current study.

The 12-month prevalence of ADHD in this sample was 9.89% (SE 1.05). Analysis of the patterns of comorbidity showed that children with enuresis had 2.88 times increased odds (95% CI 1.26–6.57) of having ADHD as compared with those without enuresis, after adjustment for demographic factors (Table 3). We examined associations between enuresis and individual subtypes of ADHD, but the numbers were too small for meaningful analysis. There was no association between mood or anxiety disorders with enuresis. Although there was an increased proportion of youths with CD among those with enuresis compared with those without, the association was not significant.

DISCUSSION

This is the first nationally representative estimate of the prevalence of enuresis in the United States based on standardized diagnostic criteria. We found that 4.45% of U.S. children ages 8 to 11 years have enuresis. In addition to replication of the demographic correlates of enuresis from previous studies conducted outside the United States, we also show an association between enuresis and ADHD that has been shown in previous studies.

Our finding of the maximal prevalence of enuresis at age 8 years, followed by a decline to age 11 years, is consistent with the findings of most previous studies.^{1–8,10–12,18,19} Also confirming the findings of previous population-based surveys,^{1,5–7,10,19} there was a 2.7-fold greater risk of enuresis among boys than girls. We also found that black parents reported a twofold higher rate of enuresis in their children than white parents, which persisted after controlling for socioeconomic status. This association confirms previous studies of demographic correlates of enuresis.^{14,17,27} Contrary to previous clinical studies,^{31,32} socioeconomic status was not associated with enuresis in the current study.

The association between enuresis and ADHD confirms the findings of previous clinical studies^{31,33–42} and population-based studies^{6,7,10,18} in a large nationally representative sample. Although we could not address the explanations for this association, previous research has suggested that both enuresis and ADHD are related to delays in central nervous system maturation. This hypothesis is supported by findings of growth delay⁴³ and a higher rate of rhythmic slow wave activity on EEG.⁴⁴ However, the results of a family study suggest that ADHD and enuresis are etiologically independent.⁴⁵

Comorbidity between enuresis and ADHD could either be due to common etiologic pathways underlying these two conditions or due to “causal” relations in which the nonresolution or treatment of one disorder increases the risk for the other disorder.⁴⁶ Prospective studies, such

as the Great Smoky Mountains Study of Youth,¹⁵ found that enuresis has a high level of continuity at 3- to 7-year follow-up. However, these authors did not report on whether the presence of enuresis earlier in life increased the risk of ADHD or other psychiatric disorders later in life. In a retrospective study, a higher rate of childhood enuresis was found among adults with bipolar disorder as compared with adults without mood disorders.⁴⁷ Future developmental epidemiological studies are needed to better understand the comorbidity between enuresis and other psychiatric disorders and the possible role of enuresis in the development or nonresolution of other disorders.

Treatment targets for enuresis include arousal, nocturnal urine production, and abnormalities in urine storage/voiding.⁴⁸ Management of enuresis includes maintaining a voiding diary, addressing the often comorbid constipation, alarms, and medications (imipramine and desmopressin).⁴⁸ The use of alarms for children with enuresis is associated with nearly 4 fewer wet nights per week compared with no treatment or placebo.⁴⁹ The NHANES collected information about the use of medications for bed-wetting but did not collect information about the use of alarms. Our finding that a little more than one third of the children with enuresis received health service confirms the findings of previous epidemiological studies.^{1,13} The relatively small proportion of children who received health service could be an indication that many families wait for spontaneous resolution of the symptoms. This may be especially true of familial enuresis, for which the parents have reason to expect resolution of symptoms. Lack of medical attention to enuresis may also be a cause for concern because the persistence of enuresis past the age of 7 years is frequently associated with low self-esteem in children.^{28, 29} In addition to reducing enuresis symptoms, successful treatment of enuresis is also associated with improvement in self-esteem.^{28,50} In the current study, lower odds of receiving health service for enuresis was associated with comorbid ADHD.

Recent studies, including a double-blind randomized placebo-controlled trial, have noted that atomoxetine, a medication that is approved for the treatment of ADHD, has been found to decrease frequency of bedwetting among children with enuresis with or without ADHD.^{51,52} Interestingly, an earlier study found that the presence of ADHD predicted worse outcome for treatment of enuresis with alarm, DDAVP, or imipramine.⁵³ In the current study, children with ADHD who received medications were less likely to report enuresis than children ADHD with who did not receive medications. Among the 117 children with ADHD, 10 (14.3%, SE 4.4) of the 87 who did not receive medications for ADHD reported enuresis. Only 2 (7.4%, SE 7.1) of 30 children who received ADHD medications reported enuresis. However, this difference was not statistically significant ($\chi^2 = 0.597$; $p = .446$). More studies are needed to clarify the relation between treatment of ADHD/enuresis and the resolution of the other disorder.

There are several limitations of this study. First, the diagnosis of enuresis was not validated by medical evaluation. The diagnosis of *DSM-IV* enuresis requires exclusion of medical conditions that may have contributed to bed-wetting. As with most epidemiological studies, medical evaluation was not part of the diagnostic assessment in the current study. However, C-DISC 4.0, which was used in 2001–2004 NHANES (data used in the current study), does include a question: “In the last year, has [he/she] suffered from any medical condition that made [him/her] wet the bed during the night?” The presence of constipation, which is frequently a cause of enuresis, was not assessed specifically. A second limitation is the lack of an independent assessment of impairment at school or another situation because of inattention/hyperactivity symptoms. The *DSM-IV* diagnosis of ADHD requires information about impairment in two settings (e.g., at home and at school). Although the *DSM-IV* does not specifically require it, two-situation impairment is best established by interviewing caregivers in two different situations, for example, at home and at school. In this study, we have only the parent’s report of impairment at school and at home. The third limitation is that this study could not provide information on causal links between these conditions because of the cross-sectional

nature of the study. Moreover, there was no direct clinical evaluation of the history of onset of these conditions, and there was no systematic evaluation of potential factors that could explain these conditions.

Overall, this study highlights the common occurrence of enuresis in children ages 8 to 11 years and its frequent comorbidity with ADHD. These findings suggest that children being assessed for either ADHD or enuresis should also be evaluated for the presence of the other condition. This study shows that few families seek treatment for enuresis, although earlier studies suggest that this disorder causes significant distress and family burden, especially in children older than 7 years. The findings of this study suggest that it is important to specifically inquire about symptoms of bed-wetting and its effects on the emotional health of the child and the family. Future longitudinal research is needed to determine the following: the influence of ADHD and other comorbid disorders on the persistence or re-emergence of enuresis, the factors that influence families to seek health service/treatment for enuresis, and the impact of treating one condition (enuresis or ADHD) on the concurrent symptoms or future occurrence of the other condition.

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TABLE 1Demographic Characteristics of the Sample^a

	<i>n</i>	Percent (SE)
Sex		
Male	560	52.47 (1.80)
Female	576	47.53 (1.80)
Age, y		
8	283	24.01 (1.50)
9	282	24.83 (1.55)
10	281	25.73 (1.39)
11	290	25.44 (1.40)
Race/ethnicity		
White	342	62.17 (2.76)
Black	386	14.87 (1.90)
Hispanic/other	408	22.96 (2.51)
Poverty index ratio		
Above poverty	739	76.19 (2.01)
Below poverty	353	21.43 (1.95)
Unknown poverty	44	2.38 (0.51)

^a*N* = 1,136, representing 12,832,629 U.S. children ages 8 to 11 years.

TABLE 2

12-Month Weighted Prevalence Percent and Adjusted Odds Ratios of Enuresis by Demographic Characteristics

Demographics	Cases	% (SE)	AOR ^a (95% CI)
Sex			
Male	43	6.21 (1.27)	2.69 (1.37–5.26)
Female	19	2.51 (0.65)	Reference
Age, y			
8	21	7.75 (1.88)	2.63 (1.30–5.31)
9	14	3.75 (1.04)	1.20 (0.45–3.21)
10	13	3.45 (1.48)	1.01 (0.33–3.10)
11	14	3.03 (1.07)	Reference
Race/ethnicity			
White	15	4.34 (1.25)	Reference
Black	31	7.99 (1.83)	2.02 (1.03–3.98)
Hispanic/other	16	2.46 (0.59)	0.59 (0.26–1.30)
Poverty index ratio			
Above poverty	35	4.39 (1.10)	1.22 (0.48–3.06)
Below poverty	23	4.38 (1.31)	Reference
Unknown poverty	4	7.05 (3.27)	1.55 (0.58–4.18)
Enuresis			
Total	62	4.45 (0.81)	

Note: AOR = adjusted odds ratio; CI = confidence interval.

^a AOR: adjusted odds ratio from model containing all variables shown in the table.

TABLE 3Association Between Enuresis and ADHD^a

	Enuresis Weighted Prevalence % (SE)	AOR (95% CI) ^b
Comorbid with ADHD	12.52 (4.02)	2.88 (1.26–6.57)
Without ADHD	3.56 (0.73)	

Note: ADHD = attention-deficit/hyperactivity disorder; AOR = adjusted odds ratio; CI = confidence interval.

^a $\chi^2 = 7.14$; $p = .001$.

^b AOR (95% CI): adjusted odds ratio and 95% confidence interval from model controlling for age, sex, race, and poverty index ratio.