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Addressing Discrepancies Between ADHD Prevalence and Case Identification Estimates Among U.S. Children Utilizing NSCH 2007–2012

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Abstract

Objective: Among U.S. children, ADHD epidemiological estimates (3%–5%) vary significantly from case identification rates (over 11%), leading to confusion about true incidence and prevalence. We investigated the extent to which this discrepancy could be resolved by definitional issues through reexamining the most cited U.S. survey of case identification, the National Survey of Children's Health (NSCH).

Method: Using NSCH 2007/2008 and 2011/2012, we stratified identification of ADHD by current status, severity, psychiatric comorbidity, and ADHD medication usage. Using those criteria, definitional strength was coded into "Definite," "Probable," "Doubtful," and "No."

Results: "Definite" ADHD in caseness in 2007/2008 was 4.04%, increasing to 5.49% in 2011/2012, roughly corresponding to epidemiological estimates. "Definite" ADHD was the primary contributor to an overall increase in caseness over that period.

Conclusion: This analysis strengthens understanding of discrepancies in estimated ADHD rates. When low confidence identification is considered false positives, ADHD case identification rates match epidemiological estimates more closely.

Keywords

ADHD; prevalence; NSCH; case identification

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Introduction

A striking feature of current ADHD epidemiology is the dramatic gap between estimated prevalence and rates of clinical case identification. This gap is rarely addressed and leads to confusion about exactly how common ADHD is in the population. The present study therefore explores to what extent that discrepancy may be definitional—for example, clinical case identifications might be higher because they classify ADHD in a manner that includes subthreshold cases by *Diagnostic and statistical manual of mental disorders* (*DSM*) criteria. Put another way, our goal was not to estimate ADHD true prevalence but a more nuanced aim: to evaluate at what cut point estimated true prevalence from epidemiological studies was recoverable in national telephone survey data of clinical usage, to assist communications about these various data sources on ADHD. Before we proceed further, our terminology bears some explanation.

The term *prevalence* as intended here means estimated true cases in the population by full *DSM* criteria (i.e., duration, cross situation, multi-informant). This value is estimated by studies that are restricted to multi-informant evaluations with structured or semistructured clinical interviews in population or community samples (see below). “Caseness,” on the contrary, refers to how many children are actually identified or treated by a professional in the community, primarily as estimated by nationwide parent survey. While these surveys are limited by parent recall or construal, they may be less biased than simply relying on parent-report of ADHD symptoms, which are known to inflate ADHD estimates (Willcutt, 2012; Wolraich, Hannah, Baumgaertel, & Feurer, 1998). Caseness can also be estimated by examination of health care records, as in Musser et al. (2014), although such estimates also may be nonrepresentative. Generally, however, caseness rates are higher than prevalence rates as defined here. In the present study, our hypothesis is that caseness by parent-report of clinician diagnosis, as relied on in widely cited Centers for Disease Control and Prevention (CDC) surveys, likely includes clinician-identified cases that may have met impairment criteria, but would not meet *DSM* criteria in a multi-method, structured evaluation (thus, perhaps largely accounting for the discrepancy with epidemiological prevalence estimates).

While it may seem intuitive that not all “true” cases are identified by a health professional (due to a lack of access to care, a lack of insurance, other factors) and not all diagnoses are “true” positive (due to clinician error, or subHD prevalence, such surveys are routinely cited as evidence for ADHD’s true prevalence without examination of that claim (e.g., in media reports, Elsevier, 2013; Gregoire, 2014; Kounang, 2013; Mayor, 2015; Schwarz & Cohen, 2013). Here, we seek to clarify whether it may be plausible that a more strict definition applied to available survey data can in fact more closely approximate true prevalence estimates from other studies, and thus assist communication to the public about the phenomenon of ADHD. Clarifying ambiguities in the data available is also important for future studies of diagnostic thresholds. If clinicians are treating large numbers of children who do not meet official diagnostic criteria, then the reason for this is worth trying to understand. It may be that the criteria are too strict and many more children are impaired than previously thought. Or it may be that clinicians are applying the criteria poorly and/or are misidentifying children due to insufficient training in differential diagnosis, or to lack of alternative resources for children needing care for related problems.

To the goal of resolving these questions, we will first briefly document the discrepant claims to which we have been referring. With regard to worldwide epidemiological prevalence estimates, Polanczyk, de Lima, Horta, Biederman, and Rohde (2007) conducted a meta-analysis of epidemiological studies from 1978 to 2005 using *DSM*- or ICD-based diagnostic criteria, estimating a worldwide prevalence of 5.29%, 95% confidence interval (CI) = [5.01, 5.56]. Later, using different study inclusion criteria (i.e., using studies that had a minimum of three diagnostic groups of disorders—for example, anxiety disorders), Polanczyk, Salum, Sugaya, Caye, and Rohde (2015; reviewing literature from 1985–2012) estimated worldwide prevalence at 3.4% (95% CI = [2.6, 4.5]). Thomas, Sanders, Doust, Beller, and Glasziou (2015) conducted a meta-analysis of literature from 1977 and 2013, reporting a worldwide ADHD prevalence of 7.2% (95% CI = [6.7, 7.8]), speculating that their less restrictive literature inclusion criteria (e.g., no language exclusion criteria or not including ICD-10 studies—which employ more restrictive criteria) explained their higher estimate (Polanczyk et al., 2007; Polanczyk et al., 2015). In perhaps the most sophisticated analysis to date, Erskine et al. (2013) conducted a Bayesian meta-analysis of studies from 1980 to 2008 using *DSM*- or ICD-based diagnostic criteria. Initially, data drawn for this study were from what was previously been reported by Polanczyk et al. (2007) with an additional manual search of the literature being conducted up until 2008 and more restrictive study selection criteria applied (out of 102 studies included in the Polanczyk et al., 2007, 37 were included in Erskine et al., 2013). They estimated a worldwide prevalence of 2% to 4% (using advanced imputation methods to estimate missing regions), with no reliable changes across 1990, 2005, and 2010.

To our knowledge, there is only one meta-analysis that examines epidemiological studies to estimate ADHD prevalence in the United States. Erskine et al. (2013) conducted a Bayesian analysis with a U.S. subset of the data they used for worldwide estimates, and reached an estimate of approximately 3%. There are also individual epidemiological studies conducted with a U.S. population. These estimates, employing rigorous methods for assessing the condition of having ADHD (by using multiple informants [e.g., parent and school teacher], multi-methods), ranged from 4% (Musser et al., 2017) to 8.9% (McKeown et al., 2015), with the exception of one higher estimate based on Medicaid claims data from Nyarko et al. (2017), which may be an outlier for reasons detailed below. Wolraich et al. (1998) conducted a Tennessee countywide survey of teachers who completed a *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994)–based questionnaire of disruptive behaviors for children from kindergarten to fifth grade. Their prevalence of ADHD was estimated at 6.8% when functional impairment was required for a diagnosis; however, teacher ratings alone likely overestimate ADHD as compared with identifications by *DSM-IV* or *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013) criteria, which require cross-informant convergence on impairing symptoms. In a more rigorous study, McKeown and colleagues (2015) conducted a community-based study in South Carolina and Oklahoma, identifying children with ADHD via parents' and teachers' reports followed by multiple parent interviews (that used the Diagnostic Interview Schedule for Children–IV [DISC-IV]). Their weighted prevalence estimate was 8.9% based on *DSM-IV* criteria (i.e., presence of 6+ DISC-IV symptoms; problem onset of age <7 years old; ⩾2 moderate or ⩾1 severe rating of

functional impairment; and a teacher report of ⩾4 symptoms). Getahun et al. (2013) conducted another type of prevalence estimate, using insurance claims: They reported that 4.9% of the children who were insured by Kaiser Permanente Southern California from 2001 to 2010 had a diagnosis of ADHD (using the following criteria: [a] parents' and teachers' report of behavioral and emotional problems during the past 6 months—documented on a Child Behavior Checklist; [b] a clinical interview performed by a qualified mental health professional; and [c] received drugs specific to ADHD. Their data were extracted from pharmacy records). Similarly, Musser et al. (2017) reported prevalence of ADHD by extracting data from electronic medical records between 1995 and 2013 from large regional health care systems in the upper Midwest. Children aged 5 to 12 years with at least two time points of a recorded diagnosis of ADHD (via ICD-code) were included as ADHD cases. Their prevalence estimate was 4%. Nyarko et al. (2017) reported treated prevalence of medically managed ADHD of children across the United States by extracting data from employer-sponsored insurance databases between 2009 and 2015, and reported the treated prevalence ranging from 4.5% (in 2009) to 6.7% (in 2015). Children aged 6 to 17 years were classified as having medically managed ADHD in a given year if during that year they had (a) ⩾2 outpatient claims with an ICD version 9 or 10 diagnosis code for ADHD or (b) one outpatient claim with an ADHD code and ⩾2 prescription claims for a Food and Drug Administration (FDA)–approved ADHD medication. As briefly mentioned above, Nyarko et al. also provide an estimate based on Medicaid claims data: That estimate ranged from 11.8% (in 2009) to 12.6% (in 2015)—considerably higher than any of the other U.S. based epidemiological studies. Nyarko et al. (2017) explain that the higher number is likely due to two main factors: (a) prevalence of ADHD is noted to be higher in low income populations (and thus, not generalizable) and (b) the prevalence may be overestimated because ADHD is often used as a criterion to award disability benefits.

Case identification rates in the U.S. population—based on the National Survey of Children's Health (NSCH), our caseness comparison here—are considerably higher: Those estimates range from around 11.0% to 12.0%. The NSCH is a population-based telephone survey conducted by the CDC approximately every half-decade (CDC & National Center for Health Statistics [NCHS], 2013). We used the NSCH in our reanalysis because of its authoritativeness; the survey is state of the art, with weighted, nationally representative, probability sampling. NSCH's method for identifying ADHD consists of interviewing a parent (about a randomly selected child) and asking whether a doctor or other health care provider has ever said that child has ADHD. This is followed by questions asking whether ADHD is still present, whether the child is taking ADHD medication, and whether the parent considers the ADHD mild, moderate, or severe. (Similar questions are asked about other childhood problems such as conduct disorders).

Using NSCH, Visser et al. (2014) reported on rates of U.S. children aged 4 to 17 years "ever identified" with ADHD, "currently" having ADHD, and taking medications for ADHD, and showed a change from 9.5% in 2007 to 11.0% in 2011; Collins and Cleary (2016), also using NSCH data, reported on U.S. youth aged 5 to 17 years "ever identified" with ADHD, showing a change from 10.4% in 2007 to 12.0% in 2011. Pulcini, Zima, Kelleher, and Houtrow (2017), using NSCH data, reported overall prevalence in the United States by age group (6–11 years and 12–17 years) of "ever identified" ADHD, showing changes from

9.1% in 2007 to 10.4% in 2011, and from 12.4% to 14.2% in the younger and older age groups respectively. The most commonly cited figure in the United States is approximately 11%, based on the most recent NSCH conducted by the CDC (Elsevier, 2013; Gregoire, 2014; Kounang, 2013; Mayor, 2015; Schwarz & Cohen, 2013).

The NSCH serves a critical function in tracking health care utilization, and at the same time is often cited in media reports and influences public perception of ADHD prevalence. Our goal, therefore, is not to criticize its approach but rather to investigate why the rates of case identification are higher than most of the epidemiological prevalence estimates. It is possible that some cases (e.g., mild or recovered) would not be counted in the studies used in epidemiological surveys above. A simple exploration of this point is our fundamental goal here.

This discrepancy has been surprisingly little investigated yet poses a substantial problem for public understanding of the scope of ADHD. What accounts for this discrepancy? Some hypotheses are readily apparent. Perhaps health care providers overidentify possible ADHD when talking to parents (Getahun et al., 2013), such that results from the CDC survey include many false positives. A related hypothesis is that discrepancies result from clinicians' inconsistent application of *DSM* criteria. However, recent results from a national survey of clinicians about their ADHD diagnostic practices reported that more than 80% are including reports from multiple informants to identify ADHD, using *DSM*-cutoffs, requiring evidence of impairment, and conducting at least some form of clinical interview (Wolraich, Bard, Stein, Rushton, & O'Connor, 2010). Nonetheless, in asking whether their child has been "ever diagnosed" with ADHD, the NSCH may capture past diagnoses that occurred before newer formal diagnostic guidelines were fully adopted. Another parallel possibility is that the epidemiological meta-analyses and perhaps the *DSM* criteria themselves are too stringent. Evidence for this possibility comes from studies suggesting substantial impairment in *DSM*-based "sub-threshold" cases of ADHD (Kieling et al., 2010; Rowland et al., 2015).

We hypothesized that a closer reading of the NSCH data could help us begin to resolve this discrepancy and assist communication among scientists, clinicians, the lay public, and policy makers. Possibly the often-cited prevalence of 11% includes false positives and even self-corrected diagnoses (e.g., "ever diagnosed" from the NSCH survey where the child does not "have the condition now").

We also consider whether we can gain purchase on the hypothesis that relatively high ADHD caseness identification reflects the possible conflation of ADHD symptoms with a comorbid condition—as ADHD in children is often associated with psychiatric comorbidities. Jensen and Steinhausen (2015) reported 52.0% of children aged between 4 and 17 years and diagnosed with ADHD had at least one comorbidity and 26.2% had two or more comorbidities. A retrospective cohort study, using South Carolina's Medicaid claims' data set in 22,452 patients aged ⩽17 years and diagnosed with ADHD (between 1996 and 2006), found that 5.6% had a major depressive disorder, 14.2% had an anxiety disorder, and 39% had a conduct order/oppositional-defiant disorder (Jerrell, McIntyre, & Park, 2015). Lingineni et al. (2012) reported that those who had depression and anxiety were approximately 5 and 3 times more likely, respectively, to be ever diagnosed with ADHD

using the NSCH 2007–2008. Most recently, a study using the NSCH 2016 data reported on children who currently have ADHD and a comorbid condition: about 17% had depression, 33% had anxiety problems, and 52% had behavioral or conduct problems (Danielson, Bitsko, et al., 2018).

The new contribution here is threefold. First, we conduct a more granular analysis that addresses aspects of ADHD probability in the NSCH data set that were not considered in previous analyses, including severity, treatment, comorbidity, and stability. Second, we stratified caseness by sex and age, to help isolate where major changes in identification are occurring. Third, methodologically, the approach we took represents a first attempt to recapture a possible true prevalence estimate by reexamining the most cited U.S. survey of children's health. Given the difficulty of conducting multi-informant, interview-based studies of large representative populations, arriving at such estimates by reexamining the NSCH would be helpful. Overall, the hope is that this description would help to address the concern that diagnoses from national/state population surveys represent overdiagnosis of ADHD (Thomas et al., 2015). We do not suggest that this method would supply a final word on "true" ADHD prevalence, but intend to explore whether a fairly simple stratification of existing data can help resolve discrepancies between estimates from different types of studies.

Method

NSCH Data and Survey Description

We used data from the 2007–2008 ("2007") and 2011–2012 ("2011") NSCH. The full sample sizes of the 2007 and 2011 surveys were 91,642 and 95,677, respectively (Blumberg et al., 2012; CDC & NCHS, 2013). See below for our analytic sample size. The NSCH is a national, cross-sectional, stratified, representative telephone survey conducted in 2002/2003, 2006/2007, and 2011/2012 across the United States in English and Spanish. In the NSCH, telephone numbers are called at random to identify households with one or more children below 18 years of age. In households with multiple children, one child was randomly selected to be the subject of the interview. In 2011, a sample of cell phone numbers was added due to the rise in the prevalence of cell phone–only households (landline and cell phone interview completion rates: 54.1% for landline interviews and 41.2% for cell phone interviews in 2011; CDC & NCHS, 2013). The survey results are weighted to represent the national population of noninstitutionalized children aged 0 to 17 years. The CDC NCHS conducts the survey and produces a public-use data set.

Analytic Sample

Following precedent, and to make our results comparable with prior studies using NSCH data (Lingineni et al., 2012; Waring & Lapane, 2008), we subset children aged 5 to 17 years. This is important to enhance study validity. That is, like prior studies, we agreed that in the age period from 0 to 4 (a) ADHD diagnosis remains somewhat controversial (Ford-Jones, 2015), in part, because many toddlers and pre-schoolers do not have a second setting outside the home in which their behavior is consistently observed—thus many providers are reluctant to identify ADHD in that age range (Pliszka & AACAP Work Group on Quality

Issues, 2007) and (b) an unknown number of false negatives will therefore exist in that age group. As far as missing data, we included all cases with valid responses on the variables needed to make an ADHD categorization (see "Measures" section for details) yielding a total weighted sample size of 68,301 and 70,609 for the 2007 and 2011 surveys respectively.

Measures

Definitions of ADHD.

To test the hypothesis that the NSCH methods include cases identified that would not meet ADHD criteria under a more rigorous definition such as used in the epidemiological meta-analyses, we needed to create a method to stratify the identification of ADHD according to the probability that they would do so, by taking into account the available indicators: current versus lifetime ADHD status, severity, psychiatric comorbidity, and medication treatment. While doing so would necessarily be somewhat arbitrary without cross validation data or precedent in the literature, it enables us to illustrate an approach that can be later refined to help different study methodologies reach better consensus estimates and increase confidence in the extent of ADHD in the population. Thus, our precise stratification methodology is illustrative and not definitive—this is acceptable because the main goal here is to determine at what cut point in these data the prevalence estimates from more extensive evaluations are approximated. Our method, based on a priori rational grounds, was as follows:

We operationalized the levels of probability with four levels of "confidence":

a. High confidence, labeled as "Definite" ADHD: The survey responses indicated that ADHD was (a) current as well as ever diagnosed and (b) "moderate or severe." We judged these most likely to be identified if a full multi-informant, structured interview study was conducted;

b. Medium confidence, labeled as "Probable" ADHD: The survey responses indicated ADHD was (a) current as well as ever diagnosed and (b) treatment with medication was ongoing (perhaps lending some support to probability of diagnosis), whereas (c) severity was "mild" (perhaps calling into question whether they would meet full *DSM* criteria);

c. Low confidence; if false positives exist, they would fall in this group. We labeled this group as "Doubtful" ADHD, meaning they would be most likely to be excluded in a full structured interview or multi-informant study. These were cases in which survey responses indicated that ADHD was (a) current but "mild," and not requiring treatment, and a comorbid condition was present that might account for problems labeled as ADHD;

d. Extremely doubtful tentatively labeled "NOT" ADHD by *DSM*: ADHD was no longer present, untreated, suggesting perhaps transient problems had been identified as ADHD. This group also included those never identified with ADHD.

These levels of confidence serve here as one way to attempt to recover the likelihood of a positive diagnosis for a given child from an interview-based, multi-method and multi-

informant evaluation for ADHD impairment as was estimated by Erskine et al. (2013) and Polanczyk et al. (2015). To control for errors in our assignments, we present the stratified data below in different ways.

The data used to organize ADHD identification into those four "confidence" categories were obtained from the following questions: (a) "For each condition, please tell me if a doctor or other health care provider ever told you that [S.C.] has the condition, even if [he or she] does not have the condition now" (where attention-deficit disorder [ADD] and ADHD were listed as choices) (b) "Does [S.C.] currently have [condition]?" (c) "Would you describe [his or her] [condition] as mild, moderate, or severe?" and (d) "Is [S.C.] currently taking medication for ADD or ADHD?"

Data on psychiatric comorbidities.—We included data on the following common psychiatric comorbidities of ADHD: depression, anxiety problems, and behavioral or conduct problems (such as oppositional defiant disorder or conduct disorder). Those data were obtained from the following questions: (a) "…please tell me if a doctor or other health care provider ever told you that [S.C.] had the condition, even if [he or she] does not have the condition now." Then, if so, the following question was asked: (b) "Does [S.C.] currently have [CONDITION]?"

We considered the comorbidity "present" if both questions were answered yes. Otherwise, we considered it absent. From there, we classified comorbidity as (a) none, (b) externalizing only, (c) internalizing only, or (d) both externalizing and internalizing comorbidities. This allowed us to secondarily consider both comorbidity rates and whether comorbidities were related to change in case identification over time.

Demographics.—Because ADHD identification and prevalence may vary by age as children develop, we stratified results by sex (boy vs. girl) and three age groups (5–6 years, 7–12 years, and 13–17 years) in addition to summarizing the entire sample.

Data Analysis

We used the subpopulation command to subset children aged 5 to 17 years following the NSCH guideline (CDC & NCHS, 2013), to avoid the variance misestimation that can occur from subsetting of stratified samples. Weighted analyses were conducted to estimate caseness of an ADHD diagnosis by the four categories (i.e., *Definite, Probable, Doubtful*, and *Not ADHD*). Data were stratified by age group, and further stratified by sex within age group. Finally, we also examined caseness of having psychiatric comorbidities among "Definite" ADHD cases. Missing data were handled by full information maximum likelihood (FIML) procedures, one of the state-of-the-art methods for treating missing data. Specifically, FIML was used to estimate the proportions of ADHD cases. The weighted proportions were estimated with Mplus software (version 7.31) using the WEIGHT and STRATIFICATION commands to account for sampling weights, sample group (landline versus cell phone for 2011 data), and state of residence as required for the NSCH data set to provide nationally representative parameter estimates. To compare these proportions (i.e., caseness estimates) between the years, we used standard two-sample proportion tests with large-sample 95% CIs available in Stata (version 14.2).

Results

Case Identification of ADHD

The breakdown of our descriptive categorizations is displayed in Tables 1 and 2. Our proposed definition of "Definite" ADHD yielded estimated caseness among U.S. children aged 5 to 17 years of 4.0% and 5.5% for the 2007 and 2011 surveys, respectively (an increase of 36%). These numbers are quite close to the upper end of the range identified in meta-analyses of more comprehensive studies by Polanczyk et al. (2015), and similar to the rates in health care system surveys that require the diagnosis to be given on at least two occasions (Getahun et al., 2013; Musser et al., 2017), although above the more conservative Bayesian estimates by Erskine et al. (2013). If we include the 2.3% of children who were noted as "Probable" ADHD, we arrive at caseness estimate of just under 8% in the 2011 survey, well above the estimated population true prevalence although similar to the rate proposed by McKeown et al. (2015). The estimated caseness of "Doubtful" ADHD was relatively small (i.e., 1.5% in 2007 and 1.6% in 2011).

Case Identification of ADHD by Age and Sex

Caseness of ADHD by severity groups are presented by sex- and age-stratified groups in Table 3. As expected, "Definite" ADHD was more common as children got older and among boys although interestingly boys saw a slight decrease from childhood to adolescence (8.9% vs. 7.3% in the 2011/2012 survey) whereas girls did not (3.6% vs. 3.7% in the 2011/2012 survey).

Also as expected, "Definite" ADHD was more than twice as high in boys as in girls in both 2007 and 2011. However, the relative increase in "Definite" ADHD cases over time was more pronounced for girls as noted in Table 3. For instance, "Definite" ADHD cases for girls in years 7 to 12 increased from 2.1% to 3.6% (i.e., a relative increase of 70.1%) while "Definite" ADHD cases for boys for the same age group increased from 7.2% to 8.9% (i.e., a relative increase of 23.1%). This may reflect a growing awareness of ADHD in girls.

Psychiatric Comorbidity Among "Definite" ADHD

Approximately 5.5% of U.S. children had "Definite" ADHD in 2011 by our proposed definition. In the national data set, this represents 3,832 children. Of those, 47.1% had been told they had another mental health condition also: 15% had externalizing comorbidities only, 13% had internalizing comorbidities only, and 19% had both externalizing and internalizing comorbidities (Table 4). From 2007 to 2011, the proportion of "Definite" ADHD cases with externalizing comorbid conditions only declined, making it unlikely that misidentification of ADHD among children with externalizing conditions was driving the increase in "Definite" cases.

Discussion

In the midst of sustained controversy over whether ADHD is overdiagnosed and uncertainty about the true prevalence, we attempted a close examination of the NSCH 2007–2011 data to evaluate the likelihood that definitional variation could allow the NSCH data to

approximate prevalence estimates from more extensive but costly prevalence studies, and at what cut point in those data such estimates are in fact approximated. It was hoped this would also help to clarify sources of potential excess case identification in telephone surveys of clinical usage (or conversely, underidentification of true cases in more rigorous interview studies). Resolving this could assist communication among scientists, clinicians, and the public toward convergence on the extent of ADHD in the population. We illustrate this approach by proposing a simple confidence rating from the existing survey data. Cross validation data would confirm whether this or an alternative would be superior in matching cases that would be captured in a multi-informant or structured interview study.

We based our severity and thus confidence rankings on the following criteria: current status, severity, psychiatric comorbidity, and medication treatment. If these proposed ratings are accepted for the sake of illustration here, then the results helpfully suggest a cut point at which methodologies do converge in prevalence estimates. We found that approximately 5.5% of U.S. children aged 5 to 17 years met our “high confidence” determination of “Definite” ADHD in 2011 (and 4.0% in 2007), which was broadly consistent with authoritative meta-analyses.

If parental reports of clinician diagnoses are relatively accurate, then this result implies that the excess case identification seen in the population would be attributable to clinician application of more relaxed criteria than required in the *DSM-IV*—at least when making a single-time-point diagnosis. Clinicians might do this out of perceived clinical necessity because subthreshold cases are also impaired or due to insufficient training on differential psychiatric diagnosis (although recent data suggest most clinicians are careful in this regard; Kieling et al., 2010; Rowland et al., 2015)—possibly because they are identifying temporary, situational, or comorbid problems as ADHD.

The possibility of impaired subthreshold cases being identified is consistent with our observation that if we include the 2.3% of children we determined as “Probable” ADHD, we arrived at a caseness estimate of 7.8%. Based on these data, and if for the moment we assume that (a) parent-report of clinician diagnoses of their children are relatively accurate and (b) the multi-method surveys are closer to “true” *DSM* prevalence rate, then the discrepancy between multi-method population surveys and parent-reported clinician-delivered diagnoses is attributable to one of two factors. Either it is due to clinicians deciding to diagnose children who by full *DSM* evaluation would be “Not Otherwise Specified” (NOS) or subthreshold, or to diagnosing children who have situational problems or for which a comorbid diagnosis would account for symptoms.

Clearly there are limitations to our ability to draw from suppositions from the data available here. Most obviously, we lack a cross validation test to confirm that cases we label as “Definite” or “Probable” would in fact be identified by a survey method comparable with those used in prevalence studies (Erskine et al., 2013; Polanczyk et al., 2015). Recently, the CDC conducted a small follow-up telephone interview study among children with ADHD who participated in the 2011–2012 NSCH (CDC, NCHS, & State and Local Area Integrated Telephone Survey, 2015). We look forward to seeing whether that upcoming publications based on that additional information might validate our findings.

A unique finding of this study was that most (~80%) of the growth in ADHD caseness from 2007 to 2011 were in our "Definite" ADHD category. As the "Definite" categorization is our best approximation of a "true" caseness as would be discovered in a multi-method study (i.e., it includes children who meet either the criteria of currently having an ADHD diagnosis of moderate or severe), this finding argues against two often suggested and related hypotheses regarding trends in ADHD: either that it is driven by relaxation in the application by clinicians of diagnostic standards (American Psychiatric Association, 2013; Batstra & Frances, 2012) or by some other increase in false–positive identifications. If either were true we would expect to see increases in our "low confidence" identifications over time—in contrast to what we found.

Note that these concerns about secular trends are orthogonal to the question of whether changes in *DSM* criteria over time account for increased prevalence. There is evidence that revisions from *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.; *DSM-III*; American Psychiatric Association, 1980) to *DSM-IV* led to increased prevalence (Polanczyk et al., 2007; Wang et al., 2017) although other studies question this (Polanczyk et al., 2015; Thomas et al., 2015). Changes from *DSM-IV* to *DSM-5* may also increase prevalence (McKeown et al., 2015), but those changes had not occurred during the period studied by NCHS here.

Like previous studies (Pastor, Reuben, Duran, & Hawkins, 2015; Visser et al., 2014), we found higher rates of ADHD among boys (in all age groups). However, the rate of *increase* of "Definite" ADHD caseness was higher in girls than in boys (comparing 2007 with 2011). This may reflect an increased awareness of how ADHD may manifest differently in girls (Skogli, Teicher, Andersen, Hovik, & Øie, 2013).

A few other caveats for our findings, related to potential artifacts in the data we examined, should be kept in mind. For one thing, we note that the "Definite ADHD" rate increased over time without an accompanying increase in comorbidity. This suggests that increases in case identification are not due to overidentification of comorbid cases. However, it will be still important to examine trends of comorbid psychiatric conditions among children with ADHD and to see whether that is related to change of prevalence estimates of children with ADHD.

In our study, 53.8% of the children identified with "Definite" ADHD had a psychiatric comorbidity from using the 2007 NSCH (21% had depression, 26% anxiety, and 40% behavioral/conduct problems); using NSCH 2011, we found that the proportion dropped slightly to 47.1% (18% depression, 25% anxiety, and 34% behavioral/conduct problems). When comparing our estimates with those in Danielson, Bitsko, et al., (2018; who used the 2016 NSCH and as mentioned earlier, estimated: 17% depression, 33% anxiety, and 52% behavioral/conduct problems), it may appear that the prevalence of those comorbidities among children with ADHD increased since 2011. However, because different NSCH databases were used and because of methodological differences between our study and Danielson et al., direct comparisons are problematic: Danielson, Bitsko, et al., (2018) reported on a broader population (i.e., they included children with mild ADHD as well as children with moderate/severe ADHD while we operationalized our "Definite" group as children with moderate/severe ADHD), and the method of data collection in NSCH 2016

differed markedly from earlier NSCH reports (i.e., from a telephone survey to an online/mail-based survey). Our findings are also discrepant with those from a Medicaid billing system (Jerrell et al., 2015), wherein only 5.6% of ADHD youth had a major depressive disorder, 14.2% had an anxiety disorder, and 39% had a conduct disorder/oppositional-defiant disorder. Again, comparisons with cases derived from the Medicaid billing system is difficult, as such caseness focuses exclusively on diagnosed cases seeking treatment from a certain socioeconomic segment of the population, with a stratified national sample.

The usage of cell phone data collection in the 2011 survey differs from the 2007 survey methodology. Visser et al. (2014) reported that analyses of restricted-use data suggest that children in cell phone–only households in 2011 were more likely to have ADHD than children living in landline households (10.0% vs. 8.4%) and the "Definite" ADHD showed the same pattern in our analysis (6.2% in cell phone–only vs. 4.9% in landline). Therefore, the relatively higher cases in the 2011 survey might be at least partially spurious and influenced by methodological differences. Third, although medication treatment and psychiatric comorbidity were included to increase the sophistication of our case estimate, other forms of treatment for ADHD were not collected in the NCHS and our estimates of ADHD treatment may be an underestimate compared with when all treatment paradigms are considered.

Of further consideration regarding the data we used for this analysis is the methodological issues regarding parent-report data, of the sort used in NSCH. Parent-report of clinical diagnosis might underestimate "true prevalence" because not all parents of children with ADHD may bring their children to health care providers for evaluation, or due to recall bias or social desirability bias. Parent-report of diagnosis and treatment used in the NSCH survey have not been validated against medical records or clinical evaluation (Danielson, Bitsko, et al., 2018; Danielson, Visser, et al., 2018; Visser et al., 2014). However, Visser et al. reported that parent-report of an ADHD diagnosis (restricted the sample to California from the 2007 NSCH survey) results in similar prevalence estimates to those attained through analysis of insurance claims data within Southern California (Getahun et al., 2013), suggesting some support for the veridicality of the parent-reports of clinical diagnosis (Visser, Danielson, Bitsko, Perou, & Blumberg, 2013).

While it is well known that parents' own ratings of whether their child has high ADHD symptoms overestimates ADHD prevalence as defined in *DSM-IV* or *DSM-5* (Willcutt, 2012; Wolraich et al., 1998), the NSCH survey is not directly comparable with those studies that ask parents to rate their children's ADHD symptoms and use that to estimate prevalence. In the NSCH, parents are asked whether a doctor or other health care provider has given their child a diagnosis of ADHD. This should avoid some of the overestimation due to parent-report bias when asked to report symptoms. Nonetheless, it is still possible that parents overreport clinician diagnoses of their children.

Conclusion

The goal of this study was not to definitively estimate true prevalence but to address a more nuanced question: assessing whether estimates of true prevalence from epidemiological

studies could be readily recovered in telephone survey data about clinical usage. Our study showed that among U.S. children aged 5 to 17 years, parent-reported ADHD caseness drops from around 11% to just below 8% when mild, never treated cases of ADHD are considered as possible false positives, and to about 5.5% when we restrict caseness to a diagnostic profile we propose would likely be identified in a more rigorous and costly epidemiological study. Thus, discrepancies between surveys of clinical usage and epidemio-logical studies may be resolvable on definitional grounds. This can help clarify what is going on with ADHD identification in the United States and lead to better integration and communication among scientists, clinicians, and the public.

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Table 1.

Estimated Caseness of ADHD by ADHD Classification (National Survey of Children's Health, 2007–2012).

		2007–2008 (*n* = 68,301)				2011–2012 (*n* = 70,609)				Change		Relative %	
ADHD classification	**Description**	***N***	**Cumulative *n***	***%***	**Cumulative %**	***n***	**Cumulative *n***	***%***	**Cumulative %**	**% Change**	**% change**	**Cumulative % change**	**95% CI absolute change**
Definite	Moderate/severe (all)	2,759	2,759	4.04	4.04	3,873	3,873	5.49	5.49	1.45	1.45	35.8	[1.22, 1.67]
Probable	Mild and meds (all comorbidities)	1,379	4,138	2.02	6.06	1,651	5,524	2.34	7.82	0.32	1.76	15.8	[0.16,0.47]
Doubtful	Mild + externalizing comorbidities only, no meds	105	4,243	0.15	6.21	125	5,649	0.18	8.00	0.02	1.79	15.2	[−0.02, 0.07]
	Mild + both externalizing and internalizing comorbidities, no meds	40	4,283	0.06	6.27	58	5,707	0.08	8.08	0.02	1.81	40.3	[−0.004, 0.05]
	Mild + internalizing comorbidities only, no meds	85	4,368	0.12	6.40	1 15	5,822	0.16	8.25	0.04	1.85	30.9	[−0.001, 0.08]
	Mild + no comorbidities, no meds	823	5,191	1.20	7.60	802	6,624	1.14	9.38	−0.07	1.78	−5.7	[−0.18,0.04]
Not ADHD	ADHD ever but not current, no meds	1,471	6,662	2.15	9.75	1,434	8,058	2.03	1 1.41	−0.12	1.66	−5.7	[−0.27, 0.03]
	No ADHD ever	61,639	68,301	90.25	100.00	62,551	70,609	88.59	100.00	−1.66		−1.8	[−1.98,−1.33]

Note. Weighted frequencies are rounded to the nearest integer. CI = confidence interval.

Table 2.

Estimated Caseness of ADHD by Simplified ADHD Classification (National Survey of Children's Health, 2007–2012).

	2007–2008 (*n* = 68,301)				2011–2012 (*n* = 70,609)				Change 2008–2012		
ADHD classification	***n***	**Cumulative *n***	**%**	**Cumulative %**	***n***	**Cumulative *n***	**%**	**Cumulative %**	**Absolute Δ**	**Relative Δ**	**95% CI absolute change**
Yes	2,759	2,759	4.04	4.04	3,873	3,873	5.49	5.49	1.45	35.79	[1.22, 1.67]
Probable	1,379	4,138	2.02	6.06	1,651	5,524	2.34	7.82	0.32	15.81	[0.16,0.47]
Doubtful	1,053	5,191	1.54	7.60	1,100	6,624	1.56	9.38	0.02	1.05	[−0.11,0.14]
No	63,110	68,301	92.40	100.00	63,985	70,609	90.62	100.00	−1.78	−1.93	[−2.07,−1.49]

Note. Weighted frequencies are rounded to the nearest integer. CI = confidence interval.

Table 3.

Estimated Caseness of ADHD by Age and Sex (National Survey of Children's Health, 2007–2012).

	2007–2008 (n = 68,301)						2011–2012 (n = 70,609)						Change 2008–2012								
ADHD classification	***n***	**%**	***n***	**%**	**n**	**%**	***n***	**%**	***n***	**%**	***n***	**%**	**Absolute Δ**	**Relative Δ**	**95% Cl absolute change**	**Absolute Δ**	**Relative Δ**	**95% Cl absolute change**	**Absolute Δ**	**Relative Δ**	**95% Cl absolute change**
	Boys																				
	5–6 years		7–12 years		13–17 years		5–6 years		7–12 years		13–17 years		5–6 years			7–12 years			13–17 years		
Yes	107	2.30	1,061	7.23	942	5.85	219	4.14	1,436	8.90	1,100	7.30	1.84	80.09	[1.15,2.53]	1.67	23.1	[1.06,2.28]	1.46	24.92	[0.91,2.01]
Probable	22	0.47	473	3.22	523	3.25	49	0.93	477	2.96	634	4.21	0.45	95.98	[0.13,0.78]	−0.27	−8.3	[−0.65, 0.12]	0.96	29.68	[0.54, 1.39]
Doubtful	49	1.05	241	1.64	501	3.11	67	1.27	296	1.83	408	2.71	0.21	20.31	[−0.21,0.63]	0.19	1 1.7	[−0.10,0.48]	−0.40	−12.88	[−0.77, −0.03]
No	4,482	96.18	12,905	87.91	14,144	87.80	4,961	93.67	13,932	86.31	12,917	85.78	−2.51	−2.61	[−3.38,−1.67]	−1.59	−1.8	[−2.34, −0.85]	−2.02	−2.30	[−2.77,−1.27]
	Girls																				
	5–6 years		7–12 years		13–17 years		5–6 years		7–12 years		13–17 years		5–6 years			7–12 years			13–17 years		
Yes	31	0.71	294	2.14	373	2.54	67	1.36	566	3.64	502	3.70	0.64	90.4	[0.24, 1.05]	1.50	70.1	[1.12, 1.88]	1.16	45.75	[0.76, 1.57]
Probable	16	0.37	136	0.99	263	1.79	1 1	0.22	231	1.49	282	2.08	−0.15	−39.4	[−0.37, 0.08]	0.50	50.1	[0.24, 0.75]	0.29	16.12	[−0.03,0.61]
Doubtful	12	0.28	135	0.98	164	1.12	18	0.36	123	0.79	208	1.53	0.09	32.2	[−0.14,0.32]	−0.19	−19.5	[−0.41,0.02]	0.42	37.35	[0.15, 0.68]
No	4,289	98.64	13,159	95.88	13,883	94.55	4,839	98.05	14,612	94.08	12,566	92.68	−0.59	−0.6	[−1.10,−0.07]	−1.81	−1.9	[−2.31,−1.31]	−1.87	−1.98	[−2.44,−1.30]
	All 5–6 years		7–12 years		13–17 years		5–6 years		7–12 years		13–17 years		5–6 years			7–12 years			13–17 years		
Yes	140	1.55	1,344	4.72	1,303	4.23	285	2.78	2,015	6.35	1,587	5.54	1.23	79.1	[0.82, 1.63]	1.63	34.5	[1.26, 1.99]	1.31	31.11	[0.97, 1.66]
Probable	38	0.42	601	2.1 1	781	2.53	60	0.59	708	2.23	907	3.17	0.16	38.9	[−0.04, 0.36]	0.12	5.7	[−0.11,0.35]	0.63	25.01	[0.37, 0.90]
Doubtful	62	0.69	374	1.31	658	2.13	85	0.83	419	1.32	610	2.13	0.14	20.6	[−0.10,0.39]	0.01	0.5	[0.18,0.19]	0.00	−0.21	[−0.24, 0.23]
No	8,775	97.34	26,132	91.85	28,093	91.1 1	9,818	95.80	28,574	90.09	25,541	89.16	−1.53	−1.6	[−2.05,−1.02]	−1.76	−1.9	[−2.22.−1.30]	−1.94	−2.13	[−2.43,−1.47]

Note. Weighted frequencies are rounded to the nearest integer. CI = confidence interval.

Table 4.

Estimated Caseness of ADHD: Definite ADHD group Only (National Survey of Children's Health, 2007–2012).

Comorbid classification	2007–2008				2011–2012				Change 2008–2012		
	n	Cumulative *n*	%	Cumulative %	*n*	Cumulative *n*	%	Cumulative %	Absolute Δ	RelativeΔ	95% CI absolute change
Externalizing comorbidities only	533	533	19.56	19.56	581	581	15.16	15.16	−4.40	−22.5	[−6.27, −2.52]
Internalizing comorbidities only	378	1,465	13.87	33.43	495	1,805	12.92	28.08	−0.95	−6.9	[−2.63, 0.72]
Both externalizing and internalizing comorbidities	554	1,087	20.33	53.76	729	1,310	19.02	47.10	−1.31	−6.4	[−3.26, 0.65]
None	1,260	2,725	46.24	100.00	2,027	3,832	52.90	100.00	6.66	14.4	[4.21,9.1 1]

Note. The total *N* in this table may not match up exactly with the total weighted frequency of Definite ADHD in Tables 1 and 2 due to missing data of comorbidities and weighting. Weighted frequencies are rounded to the nearest integer. CI = confidence interval.