Time Trends in Incidence Rates of Diagnosed Attention-Deficit/Hyperactivity Disorder Across 16 Years in a Nationwide Danish Registry Study

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ABSTRACT

Objective: To investigate time trends in incidence rates of first-time diagnosed attention-deficit/hyperactivity disorder (ADHD) in a nationwide sample aged 4–65 years across 16 years and identify potential contributing factors to these time trends.

Method: Incidence rates of first-time diagnosed ADHD based on *ICD-10* criteria in Danish psychiatric hospitals per 100,000 person years (PY) were calculated for the total population, the 2 sexes, and 4 age groups using data from the Danish Psychiatric Central Research Registry and annual census data. Time trends and the role of contributing factors were analyzed and identified using joinpoint regression procedures by calculating annual percent changes for the time period 1995–2010.

Results: A total of 20,281 patients were diagnosed with ADHD and incidence rates increased from 7.3 to 91.2 per 100,000 PY during the study period. Joinpoint analysis suggested that incidence rates for diagnosed ADHD rapidly increased from 1998 to 2002, peaked from 2002 to 2008, and slowed down from 2008 to 2010. Contributing factors to the observed time trends were a general increase in patients seen in psychiatry for any mental disorder and an increased awareness and recognition of ADHD in females, adolescents, and adults.

Conclusions: These results provide empirical data needed in the public and professional debate often based on theoretical rather than empirical arguments. Results support the notion of increasing incidence rates of diagnosed ADHD and identify that contributing factors are a general increase in the number of patients assessed in psychiatry and an increased recognition of females, adolescents, and adults with ADHD.

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Both among the lay public and professionals and in the media, there exist the impression and assumption that attention-deficit/hyperactivity disorder (ADHD) has been increasing in the general population in the recent past. A recent large study of parent-rated ADHD in the United States found a large increase in prevalence in 2011 compared to 2003.[1] Similarly, the prevalence rate of treated ADHD increased significantly from 1999 to 2005 in Taiwan.[2] In the discussion of these time trends, various explanations have been put forward including overdiagnosis/treatment, narrowing of the construct of normality or widening of the construct of ADHD,[3,4] bridging the gap between those in need of treatment and those who get treatment,[5,6] and actual increases in the baseline rate of those who develop ADHD, to name just the most frequent. However, an empirical foundation for these explanations is lacking. Furthermore, a major meta-analysis of international studies in the past 3 decades found no evidence to suggest an increase of ADHD in children in the community and concluded that variability in ADHD prevalence estimates is mostly accounted for by methodological characteristics of the various studies.[7]

Whereas prevalence studies in the community are based on parent or teacher ratings of ADHD supplemented by expert interviews in some but not all, incidence rates rest on diagnosed ADHD. Findings on incidence rates of diagnosed ADHD vary according to the age-groups and definitions used in various studies. Incidence rates in children and adolescents have, for example, been found to range between 320 and 900 per 100,000 person years (PY).[8,9] Males seem to have 3 to 4 times higher incidence rates of ADHD compared to females, and most cases are diagnosed at ages 5–10.[8–12]

However, since ADHD might be increasingly diagnosed, studies on time trends of diagnosed ADHD are needed rather than simply assuming that ADHD incidence rates are stable across time. In contrast to prevalence studies, to the best of our knowledge, only 2 studies have reported on annual incidence rates of diagnosed ADHD for an extended period allowing for time trend analysis. One discussion article was based on Danish data similar to the data used in the present study, but that study did not address detailed time trends and any contributing factors to the observed trends.[4] The other study was based on the Taiwanese National Health Insurance registry data from 1996 to 2005 and found that among 0–17 year olds the annual incidence rates for diagnosed ADHD increased from 20 to 340 per 100,000 PY during those years.[11]

There are more studies investigating incidence rates and associated time trends for medically treated ADHD than studies investigating incidence rates of diagnosed ADHD. However, those studies do not capture the increases in nonmedicated cases with ADHD. Furthermore, those studies are very likely affected by a generally increasing time trend toward prescribing medication more frequently for patients with ADHD.[13,14]

A recent Danish registry–based study found that incidence rates of dispensed stimulants increased from approximately 100 to 900 per 100,000 PY among 6–12 year old boys from 1997 to 2011.[15] This trend was also documented in the United States but with higher estimates of the incidence

Clinical Points

- Evidence based on a large nationwide Danish registry shows that newly diagnosed attention-deficit/hyperactivity disorder (ADHD) has increased over 16 years.
- These time trends were in part explained by a general increase in the number of individuals receiving psychiatric care and an increased recognition of ADHD in females, adolescents, and adults.
- It is premature to conclude that the true number of individuals with ADHD in the population has definitely increased.

rates of treated ADHD than documented in Denmark.[14] In addition, some contributing factors to this increase have been identified. In the United States, a rapid growth in the rate of females receiving treatment has led to decreasing male to female ratios.[16] Similar sex trends have been found in Australia,[17] the Netherlands,[18] and the United Kingdom.[19] Furthermore, an increased awareness of ADHD and the need for treatment in affected adolescents and adults have contributed to the population level increase.[15,20] In addition, ADHD has been diagnosed more frequently among younger rather than older cohorts.[7]

The aim of the present study was the analysis of time trends in incidence rates of diagnosed ADHD based on Danish nationwide psychiatry registry data for the time period 1995–2010 and the population aged 4–65 years. The study also looked into the effects of age, sex, and time trends on incidence rates of any psychiatric disorder as potential contributing factors to the population-wide time trends in incidence rates.

METHOD

Nationwide registry data from the public health service were the source of data in the present study. Using registry data for research purposes in Denmark is made possible since all inhabitants of Denmark are given a unique 10-digit identification number at birth, which makes it possible to track each individual in Denmark across time and registries.[21] Every time a Danish citizen goes to the hospital, moves through the education system, has children, and more, records of these events are stored in one of the many Danish registries under the person's identification number. In Denmark, health care is free and available regardless of income and socioeconomic status. Public services and hospitals thus provide a good and relatively unbiased source of data since mental health care is assessable and records of the patients' contact to psychiatry are stored in the registries. Private clinics and practices see by-and-large similar and often less severe manifestations of disorders, but they are exempted from the obligation to record data for the registries.

The data on psychiatric diagnoses used in the present study came from the Danish Psychiatric Central Research Registry (DPCRR), which contains data from all psychiatric institutions in Denmark.[22] The data are restricted to diagnoses and do not include any information on intervention. Data access needs to be applied for through Statistics Denmark (www.dst.dk). In Danish psychiatric hospitals, assessment and diagnosis are carried out by specialists in psychiatry and in an interdisciplinary setting consisting of psychiatrists, psychologists, social workers, nurses, and others. Psychopathological and somatic assessment, psychological testing, behavioral observations, and multi-informant assessments form the basis for diagnoses.

Data from the DPCRR were used to identify (1) all incident cases of patients diagnosed with ADHD (F90) according to *ICD-10* criteria and (2) the total number of persons diagnosed with any mental disorder in the time period 1995–2010. An incident case of ADHD was defined as a person in the registry in the age range of 4–65 years with a first-time diagnosis of F90 given in an inpatient or outpatient facility. Cases diagnosed only in emergency rooms or cases diagnosed before 1995 were excluded. An incidence of any psychiatric disorder was defined as the incidence of one of the following diagnoses: substance use disorders (F1x); psychotic disorders (F2x); affective disorders (F3x); phobias, anxiety disorders, and reactions to severe stress (F40–43); eating disorders (F50); autism spectrum disorders (F84); and hyperkinetic and conduct disorders (F90–F91), in the same age and time period as studied for ADHD. The same exclusion criteria were applied. Yearly Danish census data for the calculation of incidence rates were available from Statistics Denmark.

Statistical Analyses

Incidence rates of ADHD were age- and sex-standardized and further adjusted for the overall increase in incidence rates of patients diagnosed with any psychiatric disorders. Data were adjusted for the increase in the incidence rates of patients diagnosed with any psychiatric disorder by calculating weights based on the age- and sex-standardized incidence rates for any psychiatric disorder. Both adjusted and nonadjusted incidence rates were calculated. (We use the term "nonadjusted incidence rates" to refer to age- and sex-standardized incidence rates not adjusted for the time trends in psychiatry in general.) This procedure allowed not only for the investigation of the time trend of the actual incidence rates of ADHD, but also for an analysis of whether or not the observed time trends were related to a general increase in the rate of the Danish population receiving psychiatric care. Incidence rates were calculated separately for the 2 sexes and the following age groups: preschool age (4–5 years), school age (6–12 years), adolescence (13–17 years), young adulthood (18–29 years), and adulthood (30–65 years).

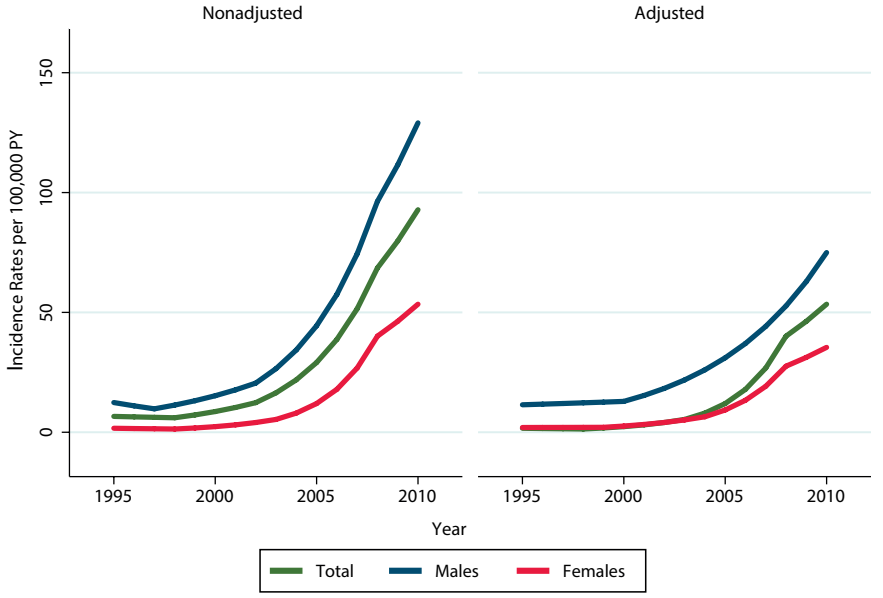
To identify time trends and allow for comparisons of various age and sex groups, data were fitted using Joinpoint Regression software version 4.0.4.[23] Joinpoint regression was originally developed to analyze time trends in cancer rates. This regression procedure fits observed time trend data to linear functions. Rather than estimating one linear trend for the whole observation period, so-called joinpoints, which segment the interpolation line, are identified. A

Table 1. Sex and Age Distributions (n, %) for Incident Cases With ADHD and Any Psychiatric Disorder

	ADHD						Any Psychiatric Disorder					
	Male		Female		Total		Male		Female		Total	
Age Group	n	%[a]	n	%[a]	n	%[b]	n	%[a]	n	%[a]	n	%[b]
Preschool (4–5 y)	1,276	80.9	302	19.1	1,578	7.8	3,790	78.9	1,013	21.1	4,803	1.9
School age (6–12 y)	7,938	82.9	1,633	17.1	9,571	47.2	18,375	73.3	6,681	26.7	25,056	10.0
Adolescence (13–17 y)	2,554	69.5	1,122	30.5	3,676	18.1	10,711	37.1	18,160	62.9	28,871	11.6
Young adulthood (18–29 y)	2,171	66.1	1,114	33.9	3,285	16.2	27,966	40.7	40,731	59.3	68,697	27.5
Adulthood (30–65 y)	1,318	60.7	853	39.3	2,171	10.7	56,854	46.5	65,326	53.5	122,180	48.9
Total	15,257	75.2	5,024	24.8	20,281	100.0	117,696	47.2	65,326	52.8	249,607	100.0

[a]Sex distribution.
[b]Age distribution.

Figure 1. Adjusted and Nonadjusted Time Trends in Incidence Rates of Diagnosed ADHD in the Total Population and for Males and Females



joinpoint is a break in the data where the annual percent change (APC) varies compared to the previous specified joinpoint. Joinpoint regression software estimates zero to several models describing the time trend data and chooses which model is the best fit. This is estimated in a series of permutation tests that identify the smallest number of joinpoints needed to explain the data. The best fitting model is the model with the least number of joinpoints, such that adding an additional joinpoint does not significantly improve the explanation of data. Thus, the software helps to identify the simplest model needed to explain data. These procedures provide a highly informative way of investigating time trends in incidence rates and are useful in subgroup comparisons (eg, males vs females) across time. Figures were produced with the help of the Stata 11 software.[24]

RESULTS

Sample Description

A total of N = 20,281 persons had an incidence of ADHD in the time period 1995–2010, and a total of N = 249,607 patients had an incidence of any psychiatric disorder. Sex and age distributions are presented in Table 1 for ADHD and for any psychiatric disorder. In ADHD, most cases had their incidence in school age, and the male to female distributions showed a clear male predominance early in life, which decreased with increasing age. For any psychiatric disorder, cases were predominantly diagnosed in adulthood, and there was a male predominance in childhood whereas the majority of diagnosed patients in adulthood were female.

Time Trends in Incidence Rates for ADHD in the Total Sample

Nonadjusted incidence rates for diagnosed ADHD increased from 1995 to 2010 by a factor of 12.5 from 7.3 to 91.2 per 100,000 PY (Figure 1), whereas incidence rates for any psychiatric disorder increased only by a factor of 1.4 from 320.4 to 438.6 per 100,000 PY. After adjusting the incidence rates for ADHD for the general increase in incident psychiatric cases, the incidence rates still increased during the observation period but were down-sized to a 7.4-fold increase from 7.3 to 53.8 per 100,000 PY.

Results of joinpoint regression analysis are shown in Table 2 for adjusted and nonadjusted incidence rates of ADHD

Table 2. Annual Percent Change (APC) in Nonadjusted and Adjusted Incidence Rates of ADHD 1995–2010 in the Total Population and by Sex[a]

	Total		Male		Female	
	Joinpoints	APC	Joinpoints	APC	Joinpoints	APC
Nonadjusted	0 Joinpoints		0 Joinpoints		0 Joinpoints	
	1995–2010	22.6[b]	1995–2010	20.2[b]	1995–2010	31.7[b]
	1 Joinpoint		**1 Joinpoint**		**1 Joinpoint**	
	1995–1998	−7.5	1995–1998	−6.4	1995–1998	−10.6[b]
	1998–2010	27.4[b]	1998–2010	24.4[b]	1998–2010	38.9[b]
	2 Joinpoints		2 Joinpoints		2 Joinpoints	
	1995–1998	−3.4	1995–1997	−11.8	1995–1998	−7.7
	1998–2002	21.2[b]	1997–2002	17.0[b]	1998–2003	34.4[b]
	2002–2010	30.1[b]	2002–2010	27.1[b]	2003–2010	41.9[b]
	3 Joinpoints		3 Joinpoints		3 Joinpoints	
	1995–1998	−3.0	1995–1997	−11.2	1995–1998	−6.7
	1998–2002	19.6[b]	1997–2002	16.0[b]	1998–2003	31.7
	2002–2008	33.1[b]	2002–2008	29.4[b]	2003–2008	49.6[b]
	2008–2010	16.4	2008–2010	15.8	2008–2010	15.4
Adjusted	0 Joinpoints		0 Joinpoints		0 Joinpoints	
	1995–2010	16.6[b]	1995–2010	14.4[b]	1995–2010	24.6[b]
	1 Joinpoint		**1 Joinpoint**		1 Joinpoint	
	1995–2000	2.9	1995–2000	2.3	1995–1999	−1.7
	2000–2010	22.2[b]	2000–2010	19.3[b]	1999–2010	31.8[b]
	2 Joinpoints		2 Joinpoints		2 Joinpoints	
	1995–2000	2.5	1995–1997	−8.6	1995–1999	1.6
	2000–2008	22.8[b]	1997–2001	9.7	1999–2002	23.6
	2008–2010	17.8[b]	2001–2010	19.3[b]	2002–2010	34.4[b]
	3 Joinpoints		3 Joinpoints		**3 Joinpoints**	
	1995–2000	3.6	1995–1997	−9.2	1995–1999	1.0
	2000–2005	20.0[b]	1997–2992	10.8[b]	1999–2004	25.7[b]
	2005–2008	29.0[b]	2002–2008	21.3[b]	2004–2008	43.7[b]
	2008–2010	12.9	2008–2010	12.4	2008–2010	13.4

[a]Best fitting models are boldface.
[b]Significant increase/decrease in APC.

per 100,000 PY. Joinpoint regression identified 1 significant joinpoint to fit the data best for both the adjusted and the nonadjusted models, and estimated the APC for nonadjusted incidence rates per 100,000 PY to change from −7.5 from 1995 to 1998 to 27.4 from 1998 to 2010. A similar trend was identified for the adjusted rates, with APC increasing from 2.9% per year from 1995 to 2000 to 22.2% per year from 2000 to 2010.

Time Trends in Incidence Rates for ADHD in Males and Females

Age-adjusted incidence rates for diagnosed ADHD increased from 12.7 to 126.2 per 100,000 PY in males and from 1.6 to 53.0 per 100,000 for females. After adjusting for the increase in the total number of incident cases with a psychiatric disorder, incidence rates in males increased from 12.7 to 69.3 per 100,000 PY and in females from 1.6 to 35.0 per 100,000 PY. Figure 1 presents these time trends. Results from joinpoint regression analysis found that for both adjusted and nonadjusted rates, the incidence rates for males were higher than for females, but the increases in APCs were more pronounced in females (see Figure 1 and Table 2). The male to female ratios went down from 7:1 in 1995 to 2:1 in 2010. The trend was more pronounced for some age groups than others as documented in the next section.

Time Trends in Incidence Rates for ADHD by Age Groups

As shown in Figure 2, incidence rates increased for all age groups in the population. Nonadjusted incidence rates per 100,000 PY increased for preschoolers (20.5 to 136.6), school-aged children (54.9–312.5), adolescents (9.3–219.3), young adults (0.2–123.3), and adults (0.0–22.8). Also, for the adjusted incidence rates per 100,000 PY, the rates increased, though on a lower level, for preschoolers (20.5–81.7), school-aged children (54.9–156.8), adolescents (9.3–89.1), young adults (0.2–73.2), and adults (0.0–22.9). Results of the joinpoint regression showed that the APC had the largest increases for the older age-groups, particularly among adolescents and young adults, as shown in Table 3. The male to female ratios dropped from 5.2:1 to 2.1:1 in preschoolers, from 7.5:1 to 3:1 in school-aged children, from 8.1:1 to 1.6:1 in adolescents, from 7.8:1 to 1.7:1 in young adults and from 1.9:1 to 1.4:1 in adults.

Figure 2. Adjusted and Nonadjusted Time Trends in Incidence Rates of Diagnosed ADHD by Age-Group at Diagnosis

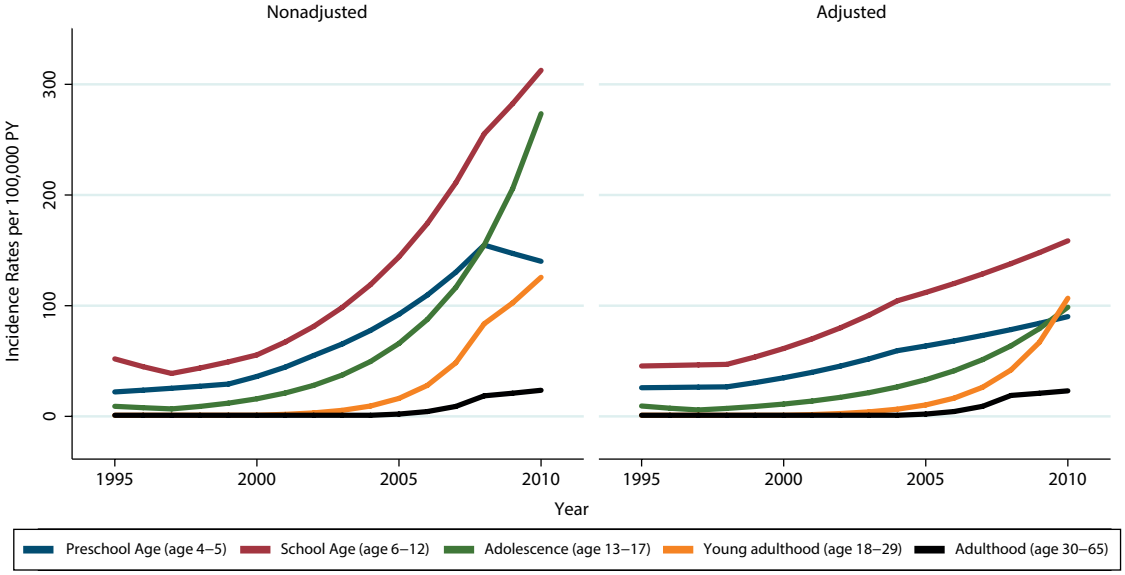


Table 3. Annual Percent Change (APC) in Nonadjusted and Adjusted Incidence Rates of ADHD 1995–2010 by Age[a]

	Preschool Age 4–5 y		School-Age Age 6–12 y		Adolescence Age 13–17 y		Young Adulthood Age 18–29 y		Adulthood Age 30–65 y	
	Joinpoints	APC	Joinpoints	APC	Joinpoints	APC	Joinpoints	APC	Joinpoints	APC
Nonadjusted	0 Joinpoints		0 Joinpoints		0 Joinpoints		0 Joinpoints		0 Joinpoints	
	1995–2010	16.1[b]	1995–2010	16.1[b]	1995–2000	29.3[b]	1995–2000	46.3[b]	1995–2000	25.2[b]
	1 Joinpoint		**1 Joinpoint**		**1 Joinpoint**		1 Joinpoint		1 Joinpoint	
	1995–2008	17.4[b]	1995–1997	−17.6	1995–1997	−13.8	1995–2000	4.1	1995–2003	−1.6
	2008–2010	−1.6	1997–2010	18.8[b]	1997–2010	32.9[b]	2000–2010	66.1[b]	2003–2010	67.5[b]
	2 Joinpoints		2 Joinpoints		2 Joinpoints		**2 Joinpoints**		**2 Joinpoints**	
	1995–1999	8.5[b]	1995–1997	−14.1	1995–1997	−16.2	1995–2000	1.4	1995–2004	0.2
	1999–2008	20.2[b]	1997–2000	14.1	1997–2008	34.6[b]	2000–2008	72.8[b]	2004–2008	106.9[b]
	2008–2010	−6.4	2000–2010	19.7[b]	2008–2010	14.8	2008–2010	22.5[b]	2008–2010	12.7
Adjusted	**0 Joinpoints**		0 Joinpoints		0 Joinpoints		0 Joinpoints		0 Joinpoints	
	1995–2010	10.4[b]	1995–2010	9.6[b]	1995–2010	20.8[b]	1995–2010	40.5[b]	1995–2010	25.2[b]
	1 Joinpoint		**1 Joinpoint**		**1 Joinpoint**		**1 Joinpoint**		1 Joinpoint	
	1995–2006	11.8[b]	1995–1997	−8.2	1995–1997	−21.5	1995–2000	0.0	1995–2003	−1.6
	2006–2010	4.7	1997–2010	10.9[b]	1997–2010	24.4[b]	2000–2010	59.5[b]	2003–2010	67.5[b]
	2 Joinpoints		2 Joinpoints		2 Joinpoints		2 Joinpoints		**2 Joinpoints**	
	1995–1999	7.1	1995–1998	−4.6	1995–1997	−14.6	1995–2000	−2.4	1995–2004	0.2
	1999–2003	16.9[b]	1998–2004	14.5[b]	1997–2001	16.6	2000–2008	65.5[b]	2004–2008	108.1[b]
	2003–2010	7.0[b]	2004–2010	7.8[b]	2001–2010	27.1[b]	2008–2010	20.6	2008–2010	10.4

[a]Best fitting models are boldface.
[b]Significant increase/decrease in APC.

DISCUSSION

The aim of the present study was to identify the annual incidence rates of diagnosed ADHD in the Danish population aged 4–65 years from 1995 to 2010 and to investigate contributing factors to these time trends observed in the total population. In accordance with expectations and results from previous studies on incidence rates of diagnosed and treated ADHD,[4,15] a major increase in incidence rates per 100,000 PY was identified. Nonadjusted rates increased from 7.3 to 91.2 and adjusted rates from 7.3 to 53.8 per 100,000 PY. This study is the first to look at incidence rates of diagnosed ADHD in the life-time age range from 4 to 65 years, and it covers the most extended observation period to date, so that these numbers cannot be compared with other studies from other regions of the world.

A substantial part of the increasing incidence rates of diagnosed ADHD could be attributed to a general increase in

the number of individuals receiving psychiatric assessment and treatment. The nonadjusted 12.5-fold increase in incidence rates of diagnosed ADHD in the population was reduced to an adjusted 7.4-fold increase, which of course is still remarkable. Thus, these results identify that part of the explanation for the increases in rates of diagnosed ADHD is not unique to ADHD but part of a broader societal trend. While the present study is the first to show these associations based on Danish data, it may well be assumed that similar trends pertain also to many other countries. The increasing numbers of people diagnosed with, for example, depression have been documented in international surveys.[25,26] Our own analyses have shown that the numbers of patients diagnosed with depression[27] and autism spectrum disorder[28] have also increased considerably in Denmark in the same time period.

There are no population-based prevalence studies in Denmark that have estimated the true prevalence rate or incidence rate of ADHD in the community. Thus, the reported numbers of first-diagnosed individuals with ADHD are the only ones available. Since none of the private clinics report data on the number of diagnosed ADHD cases to the DPCRR, the results of the study represent conservative figures only. However, the relatively small number of patients diagnosed with ADHD in the total population, which in the age-group 4–65 years totals some 4.5 million people, does not support a theory of ADHD being overdiagnosed. A Danish study of treated ADHD documented that only 1.56% of Danish children and adolescents are treated with psychostimulants,[29] a prevalence well below the estimated prevalence for ADHD in children and adolescents of 3%–6%.[30]

There were some hints as to the reasons for the remaining increase in ADHD diagnoses even after the general increase of patients with any mental disorder had been taken into account. Two factors could be identified; namely, sex and age. For females, the APCs were almost twice as high as for males. This finding is in line with some recent study findings indicating decreasing male to female ratios in the incidence rates of treated ADHD.[16–19] In the present study, the time trends in incidence rates contributed to an overall decrease of male to female ratios from 7:1 in 1995 to 2:1 in 2010. This decrease in male to female ratios may have been caused partly by the large increase in adolescents and adults diagnosed with ADHD, since the male to female ratios are thought to be smaller in adolescents and adults.[31] However, the most pronounced drops in male to female ratios were observed in children and adolescents. These results suggest that major contributing factors to the presented time trends have been an increased professional awareness and referral of females of all ages with ADHD.

The reason ADHD has been overlooked for a long time in females is not yet fully understood. Some studies suggest that male and female expressions of ADHD symptoms and comorbidities might be different, with females being less disruptive compared to boys,[32] while other studies show no apparent sex differences.[33] As shown in a recent analysis by the authors,[34] males more frequently display problematic comorbid disorders with disruptive features and impaired social functioning and development such as conduct disorder, oppositional defiant disorder, and autism spectrum disorders, whereas females more frequently have internalizing symptoms. Further, the professional widening of the focus on ADHD, including the availability of sex-specific norms of screening tools for ADHD such as ADHD-rating scales,[35] might have influenced the identification of ADHD in females during the past 5 to 10 years.

Another finding of the present study, and a partial explanation for the increased incidence rates, was the large APC in incidence rates of diagnosed ADHD in adolescents and adults. Since the diagnostic criteria require onset of ADHD symptoms before the age of 7 years in the *ICD-10*[36] and before the age of 12 years in the new *DSM-5* classification,[37] the present findings have to be regarded as the incidence of first-time diagnosis rather than as the incidence of the disorder. Increases in incidence rates of diagnosed and treated ADHD in adolescents and adults have been documented also by other recent studies, and this trend most likely has been caused by increased professional awareness of ADHD beyond childhood and adolescence.

This trend of also diagnosing ADHD in adolescents and particularly in adults is only recent in most countries because ADHD had been considered for decades to be a childhood diagnosis and because the recognition of ADHD as a persisting life-time disorder[38] is fairly new. Before the beginning of the new century, the increase in incidence rates of diagnosed adult ADHD had not yet occurred due to the temporal delay in transfer of knowledge and expertise from research to clinical practice. Many patients with ADHD who might have experienced substantial difficulties in social and academic functioning were probably more likely at that time to be labeled as poorly reared or difficult children, or as children with learning difficulties or unspecific behavioral abnormalities, rather than understood as individuals affected by an impairing neuropsychiatric disorder.

Furthermore, specific diagnostic criteria for ADHD were not in use in Denmark before 1994 when the *ICD-10* was introduced. Thus, specific diagnostic criteria were not yet available during the childhood years of the adults in the years 1995–2010, so those patients might have been diagnosed rather late. This deficit may also have contributed to the more recent increase in incidence rates. Finally, there may be other still unknown factors contributing to the increase in the actual ADHD morbidity, which were not testable in the present study. Future studies should be open for detecting both societal and neurobiological risk factors that might contribute to an increase in ADHD morbidity.

Limitations

Although the present study is unique in its investigation of time trends of diagnosed ADHD in a nationwide cohort population across all ages and both sexes, some limitations have to be considered. First, a comparison of the rates

of persons diagnosed with ADHD to the incidence rates of treated ADHD in other registry sources suggests that there are patients who had been treated for ADHD, without having contact with psychiatry. The present sample does not cover the cases in the Danish population treated outside psychiatry.

The issue of the validity of the data represents another limitation that is applicable to all registry studies. ADHD diagnoses are currently being validated by the authors in children and adolescents diagnosed in 1995–2005, and preliminary, not-yet-published results indicate a high degree of validity with only few misclassifications. For adults and the time period after 2005, the registry data still need validation. However, complementary data analyses on prescription rates for children and adolescents in Denmark between 1996 and 2010 showed significant increases in stimulant prescriptions[39] matching the increase of incidence rates of ADHD in the present study. Similarly, the analyses of comorbid disorders in ADHD based on the large psychiatric registry data from the same time period revealed patterns of disorders which are very much in accordance with findings from smaller clinical ADHD samples.[40] In addition, various studies based on the DPCRR have shown that, in general, the validity of the diagnoses is high. This has been shown particularly for autism,[41] schizophrenia,[42,43] and adult affective disorders.[44]

Finally, the results from this study might not generalize to other countries where treatment and assessment are not available to the same extent as in Denmark. However, comparisons to findings from studies of treated ADHD suggest that the major time trends are not unique to Denmark.[13–16]

CONCLUSIONS

The results of the current study clearly indicate an increase in the incidence rates of diagnosed ADHD. This finding is partly due to a general increase in the population of persons seeking psychiatric treatment and assessment. Thus, increasing incidence rates might in part be a result of bridging the gap between those in need of treatment and those receiving it; this holds true particularly for females, adolescents, and adults. However, increases also were seen for patients classically known to have ADHD; namely, school-aged children and especially boys. Because ADHD is a relatively recent diagnosis in the psychiatric nosology, social awareness of ADHD has developed only in the more recent past and a relatively small number of persons in the population have actually been diagnosed. Thus, it seems premature to conclude that at present ADHD is overdiagnosed. Incidence rates are expected to increase when new knowledge and new ways of classifying behavior become available.

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Author contributions: Idea, design, interpretation of results and writing of manuscript were jointly conducted by Ms Jensen and Dr Steinhausen. Statistical analyses were carried out by Ms Jensen.
Potential conflicts of interest: **Ms Jensen** reports no conflicts of interest. **Dr Steinhausen** has worked as an advisor and speaker for the following pharmaceutical companies: Janssen-Cilag, Eli Lilly, Novartis, Medice, Shire, and UCB. In the past, he has received unrestricted grants for postgraduate training courses or conferences by Janssen-Cilag, Eli Lilly, Novartis, Medice, and Swedish Orphan International. Within the last 4 years, he has received no financial support for drug studies.
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