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ORIGINAL CONTRIBUTION

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How often are German children and adolescents diagnosed with ADHD? Prevalence based on the judgment of health care professionals: results of the German health and examination survey (KiGGS)

Abstract *Background* Attention deficit-/hyperactivity disorder (ADHD) is a chronic disorder with a substantial lifelong impact on personal and social functioning, academic performance, and the health system in general. Extended knowledge regarding its epidemiology will help to optimise the distribution of health resources and support affected children and adolescents. *Objectives* To report (1) the lifetime prevalence rates of ADHD in children and adolescents in Germany ages 3–17 years diagnosed by health care professionals, (2) the symptoms of hyperactivity and inattention in children and adolescents, and 3) the distributions and odds ratios for gender, age, socioeconomic status (SES), and history of migration. *Methods* Data were collected from May 2003 until May 2006 in 167 representatively selected sample points in Germany. A total of 17,461 children and adolescents (7,569 boys and 7,267 girls) were medically and physically examined, and their parents completed a self-administered questionnaire. Parent-reports of a lifetime ADHD diagnosis by a medical doctor or psychologist were taken as case definitions. Additional information was obtained via the parents from the strengths and difficulties questionnaire (SDQ) and also from trained observers. *Results* The overall lifetime prevalence of ADHD diagnosis was 4.8%. As expected, there was a significant gender difference between boys (7.7%) and girls (1.8%). Additionally, 4.9% of subjects had scores above threshold on the Inattention/ Hyperactivity subscale of the SDQ. As expected, a significant age effect was found for ADHD diagnosis (1.5% preschool age; 5.3% primary school; 7.1% secondary school). There were neither German east/west differences nor differences for rural versus urban areas. However, socioeconomic status was significantly associated with the prevalence of diagnosis (low SES: 6.4%, medium SES: 5.0%; high SES: 3.2%). *Conclusion* The prevalence of diagnosed ADHD and the influence of its mediating factors found in our study are in line with those from other European countries, but our findings reflect a lower band of variation.

Key words prevalence – Germany – ADHD – children – adolescents

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Introduction

Attention deficit-/hyperactivity disorder (ADHD) is a chronic disorder with a substantial lifelong impact on social and academic performance as well as the health system in general. ADHD is one of the most prevalent behavioural disorders in children and adolescents [25]. In recent years, there have been many controversies regarding the extent to which children and adolescents are affected by ADHD. However, prevalence data between studies vary and depend not only on the sample of children but also on methodological factors like classification systems and assessment procedures [7]. In a systematic review, the worldwide pooled prevalence rate for ADHD was 5.29% [22]. Using a multi-

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variate meta-regression approach, Polanczyk et al. [22] further showed that methodological differences (including diagnostic criteria, source of information, and requirement of impairment for diagnosis) explained more variance than the geographic origin of the study. Nevertheless, national differences play an important role since health authorities must allocate health resources; it is thus important for epidemiologic research to identify possible factors influencing the etiology and course of the disorder. In order to draw valid conclusions, the representativeness of a sufficiently large sample is crucial for the estimation of ADHD prevalence. The aspect of representativeness has been covered in the review by Polanczyk et al. [22] on a descriptive level but was not analysed statistically.

Selecting studies with representative samples that are neither school-based nor clinically recruited leaves only a few studies remaining for analysis. Interestingly, the variability of the prevalence rates in these studies is very similar. Only a few surveys with representative samples worldwide have estimated the prevalence rates of ADHD [7]. Using a diagnosis-based list of all worldwide available samples [7], only four studies fulfill the criteria of a) representativeness and b) a sufficiently large number of participants (i.e. $n > 1{,}000$). Interestingly, these studies show a quite narrow range of prevalence estimates (5.0% [4]; 5.8% [27]; 6.6% [23]; 6.8% [15]). The non-representative study samples in the list show more heterogeneity and tend to report higher prevalence rates.

Studies based in part on dimensional scales (e.g. the Strengths and Difficulties Questionnaire (SDQ) [12, 13]) were not included in the search for worldwide prevalences mentioned above. However, the dimensional approach can contribute substantial information on the prevalence of ADHD-related symptoms, especially in representative, population-based studies. Therefore, dimensional approaches are used in many surveys [14, 16] and are strongly supported by neuropsychological [10] and genetic [20, 29] research strategies.

Given the importance of dimensional approaches and the availability of surveys comparable to the survey under examination, we expanded our search on topics to include the reported lifetime diagnosis of ADHD and the use of the SDQ.

Two large surveys are not included in the worldwide prevalence list of Farone et al. [7]: the U.S. national health interview survey (NHIS) [5] and the survey of Mental Health of Children and Young People in Great Britain (British Survey) [8]. The NHIS includes 10,367 children ages 4–17 with a response rate of 79.4%. The lifetime prevalence of ADHD was reported by parents to be 7.8%. Significant differences were found regarding age, gender, and ethnicity. The socioeconomic status was related to the prevalence of diagnosis only in the subgroup of females. Cross-validation of the diagnosis with symptoms on the SDQ suggests that both under- and over-diagnosis is to be expected in the U.S. paediatric population [5].

The second study, which is similar to the German KiGGS survey, is the survey of Mental Health of Children and Young People in Great Britain [8]. The British survey includes 10,438 children ages 4–16. The response rate was 76%, which is almost as high as that in the US survey. The overall prevalence rate for ADHD was 2.23%, with a strong gender effect (boys 3.62% vs. girls 0.85%). Mojtabai [21] compared the NHIS and British Survey and found similar psychometric properties for the SDQ. However, rates for emotional disturbances and behavioural problems were higher but those for ADHD were lower in the British survey.

An extended knowledge regarding the epidemiological aspects of the disorder will help to optimise the distribution of health resources and support children and adolescents suffering from ADHD. Until now, however, representative data from Germany have been missing. The German health interview and examination survey for children and adolescents (KiGGS) can fill this gap. The first results regarding the prevalence of ADHD based on KiGGS data have already been published elsewhere [24]. The aim of this paper is to present distributions and odds ratios for both the lifetime prevalence of parent-reported ADHD diagnosis based on the judgment of health care professionals (e.g. medical doctors or psychologists) as well as potential ADHD (symptom-based) for German children and adolescents from 3–17 years in age. This supplemental issue presents results of two different approaches for estimating representative prevalence rates of ADHD in Germany. The current paper reports estimates based on the parent-reported diagnoses given by medical doctors and psychologists in the representative KiGGS sample ($n = 14{,}836$). Another estimation (see Döpfner et al. this issue [6]) is based on ADHD symptoms and related impairments reported by parents in the BELLA sample ($n = 2{,}863$), which is a randomly selected subsample of the KiGGS-sample. The two approaches will be compared and discussed in more detail later in this paper.

Methods

Procedure and sample

The KiGGS study is a nationwide, representative, cross-sectional health interview and examination survey with a total of 17,641 examined children and

adolescents aged 0–17 years. The participants were medically and physically examined and tested. Parents and children older than 11 years completed an extensive self-administered questionnaire that included psychological and social testing. The data were collected from May 2003 until May 2006 in 167 representatively-selected sample points all over Germany. It was the aim of the KiGGS study to ascertain for the first time combined data on physical, psychological, and social health issues according to the WHO the objectives, design, and measurements of the KiGGS study can found in [19].

Instruments

The lifetime prevalence of ADHD was assessed in the parent questionnaire for children aged 3–17 years with the distinctive question "has your child ever been diagnosed with an attention deficit-/hyperactivity disorder", which was rated on a three-point scale ("yes", "no", or "I don't know"). An extension question asked "if yes, how was the disorder diagnosed?" and provided a rating scale ("medical doctor", "psychologist", or "others"). From a total of 14,836 participants between 3 and 17 years, information on parent-reported medical doctor or psychologist ADHD diagnosis was available for 13,771 children and adolescents from 3 to 17 years (6,929 boys and 6,842 girls).

To determine whether some children show ADHD symptoms without having an ADHD diagnosis, the hyperactivity-inattention subscale score of the parent-rated version of the SDQ was used. The SDQ is a brief screening tool for emotional and behavioural problems with child psychiatric relevance [11]. The homogeneity (Cronbach's α) of the hyperactivity-inattention subscale in the KiGGS-sample averaged to $\alpha = 0.77$ and ranged from $\alpha = 0.77$ (lowest score, age cohort 3–6 years) to $\alpha = 0.79$ (highest score, age cohort 11–13 years) [17]. The hyperactivity-inattention subscale score was calculated for 13,056 participants.

Additionally, behavioural observation concerning the cardinal symptoms of ADHD was performed. Inattention, hyperactivity, and impulsivity were rated by an examiner for children ages 3–11 years during medical and physical testing. The arrangement followed theoretical deliberations. Each symptom was represented by two items rated on a four-point Likert-scale ("not at all", "a little bit", "quite a few", and "very much" for variable scores 1–4). Average scores for each symptom were calculated as well as an overall symptoms score. Subjects were classified abnormal if they showed an overall value ≥6. Standardisation of observation was assured through an intensive observational training, and evaluation of this assessment showed a very high concordance of judgment between raters [18]. Behavioural observation scores were calculated for 7,919 children and adolescents 3–11 years in age.

Case definition

Case definitions in the field of ADHD research depend on classification systems (e.g. ICD-10 and DSM-IV), because these systems provide different inclusion and exclusion criteria. However, cross-validations between the ICD-10 and DSM-IV classification systems have pointed out that different case prevalences do not arise from different concepts but rather from different threshold values [28]. According to the ICD-10, a definite number of symptoms in all three main categories should be met; in contrast, the DSM-IV requires only one of the two categories to be satisfied. Moreover, while the DSM-IV only demands a certain number of impulsivity or hyperactivity characteristics in general, the ICD-10 asks for a minimum number of characteristics in each category (impulsivity or hyperactivity). Nevertheless, ADHD according to the ICD-10 and ADHD according to DSM-IV can be considered similar [26].

The following case definition does not claim to be a clinical diagnosis. However, it can be considered as an optimisation of a clinically-justified ADHD profile taking into account the survey conditions. Therefore, it represents the best available approximation to a clinical diagnosis. According to international diagnosis criteria, we define individuals to be affected with ADHD if the diagnosis was provided by a medical doctor or a psychologist. Potential ADHD is evident if individuals reach a clinically significant score of ≥7 on the hyperactivity-inattention subscale of the SDQ and have not yet been given a diagnosis by a medical doctor or psychologist. Additionally, those 3- to 11-year-olds who reach an overall symptom score ≥6 in the behavioural observation but have either not yet been diagnosed or not reached a clinically significant score on the hyperactivity-inattention subscale of the SDQ are considered abnormal with respect to the cardinal symptoms of ADHD.

Statistical analysis

The statistical analyses are based on the sample data weighted to represent the age-, gender-, regional-, and citizenship-structure of the German population (reference data 31.12.2004). The number of cases reported in the tables refers to the weighted data and thus might deviate from the number of cases reported in the former description of the sample.

Table 1 Lifetime prevalence rates of ADHD cases[a] and potential ADHD cases[b] for children and adolescents (age 3–17 years)

	ADHD cases[a]		ADHD potential cases[b]	
	% (95% CI)	*n*	% (95% CI)	*n*
Total	4.8 (4.4–5.3)	667	4.9 (4.5–5.4)	644
Gender				
Boys	7.9 (7.1–8.7)	545	6.4 (5.7–7.2)	406
Girls	1.8 (1.4–2.2)	122	3.6 (3.1–4.1)	238
Age				
3–6 years	1.5 (1.1–2.1)	52	6.0 (5.1–7.0)	199
7–10 years	5.3 (4.6–6.2)	185	6.4 (5.5–7.5)	209
11–13 years	7.1 (6.1–8.2)	194	5.0 (4.2–6.0)	127
14–17 years	5.6 (4.8–6.6)	236	2.8 (2.2–3.5)	109
SES				
Low	6.4 (5.4–7.5)	220	8.0 (6.9–9.2)	256
Medium	5.0 (4.3–5.7)	319	4.6 (4.0–5.3)	280
High	3.2 (2.6–4.1)	125	2.9 (2.3–3.6)	107
History of migration				
Migrant	3.1 (2.1–4.5)	51	5.9 (4.5–7.7)	94
Non-migrant	5.1 (4.6–5.6)	616	4.8 (4.4–5.3)	550

[a]ADHD case: diagnosis by a medical doctor or a psychologist
[b]ADHD potential case: SDQ-subscale inattention/hyperactivity score ≥7 and not yet given a diagnosis by a medical doctor or psychologist
[c]For 48 participants, no complete datasets of the the SDQ hyperactivity-inattention subscale were available

Descriptive statistics (percentage and 95% confidence intervals) for ADHD cases and potential ADHD cases are presented for the total sample and by age, gender, socioeconomic status, and history of migration groups. Binary logistic regression modeling was performed for ADHD cases and potential ADHD cases with the factors gender, socioeconomic status, history of migration, and age as covariates. Confidence intervals that do not overlap are considered significant at the $\alpha < 0.05$ level. All statistical analyses were performed with the SPSS 15.0 "Complex Samples" Module.

Table 2 Results of binary logistic regressions for ADHD cases[a] and potential ADHD cases[b] with age, gender, socioeconomic status (SES), and history of migration

	ADHD cases[a]		ADHD potential cases[b]	
	OR	(95% CI)	OR	(95% CI)
Age	1.09	(1.07–1.11)	0.93	0.91–0.95
Gender				
Boys	4.80	(3.77–6.12)	1.85	1.53–2.22
Girls	1.00 (Ref.)		1.00 (Ref.)	
SES				
Low	2.27	(1.70–3.04)	3.04	2.29–4.05
Medium	1.60	(1.22–2.10)	1.70	1.27–2.29
High	1.00 (Ref.)		1.00 (Ref.)	
History of migration				
Migrant	0.50	(0.32–0.78)	0.97	0.72–1.30
Non-migrant	1.00 (Ref.)		1.00 (Ref.)	

[a]ADHD case: diagnosis by a medical doctor or psychologist
[b]ADHD potential case: SDQ-subscale inattention/hyperactivity score ≥7 and not yet given a diagnosis by a medical doctor or psychologist

Results

The prevalence rates of ADHD cases and potential ADHD cases in the total sample as well as the distributions for gender, age, socioeconomic status, and history of migration groups are shown in Table 1. The odds ratios for ADHD cases and potential ADHD cases are shown in Table 2. A total of 4.8% of children and adolescents in Germany have ever been diagnosed with ADHD by a medical or psychological professional. As expected, the prevalence among boys is significantly higher than that among girls (OR = 4.80). Prevalence rates increase from 1.5% during preschool (3–6 years) to 5.3% during primary school age (7–10 years) and further rise to 7.1% at 11–13 years of age. Lifetime prevalence declines again to 5.6% in adolescents (14–17 years). The increase of lifetime prevalence for the total sample can be mainly attributed to the rising prevalence in boys. The most striking increase is reported in boys during the transition from preschool to elementary school, where prevalence jumps from 2.4 to 8.7% (data not shown). Between 11 and 17 years, approximately every 10th German boy but only every 43rd German girl has been diagnosed with ADHD.

ADHD is more frequently reported for subjects with low socioeconomic status (OR = 2.27). Except for children aged 3–6 years, further significant differences persist among age groups (data not shown). Parents from families with a history of migration report significantly fewer ADHD diagnoses of their children than parents of families without a history of migration (OR = 0.50). There are no statistically significant differences with regard to geographical characteristics (e.g. former eastern vs. former western part of Germany or urban (defined as communities with more than 100,000 inhabitants) versus rural areas (defined as communities with less than 100,000 inhabitants, data not shown).

We examined potential ADHD cases defined by the hyperactivity-inattention subscale of the strength and difficulties questionnaire and found an additional 4.9% of subjects add to the cases already classified (boys: 6.4%; girls: 3.6%; OR = 1.85). The prevalence of abnormal behaviour with regard to the symptoms of inattention and hyperactivity in preschoolers aged 3–6 years rises by an additional 6.0%, in children aged 11–13 years rises by 5.0%, and in adolescents aged 14 and 17 years rises by 2.8%. Differences are statistically significant between boys and girls both in total and across all age groups (data not shown).

Table 3 Number and percentages of children classified as abnormal with regard to the cardinal symptoms of ADHD in the behavioural observation[a]

Age (years)	Behavioural observation[b]	
	%	*n*
3	4.2	29
4	4.3	33
5	1.7	13
6	1.6	13
7	1.1	9
8	0.6	5
9	0.4	3
10	0.1	1
11	0.3	2

[a]Only subjects not classified as ADHD cases or ADHD potential cases
[b]Only for ages 3–11 years

In contrast to diagnosed ADHD cases, children from families with a migration history exhibit higher percentages of ADHD symptoms than those from families without such a history. However, the difference is not statistically significant. This trend is seen in all age groups except of 3- to 6-year-olds (data not shown). Consistent with the findings in diagnosed ADHD cases, ADHD symptoms are reported more frequently for subjects with a low SES. Children and adolescents from families with a low SES display 1.7 times more frequent ADHD symptoms than those from families with a medium SES and 2.8 times (OR = 3.04) more frequent ADHD symptoms than those from families with a high SES (OR = 1.70).

Findings from our behavioural observation are presented separately for each age cohort in Table 3. The proportion of children classified as abnormal in the behavioural observation (besides diagnosed ADHD and proxy-assessment via the SDQ) declines steadily with rising age. It is marginal except for children aged 7 years.

Discussion

The aim of this paper was to present representative data regarding the prevalence of diagnosed attention deficit-/hyperactivity disorder (ADHD) in Germany from a population-based and sufficiently large epidemiological sample. With the KiGGS study, representative data on ADHD is available for the first time for the entire age range of 3–17 years. The parent-reported lifetime prevalence for medical doctor or psychologist diagnosis of ADHD of their children was 4.8%. This result is in line with prevalence estimations from other European countries. Taking the variations of international prevalence rates into account, however, the German rate of 4.8% is lower than many previously-reported rates. Comparison with international comparative suggests that this low rate may reflect an orientation to the ICD-10 diagnostic system, which is stricter in the case definition of ADHD than the DSM-IV. Further, 4.9% of subjects showed a clinically significant score on the hyperactivity-inattention subscale of the SDQ. Particularly at the preschool ages, behavioural observation made a relevant contribution to the incremental prevalence of ADHD symptoms. However, one has to keep in mind that hyperactive and impulsive behaviour in preschoolers is difficult to differentiate from natural, developmentally-determined activity. Furthermore, it is striking that as many as 1.5% of the 3- to 6-year-olds were already diagnosed with ADHD by a professional according to their parents.

As expected, boys were diagnosed with ADHD significantly more frequently than girls and also exhibited more ADHD symptoms than did girls. These results are concordant with clinical observations [1]. However, distinctive gender effects in ADHD diagnosis could be caused by a referral-bias, as suggested by some epidemiological surveys [2, 3]. In the age group between 14 and 17 years, the lifetime prevalence of ADHD diagnosis was lower. A rising societal awareness of ADHD in recent years may explain these findings [9], whereas declining proportions of parent-reported ADHD symptoms in older age groups can plausibly be explained with the altering symptomatology of ADHD in adolescents. The association with SES may reflect mutual influences between ADHD and lower academic output and lower economic income. A remarkable effect became evident in families with a history of migration. Although they reported fewer ADHD diagnoses for their children, they also reported ADHD symptoms more frequently. An explanation of this could involve migrant-specific patterns of utilisation of medical services, a migrant-specific low diagnosis rate, or even cultural differences in the tolerance of symptoms [2].

Prevalence estimations of the BELLA subsample (Döpfner et al. [6] this issue) differ in several aspects from our results. First, they differ with respect to the sample size and age spectrum. While our results are based on the available full set of representative data (n = 14,836) for ages 3–17 years, the BELLA sample (n = 2,863) is a randomly drawn subsample of 26.1% of the KiGGS participants aged from 7–17 years. Randomly drawn samples from a representative sample are theoretically also representative. However, positive selection of those participants who are willing to accept additional assessment has to be taken into account. The slightly higher rate in the frequency of diagnosed ADHD in the BELLA sample (6.5%) versus

our sample (5.9% for the same age range (7–17 years) in the KiGGS sample) may support this interpretation. Parents, who agreed to participate in the additional assessment seem to have more often children and adolescents with diagnosed ADHD. Second, the methods of assessment were different. The KiGGS assessment was made via 1) written questionnaires inquiring about both a clinician-based ADHD diagnosis and the dimensions of ADHD symptoms and 2) behavioural observations by trained staff; in contrast, the BELLA assessment was made via written questionnaires and standardised telephone interviews [6]. Third, the approximation of an ADHD-diagnosis in sense of a case definition was different. While in the KiGGS-sample the case definition is based on the parent-reported clinical diagnosis of a health care professional (medical doctor or and psychologist) added by questionnaire (SDQ) and observational data, the BELLA-sample defines ADHD by the parent-based answers to ADHD-defining symptoms including aspects of impairment and pervasiveness. Health care professionals may only approximate the academically defined ADHD-diagnosis, however, the child's need for support and the given clinical judgement implies the situation of the child at school, in the family and with peers. Information of cross-situational symptoms, impairment and pervasiveness may be integrated in the clinical diagnosis reflecting on an ecologically valid basis the need for support in the health care system. The clinical diagnosis may have limitations in accuracy due to symptom criteria. On the other hand, adding up symptoms on the basis of parent's estimations without a full range clinical assessment may not accurately reflect the ADHD-cases diagnosed and treated by medical doctors and/or psychologists and may thus be ecologically less valid.

The importance of this difference between clinical diagnosis (as reported by the parents) and information on symptoms, impairment, and pervasiveness is reflected by the data. According to Döpfner et al. [6], only 29.1% diagnosed cases fulfilled the full range of symptoms based on the parent-rated assessment with the FBB-HKS; only 49.2% of those who fulfilled the criteria based on parent reports had already been diagnosed with ADHD by a medical doctor or psychologist. The unexpected differential effects regarding the ratio of urban versus rural prevalences found in the BELLA sample [6], which were not found in the KiGGS-sample, may also be attributed to differences in the case definition.

With respect to the two approaches (KiGGS versus BELLA), we conclude that the estimated prevalence rates focus on different aspects. Whenever representative, parent-reported and symptom-based comparisons are the focus of interest, the BELLA results should be considered. If representative information on diagnoses based on clinical judgments reported by parents is of interest, however, the KiGGS results should be taken into account.

Since ADHD is a lifelong chronic disorder and has an impact on the social and academic development of an individual, valid estimations regarding the prevalence and population distribution are important information for decision-makers in the health care system. To prevent detrimental consequences for those children affected by ADHD, the main focus of preventive and intervention measures should be aimed at early diagnosis and effective and thoroughly-surveyed multi-mode treatment for those affected.

Conflict of interest All authors declare no conflict of interest.

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