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Symptoms of ADHD are highly common in undiagnosed adults – A cross-sectional study in a large population of Danes

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Abstract

Objective: The prevalence of Attention-Deficit/Hyperactivity Disorder (ADHD) among adults is well established in the general population. So far no studies have addressed the prevalence of ADHD symptoms in otherwise healthy individuals. The aim of the present study is to characterize the distribution of self-reported ADHD symptoms and ADHD subtypes across sex and age intervals in healthy Danes.

Methods: A total of 26,217 individuals (aged 18-67 years) who completed the Adult ADHD Self-Report Scale V1.1 (ASRS) were included in the study population. We used logistic regression to assess the association of age and sex with positive ADHD screens across three different ASRS scoring methods.

Results: The prevalence of ADHD in the study populationwas 1.1-2.7% depending on the applied ASRS scoringmethod. ADHD symptoms decreased with increased donor age.

Conclusion: Severe symptoms of ADHD are not uncommon among undiagnosed individuals. The prevalence of self-reported ADHD varied by the applied scoring method of ASRS.

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Introduction

Attention-Deficit Hyperactivity Disorder (ADHD), with the core symptoms in attention, hyperactivity, and impulsiveness, is the most common psychiatric disorder among children and adolescents. Previously, ADHD was assumed to be a childhood behavioral disorder, however, several follow-up studies indicate that 50-78% of children diagnosed with ADHD continue to have the symptoms in adulthood [1–5]. In addition, individuals with late-onset ADHD have been described suggesting that ADHD can develop across the entire lifespan [2,6–8].

Reported estimates of ADHD prevalence vary markedly, primarily because of methodological differences across studies. The worldwide pooled prevalence of ADHD among children and adolescents has been estimated to be 5.3% [9] whilemore recent meta-analyses have suggested a slightly higher prevalence (~7%) [10,11]. In contrast, the average prevalence of ADHD in the general adult population is between 1.1-5% [12-14] but these estimates might be grossly underestimated and suffer from ascertainment biases related to the high number of unrecognizedand inaccurately diagnosed adults [12,15-17]. None-the-less, both symptoms related to inattention and hyperactivity have been shown to be rather common (~60%) in the general population which underline that ADHD symptoms form a continuum [18].

It is generally accepted that ADHD symptoms manifest differently between genders and that boys are more often affected than girls [19–23]. However, this gender-discrepancy varies across ADHD subtypes and tends to level off into adulthood where men and women are almost equally affected [12,24–26]. This shift in sex ratio towards similar prevalence's may reflect that young girls primarily are affected by the often undetected inattention subtype [27-29]. In addition to gender, follow-up studies have suggested that ADHD symptomatology differs over time and in particular changes during adolescence. In adulthood, the hyperactivity-impulsiveness subtypes of ADHD often become less apparent whereas the inattention subtype seems to persist [1,3,17,30–33]. This lack in symptom profile stability during life has called for more adult-specific diagnostic criteria for ADHD subtypes [34].

One of the most commonly used ADHD screening instruments in adults is the Adult ADHD Self-Report Scale V1.1 (ASRS) developed by the working group of adult ADHD for the World Health Organization (WHO) [35]. The ASRS consists of an 18-item scale evaluating the dimensions of inattention and hyperactivity-impulsiveness subtypes of ADHD in adults. Multiple published studies find that the ASRS is a reliable and valid instrument for screening for ADHD symptoms in adults in clinical and community samples [36,37]. Since the ASRS is designed for unsupervised self-reporting of ADHD symptoms and, in addition, is both time-efficient and cost-effective it has been widely used in large scale studies [12,14,37-41]. The use of different scoring methods and cut-off values of the ASRS in the literature has been controversial [35-37]. The most widely use diversion of the ASRS is the fast 6-items ASRS screener that was originally extracted by stepwise logistic regression from the full 18-item ASRS scale [35]. The 6-item ASRS screener has been shown to outperform the 18-item ASRS with respect to sensitivity, specificity, and accuracy [37]. Two alternative ASRS scoring methods have, in addition, been used which either assess the total sum score of all 18 items (with a predefined cut-off value) or a separation of the 18-items into two subscales - with nine items each - evaluating either symptoms of inattention or hyperactivity-impulsiveness corresponding to the DSM-IV symptoms of ADHD [35-37].

Aims of the study

The aim of the study is to estimate the prevalence of self-reported ADHD symptoms in healthy adults from the Danish Blood Donor Study. Since several scoring methods of the ASRS exist, we here used the three most commonly reported scoring methods in the literature in order to compare estimates within the study population and across studies. We examine the sex and age related variations in self-reported ADHD symptoms and subtypes.

Materials and methods

Study population

A total of 27,315 participantswere included in the present study. Data were collected between May 1,2015 and February 1,2017 as part of the Danish Blood Donor Study (DBDS; www.dbds.dk) [42,43]. In brief, the DBDS is an ongoing multicenter, population-based study and biobank initiated in 2010. To date, more than 110,000 voluntary blood donors from blood banks across Denmarkhave been included. Preliminary data suggest a response rate of 95% among invited blood donors [42]. All participants are between 18 and 67 years of age, are generally healthy and un-medicated [44]. At enrollment, oral and written informed consent is obtained from all participants and a digital tablet-based questionnaire including the ASRS is completed [43].

The Danish Data Protection Agency (2007-58-0015) and the Ethical Committee of Central Denmark (M-20090237) have approved the study.

Of the 27,315 participants included in the present study, 27,217 (96.0%) completed all 18 items of the full edition of ASRS.The remaining 1,098 individuals were excluded from the study population due to missing ASRS scores. These 1,098 individuals did not differ with respect to sex (P=0.5) but were significantly older (median age: 51.1 years) compared to the remaining study population (median age: 41.6 years) (Mann-Whitney U test, P<0.00001).

Adult ADHD self-reported scale

Self-reported ADHD symptoms in this study population were evaluated by the V1.1 ASRS full edition [35] adapted to Danish [45]. It consists of 18 symptom items based on the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM IV; American Psychiatric Association [APA], 1994) of which the first six items are the most predictive of ADHD symptoms and forms the short ASRS screener [37]. The ASRS full edition consists of nine items that represent symptoms related to inattention (items 1-4 and 7-11), and nine items assessing symptoms of hyperactivity-impulsiveness (items 5-6 and 12-18). Each of the items is scored on a five-point Likert rating scale with 0="never", 1="rarely", 2="sometimes", 3="often", and 4="very often" based on the participant's experiences over the last 6 months. Thus, a high score indicates a greater severity of self-reported ADHD symptoms. While the ASRS has not been validated in a Danish setting, it is a widely used and valid screening instrument regarding ADHD symptoms in adults and has shown good reliability and diagnostic utility among adolescent and adults [36,37,46-48] also in Scandinavian [49]. A more detailed description of the ASRS questionnaire can be found elsewhere [35].

Scoring of ASRS

As originally suggested by Kessler et al. [35,37], different scoring methods can be used to assess self-reported ADHD symptoms using ASRS. In this study, we used the following three different approaches (Table 1): (1) The first approach (referred to as "ASRS 6-items screener") involves summing the scores of the first six items of the ASRS full edition (range: 0-24). Sum scores ≥14 indicate a positive screening result. (2) The second approach (referred to as "ASRS full edition") addresses ADHD symptoms on the 18-items ASRS fulledition (range: 0-72). Total sum scores ≥37 corresponds to a positive screening result. (3) The third approach (referred to as "inattention/impulsiveness subscale") is based on the nine items per subscale (range: 0-36) related to either the inattention or hyperactivity-impulsiveness items. All individuals with a full editionsum score on either subscales of ≥24 were considered to have a positive screening result for ADHD.

The comparison group consisted of the remaining individuals from the study population with ASRS scores below the predefined cut-off values described in Table 1.

Statistical analysis

Descriptive statistics of the three ASRS scoring methods (below or above the predefined cut-off values) are for categorical variables presented as number and percentage and for continuous variables as median with Interquartile Range (IQR). Age of each participant was calculated at the time of completed ASRS-questionnaire and categorized as ≤25, 26-30, 31-35, 36-40, 41-45, 46-50, and >50 years.

Logistic regression analysis was used to assess the effect of age and sex on the presence of self-reported ADHD symptoms across the different ASRS scoring methods. Here, the age groups >50 years was set as the reference group. In addition, an analysis that adjusted for sex was performed. Odds Ratios (OR) with 95% confidence Intervals (CI) are presented and $P<0.05$ were considered statistical significant. Data analysis was conducted using the statistical program STATA 13.1 (StataCorp, college station, Texas, USA).

Results

In total, 26,217 individuals (median age (IQR): 41.6 (29.9-51.7) years) from the DBDS completed the ASRS full edition were 54.2% were males (median age (IQR): 42.1 (31.3-51.9) years)and 45.8% were females (median age (IQR): 40.9 (28.2-51.4) years).

Table 1 shows the numberof individuals who either screened positive or negative for ADHD using the three alternative scoring methods for ASRS (the ASRS 6-item screener (median mean age (IQR): 31.2 (25.3-39.1) years versus 41.9 (30.1-51.8) years, respectively), the ASRS full edition (median age (IQR): 30.5(25.2-40.5) years versus 41.9 (30.2-51.9) years, respectively), and the inattention/hyperactivity-impulsiveness subscales (median age (IQR): 30.5 (25.2-40.2) years versus 41.7 (30.0-51.8) years, respectively), see methods for further details). According to standard cut-offs for the ASRS 6-items screener, 2.1% (95% CI: 2.0 to 2.3) of the study population scored ≥14 and thereby screened positive for adult ADHD. When using either the ASRS full edition or the inattention/hyperactivity-impulsiveness subscales scoring method, 2.6% (95% CI: 2.4 to 2.8) and 1.1% (95% CI: 0.9 to 1.2), respectively screened positive for ADHD in our study population (Table 2).

Figure 1 illustrates that only little overlap existed between individuals that screened positive for ADHD when using the three applied scoring methods of ASRS. A total of 557 individuals or 2.1% were positive for the ASRS 6-items screener, 690 individuals or 2.6% in the ASRS full edition and 291 individuals or 1.1% in the inattention/hyperactivity-impulsiveness subscales scoring method.

Significantly more males than females were found to screen positive for ADHD for the ASRS 6-item screener scoring method (OR=1.8, 95% CI: 1.5-2.2). In contrast, no differences between males and females were found for the ASRS full edition or the inattention/hyperactivity-impulsiveness subscales scoring methods (data not shown).

Age-related variation in self-reported ADHD symptoms were investigated for the following age groups (in years): ≤25, 26-30, 31-35, 36-40, 41-45, 46-50, and >50 across the three different scoring methods applied (Table 1). In this study population, the prevalence of ADHD symptoms decreased continuously with increasing age irrespective of ASRS scoring method.

Among the 1.1% (N=291) of the study population who screened positive for ADHD by the inattention/hyperactivity-impulsiveness subscales, 47.8% (95% CI: 42.0 to 53.5) were identified as the inattention subtype (29.6% males and 18.2% females), 35.1% (95% CI: 29.8 to 40.7) of the individuals with the hyperactivity-impulsiveness subtype (16.2% males and 18.9% females), while 17.2% (95% CI: 13.2 to 22.0) were in the group with the combined subtypes both including inattention and hyperactivity-impulsiveness dimensions (9.3% males and 7.9% females). Figure 2 illustrates the distribution of males and females on the inattention or hyperactivity-impulsiveness subscales (here the combined subtype is included in both the inattention or hyperactivity-impulsiveness dimensions). A significant sex difference was found between the inattention or hyperactivity-impulsiveness subtypes (p=0.015), males showed a higher prevalence than females for the inattentive subtype (59.8% males versus 40.2% females) and viseversa females showed a higher prevalence for the hyperactivity-impulsiveness subtype (51.3% females versus 48.7% males). Furthermore, Figure 3 illustrates the different age range among males and females stratified by ADHD subtype using the inattention/hyperactivity-impulsiveness subscale. Here, both the inattention and hyperactivity-impulsiveness symptoms seem to decrease by increasing donor age in the study population. The inattention subtype more frequently affected males less than 35 years of age than females whereas the opposite was true for the hyperactivity-impulsiveness subtype at ages less than 30 years.

Logistic regression analyses were performed to examine positive screening for ADHD as a function of age when using each of the three scoring methods of ASRS (Table 2). Here, above 50 years was set as the reference group. The lowest prevalence of self-reported ADHD was found for the >50 years age group and the risk decreased by increased donor age. The ORs were highly similar when adjusting for sex.

Discussion

In this large cross-sectional study on the occurrence of self-reported ADHD symptoms among otherwise healthy Danish blood donors, the estimated prevalence were 2.6%, 2.1%, and 1.1%, respectively when using either the ASRS full edition, the ASRS 6-items screener, or the inattention/hyperactivity-impulsiveness subscale scoring methods of the ASRS V1.1. Our study

thereby illustrates that even in a healthy population of blood donors a considerable number of individuals have a score above the threshold for possible having the ADHD syndrome. Our prevalence estimates are similar to those previously reported [12–14,50], and supports the need for a targeted approach towards ADHD diagnosis in adults in general.

Several aspects of our study merit further discussion. First, there was only minor overlap of individuals screening positive for ADHD with the three most widely used ASRS scoring methods (35,37) (Table 2 and Figure 1). These discrepancies illustrate how critical the ASRS scoring methods are to the identification of individuals potentially suffering from ADHD, which subsequently influence the prevalence estimates of these screening results. Hence, our study highlights the need for a better understanding of the underlying differences between the ASRS scoring methods, and suggests that the ASRS screening scale should be used with caution and never replaces a clinical examination using golden standard evaluations. Whether the discrepancies between scoring methods are specific to the Danish translation of the ASRS and the blood donor population is not known, however, the Swedish translation of ASRS has shown promising psychometric properties in an population of adolescents with ADHD [49].

Secondly, it is widely accepted that the sex differences of ADHD becomes less prevalent with age [12,24–26,50]. In our study population, statistically significant sex-specific variation in the ADHD prevalence was observed for the ASRS 6-item screener (Table 1). This could reflect a more positive response style among male than female blood donors on the 6-item ASRS screener, or suggest that the 6-item ASRS screener exclude important information related to sex that is included in the remaining 12 items.

Thirdly, in line with previous published results [1,3,17,30-33], we found that the inattention ADHD subtype was more prevalent that the hyperactivity-impulsiveness subtype. This was as expected that adult who suffer from hyperactivity and impulsiveness are less inclined to become blood donors (Figure 2). Further stratifying the inattention or hyperactivity-impulsiveness ADHD subtypes by sex and age, we found that the prevalence of both the inattention and hyperactivity-impulsiveness subtypes decreased with increased age. This suggests that - in contrast to cross-sectional studies - the inattention subtype does not tend to persist during life for either male or female blood donors or more likely that older blood donors with severe ADHD symptoms are not part of the DBDS [1,3,17,30–33] (Figure 3). Furthermore, in the younger ages, males and females showed different profiles of the inattention and hyperactivity-impulsiveness ADHD subtypes (Figure 3). To our knowledge, no other studies have reported such sex-discrepancies in relation to ADHD subtype thus; it remains unknown whether this observation is study-specific or generalizable to the broader adult population.

Strengths and limitations

The findings of the study gain their strengths from the use of a large healthy population of blood donors who have volunteered to participate in the DBDS. Importantly, the DBDS is a nation-wide study and as 95% of all invited blood donors agree to participate [42]. Our study population is representative of the entire population of Danish blood donors. Our study is the first to examine ADHD symptoms in otherwise healthy blood donors, and constitute an important addition to the existing literature on self-reported ADHD symptoms and could serve as a rough lower-bound approximation of the true prevalence of ADHD in population-based samples.

The study is limited by a number of factors that needs to be considered. Most importantly, the study is based on blood donors who comprise a highly selected population of healthy average middleclass citizens where aggressive, impulsiveness, and unreliable personalities are not represented, which subsequently limits the generalizability of our findings [44].

In addition, the Danish version of the ASRS is widely used in Danish settings but has never been officially validated. However, we believe that the Danish version is very similar to other versions used worldwide. Furthermore, a recent validation study of ASRS has been made in Sweden with good results [49] suggesting similar results related to the Danish version.

In this study, we only included the ASRS and thereby not thorough golden standard clinical interviews and examinations. Currently, it is not possible to re-contact individuals included in the DBDS for a follow-up analysis to confirm a positive screen for ADHD thus, the false positive/false negative rate in this study can therefore not be determined.

It could be speculated that the digital tablet-based questionnaire including the ASRS [43] could be too long to complete for some individuals with ADHD resulting in recruitment bias. The individuals that were excluded from the study population due to missing items (N=560) were significantly older when compared to the remaining population, which suggests that individuals either were excluded because of confusions/misunderstandings related to the tablet-based questionnaire which might happen more often in the older generations or because of ADHD and older age.

Finally, either pregnant or lactating females are allowed to donate blood and are therefore not included in the DBDS. This could result in non-random sex differences especially for the childbearing ages included in the study. However, since there are no significant differences in age between males and females in the study population this bias might be less important.

This study is the first to evaluate self-reported ADHD symptoms using the ASRS in an adult population of 26,217 healthy Danish blood donors. By the use of three alternative ASRS scoring methods, 1.1% to 2.6% of the blood donors screened positive for ADHD, indicating that the prevalence of self-reported ADHD symptoms are highly dependent on the applied ASRA scoring method and needs to be validated for ADHD assessment.

Acknowledgment

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Figures

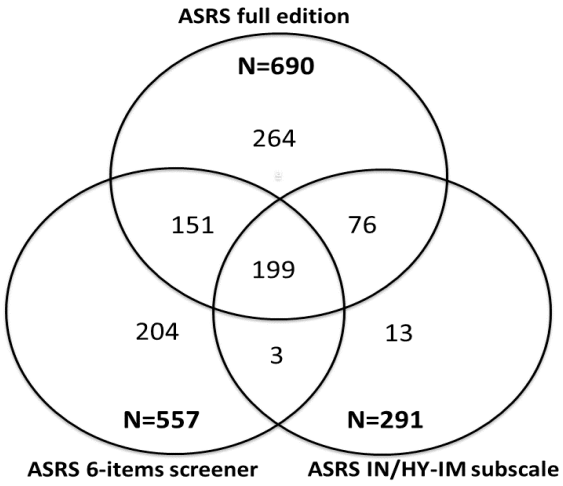

Figure 1: Number of individuals with a positive ADHD screen according to the ASRS 6-items screener, the ASRS full edition, and the inattention/hyperactivity-impulsiveness subscale (IN/HY-IM) cut-off values, respectively among the 26,217 individuals from DBDS. The number of individuals with a positive ADHD screen according to the three alternative scoring methods of the ASRS in DBDS (N=26,217) (see method for details regarding the different scoring methods).

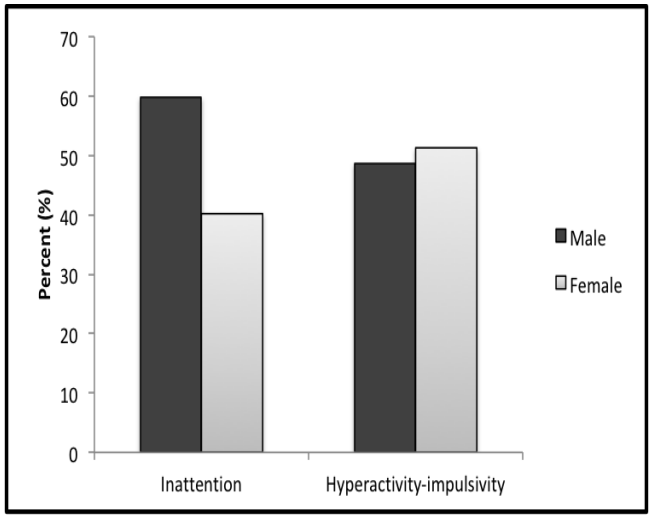

Figure 2: ADHD subtypes stratified by sex based on the inattention/hyperactivity-impulsiveness subscale scoring method of the ASRS. The figure illustrates the number of males and females (N=291) with an ASRS score ≥24 on either the in attention or hyperactivity-impulsiveness subscale. The same individual will appear in more than one group due to the combined subtype of ADHD (score ≥24 on both the in attention and hyperactivity-impulsiveness subscale).

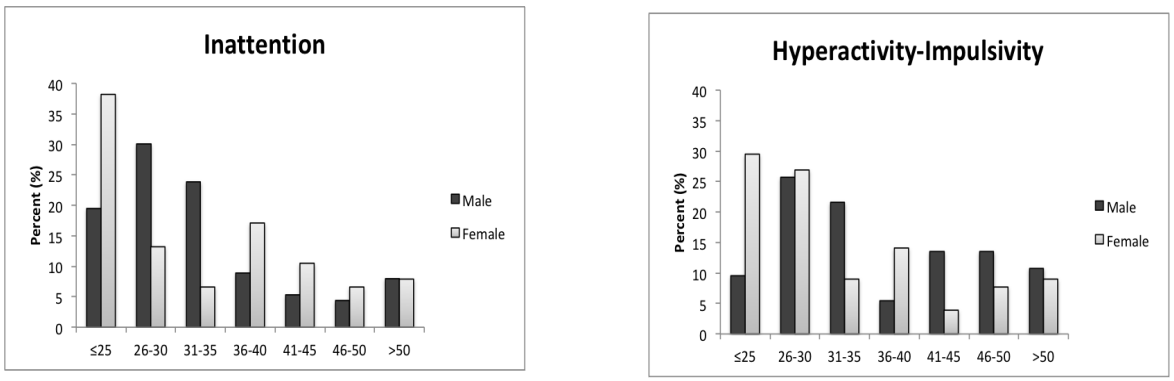

Figure 3: Age range of the inattention and hyperactivity-impulsiveness subtypes of ADHD using the inattention/hyperactivity-impulsiveness subscale scoring method of the ASRS. Age range for males and females with either the inattention (left figure) or the hyperactivity-impulsiveness (right figure) subtypes of self-reported ADHD symptoms illustrated as the percentage of the total number of individuals with a positive ADHD screen on either subscales. Here, individuals with the combined subtype (inattentionand hyperactivity-impulsiveness) of ADHD will appear in both the inattentionand the hyperactivity-impulsiveness analysis.

Tables

Table 1: Differences between individuals screening positive and negative for ADHD among individuals in the DBDS according to the three alternative scoring methods of the ASRS and their respective cut-off value.

	ADHDassessment						
Scoring method	**ASRS 6-items screener**		**ASRS full edition**		**Inattention/hyperactivity-impulsiveness subscale**		**Total**
Cut-off	≥14		≥37		≥24		
Items	1-6		1-18		1-4+7-11/5-6+12-18		
	ADHD	**No ADHD**	**ADHD**	**No ADHD**	**ADHD**	**No ADHD**	**N**
N (%)	557 (2.1)	25,660 (97.9)	690 (2.6)	25,527 (97.4)	291 (1.1)	25,926 (98.9)	26,217 (100)
Gender (%):							
Male	380 (2.7)	13,828 (97.3)	385 (2.7)	13,823 (97,3)	160 (1.1)	14,048 (98,9)	14,208 (54.2)

Female	177 (1.5)	11,829 (98.5)		305 (2.5)	11,701 (97.5)		131 (1.1)	11,875 (98.9)	12,006 (45.8)
Age in years (%):									
≤25	132 (4.3)	2,911 (95.7)		162 (5.3)	2,881 (94.7)		69 (2.3)	2,974 (97.9)	3,043 (11.6)
26-30	130 (3.7)	3,425 (96.3)		176 (5.0)	3,379 (95.1)		72 (2.0)	3,483 (98.0)	3,555 (13.6)
31-35	98 (3.6)	2,650 (96.4)		93 (3.4)	2,655 (96.6)		46 (1.7)	2,702 (98.3)	2,748 (10.5)
36-40	66 (2.4)	2,719 (97.6)		83 (3.0)	2,702 (97.0)		31 (1.1)	2,754 (98.8)	2,785 (10.6)
41-45	7 (1.8)	3,063 (98.2)		58 (1.9)	3,062 (98.1)		24 (0.8)	3,096 (99.2)	3,120 (11.9)
46-50	33 (1.0)	3,184(99.0)		45 (1.4)	3,172 (98.6)		22 (0.7)	3,195 (99.3)	3,217 (12.3)
>50	41 (0.5)	7,708 (99.5)		73 (0.9)	7,676 (99.0)		27 (0.4)	7,722 (99.7)	7,749 (29.6)

Note: All items of the ASRS are scored on a five-point response scale ranging from 0 to 4. The presented cut-off values are based on Kessler et al. [35,37]. ASRS; Adult ADHD Self-Report Scale

Table 2: Odds ratios and 95% confidence intervals across different age ranges among blood donors screening positive for ADHD when compared to individuals screening negative for ADHD in the DBDS.

	ASRS 6-items screener	Adjusted for sex	ASRS full edition	Adjusted for sex	Inattention/hyperactivity-impulsiveness subscale	Adjusted for sex
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age in years:						
≤25	8.5 (6.0-12.1)***	9.4 (6.6-13.4)***	5.9 (4.5-7.8)***	6.0 (4.6-8.0)***	6.6 (4.2-10.4)***	6.7 (4.3-10.6)***
26-30	7.1 (5.0-10.2)***	7.3 (5.1-10.4)***	5.5 (4.2-7.2)***	5.5 (4.2-7.3)***	5.9 (3.8-9.22)***	5.9 (3.8-9.3)***
31-35	7.0 (4.8-10.0)***	6.8 (4.7-9.8)***	3.7 (2.7-5.0)***	3.7 (2.7-5.0)***	4.9 (3.0-7.9)***	4.8 (3.0-7.8)***
36-40	4.6 (3.1-6.8)***	4.5 (3.0-6.7)***	3.2 (2.4-4.4)***	3.2 (2.3-4.4)***	3.2 (1.9-5.4)***	3.2 (1.9-5.4)***
41-45	3.5 (2.3-5.2)***	3.5 (2.3-5.2)***	2.0 (1.4-2.8)***	2.0 (1.4-2.8)***	2.2 (1.28-3.9)**	2.2 (1.3-3.8)**
46-50	2.0 (1.2-3.1)***	2.0 (1.2-3.1)**	1.5 (1.0-2.2)*	1.5 (1.0-2.2)*	2.0 (1.1-3.5)*	2.0 (1.1-3.5)*
>50	1	1	1	1	1	1

Note: OR: Odds Ratio; CI: Confidence Interval; *p<0.05, **p<0.01, ***p<0.001.

Declaration of Interest

Dr. Werge has served as a lecturer for and consultant to H. Lundbeck A/S. The rest of the authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

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