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Socio-demographic characteristics of adults with self-reported ADHD symptoms in a Danish population of 12,415 blood donors

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Abstract

Objective: To characterize the socio-demographic profile of otherwise healthy blood donors with self-reported ADHD symptoms.

Methods: The study included 12,415 adult participants from the Danish Blood Donor Study. ADHD symptoms were assessed using the 18-items Adult ADHD Self-Report Scale v.1.1 (ASRS). Socio-demographic variables (including nationality, place of residence, marital status, and number of children, educational level, employment status, and income) were obtained from national Danish registers and association with ADHD symptoms were examined by multivariable logistic regression analysis.

Results: Screening positive for ADHD symptoms, reported by 322 participants (2.6%), were associated with low level of education (OR_{adj}=2.10, 95%CI:1.38-3.18), low income (OR_{adj}=1.55, 95%CI:1.15-2.09), and unemployment (OR_{adj}=1.56, 95%CI:1.02-2.39).

Conclusions: ADHD symptoms are common among blood donors and tend to be associated with negative outcomes in relation to educational attainment, income, and work status. Our findings highlight the importance of early recognition and treatment in order to prevent the presumed negative consequences for individuals with self-reported ADHD.

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common psychiatric disorders among children and adolescents. It is characterized by develop mentally inappropriate levels of Inattention (IN) and/or Hyperactivity (HY) and Impulsivity (IM) behavior that vary with age and development. Onset of disease is often in early childhood with a worldwide pooled prevalence of ~5% in school-age children [1].

Historically, ADHD was considered to be a childhood-onset disorder and recent longitudinal follow-up studies suggest that the ADHD symptomatology and related impairments persist into adolescence and adulthood in approximately 29-65% of those diagnosed in childhood [2–4].

Studies suggest that 1.1-5% of the general adult population is affected by ADHD [5–7]. But while the disorder is well recognized among children several studies indicate that ADHD is highly overlooked and/or untreated in adults [5,8], which might lead to underestimated prevalence estimates in the general adult population.

ADHD symptoms manifest somewhat differently in adults and children [1,9]. Here, the symptoms related to HY-IM often become less prominent with age, while the IN symptoms persist [2,4,10–13]. Adults with ADHD still experience numerous impairments on several aspects of life including behavior [14], social skills [15,16], educational achievement [17–20], occupational performance including work stability [14,18,21,22], and maintaining relationships [23] when compared to individuals without the disorder [24–26]. Furthermore, adult ADHD is often accompanied by psychiatric co-morbidity [27–29], substance abuse [14,30–32], and crime [33–35]. Thus, if left untreated, the core symptoms of ADHD are a major cause of life-long challenges [21] which also have seriously implications on public health [36]. However, early recognition and treatment, which typically involve medication or behavioral interventions have been shown to be effective in terms of alleviatory [37–40].

Initial screening instruments for ADHD among adults (such as the Adult ADHD Self-Report Scale v.1.1 (ASRS) [41,42]) have been developed. Such instrument is easy and cost effective and can be completed as a self-administered questionnaire. Thus, ASRS can identify adults with a high risk of ADHD and furthermore inform about the prevalence and negative implications in large samples which to date primarily have been assessed in populations that meet the diagnostic criteria for ADHD. Therefore, in the present cross-sectional study, we provide novel insights of self-reported and unrecognized ADHD symptoms, its prevalence and socio-demographic profile in a pragmatic sample of otherwise healthy and un-medicated adult blood donors where biases related to diagnosis and treatment do not influence the results. We use of the comprehensive Danish registers and choose to include information on sex, age, nationality, place of residence, marital status, number of children, educational level, employment status, and income at the individual level.

Materials and methods

Study Design

The study included participants recruited from the Danish Blood Donor Study (DBDS) (www.dbds.dk), an ongoing prospective cohort of voluntary blood donors recruited from blood banks across Denmark [43,44]. The DBDS was initiated in 2010 and currently includes more than 100,000 blood donors. Preliminary data suggests that ~95% of invited donors accept to participate in DBDS [43]. Included blood donors are 18-67 years of age, inherently in good health, and un-medicated. At enroll-

ment, each participant gives oral and written informed consent to participate in the study and furthermore approves that their personal data is being linked to the comprehensive Danish nation-wide registers. A more detailed description of DBDS and blood donors in general can be found in Pedersen et al. [43] and Burgdorf et al [44,45].

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

Participants

From May 2015 to May 2016, a total of 13,448 blood donors completed a tablet-based health-related questionnaire [44] including the Adult ADHD Self-Report Scale v1.1 (ASRS) [41] of which 12,888 (95.8%) participants completed the ASRS full edition. Furthermore, 473 (3.5%) individuals were excluded from the study population due to unknown socio-demographic data (see Figure 1), thus the final sample consisted of 12,415 (92.3%) blood donors. Significantly more females (60.7%) than males (39.3%) with unknown socio-demographic data were excluded from the study population (*P*<0.000, Pearson's chi-square test) and the excluded individuals were significantly younger than the remaining sample (median age (Interquartile range (IQR)): 24.4 (19.6-25.2) years versus 40.6 (29.1-50.8) years, Mann-Whitney U test, *P*<0.000) (see S1 Figure).

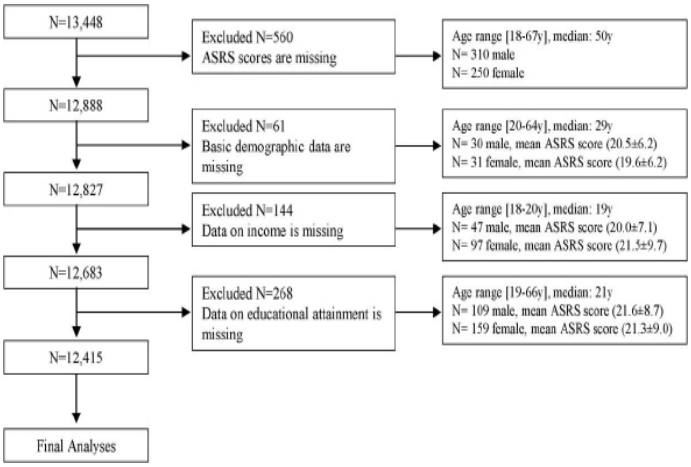

Figure 1: Flow chart of the proportion of participants that was included in the study. ASRS: Adult ADHD Self-Report Scale v.1.1, y: years.

Assessment of ADHD

Current self-reported ADHD symptoms among blood donors in the DBDS were assessed by a Danish version of the ASRS questionnaire [41,46]. The ASRS is an 18-item questionnaire assessing the dimensions of IN (items 1-4 and 7-11) and HY-IM (items 5-6 and 12-18) of self-reported ADHD symptoms based on the DSM-IV diagnostic criteria of ADHD [41]. ASRS is validated and widely used as a screening instrument regarding ADHD symptoms in adults [42,47–50] also in Scandinavia [51]. Each of the 18-items are scored on a five-point response scale with 0="never", 1="rarely", 2="sometimes", 3="often", and 4="very often" based on the experiences over the last 6 months. A total scale score is obtained by summarizing the response scores for all 18 items (total range 0-72). As previously recommended by Kessler et al. [52], we dichotomized the total scale score into the symptom-based variable "non-ADHD" (scores 0-36) and "ADHD" (scores 37-72) (sensitivity: 57.2%, specificity: 96.5%, and AUC: 0.77). Thus, throughout the paper the term ADHD is referring to individuals screening positive for ADHD using the ASRS.

Furthermore, we divided the male and female ADHD individuals into three groups according to whether they scored higher on the IN subscale or the HY-IM subscale, respectively, or the combined subscale (scored equally on the two subscales).

A more detailed description of the ASRS questionnaire can be found elsewhere [41].

Assessment of socio-demographic variables

This study used the comprehensive and nation-wide Danish registers that contain detailed information about the entire Danish population at the individual level. The registers are organized and continuously updated through a research environment maintained and monitored by Statistics Denmark.

In Denmark, all residents are assigned an unique personal identification numbers (Central Person Register (CPR) number) [53,54], which ensures accurate linkage of individual information within and across various Danish registers. By the use of an encrypted CPR of each blood donor included in the study, we extracted socio-demographic variables from the following three registers or databases: (1) The Danish Civil Registry [53,54], which among other things contains information on sex, date of birth, nationality, and continuously updated information on vital status, place of residence, family members, and marital status. (2) The Population Education Register [55] which contains information on highest level of completed education, and (3) the Danish Integrated Database for Labour Market Research [56] which contains personal labor market affiliation and socio-economic data of the entire Danish population.

In this study, the age of the blood donors were categorized into 7 groups (25 or less, 26-30, 31-35, 36-40, 41-45, 46-50, and 50 years or more) with 50 years as the reference group. Nationality was dichotomized into the variables "native Danes" and "other" (descendants of immigrant or immigrants). Furthermore, the urbanization level was calculated for each blood donor as individuals per square kilometer in the municipality of residence and subsequently stratified into three categories corresponding to whether the municipality of residence had a "high" (more than 358 persons/km^2, corresponding to the highest third), "medium" (358-88 persons/km^2, corresponding to the middle third), or "low" (less than 88 persons/km^2, corresponding to the lowest third) urbanization level. We stratified marital status into three categories: "married/widowhood", "divorced", or "unmarried". The number of children of each blood donor was categorized into "0", "1", or "2 or more". Employment status was divided into three strata: "employed", "unemployed", or "student". Here, individuals on retirement were grouped according to their employment status before the retirement. Educational level was defined as the highest completed education of each participant. Here, three levels were considered: "primary" (elementary school), "secondary" (high school, vocational education, or a shorter higher education), or "higher" (medium and long higher education). The total personal annual income level was classified as "low" or "high" separated by the median of the entire study population, the female study population, or the male study population, respectively. All socio-demographic variables were extracted from 2014 except employment status and educational level that was obtained at the 2013 level.

Statistical analysis

All statistical analyses were performed using the statistical packages STATA version 14 (StataCorp, College Station, Texas, USA). Socio demographic variables were described as number and percentages for females, males, and the total study population of blood donors with and without ADHD ("ADHD" vs. "non-ADHD") according to the cut-off of the ASRS (see method for further details). The estimated prevalence of ADHD in the study population was presented as percentage with 95% Confidence Interval (CI). Differences in proportions between ADHD and non-ADHD individuals were assessed using Pearson's chi-square analysis.

Association between adult ADHD (dependent variable) and socio-demographic variables, including age, nationality, urbanization level, marital status, number of children, employment status, educational level, and income level were analyzed using logistic regression. Both an unadjusted analysis and an adjusted analysis including age and all socio-demographic variables were performed - all stratified by sex. Odds ratios (OR) with 95% CI were reported for each subgroup. P-value less than 0.05 was considered statistically significant. Given the size of the study population it is important to note that even small differences can lead to significant findings and here the OR reflects the increased odds of a given trait. The OR represents the odds (odds is the probability of the event divided by the probability of the event not occurring) that an outcome (different socio-demographic variables) will occur given a particular exposure (ADHD symptoms), compared to the odds of the outcome occurring in the absence of that exposure.

Results

In total, 12,415 blood donors (median age (IQR): 40.6 (29.1-50.8) years) from the DBDS were included in the study where 54.8% were males (median age (IQR): 40.2 (30.4-51.1) years) and 45.2% were females (median age (IQR): 39.8 (27.5-50.4) years). The study population was predominantly native Danes (98.4%) that lived in urban municipalities (52.0%), and were either married/widowhood (46.0%) or unmarried (47.2%). Furthermore, the majority of the participants had either no children (43.5%) or two or more (44.4%), were employed (88.6%), and had at least finished high school, vocational education, or a shorter higher education (57.9%) (Table 1 column 1).

Figure 2 shows the distribution of the ASRS scores within the study population and according to standard cut-off values of the ASRS, 2.6% (95%CI: 2.3-2.9) of the blood donors screened positive for ADHD. Figure 3 illustrates that ADHD individuals were mostly affected by the IN subtype and that males and females had an overall significantly different ADHD symptomatology (P=0.03). Here, males tend to be more affected by the IN subtype of ADHD while females were more affected by the HY-IM subtype.

Table 1 shows the socio-demographic characteristics of the participants according to the ASRS test result for the ADHD and non-ADHD groups (Table 1 column 2-7). Statistically significant differences between the ADHD group and the non-ADHD groups were observed for age, urbanization level, marital status, number of children, employment status, educational level, and income level (Table 1 column 8).

The results of the unadjusted and adjusted logistic regression analyses are presented in Table 2. No significant sex differences regarding the presence of ADHD symptoms were found among blood donors (P=0.25).

The prevalence of ADHD varied by age where blood donors between 18-40 years showed an increased odds ratio for experience ADHD symptoms when compared to the >50 age group.

Blood donors with low educational attainment exhibited a significantly higher odds of screening positive for ADHD relative to the high educational level (OR_{adj}=2.10, 95%CI: 1.38-3.18) when adjusted for all socio-demographic variables. In addition, we observed more female blood donors with ADHD symptoms in the low income group than in the high income group (OR_{adj}=1.62, 95%CI: 1.02-2.56). Unmarried males faced a significantly elevated occurrence of ADHD symptoms when compared to married males (OR_{adj}=1.93, 95%CI: 1.15-3.24). The same was seen among unemployed males when compared to employed males (OR_{adj}=2.16, 95%CI: 1.25-3.73). For urbanization level, a trend was observed with high urbanization level associated with a higher prevalence of ADHD compared to low urbanization level (OR_{adj}=1.34, 95%CI: 0.97-1.86), while nationality and number of children was not significantly associated with ADHD status.

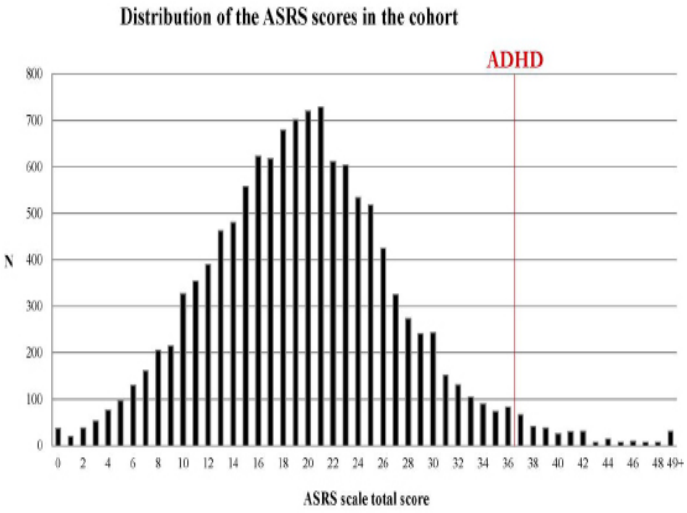

Figure 2: Distribution of the total scale score on the ASRS for the 12,415 blood donors. The ASRS total scale scores are shown for the study population. Here, blood donors with a sum score equal or higher than 37 were considered to screen positive for ADHD (marked by the red line).

Table 1: Socio-demographic characteristics of the study population.

Characteristics	Total	ADHD			Non-ADHD			P[a]
		Female	Male	Total	Female	Male	Total	
Gender, n (%):	12415 (100)	142 (44.1)	180 (55.9)	322 (2.6)	5469 (45.2)	6624 (54.8)	12093 (97.4)	0.689
Age in years, median (IQR):	40.1 (29.1-50.8)	30.2 (25.1-39.4)	32.6 (26.9-39.3)	31.8 (26.1-39.3)	39.4 (27.7-50.6)	40.9 (30.6-51.3)	40.4 (29.2-51.0)	
Age in years, n (%):								
≤25	1404 (11.3)	33 (56.9)	25 (43.1)	58 (4.1)	775 (57.6)	571 (42.4)	1346 (95.9)	0.000
26-30	2005 (16.1)	37 (43.0)	49 (57.0)	86 (4.3)	938 (48.9)	981 (51.1)	1919 (95.7)	
31-35	1418 (11.4)	16 (31.4)	35 (68.6)	51 (3.6)	541 (39.6)	826 (60.4)	1367 (96.4)	
36-40	1369 (11.0)	21 (42.9)	28 (57.1)	49 (3.6)	545 (41.3)	775 (58.7)	1320 (96.4)	
41-45	1458 (11.7)	11(42.3)	15 (57.7)	26 (1.8)	615 (42.9)	817 (57.1)	1432 (98.2)	
46-50	1428 (11.5)	7 (36.8)	12 (63.2)	19 (1.3)	616 (43.7)	793 (56.3)	1409 (98.7)	
>50	3333 (26.8)	17 (51.5)	16 (48.5)	33(1.0)	1439 (43.6)	1861 (56.4)	3300 (99.0)	
Nationality, n (%):								
Native Danes	12221 (98.4)	-	-	313 (2.6)	5370 (45.1)	6538 (54.9)	11908 (97.4)	0.071
Other	194 (1.6)	-	-	9 (4.6)	99 (53.5)	86 (46.5)	185 (95.4)	
Urbanization level (persons/km^2), n (%):								
High	6455 (52.0)	85 (43.8)	109 (56.2)	194 (3.0)	2844 (45.4)	3417 (54.6)	6261 (97.0)	0.002
Medium	2912 (23.5)	30 (40.5)	44 (59.5)	74 (2.5)	1259 (44.4)	1579 (55.6)	2838 (97.5)	
Low	3048 (26.6)	27 (50.0)	27 (50.0)	54 (1.8)	1366 (45.6)	1628 (54.4)	2994 (98.2)	
Marital status, n (%):								
Married/Widowhood	5710 (46.0)	45 (49.5)	46 (50.5)	91 (1.6)	2313 (41.2)	3306 (58.8)	5619 (98.4)	0.000
Divorced	839 (6.8)	8 (47.1)	9 (52.9)	17 (2.0)	444 (54.0)	378 (46.0)	822 (98.0)	
Unmarried	5866 (47.2)	89 (41.6)	125 (58.4)	214 (3.6)	2712 (48.0)	2940 (52.0)	5652 (96.4)	
Number of children, n (%):								
0	5405 (43.5)	87 (44.8)	107 (55.2)	194 (3.6)	2480 (47.6)	2731 (52.4)	5211 (96.4)	0.000
1	1500 (12.1)	13 (33.3)	26 (66.6)	39 (2.6)	563 (38.5)	898 (61.5)	1461 (97.4)	
≥2	5510 (44.4)	42 (47.2)	47 (52.8)	89 (1.6)	2426 (44.8)	2995 (55.2)	5421 (98.4)	
Employment status, n (%):								
Employed	10998 (88.6)	116 (45.0)	142 (55.0)	258 (2.3)	4824 (44.9)	5916 (55.1)	10740 (97.7)	0.000
Unemployed	523 (4.2)	10 (37.0)	17 (63.0)	27 (5.2)	243 (49.0)	253 (51.0)	496 (94.8)	
Student	894 (7.2)	16 (43.2)	21 (56.8)	37 (4.1)	402 (46.9)	455 (53.1)	857 (95.9)	
Educational level[b], n (%):								
Low	1252 (10.1)	25 (50.0)	25 (50.0)	50 (4.0)	542 (45.1)	660 (54.9)	1202 (96.0)	0.000
Middle	7188 (57.9)	85 (43.0)	115 (57.5)	200 (2.8)	3044 (43.6)	3944 (56.4)	6988 (97.2)	
High	3975 (32.0)	32 (44.4)	40 (55.6)	72 (1.8)	1883 (48.2)	2020 (51.8)	3903 (98.2)	
Income level[c], n (%):								
Low	6208 (50.0)	100 (45.2)[c]	121 (54.8)[c]	225 (3.6)[c]	2706 (45.2)[c]	3281 (54.8)[c]	5983 (96.4)[c]	0.000
High	6207 (50.0)	42 (41.6)[c]	59 (58.4)[c]	97 (1.6)[c]	2763 (45.3)[c]	3343 (54.7)[c]	6110 (98.4)[c]	
ASRS score, mean (SD):	19.7±7.8	41.7±5.3	41.5±4.9	41.6±5.1	19.2±6.9	19.1±7.0	19.1±6.9	0.000

[a]The P-value refers to thecomparison between the $ADHD_{(Total)}$ and the non-$ADHD_{(Total)}$ group by Pearson's chi-square test.
[b]Highest educational level attained.
[c]Total annual personal income. Here, the median annual personal income is based on either the female blood donors, male blood donors, or the total study population.
Note. "-"; according to Danish legislation, we had too limited power (less than four exposed participants) to further subdivide by sex. IQR; interquartile range.

Table 2: Odds ratio and 95% confidence intervals of ADHD among blood donors by logistic regression analyses

	Crude OR (95% CI)[a]			Mutually adjusted OR (95% CI)[b]		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**
Age in years						
≤25	3.60 (1.99-6.51)***	5.09 (2.70-9.60)***	4.31 (2.80-6.64)***	2.52 (1.06-5.98)*	3.32 (1.50-7.36)**	2.73 (1.55-4.83)***
26-30	3.34 (1.87-5.96)***	5.81 (3.29-10.27)***	4.48 (3.00-6.72)***	3.06 (1.33-7.00)**	4.50 (2.19-9.26)***	3.49 (2.05-5.95)***
31-35	2.50 (1.26-4.99)**	4.93 (2.71-8.95)***	3.73 (2.40-5.81)***	2.96 (1.37-6.39)**	4.49 (2.28-8.83)***	3.65 (2.22-6.01)***
36-40	3.26 (1.71-6.23)***	4.20 (2.26-7.81)***	3.71 (2.38-5.80)***	3.77 (1.93-7.36)***	4.18 (2.19-7.97)***	3.93 (2.48-6.23)***
41-45	1.51 (0.71-3.25)	2.14 (1.05-4.34)*	1.82 (1.08-3.05)*	1.74 (0.81-3.77)	2.14 (1.04-4.37)*	1.92 (1.14-3.23)*
46-50	0.96 (0.40-2.33)	1.76 (0.83-3.74)	1.35 (0.76-2.38)	1.04 (0.43-2.54)	1.76 (0.83-3.75)	1.41 (0.80-2.49)
>50	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Nationality						
Native Danes	-	-	1 [ref]	-	-	1 [ref]
Other	-	-	1.85 (0.94-3.65)	-	-	1.62 (0.81-3.22)
Urbanization level (persons/km²)						
High	1.51 (0.98-2.34)	1.92 (1.26-2.94)**	1.72 (1.27-2.33)***	1.29 (0.80-2.07)	1.42 (0.90-2.24)	1.34 (0.97-1.86)
Medium	1.21 (0.71-2.04)	1.68 (1.04-2.73)*	1.45 (1.01-2.06)*	1.13 (0.67-1.93)	1.51 (0.92-2.47)	1.33 (0.93-1.91)
Low	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Marital status						
Married/ Widow-hood	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Divorced	0.93 (0.43-1.98)	1.71 (0.83-3.52)	1.28 (0.76-2.15)	0.91 (0.42-1.99)	1.85 (0.88-3.88)	1.32 (0.77-2.27)
Unmarried	1.69 (1.17-2.42)**	3.06 (2.17-4.30)***	2.34 (1.82-3.00)***	0.66 (0.36-1.23)	1.93 (1.15-3.24)*	1.21 (0.82-1.80)
Number of children						
0	2.03 (1.40-2.94)***	2.50 (1.76-3.53)***	2.27 (1.75-2.92)***	1.23 (0.62-2.44)	0.66 (0.37-1.17)	0.87 (0.56-1.35)
1	1.33 (0.71-2.50)	1.84 (1.14-3.00)*	1.63 (1.11-2.38)*	1.24 (0.64-2.40)	0.98 (0.58-1.68)	1.10 (0.73-1.66)
≥2	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Employment status						
Employed	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Unemployed	1.71 (0.89-3.31)	2.80 (1.67-4.70)***	2.27 (1.51-3.40)***	1.12 (0.56-2.23)	2.16 (1.25-3.73)**	1.56 (1.02-2.39)*
Student	1.66 (0.97-2.82)	1.92 (1.20-3.07)**	1.80 (1.26-2.55)**	0.92 (0.52-1.61)	1.05 (0.63-1.77)	0.97 (0.67-1.42)
Educational level[c]						
Low	2.71 (1.59-4.62)***	1.91 (1.15-3.18)*	2.25 (1.56-3.25)***	2.61 (1.40-4.89)**	1.90 (1.08-3.35)*	2.10 (1.38-3.18)***
Middle	1.64 (1.09-2.48)*	1.47 (1.02-2.12)*	1.55 (1.18-2.04)**	1.51 (0.96-2.37)	1.48 (1.00-2.19)*	1.45 (1.08-1.95)*
High	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]
Income level[d]						
Low	2.43 (1.69-3.50)***	2.09 (1.53-2.86)***	2.37 (1.86-3.01)***	1.62 (1.02-2.56)*	1.13 (0.76-1.67)	1.55 (1.15-2.09)**
High	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]	1 [ref]

[a] Univariate analysis where the crude OR have no adjustments
[b] Multivariate analysis where the OR is adjusted for all socio-demographic variables
[c] Highest educational level attained
[d] Total annual personal income. Here, the median annual personal income is based on either the female blood donors, male blood donors, or the total study population.
Note. OR; odds ratio, CI; confidence interval, "-", according to Danish legislation, we had too limited power (less than four exposed participants) to further subdivide by sex. *p<.05, **p<.01, ***p<.001.

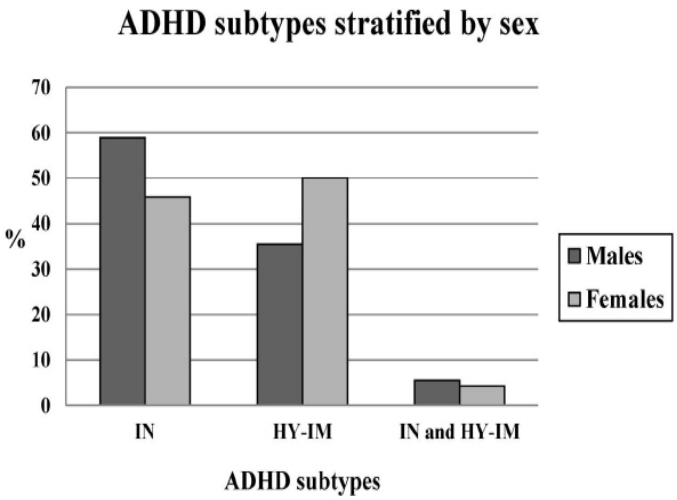

Figure 3: The distribution of ADHD symptoms stratified by sex. The inattention (IN) or hyperactivity-impulsivity (HY-IM) subtype of ADHD for male and female blood donors that screened positive for ADHD using the ASRS (N=322). Here, males and females were divided into symptom-groups according to the symptoms that were most predominant. The group "IN and HY-IM" shows that individuals has the same ASRS score on the IN and HY-IM subscale. We found an overall statistical significant difference between the distribution of the three subgroups of ADHD symptoms between males and females (*P*=0.03, chi-square). The P-values for the IN subtype, the HY-IM subtype, and the combined subtype were *P*=0.05, *P*=0.09, and *P*=0.59, respectively.

Discussion

In the present cross-sectional study, we characterize the socio-demographic profile of a population of healthy blood donors with self-reported ADHD symptoms by the use of the comprehensive Danish registers.

Our results suggest that even among otherwise healthy, undiagnosed and untreated blood donors ~3% exhibit ADHD symptoms that in a clinical setting would result in referral to a psychiatrist for a more thorough evaluation (Table 1). Our estimated prevalence is in the lower range when compared to previous studies (range 2.5-5.0%) [5,6,20,26,50,57,58], which is most likely due to the fact that blood donors have to fulfill specific health criteria, which subsequently exclude severe forms of the ADHD symptomatology. In spite of this, we still found that ADHD symptoms in this study population form a continuum of severity (Figure 2) and that donors exhibit ADHD that currently are not treated in clinical settings (Table 2).

Blood donors who were unemployed, low educated, unmarried, and had a low income had higher odds of having self-reported ADHD symptoms (Table 2), which is consistent with previous reports [14,17–26]. Surprisingly, several of the associations were driven by one sex only. Although the reason for these sex-specific impairments is unclear, it could be due to sex-differences in help seeking behavior or partly reflect gender differences in ADHD symptomatology in our study. Here, males were found to have the highest level of the IN symptoms, while this was true for the HY-IM symptoms for females (Figure 3). Previously, the IN subtype has been associated with passive social behavior, and less relationship satisfaction among college students [59,60] which partly could explain our observations related to being unmarried and unemployed. In contrast, the HY-IM subtype might make it difficult to complete an education, but easier to find a partner due to the extrovert nature of the HY-IM subtype.

We found that current ADHD symptoms decreased with increasing donor age as previously described [4,6]. Noteworthy, these results could simply reflect the cross-sectional nature of our study or a cohort effect since blood donors of increasing age are highly selected in relation to health requirements (the healthy donor effect) and subsequently also have a higher chance of being treated for an ADHD comorbid disorder [61,62]. Females had less prominent ADHD symptoms in the youngest age groups and the symptoms seemed to peak in the 36-40 years age group. These differences could reflect that the often unrecognized IN subtype among females during childhood has been given increased awareness within the last few decades, which have resulted in early recognition for the 18-35 female age groups. Yet another possibility is that young females receive more support from their families than young males and thereby able to manage their symptoms better. Furthermore, young females may have poorer insight into their own impairments, which could have resulted in underreporting of ADHD symptoms.

In our study, no significant differences with respect to ADHD symptoms were found for nationality. This difference when compared to other studies [5,20,57,63,64] could be due to the selection effect related to blood donors or that our data were based on very few individuals with other nationalities (N_{ADHD}=9 versus $N_{non\text{-}ADHD}$=185). Furthermore, we found only a trend for an association between ADHD symptoms and a high urbanization level which - if true - could be speculated to be because adult blood donors with ADHD thrive better with high pace and are subsequently drawn towards urban areas [20,62].

Strengths and limitations

The strength of the study is the large study population with a broad age range and the use of the comprehensive Danish registers that ensures accurate linkage of blood donors across different registers. Furthermore, socio-demographic variables were collected independently of the reported ADHD symptoms in a country where education is free of charge and provided by the government.

This study should be interpreted cautiously because of several important limitations. The study population constitutes voluntary blood donors who are implicitly healthier than the general population and where older blood donors are a highly selected group of individuals (the healthy donor effect). Therefore the generalizability to other settings may be limited.

Furthermore, our study used self-reported ADHD symptoms

based on the ASRS screening instrument rather than clinical diagnosis. Even though the ASRS is commonly used in Denmark and has shown good psychometric properties [42,46–49] the Danish version has never been officially validated. Thus, blood donors who would not fulfill a verified clinical diagnosis of ADHD could be included in the present study, which would subsequently inflate the results.

Because of the cross-sectional study design, we are not able to evaluate the temporal aspects of ADHD symptoms among blood donors. Thus, socio-demographic variables that tend to fluctuate in time, such as employment status, number of children, marital status, and urbanization level could be differently associated with self-reported ADHD symptoms if a longitudinal approach were applied. Similarly, no causal relationship between ADHD symptoms and socio-demographic status can be inferred from cross-sectional data. Furthermore, the different covariates examined in the study were retrieved from the Danish registers and therefore not applicable to the participants at the time of completion of the ASRS. These imprecise measures or specifications could create spurious associations that were not accounted for in the study.

Furthermore, there might be a selection bias among blood donors in relation to the different manifestations of the HY-IM subtype between males and females. Here, the HY-IM subtype among males could lead to less socially acceptable behaviors including aggression and unreliability that will exclude them as blood donors whereas this for females are reflected in less socially complicated directions.

Non-responders of the full ASRS were removed from the analyses, however; it is possible that these individuals are more affected by ADHD symptoms than participants with complete data that would subsequently lead to biased estimates.

Furthermore, the study excluded individuals with missing information on income and education. We do believe that the majority of the excluded individuals represent blood donors that are too young to have any information available in the registers when the socio-demographic variables were extracted. A smaller fraction could however; represent blood donors travelling/studying/etc. abroad with no residence in Denmark during the study period or individuals at production schools, as these are not registered (mail correspondence with Statistic Denmark). The mean ASRS scores of these excluded individuals confirmed that the exclusion is random with respect to ADHD symptoms and representative of the entire study population (Figure 1).

Conclusion

The study suggests that the prevalence of self-reported ADHD is increased among younger and lower educated blood donors. For males additional associated factors were unemployment and not being married, whereas for females low income was associated with ADHD symptoms. Our findings highlight the importance of early recognition and treatment in order to prevent the presumed negative consequences for individuals with self-reported ADHD.

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