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Original article

The risk of eating disorders among children and adolescents with attention deficit hyperactivity disorder: Results of a matched cohort study

Haitham Jahrami [a, b, *], Ahmed Malalla AlAnsari [a, b], Abdulrahman Ismaeel Janahi [b], Ammar Khalid Janahi [b], Latifa Rashid Darraj [b], Mo'ez Al-Islam E. Faris [c]

[a] Ministry of Health, P.O. Box: 12, Manama, Bahrain
[b] College of Medicine and Medical Sciences, Arabian Gulf University, Manama, Bahrain
[c] Department of Clinical Nutrition and Dietetics, College of Health Sciences/Research Institute of Medical and Health Sciences (RIMHS), University of Sharjah, Sharjah, United Arab Emirates

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ABSTRACT

Background and Objectives: There are some studies on the association between attention deficit and hyperactivity disorder (ADHD) and the risk of eating disorders (ED). Only few have examined the risk of ED among children and adolescents with ADHD. Previous research which included subjects with ADHD with other comorbidities used inadequate controls and did not focus on the type of ADHD or the role of pharmacological treatment.

Methods: This matched cohort study was conducted in the Child/Adolescents Psychiatry Unit (CAPU), Bahrain. Using the CAPU diagnostic frameworks, 70 subjects with ADHD were recruited and matched with their corresponding age- and sex- healthy controls at 1:2 ratio (70 cases:140 controls). The participants were children or adolescents aged between 8 and 19 years old. A brief interview was used to collect socio-demographic information and anthropometrics. The risk of ED was estimated using the eating attitude test −26 (EAT-2). Data were analyzed using cohort analysis.

Results: A total of 31.43% of the subjects with ADHD were screened using EAT-26 and found to be 'at risk' for ED, compared to 12.14% of the controls (OR 3.31, 95% CI 1.62−6.78). The prevalence of ED among female cases with ADHD was slightly higher than males (33.33% and 30.77%, respectively). Body weight or body mass index was a statistically significant explanatory factor for the risk of ED.

Conclusions: The present study shows that children and adolescents with ADHD have a three-fold increased risk of ED compared to healthy controls. This research raised the recommendation that children and adolescents with ADHD should be screened for disordered eating patterns.

1. Introduction

Attention deficient hyperactivity disorder (ADHD) is the most common behavioral disorder in children and adolescents [1]. A meta-analysis of 175 studies involving a sample size of more than one million subjects worldwide on ADHD prevalence in children aged 18 years or less concluded an overall pooled estimate of 7.2% (95% Confidence Interval (CI) 6.7%−7.8%) [2]. ADHD is classified into three main types: inattentive, hyperactive-impulsive, and combined [3]. Generally, males are more likely to be affected by the disorder than females, with a ratio of 3:1 [4] in population-based studies and 4:1 in clinical studies [5]. However, the inattentive type is more common among females compared to males [6]. The diagnosis of ADHD is made for children aged four years or older with a history of inattention, distractibility, impulsiveness and hyperactivity, poor school performance, and behavioral problems

* Corresponding author. Ministry of Health, P.O. Box: 12, Manama, Bahrain.
E-mail addresses: HJahrami@health.gov.bh, hjahrami@health.gov.bh (H. Jahrami), aansari@health.gov.bh (A.M. AlAnsari), ammarjanahi12@gmail.com (A.I. Janahi), a.rahmanimj@gmail.com (A.K. Janahi), latifarashiddarraj12@gmail.com (L.R. Darraj), mfaris@sharjah.ac.ae (M.A.-I.E. Faris).

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[7]. Behavioral treatments are the most common interventions and include parenting skills and parent coping strategies, classroom management, psychoeducation, and skills training such as social skills or study skills [8,9]. Pharmacologic treatments reduce core ADHD symptoms in most cases. Central Nervous System (CNS) psychostimulants (e.g., methylphenidate) are the safest option and therefore are the first line of choice for ADHD [10]. Psychostimulants affect the CNS dopaminergic pathways and therefore, in addition to symptom reductions, academic and behavioral performance may improve [11].

In the past decade, there has been a growing interest in understanding the role of developmental disorders in predicting the risk for eating disorders (ED) [12]. ED is defined in this context as a range of psychological disorders characterized by abnormal or pathological eating habits, impulsive eating behaviors, and related thoughts and emotions [3]. ED include anorexia nervosa (AN), bulimia nervosa (BM), binge eating disorder (BED), and night eatingsyndrome (NES).

The association between ADHD and the risk of ED has been frequently demonstrated [13,14]. Several studies and meta-analyses showed the cumulative prevalence of ED among patients with ADHD to be up to 24%. More specifically, the prevalence of AN was approximately 1% [15], whereas that of BN ranged from 9% [16] to 11% [17] and that of BED was between 9.5% [18] and 11.5% [19]. Contrariwise, when researchers investigated ADHD symptomatology in patients with known ED, slightly higher figures were obtained. For example, ADHD symptoms were found in 3% [20] to 16.2% [21] in patients with AN, in 9% [20] to 34.9% [21] in patients with BN, and in about 20% in patients with BED [21].

Most of the previous studies investigating ED were done on the adult population with ADHD. Only a few focused on the pediatric population, and thus the link reconciling the association of ADHD and ED is still not very conclusive [12]. Previous children's and adolescents' studies were all small in term of sample size, used a clinical sample, and did not focus on the type of ADHD or the role of pharmacological treatment.

The aim of the current research was to explore the prevalence of self-reported risk for ED among children and adolescents with ADHD of different types. The specific research objectives were to: 1) investigate the prevalence of self-reported risk for ED among cases with ADHD in comparison to healthy age- and sex-matched controls; 2) examine if the prevalence rate of self-reported risk for ED differs between ADHD subtypes; 3) determine if the prevalence rate of self-reported risk for ED differs according to pharmacologic treatment for ADHD.

We hypothesize that the overall risk of ED among young cases with ADHD will be at least twice of the controls, regardless of the sex of the participants or type of ADHD symptomology or pharmacologic treatment status for ADHD.

2. Methods

2.1. Design and participants

The current research was planned, executed, and reported in concordance with the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology: STROBE Statement [22].

This study was performed using a matched cohort design. To increase the precision of the study, a ratio of 1:2 was utilized to prevent the effect of misclassified controls (i.e., individuals who are affected with the outcome under study but who are classified as controls) [23]. Two controls were selected to match for each case based on sex and age [± one year of birth]. The control group was selected from a database of a cohort of another ongoing population-based study in the field of ED. Controls included were not previously diagnosed with any medical or psychiatric disease.

Recruitment of the cases with ADHD was carried out in the Child and Adolescent Psychiatry Unit (CAPU), Psychiatric Hospital, Salmaniya Medical Complex, Ministry of Health, Bahrain. The CAPU is the national center for diagnosis, treatment, and rehabilitation of patients with pervasive developmental disorders and other psychiatric disorders that might affect children and adolescents. Data were collected from the patients between January and April 2019. Our cases with ADHD (N = 70) were included based on a set of criteria. The inclusion criteria were the following: participants from both sexes, children and adolescents (19 years of age or less), and diagnosis with ADHD according to the CAPU protocol. The CAPU evaluation of clinical presentation includes a complete history and physical examination and a comprehensive review of information across home and school. The evaluation also takes into consideration the consequences of ADHD, such as sleep problems and school performance. The diagnosis is made against the Diagnostic and Statistical Manual of Mental Disorders (DSM) version IV-TR [24] for cases diagnosed before May 2013 or version 5 for cases diagnosed thereafter [3].

Furthermore, validated behavioral scales were used to aid in assessing ADHD & comorbid disorders in children and youth. In the CAPU, the Conners [25] brief is initially used, and if the patient scored 15 or more points, then the parent and teacher forms are also used. ADHD cases with a comorbid psychiatric (e.g., intellectual disability defined by Intelligence Quotient below 70) or medical (e.g., epilepsy) diagnosis were excluded from the study. Those who were recruited in other studies or clinical trials were also excluded from the study.

2.2. Sample size and sampling procedure

The sample size was estimated for this study using an estimated sample size for a matched case-control study. Asymptotic z test, 1:2 ratio of matched design assuming 10% probability of exposure among controls, and an OR = 3.0 of exposure in cases relatives to control. The sample size was estimated for the two-sided test with error probabilities of alpha of 0.05 and 80% of power (or beta = 0.2). The sample size calculation suggested that a minimum of 65 cases will be needed for a powered analysis. The sample of ADHD cases was selected using simple random sampling technique.

2.3. Ethical consideration

Ethical review and approval for this study were obtained from the Research Ethics Committee, Ministry of Health, Kingdom of Bahrain. Written informed consent was sought from the participants (or their legal guardian) before collecting data. Participation in this study was entirely voluntary with no monetary or non-monetary incentives.

2.4. Assessments and data collection

The participants were all interviewed to collect the required necessary information for the study and anthropometric measurements (weight and height). Digital scales were used to measure the body weight with a height rod attachment that was kept on a firm horizontal floor. The weight was recorded to the nearest 0.1 kg while the participants were standing upright and were not wearing shoes nor extra clothes (they were wearing light clothes). The height was measured with the rod attached to the weighing scale to the nearest 1.0 cm. Once the weight and height were measured, the body mass index (BMI) (kg/m^2) was calculated accordingly. The BMI was then categorized as per the World Health Organization (WHO)

Table 1
Socio-demographic characteristics and the risk of eating disorders of the attention deficit hyperactive disorder cases and healthy controls.

Characteristics	Cases (N = 70)	Controls (N = 140)
Continuous variables (mean ± SD)		
Age (Years)	13.45 (2.77)	15.62 (3.36)
Body Weight (Kg)	52.61 (16.54)	70.45 (13.27)
Body mass index (BMI)(Kg/)	19.02 (5.93)	25.57 (4.70)
Mean EAT-26 score	15.27 (6.82)	15.19 (3.62)
Categorical variables (%)		
Gender (Male)	74.29	74.29
Overweight	18.57	47.86
Obese	4.29	14.29
ADHD Type		
• Inattentive	24.29	–
• Hyperactive-Impulsive	17.14	–
• Mixed Type	58.57	–
Medication CNS Stimulants		
• Methylphenidate	38.57	–
ED Status as measured by EAT-26		
• Normal	68.57	87.86
• At risk	31.43	12.14

Table 2
Socio-demographic characteristics and the risk of eating disorders of the attention deficit hyperactive disorder cases by gender.

Characteristics	Males (N = 52)	Females (N = 18)
Continuous variables (mean ± SD)		
Age (years)	13.91 (2.03)	12.07 (1.00)
Body Weight (kg)	54.18 (17.53)	48.05 (12.57)
Body mass index (BMI)(kg/m2)	19.61 (6.25)	17.32 (4.62)
Mean EAT-26 score	15.59 (6.35)	14.33 (8.17)
Categorical variables (%):		
Overweigh	19.23	16.67
Obese	5.77	Nil
ADHD type		
• Inattentive	23.08	27.78
• Hyperactive-impulsive	57.69	61.11
• Mixed type	19.23	11.11
Medication CNS stimulants		
• Methylphenidate	42.31	27.78
ED status as measured by EAT-26		
• Normal	69.23	66.67
• At risk	30.77	33.33

Table 3
Odds ratios and confidence intervals to estimate the risk of eating disorders of the attention deficit hyperactive disorder.

	OR	95% CI	*P* value
Unadjusted model	3.31	1.62–6.78	.001
Adjusted model 1	**5.29**	**2.23–12.53**	**.001**
Body weight[a]	1.02	1.01–1.05	.044
Adjusted model 2			
Body Weight #age #gender	**5.65**	**2.35–13.61**	**.001**

[a] Similar results were obtained after adjusting for body mass index.

categories of underweight (BMI<18.5), normal (BMI 18.5–24.9), overweight (BMI 25.0–29.9), or obese (BMI≥30) [26].

A short interview comprised of demographics was administered and anthropometrics were taken by trained research assistant. For the ADHD cases, medical history, ADHD type, and any other relevant medical information including history of regular medications were obtained from the national electronic medical record.

To screen for the risk of ED among cases with ADHD and healthy controls, the short version of the Eating Attitudes Test- 26 items (EAT-26) [27] was used to evaluate the participants' attitudes with regard to preoccupation with food, dieting, inappropriate eating behaviors, physical appearance, and personal control over food and eating. EAT-26 is a commonly used self-report tool in research and clinical practice; it consists of 26 items with responses in a Likert-like scale: 0 = never, rarely or rarely, 1 = sometimes, 2 = many times, and 3 = always. The overall scores range between 26 and 78 points, with a score of 20 points or more suggesting of "at risk" of ED and warranting further evaluation. We used the standardized and validated Arabic translation of the EAT-26 [28]. Permission to use the EAT-26 was obtained from the developers via https://www.eat-26.com/. The psychometric properties of the EAT-26 are very high compared to the reference standard of a structured psychiatrist interview confirming fulfillment of an ED. A recent study showed that internal consistency is very high for the overall EAT-26 score with an approximate Cronbach alpha of 0.90 and that the score of ≥20 points is the best cut-off with a sensitivity of 100% and specificity of 97.8% [29]. The positive predictive value of cases was 91.3%, and the negative predictive value was 100%. Similar results were consistently obtained by other studies that aimed to examine the psychometric properties of the tool [30,31].

2.5. Statistical analyses

Descriptive statistics were summarized for the socio-demographic characteristics. The mean ± Standard Deviation (SD) was reported for a continuous variable, and proportion was reported for categorical variables. Logistic regression was performed, and the odds ratios (OR) and 95% confidence intervals (95% CI) were calculated, with significance considered at $P < .05$. All analyses were performed using Stata 15.0 software [32].

3. Results

This research aimed to study the prevalence of risk of ED among cases with ADHD and matched controls using a sample from the Kingdom of Bahrain. The mean EAT-26 for our entire sample was 15.22 (4.9)1 (95% CI 14.55–15.88). Table 1 describes the distribution of several socio-demographic and health indicators according to ADHD status. Cases with ADHD had lower body weight and BMI. Approximately 59% of ADHD cases were diagnosed with mixed types of ADHD, 24% had the inattentive type, and 17% had the hyperactive-impulsive type. About 39% of the cases received pharmacologic treatment in the form of CNS stimulant (methylphenidate). The mean EAT-26 scores were similar for the cases and controls; however, the cases had larger standard deviation dispersion. When the EAT-26 was converted to the binary outcome of estimating the risk of ED, 31.43% of the cases with ADHD were determined to be 'at risk' compared to 12.14% of the controls.

The disordered eating in cases with ADHD in our study was associated with BMI. For ADHD cases, the prevalence of ED among the BMI categories (underweight, normal, overweight, and obese) was found to be 27.27%, 14.39%, 53.85%, and 100%, respectively, while controls reported 7.14%, 15.38%, 11.94%, and 10%, respectively.

Table 2 describes a breakdown of the characteristics describing health and socio-demographic characteristics for cases as classified by gender. According to Table 2, male cases were approximately two years older, which suggests that boys get an earlier diagnosis compared to girls due to symptom severity. The ADHD type confirms this symptom severity hypothesis; approximately 20% of boys have hyperactive-impulsive ADHD type compared to approximately 11% of the girls' group. Girls' cases with ADHD appeared to be slightly at higher risk for ED with 33.33% of the cases screened positive using the EAT-26 compared to 30.77% of boys.

Table 3 provides the OR and 95% CI and P-Value for three

models: 1) unadjusted model, 2) adjusted for body weight, and 3) adjusted for interaction between age x gender x body weight. Cases with ADHD have a three-fold risk for ED (OR 3.31, 95% CI 1.62–6.78, $P = 0.001$) compared to controls in the adjusted model. Adjusting for age and gender did not appear to improve the predictions. However, adjusting for body weight or BMI showed that body weight is an important risk factor for predicting the risk of ED. Finally, although age or gender or age and gender were not successful predictors of ED among cases with ADHD, an interaction term of age, gender, and body weight were very sensitive in predicting the risk of ED among cases with ADHD.

4. Discussion

This study aimed to explore the prevalence of risk for ED among children and adolescents with ADHD. The main findings of this study can be summarized as follows: First, children and adolescents with ADHD have three-fold the risk of ED compared to matched healthy controls. Second, children and adolescents with ADHD in our study had a lower BMI than controls and consequently lower prevalence of overweight and obesity. Third, increased body weight/large BMI (overweight or obese) was a significant predictor for the risk of ED among children and adolescents with ADHD. Lastly, medication status (methylphenidate) did not seem to be a predictor for the risk for ED in cases with ADHD.

Our study shows that the risk of developing ED in children and adolescents with ADHD is three-fold higher than healthy controls. This finding is consistent with previous research which was predominantly done in adults with ADHD [12,14]. The epidemiological strength of association between ADHD and the risk of ED appears to be strong and stable over age. Female cases with ADHD appeared to have a slightly increased risk of ED, but this was not significant. One possible explanation for the high risk of ED among cases with ADHD is that both disorders rely on a common neural pathway, namely dopaminergic signaling [33]. Dopaminergic signaling is very important for emotions and motor functioning with the former enabling the latter, as in a combined, coordinated movement such as eating [34].

Regarding overweight and obesity in cases with ADHD, our study revealed that cases with ADHD had a lower prevalence of overweight and obesity compared to controls. Previous research shows that the risk of obesity in people with ADHD is increased and ranges between 1.37 [35] and 1.55 [36]. It must be noted, however, that these studies were inclusive of adults with ADHD, and the comorbidity between ADHD and obesity has not been examined sufficiently in younger children and adolescents.

We hypothesize that adults with ADHD will have a higher BMI compared to their healthy counterparts for two reasons. First, they experience some difficulty in planning and executing healthy behaviors, including self-care and health habits such as healthy diet and compliance with breakfast and standard three meals per day. Second, up to 70% of ADHD cases display at least one other psychiatric comorbid disorder or neurologic problem [37]. The previous two explanations do not apply to our sample because we excluded ADHD comorbid disorders and our sample consisted of children and adolescents who still live with and are cared for by their parents and are therefore dependent on them for their dietary intake to some extent. Furthermore, it must be noted that the mean basal metabolic rate (in absolute values and adjusted for fat-free body mass) was found to be higher in a sample of ADHD than in a control group by up to 150 kcal/day [38].

At first glance, a low BMI (lower prevalence of obesity) and high risk of ED in our cases seem to be incompatible with previous literature. The increased risk of ED was present mainly in cases with increased body weight or high BMI, suggesting that body weight is an explanatory factor for the increased risk. The previous research study showed that the relationship between ADHD and the risk of ED seems to be specific to cases with ED who exhibited binge eating features [12,35]. Furthermore, our study also highlighted the role of interaction between three risk factors (age, gender, and BMI), wherein these three risk factors taken together are a better predictor for ED among children with ADHD.

As expected, medications (methylphenidate) did not appear to be associated with the risk of ED in our sample of children and adolescents with ADHD. The impact of psychostimulant treatment was not consistent across previous studies, with some studies showing a significant reduction of risk of ED and others suggesting an increased risk of ED [12]. Our results could also point to the bidirectional association between psychostimulants and ED, in the sense that psychostimulants prevented the occurrence of ED in those ADHD cases taking them.

4.1. Strengths and limitations

There are several strengths which make this study important: First, its focus on children and adolescents with ADHD with no other psychiatric or medical comorbidity; second, the matched case-control design with a ratio of 1:2 makes the sample comparably large and allows for powered analysis; third, girls with ADHD are included despite their numbers being lower as compared to boys. Taken together, we advocate that our results are representative of children and adolescent cases with ADHD in our country.

There are, however, also some limitations of this study to address. First, the reliance on one single screening tool (i.e. EAT-26) might not identify the full range of symptoms associated with ED. The decision to include one instrument was to avoid consuming the time and attention of the participants, especially those with ADHD. Second, the controls were slightly older than the cases; this is because they were taken from the dataset of a cohort that aimed to examine ED in a nationally representative sample that excluded children below 12 years of age.

5. Conclusion

The present study shows that children and adolescents with ADHD have a three-fold increased risk of developing ED compared to healthy controls. No significant difference was observed between ADHD cases for age or gender, body weight or BMI; however, the results showed that increased risk of ED is associated with increased body weight or large BMI. This research raised the recommendation that children and adolescents with ADHD should be screened for disordered eating.

Ethical statement

The Research Committee of the Ministry of Health of Bahrain approved this study.

Informed consent

Informed consent was obtained from all individual participants (or their legal guardian) involved in the study.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Credit author statement

HJ: conceptualization, methodology, software, validation, formal analysis, data curation, writing - original draft, supervision, project administration, writing - review & editing.

AA: conceptualization, methodology, validation, data curation, writing - original draft, writing - review & editing.

ABJ: software, investigation, data curation.

AMJ: software, investigation, data curation.

LD: software, investigation, data curation.

MF: writing - original draft, writing - review & editing.

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