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Comorbidities Associated With Attention-Deficit/Hyperactivity Disorder in Children and Adolescents at a Tertiary Care Setting

Jigar Jogia
Zayed University

Alia H. Sharif
Zayed University

Faisal A. Nawaz
Mohammed Bin Rashid University of Medicine and Health Sciences

Abdul Rahman Khan
Mohammed Bin Rashid University of Medicine and Health Sciences

Raed H. Alawami
King Fahad Specialist Hospital, Dammam

See next page for additional authors

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Author First name, Last name, Institution

Jigar Jogia, Alia H. Sharif, Faisal A. Nawaz, Abdul Rahman Khan, Raed H. Alawami, Maryam A. Aljanahi, and Meshal A. Sultan

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Jigar Jogia, BSc, PhD¹, Alia H. Sharif, BSc (cand.)¹,
Faisal A. Nawaz, MBBS (cand.)², Abdul Rahman Khan, MBBS (cand.)²,
Raed H. Alawami, MBBS³, Maryam A. Aljanahi, BSc¹,
and Meshal A. Sultan, MBBS, FRCPC^{2,4}

Abstract

Studies have revealed high rates of neurodevelopmental and psychiatric comorbid conditions among individuals diagnosed with attention-deficit/hyperactivity disorder (ADHD). However, research on this topic in the Arab world has been limited. This study evaluates the medical, neurodevelopmental, and psychiatric comorbidities in children and adolescents diagnosed with ADHD in Dubai, United Arab Emirates (UAE). A total of 428 pediatric patients diagnosed with ADHD were included. Children and adolescents with ADHD had high rates of comorbid disorders. Twenty comorbid conditions were identified. More than 3 quarters of the study sample had at least 1 comorbid disorder. The most common comorbidity among children was autism spectrum disorder, and among adolescents was anxiety disorders. Comprehensive assessments are highly warranted to identify and manage associated comorbid conditions. Further research is needed in exploring the biopsychosocial factors contributing to the elevated rate of comorbidity in children and adolescents with ADHD.

Keywords

attention-deficit/hyperactivity disorder, children, adolescents, Dubai, United Arab Emirates, comorbidities, neurodevelopmental disorder

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Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental disorders. According to a meta-analysis of 175 studies, the worldwide prevalence of ADHD is estimated to be around 7%.¹ A systematic review of the epidemiology of ADHD in 22 Arab countries revealed comparable rates. For instance, the prevalence of ADHD, predominantly hyperactive presentation was 1.4% to 7.8%, and the prevalence of ADHD, predominantly inattentive presentation was 2.1% to 2.7%.² A study exploring the rate of ADHD among school-age children and adolescents in the United Arab Emirates (UAE) revealed significant Conners rating scale scores among 4.1% as per parents' report and among 3.4% as per teachers' report.³

Presence of comorbid conditions in children and adolescents diagnosed with ADHD is very common. According to a study, which included 1919 individuals diagnosed with ADHD, about two-thirds had at least one

¹Zayed University, Dubai, UAE

²Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, UAE

³King Fahad Specialist Hospital, Dammam, Eastern Province, Saudi Arabia

⁴Al Jalila Children's Speciality Hospital, Dubai, UAE

Corresponding Author:

Meshal A. Sultan, College of Medicine, Mohammed Bin Rashid University of Medicine and Health Sciences, PO Box 505055, Dubai, UAE.

Email: meshal.sultan@mbru.ac.ae



comorbid neurodevelopmental or psychiatric disorder.⁴ Learning difficulties are commonly present among children with ADHD.⁵ Studies have revealed that rates of grade repetitions, and poor academic performance are more frequent in this population.⁵ Studies in the Arab region revealed high rates of comorbidity. For instance, mood disorders were present in nearly one fifth of the sample, and anxiety disorders were present in about one sixth.⁶

Higher severity of symptoms, as well as ADHD combined presentation were associated with higher rates of comorbidity.⁴ Co-occurring anxiety or mood disorders have been resulting in more impairment in psychosocial functioning.⁵ Children with ADHD along with an anxiety disorder or a depressive disorder had tenfold risk of poor academic performance compared with children who only had ADHD.⁷ Furthermore, comorbidity with conduct disorder has been associated with an increased risk for cigarette smoking and substance abuse.⁸

There are only 2 studies in the Arab region that have evaluated comorbid conditions in ADHD,^{6,9} and none in the United Arab Emirates to date. We have conducted this study to explore medical, neurodevelopmental, and psychiatric comorbidities in children and adolescents diagnosed with ADHD. Data has been analyzed from a sample that had a comprehensive assessment at Al Jalila Children's Specialty Hospital, a tertiary pediatric institution in Dubai, UAE. This study explored the contributing factors that play a role in the development of ADHD and its comorbidities. Furthermore, it evaluated various determinants of co-morbidity, and their impact on the course trajectory of ADHD.

Methods

The current study is an epidemiological/descriptive study that aimed to explore retrospective data from electronic medical records in a tertiary pediatric hospital in Dubai, UAE. The study used systematic sampling on a population of children and adolescents diagnosed with ADHD at Al Jalila Children's Specialty Hospital between the years 2017 to 2020. All the assessments of the included sample were conducted by qualified child and adolescent psychiatrists. The diagnoses were based on clinical assessments as per the Diagnostic Statistical Manual of Mental Disorders, fifth Edition (DSM-5) criteria.¹⁰ For children and adolescents who had comorbid conditions, for example, autism spectrum disorder, multidisciplinary team (MDT) comprehensive assessments were conducted in line with recommendations of international guidelines.¹¹

Participants

The population of interest for this study included children and adolescents aged 4 to 17 years old, who have been diagnosed with ADHD following an evaluation at the Mental Health Services at Al Jalila Children's Specialty Hospital. The data included in the study was for all children and adolescents assessed during the years 2017, 2018, 2019, and 2020 who met the study criteria. Patients aged less than 4 years old or older than 18 years old were excluded from the study and any patient not diagnosed with ADHD were also excluded.

Materials

A data collection tool generated using Microsoft Excel obtained various demographic information, which include age, gender, as well as information relating to diagnoses, scores of relevant rating scales, birth-related parameters, and family history of neurodevelopmental disorders.

Procedure

Data was collected through the electronic records at Al Jalila Children's Specialty Hospital. To preserve confidentiality and security a de-identified patient database was compiled. All data was protected through restricted user-access via login on hospital premises only. The safety of the data and patient related information was overseen by the principal investigator who consulted with the research committee at Al Jalila Children's for any concerns or questions.

Ethics approval and consent to participate. No patients were excluded from this study based on racial, gender, religious, or cultural backgrounds. Consent was not required for this study, as it was based on assessing anonymous archival data. The local ethical review board, at Dubai Healthcare City Authority (DHCA), approval was sought before conducting the study under the IRB approval DHCR/June 2, 2020. Additional ethical approval was gained from the Zayed University Research Ethics committee.

Analysis

The data collection tool obtained various information as mentioned above. Statistical Analysis software package SPSS Version 26 was used to compile descriptive statistics and conduct correlations and paired *t*-test analyses.

Results

Demographics

The total number of medical records was for 497 children and adolescents of whom 428 were diagnosed with ADHD. The minimum age of the sample was 4 years old and the maximum was 17 years old (mean=8.29, SD=3.34). The sample included both males and females. 332 (77.6%) patients were male while 96 (22.4%) were female. The 497 patients represented 37 different nationalities, with Emirati patients evidently comprising the majority. Emirati patients made up 68.41% (n=340), followed by Egyptian patients at 4.83% (n=24), Jordanians at 2.62% (n=13), Indian and British patients at 2.0% (n=10), while Yemeni, Saudi, Lebanese, and American patients accounting for 1.81% (n=9).

Perinatal Factors

The mean birth weight of the individuals in this study was 2.7 kg, SD=0.9. Patient's mothers mean age=32.9, SD=7.4. Based on the available data, regarding gestational age at delivery, 35 (10.6%) were born premature, while 296 (89.4%) of the patients were born at full term. Paternal age mean=36.2, SD=8.5). In terms of complications during pregnancy, out of 263 reported information, 39 (14.8%) of the patients' mothers had Gestational Diabetes (GD). Out of 273 reported information, 48 (17.6%) of the patients' mothers had psychosocial stress during pregnancy. Out of 262 reported information, 4 (1.5%) of the patients' mother had anxiety during pregnancy. Out of 81 reported information, 13 (5.0%) of the patients' mothers had Pre/Post-partum depression (PPD) during or after pregnancy. Smoking during pregnancy was reported in 3 (4.2%) of the mothers out of 71 available information. Alcohol consumption during pregnancy was reported by one (1.6%) of the mothers out of 63 available information. One (0.7%) of the patients' mothers consumed drugs during pregnancy out of the 135 available information.

Comorbidity

The comorbidity rate was high in the study sample. 77% of the patients with ADHD had at least 1 comorbidity, 42% had at least 2 comorbidities, and 20% had at least 3 comorbid conditions (Figure 1). The top 5 comorbid disorders were autism spectrum disorder (ASD), learning disorder, sleep problems, language disorder, and anxiety disorders (Table 1). Patients aged 4 to 11 with ADHD (n=335) had a number of comorbid conditions namely ASD (n=83), learning disorder (n=68), language disorder (n=65), sleep problems

(n=59), and anxiety (n=48) (Table 2). Patients with ADHD aged 12 and above (n=70) had a number of comorbid conditions namely Anxiety (n=24), learning disorder (n=22), sleep problems (n=21), ASD (n=14), and intellectual disability (n=13) (Table 3).

Family History of Patients With ADHD

Twenty-two (6.3%) of the patients, out of 351 patients with available information, had family history of ADHD in first degree relatives. Thirty-four (9.9%) of the patients, out of 345 patients with available information, had a family history of ADHD in second degree relatives. Family history of ASD in first degree relatives was reported in 11 (3.2%), out of 344 patients with available information. Family history of ASD in second degree relatives was reported in 46 (13.4%) out of 344 patients with available information. Family history of anxiety disorders in first degree relatives was reported in 19 (5.7%), out of 335 patients with available information. Family history of anxiety disorders in second degree relatives was reported in 9 (2.7%), out of 334 patients with available information.

Gender and Diagnosis

A chi-square test of independence was performed to examine the relation between gender and ADHD. Females comprised 96 (22%) and males 332 (78%) of the total sample of 428 children and adolescents. The relationship between these variables was not significant $\chi^2(1, N=497)=0.16, P=.89$. In the 332 male children and adolescents with ADHD, 91 patients had comorbid ASD, 66 had sleep problems, 63 had language disorder, 63 had learning disorders, 54 had anxiety disorders, 25 had intellectual disability, and 22 had epilepsy. In the 96 female children and adolescents with ADHD, 28 had comorbid learning disorders, 21 with sleep problems, 18 had anxiety disorders, 17 had language disorders, 15 had intellectual disability, 14 had ASD, and 9 had epilepsy.

Correlational Analysis for Age and ADHD Symptomatology

The severity of symptoms as assessed by the Vanderbilt scale at baseline in 151 patients with ADHD, age 4 to 11 years, as reported by parents revealed a mean score of 5.7 (SD=2.6) for inattentive symptoms, and a mean score of 5.9 (SD=2.8) for hyperactive/impulsive symptoms. In 105 children, the same scale reported by teachers showed a mean score of 5.1 (SD=2.5) for inattentive symptoms and a mean score of 4.4 (SD=2.9) for hyperactive/impulsive symptoms (Table 4).

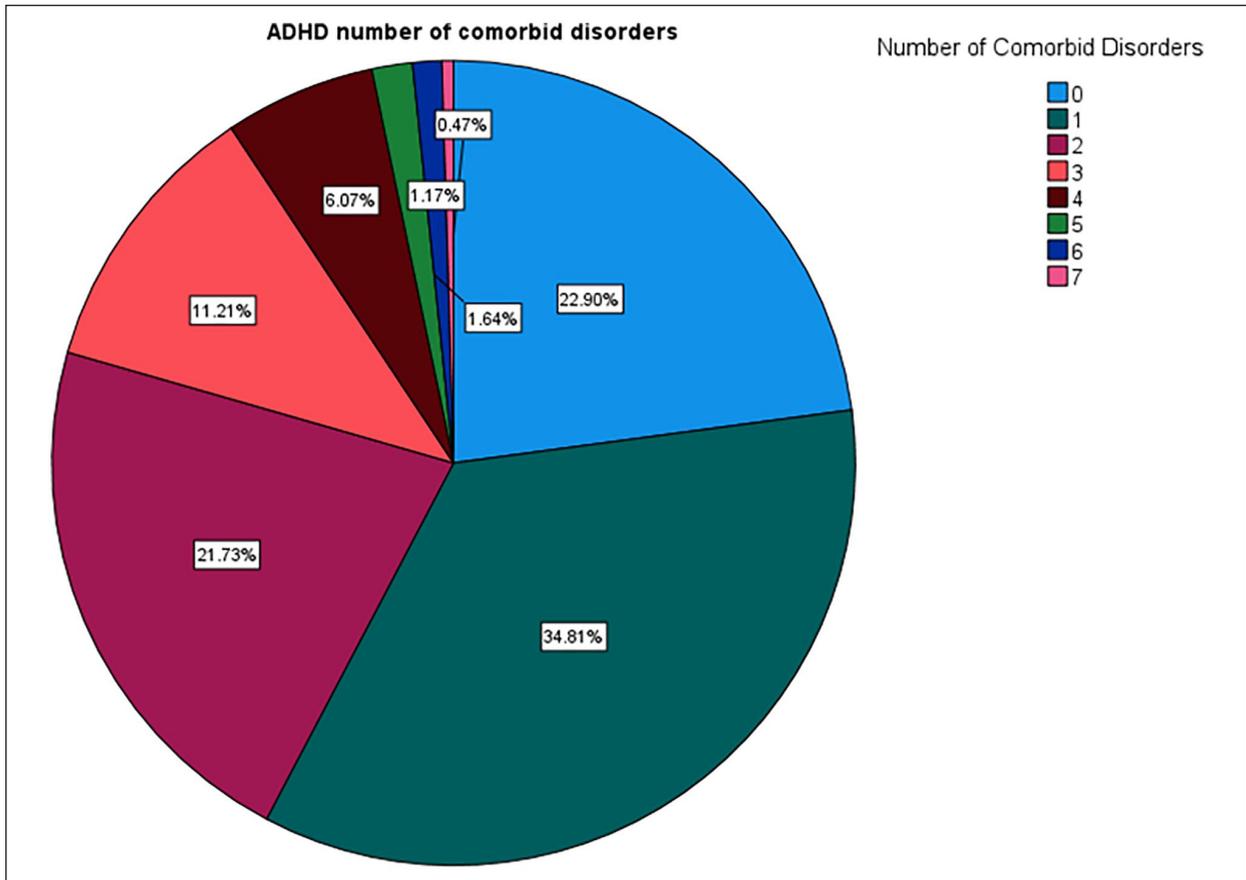


Figure 1. Number of Comorbid disorders with ADHD.

Table 1. Comorbid Disorders With ADHD in the Study Sample.

Descriptive statistics (n = 428)

	Sum	Mean	Std. deviation
Autism spectrum disorder	105	0.25	0.43
Intellectual disability	40	0.09	0.29
Language disorder	80	0.19	0.39
Motor disorder	8	0.02	0.14
Anxiety	72	0.17	0.38
Learning disorder	91	0.21	0.41
Depressive disorder	7	0.02	0.13
Oppositional defiant disorder	38	0.09	0.29
Conduct disorder	10	0.02	0.15
Obsessive compulsive disorder	8	0.02	0.14
Post-traumatic stress disorder	6	0.01	0.12
Tic disorder	12	0.03	0.17
Sleep problems	86	0.20	0.40
Sleep disorder	15	0.04	0.18
Fragile-X syndrome	4	0.01	0.10
Epilepsy	31	0.07	0.26

(continued)

Table 1. (continued)

Descriptive statistics (n = 428)			
	Sum	Mean	Std. deviation
Asthma	19	0.04	0.21
Enuresis	22	0.05	0.22
Substance abuse disorder	1	0	0.05
Suicide	0	0	0
Bipolar disorder	1	0	0.05
Schizophrenia	0	0	0
Eating disorder	6	0.01	0.12

Table 2. Comorbid Disorders With ADHD Ages 4 to 11 Years.

Descriptive statistics (n = 335)			
	Sum	Mean	Std. deviation
Autism spectrum disorder	83	0.25	0.43
Intellectual disability	26	0.08	0.27
Language disorder	65	0.19	0.40
Motor disorder	8	0.02	0.15
Anxiety	48	0.14	0.35
Learning disorder	68	0.20	0.40
Depressive disorder	3	0.01	0.09
Oppositional defiant disorder	29	0.09	0.28
Conduct disorder	9	0.03	0.16
Obsessive compulsive disorder	3	0.01	0.09
Post-traumatic stress disorder	2	0.01	0.08
Tic disorder	9	0.03	0.16
Sleep problems	59	0.18	0.38
Sleep disorder	10	0.03	0.17
Fragile-X syndrome	3	0.01	0.09
Epilepsy	25	0.07	0.26
Asthma	16	0.05	0.21
Enuresis	18	0.05	0.23
Substance abuse disorder	0	0	0
Suicide	0	0	0
Bipolar disorder	0	0	0
Schizophrenia	0	0	0
Eating disorder	5	0.01	0.12

Table 3. Comorbid Disorders With ADHD Age 12 Years and Above.

Descriptive statistics (n = 70)			
	Sum	Mean	Std. deviation
Autism spectrum disorder	14	0.20	0.40
Intellectual disability	13	0.19	0.39
Language disorder	8	0.11	0.32
Motor disorder	0	0	0

(continued)

Table 3. (continued)

Descriptive statistics (n = 70)			
	Sum	Mean	Std. deviation
Anxiety	24	0.34	0.48
Learning disorder	22	0.31	0.47
Depressive disorder	4	0.06	0.23
Oppositional defiant disorder	9	0.13	0.34
Conduct disorder	1	0.01	0.12
Obsessive compulsive disorder	5	0.07	0.60
Post-traumatic stress disorder	4	0.06	0.23
Tic disorder	2	0.03	0.17
Sleep problems	21	0.30	0.46
Sleep disorder	3	0.04	0.12
Fragile-X syndrome	1	0.01	0.17
Epilepsy	2	0.03	0.17
Asthma	2	0.03	0.17
Enuresis	4	0.06	0.23
Substance abuse disorder	1	0.01	0.12
Suicide	0	0	0
Bipolar disorder	1	0.01	0.12
Schizophrenia	0	0	0
Eating disorder	0	0	0

Table 4. Mean Scores for the Baseline Vanderbilt Scale for Patients With ADHD Age 4 to 11 Years.

Descriptive statistics		
	Mean	Std. deviation
Vanderbilt Parent Inattentive Score (Baseline) n = 151	5.72	2.56
Vanderbilt Parent Hyperactive/impulsive (Baseline) n = 151	5.90	2.81
Vanderbilt Teacher Inattentive Score (Baseline) n = 105	5.08	2.48
Vanderbilt Teacher Hyperactive/impulsive (Baseline) n = 105	4.40	2.86

Among adolescents, age 12 to 17 years, with ADHD. Only 34 adolescents had the Vanderbilt rating scale parent version, inattentive domain, completed, and 33 had the Vanderbilt rating scale parent version, hyperactive/impulsive domain, completed. The mean score for inattentive symptoms reported by parents was 6.1 (SD=2.4) and for hyperactive/impulsive symptoms was 4.5 (SD=3). Only 19 adolescents had the Vanderbilt rating scale teacher version, inattentive domain, completed, and 18 had the Vanderbilt rating scale teacher version, hyperactive/impulsive domain, completed. The mean score for inattentive symptoms reported by teachers was 4.7 (SD=2.7) and for hyperactive/impulsive symptoms was 4.1 (SD=2.6) (Table 5). Although the mean score of hyperactive/impulsive symptoms reported by parents as well as teachers was lower among the adolescent group

in comparison to the children group, it is hard to draw a conclusion given that we did not have an adequate number of Vanderbilt scale follow up scores.

Follow Up Analysis of Symptoms Among Patients With ADHD

A negative correlation was found between Vanderbilt parent scale hyperactive/impulsive domain scores at baseline with age $r(191) = -.200, P = .005$ and Vanderbilt teacher hyperactive/impulsive domain scores at baseline with age $r(126) = -.200, P = .002$. Vanderbilt scale hyperactive/impulsive domain scores declined over time.

When following a subsample of patients, with available data, from baseline to follow up at 3 months we found Vanderbilt, hyperactive/impulsive domain, scores

Table 5. Mean Scores for the Baseline Vanderbilt Scale for Patients With ADHD Age 12 to 17 Years.

Descriptive statistics	Mean	Std. deviation
Vanderbilt Parent Inattentive Score (Baseline) n=34	6.17	2.41
Vanderbilt Parent Hyperactive/impulsive (Baseline) n=33	4.48	3.01
Vanderbilt Teacher Inattentive Score (Baseline) n=19	4.68	2.72
Vanderbilt Teacher Hyperactive/impulsive (Baseline) n=18	4.05	2.60

decline on follow up at 3 months. This was based on a paired *t*-test that was conducted for both the Vanderbilt parent hyperactive/impulsive domain scale $t(26) = .258$, $P = .016$ $n = 27$; and the Vanderbilt teacher hyperactive/impulsive domain scale $t(14) = .239$, $P = .031$ $n = 15$.

Discussion

This is the first study in the UAE to examine children and adolescents with ADHD and the rates of comorbidity. The database used in the study was from a sample of patients assessed at a tertiary pediatric hospital. Our key findings reveal that in a sample of 428 pediatric population with ADHD, 77% had 1 or more comorbid disorder, 42% had 2 or more comorbid disorders, and 20% had 3 or more comorbid disorders. The top 5 comorbid disorders were autism spectrum disorder (ASD), learning disorder, sleep problems, language disorder, and anxiety disorders.

Our sample consisted of 332 males and 96 females. Chi square results revealed proportions in our sample of patients with ADHD did not differ between males and females. For the top 5 comorbidities we found gender differences in proportions of ASD and learning disorders.

The results from a correlational analysis indicated ADHD symptoms of hyperactivity/impulsivity consistently decrease with age. Also, in a subsample from baseline to 3 month follow up we observed decreased hyperactive symptoms which may be indicative of treatment response. We ran a preliminary analysis examining ADHD symptomatology as measured by the Vanderbilt Parent Version ($n = 191$) and Teacher Version ($n = 126$) Scales on a subsample.

Rate of Comorbid Disorders

The findings of this study revealed high rates of comorbid neurodevelopmental and psychiatric disorders among children diagnosed with ADHD. Twenty co-occurring disorders were reported in this study. Comorbidity with neurodevelopmental disorders, for instance ASD, learning disorders, and language disorder, was noted to be higher than other conditions.

The overlap between ADHD, externalizing (eg, oppositional defiant disorder or conduct disorder) and internalizing disorders (eg, anxiety disorders or mood disorders) has been reported in multiple studies.^{7,12-14} Furthermore, research has highlighted elevated comorbidity rate among neurodevelopmental disorders, for instance ADHD with learning disorders or autism spectrum disorder.^{12,13,15-17}

Various hypotheses have been proposed to explain comorbidity in ADHD: (1) comorbid disorders are phenotypic variabilities of ADHD rather than representing distinct disorders, (2) each comorbidity represents a separate disorder, (3) comorbid disorders share common risk factors, (4) comorbid disorders represent distinct subtypes within ADHD, (5) ADHD is an early manifestation of the comorbid disorder, (6) ADHD increases the risk for the development of the comorbid disorder.¹²

Effect of Age on Symptoms and Rate of Comorbid Disorders

This study has shown that the severity of hyperactive/impulsive symptoms was lower among adolescents in comparison to children. However, it was difficult to determine an age-related association with severity of symptoms since adequate longitudinal data was lacking. Among children aged 4 to 11 years in the study sample ASD, learning disorder, language disorder, sleep problems and anxiety disorders were the most common comorbidities. However, in adolescents aged 12 to 17 years most common comorbidities were anxiety disorders, followed by learning disorder, sleep problems, ASD and intellectual disability.

A previous study evaluating 811 children and adolescents with ADHD revealed similarities in both age groups, that is, children versus adolescents, in terms of the mean number of ADHD symptoms.¹⁸ However, some differences were noted in regards to the rate of comorbid conditions. For instance, major depression was present in 30% of the adolescents' sample, in comparison to 25% of the children's sample.¹⁸ The rate of conduct disorder was 23% among adolescents and 15%

among children.¹⁸ The rate of anxiety disorders was more similar among the 2 groups as it was 59% among adolescents and 62% among children.¹⁸ Longitudinal studies have suggested that persistence of symptoms into adulthood occurs in around two-thirds of individuals diagnosed with ADHD.¹⁹

A study assessing the effects of age on functional impairment among 416 children and adolescents revealed greater homework problems in the adolescents' group.²⁰ This difference was attributed to the increase in academic demands as students progress in school.²⁰

Effect of Gender on Symptoms and Rate of Comorbid Disorders

The majority of the study sample were male children and adolescents (78%). The rate of comorbid conditions was different, for instance 27% of the male sample had ASD while only 15% of the female sample had ASD. While 16% of the male sample had an anxiety disorder and 19% of the female sample had an anxiety disorder.

Although gender did not moderate associations between comorbid symptoms and sleep problems, there is evidence that girls with ADHD experience more sleep problems than boys with ADHD.²¹ Although our study did not find a significant association between gender and ADHD diagnosis, sleep problems were identified in a higher proportion amongst females (21.9%) than their male counterparts (19.9%). This goes in-line with existing studies on gender and sleep problems, as discussed above.

Correlations between ADHD subtypes and comorbid conditions within genders were noted in a study evaluating 1896 children.²² In children diagnosed with the combined subtype of ADHD, boys were more likely to be comorbid with mood disorders than girls.²² For those diagnosed with the inattentive type, girls were more likely to be comorbid with anxiety disorders than boys.²² In our study sample, females (18.8%) represented a higher proportion of anxiety disorders as an ADHD comorbidity than their male counterparts (16.3%).

Potential Pre- and Perinatal Risk Factors

This study has evaluated a variety of potential pre- and perinatal risk factors, for instance family history of neurodevelopmental disorders, weight at birth, premature delivery, gestational diabetes, maternal smoking, psychosocial stressors during pregnancy.

Studies have shown a heritability link associated with ADHD of up to 80%,²³ with the potential of detection as early as the first 2 years of life.²⁴ In a study by Starck et al²⁵ assessing both parents and children with ADHD,

ADHD occurrence for mothers of children with ADHD was 41.3%, 51.0% for fathers. No significant correlation between parental and child diagnoses was found.²⁵

Beyond the genetic link, there is considerable interest in the role that the prenatal environment might play in the development of ADHD. This is highlighted through various studies that looked into associations between prenatal risk factors (eg, prematurity, gestational age, birth weight, maternal smoking during pregnancy) and ADHD.²⁶⁻²⁸

Henriksen et al²⁹ conducted a nationwide cohort study of live singleton birth after spontaneous onset of labor (N=546 146) of which 4617 had a diagnosis of ADHD, further supporting the association between prematurity and ADHD.

Studies by Halmøy et al,²⁸ Henriksen et al,²⁹ and Silva et al,³⁰ all concluded that low birth weight conferred risk for ADHD in unadjusted analyses. On the contrary, Nawaz and Sultan¹⁷ found no significant association between low birthweight and ADHD, and instead found a statistical correlation with high birth weight and ADHD.

Two of these studies reported that children who are born small for gestational age (SGA) were at an increased risk for getting diagnosed with ADHD.²⁸⁻³⁰ Similar findings were observed in a large-scale study of 113 227 children where those born early preterm were rated with more symptoms of ADHD, inattention, and hyperactivity/impulsivity than term-born children.³¹

Langley et al³² demonstrated that both maternal and paternal smoking during pregnancy was associated with increased parent-reported ADHD symptoms. Recent studies on the topic of maternal substance abuse during pregnancy and ADHD diagnosis were not identified, there is a need for further investigation on this plausible relationship.

Strengths and limitations. Strengths of this study include the large sample size as well as data being collected from encounters over a 4-year period. Furthermore, it explored multiple variables that may impact comorbidity rate. Limitations of this study include missing data on some variables related to risk factors as well as missing scores of follow up rating scales. The reason for the missing data is not clear. If these information were available they could have contributed to a more in depth understanding of biopsychosocial contributing factors to the development of comorbidity as well as their impact on the trajectory of symptoms. Additionally, the limitation in reporting family history of neurodevelopmental and psychiatric disorders may be in the context of lack of resources in the past.

Furthermore, the gender distribution in the study sample resulted in a relatively small total number of

females, which impacted the ability to explore significant differences in clinical presentation. Although data was collected from the only child and adolescent mental health center of excellence in the UAE, participants were not recruited from nationwide population sampling.

Implications. Elevated rate of comorbid neurodevelopmental and psychiatric disorders in children with ADHD have been highlighted in this study. Previous studies have indicated that presence of comorbid conditions in individuals with ADHD has resulted in significant impairment in academic performance.^{7,20,33,34} Additionally, an increase in stress levels in the family household has been reported.³⁴ Longitudinal research has also shown that presence of comorbidity predicts persistence of ADHD symptoms.³⁵

These findings highlight the importance of education and awareness among parents, teachers and healthcare professionals. This includes the importance of seeking comprehensive clinical assessments. Additionally, early evidence-based interventions for ADHD symptoms and comorbid disorders are highly recommended. Accommodation at school will contribute to children with ADHD achieving their highest potential. Furthermore, assessment of stress level among parents and family members will assist in allocation of appropriate support services.

Future research recommendations. The development of ADHD has been associated with various contributing factors including demographics, genetics and co-morbidities as explored by our study. Our findings of early age of onset, male preponderance and strong comorbidity association with other childhood neurodevelopmental disorders supports the inclusion of ADHD as part of the neurodevelopmental group of disorders in the DSM-5. Due to the multifactorial nature underlying the etiology of ADHD, it is vital that we have a multidisciplinary and integrated approach for treating children and adolescents with ADHD.³⁶ In line, there should be more research done that explores the neuropsychiatric pathophysiology of ADHD. This could include looking at various medical diagnostic parameters such as electroencephalography, brain imaging or other biological markers.

Given the genetic component behind ADHD, research involving genomic sequencing and analysis is now progressing via large scale collaborations. This could have essential clinical implications as it could potentially lead to early detection, and precision-based management. A pertinent area of future research that is worth exploring is how treatment of parent ADHD might impact on child ADHD features and comorbidity. This would help us get

a deeper understanding of the etiology of ADHD, if it's mainly due to environmental or genetic factors.

Conclusion

Similar to findings of international research, this study has revealed a high rate of comorbidities in children and adolescents diagnosed with ADHD in the UAE. The results showed that the most common comorbidities were ASD, learning disorder, and language disorder, which highlights the significant overlap between neurodevelopmental disorders. Furthermore, more than 40% of the children and adolescents with ADHD in this study had at least 2 additional comorbid disorders.

Further research is needed in this field to explore the biopsychosocial factors contributing to the elevated rate of comorbidity in children and adolescents with ADHD. In the context of contribution of comorbidity to marked impairment in functioning, comprehensive assessments are highly warranted to identify and manage any associated conditions.

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Author Contributions

JJ: Contributed to developing the research question, literature search and review, study design, developing the data collection tool, data analysis, and manuscript preparation. AHS: Contributed by conducting the literature search and review, developing the data collection tool, obtaining data, data analysis, and manuscript preparation. FAN: Contributed by conducting the literature search and review, developing the data collection tool, obtaining data, and manuscript preparation. ARK: Contributed by conducting the literature search and review, developing the data collection tool, obtaining data, and manuscript preparation. RHA: Contributed by conducting the literature search and review, developing the data collection tool, obtaining data, and manuscript preparation. MAA: Contributed by conducting the literature search and review; data analysis, and manuscript preparation. MAS: Contributed to developing the research question, study design, literature review, revision of the data analysis, manuscript preparation, and supervised the study.

Declaration of Conflicting Interests

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Ethics Approval and Consent to Participate

No patients were excluded from this study based on racial, gender, religious, or cultural backgrounds. Consent was not required for this study, as it was based on assessing anonymous archival data. The local ethical review board, at Dubai Healthcare City Authority (DHCA), approval was sought before conducting the study under the IRB approval DHCR/June 2, 2020. Additional ethical approval was gained from the Zayed University Research Ethics committee.

ORCID iDs

Faisal A. Nawaz  <https://orcid.org/0000-0002-0701-7628>

Meshal A. Sultan  <https://orcid.org/0000-0002-5289-0055>

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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