

## REVIEW

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# Attention-deficit Hyperactivity Disorder and Autism Spectrum Disorder: Towards Better Diagnosis and Management

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## ABSTRACT

**Background:** Attention-deficit hyperactivity disorder (ADHA) is one of the most common comorbid disorders of autism spectrum disorder (ASD) that can accompany autism, triggered by it, or be a consequence of it. **Objective:** This review explored the prevalence of the comorbidity of both disorders, neurobiological background, symptoms, latest assessment methods, and therapeutic approaches. **Results and Discussion:** It concluded that effective assessment, diagnosis and management of ADHD in ASD children and adults is essential for this group of patients to thrive and live a good quality of life. Further research is recommended to explore the most effective intervention for such important members of our society. **Conclusion:** More studies are needed to understand the mechanisms underlying these comorbidities, and to prevent the misdiagnosis and mismanagement of these disorders. Also, to develop up to date personalized therapeutic plans for such children.

**Keywords:** ADHD, ASD, Comorbidity, Assessment, Management.

## 1. BACKGROUND

Autism is a spectrum disorder affecting the neurodevelopment of children worldwide. The American psychiatric association, in their latest edition of the diagnostic and statistical manual of mental disorders (DSM5), defines autism spectral disorder (ASD) as a neurodevelopmental disorder characterized by deficits in social communications, where individuals understand social interactions and communications differently compared to others, as well as repetitive behavior and restricted interest (1).

ASD is a spectrum of neurodevelopmental disorders that ranges between autism, Asperger's syndrome, and pervasive developmental disorder-not otherwise specified. It has been estimated lately that 1 in 36 children may suffer from ASD, indicating the importance of understanding the mechanism of ASD and developing therapeutic regimens to tackle the spread of this disorder effectively (2). Also, approximately 75% of patients with ASD suffer from comorbid psychiatric illnesses such as attention-deficit hyperactivity disorder (ADHD), obsessive-compulsive disorder, anxiety, bipolar disorder, depression, and Tic disorders including Tourette syndrome (3).

ASD children rarely interact and communicate with others and may display unique motor or verbal behaviors in comparison to children with ADHD who are usually distracted, pay little attention in class, and have difficulty sustaining mental efforts. ASD has many similarities to ADHD, but there are also differences between the two. Both disorders are considered neurodevelopment disorders, however, their diagnosis can be at different ages. ASD for example is usually diagnosed at earlier ages before even the child is three years old, while ADHD diagnosis is not confirmed until the child is older. ASD and ADHD are neurobiological disorders that manifest neuropsychological deficits similarly. These two disorders have also been linked genetically (4) and environmentally (5) such as preterm delivery.

## 2. PREVALENCE OF ADHD IN ASD

The prevalence of ASD is increasing steadily with year (6). This may be attributed to the presence of more accurate screening methods and/or the availability of highly trained clinicians and more aware caregivers who can identify the signs of the disorder at early stages. ASD is a neurodevelopmental

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spectrum disorder with symptoms that can be attributed to either hyper- and/or hypo-reactivity to sensory stimuli. Its manifestation varies between individuals. ADHD is characterized by an ongoing pattern of inattention and/or hyperactivity-impulsivity that affects the individual's daily functions and productivity. Even though both ASD and ADHD are common neurodevelopmental disorders, the prevalence of ADHD is approximately 5% (7), compared to around 1% for ASD (8).

The prevalence of ADHD in individuals with ASD according to a recent meta-analysis ranged from 50 to 70% (9). Also, a recent study showed that approximately 13% of children who were diagnosed with ADHD were also diagnosed with ASD. This co-occurrence was higher among younger children (ages 4-11) in comparison to older children (ages 12-17) (10). Also, there is genetic evidence for overlapping autistic traits and ADHD behaviors among twins, suggesting that ASD individuals are more susceptible to having ADHD than the general population (11).

### **3. NEUROBIOLOGICAL ASPECTS OF ADHD IN ASD**

Considering the high prevalence of ADHD in ASD children, understanding the pathophysiology and the neurobiological aspects of the comorbidity of those two disorders is of great importance. ENIGMA-ADHD and ENIGMA-ASD consists of research groups in imaging genomics, neurology, and psychiatry, that were established to understand functional anatomy of the brain, based on Magnetic resonance imaging (MRI), Diffusion tensor imaging (DTI), functional MRI (fMRI), genetic data of certain diseases (12). Regarding the subcortical volume analysis, both disorders showed comparable volume decreases of certain basal ganglia neurons in the brain such as the putamen as well as other deep brain structures including the amygdala, and nucleus accumbens when compared to controls. Also, the thickness of the temporal lobes in both disorders was low, while the frontal lobes of ASD individuals only showed increased cortical thickness in comparison to controls. The difference between the two disorders was also manifested in the surface area of the brain. The overall surface area of ADHD individuals was significantly smaller compared to controls, while ASD patients showed no difference in their surface area compared to controls. Additionally, the average intracranial volume (ICV) of children with ASD was higher compared both to controls and cases with ADHD. Also, the cortical thickness of certain brain regions such as the orbitofrontal, inferior frontal and cingulate areas was low in adults with ADHD compared with ASD cases and healthy controls (13).

In addition to changes in the grey matter of the brain, the white matter was also affected in such diseases. Diffusion tensor imaging (DTI) studies showed atypical white matter patterns in both ASD and ADHD. The white matter transfers and integrates substantial information between gray matter regions. Abnormalities in white matter may indicate the reason behind many psychiatric disorders. The two most used diffusion metrics

in DTI studies are fractional anisotropy (FA) and mean diffusivity (MD). FA correlates with coherence and integrity of white matter fibres while MD is indicative of cell density (14). It was reported that FA was reduced in the splenium of the corpus callosum in both ADHD and ASD individuals, and in the genu of corpus callosum of ASD individuals only. Also, MD was increased in the posterior thalamic radiation in ASD (15).

Moreover, studies of event-related potentials (ERPs) have shown that there is a distinct structural profile for ASD that differed from that of ADHD. ADHD symptoms were more linked to impaired inhibition, the pathophysiological essence of ADHD (16). Also, electroencephalogram (EEG) studies showed that ADHD presented usually with atypical profiles concerning theta and beta frequency bands (17) whereas ASD EEG findings were mainly related to alpha, beta, and gamma frequency bands (18). Also, in ASD children with cerebellar hypoplasia, it was reported that the more severe the hypoplasia was, as seen by MRI, the slower ASD children reacted when asked to orient their attention to visual stimuli, suggesting a unique role of the cerebellum in the pathophysiology of ASD (19).

### **4. PRESENTATION OF ADHD IN ASD**

Individuals with ADHD rarely present with symptoms that are specific to ASD. However, autistic children commonly show symptoms that are related to ADHD. ASD affects social communication, behavior, and imagination. ADHD symptoms are divided into attention related symptoms and hyperactivity related symptoms. The attention deficit domain may be manifested as difficulty in sustaining attention, forgetfulness, and/or distractibility, while hyperactivity may be observed as excessive talking, restlessness, and frequent interruption of others. The DSM5 criteria for diagnosing ADHD include that the age of onset is no later than 7 years and that the child malfunctions in at least two settings (for example school and home) for a duration not less than 6 months. ADHD is divided into 3 subtypes as follows: 1. Predominantly inattentive. 2. Predominantly hyperactive-impulsive. 3. The combined type, which is the most common and more severe (1, 20).

Attention is part of the executive functions of the brain and can be divided into six categories as follow: sustained attention, focused attention, visual search, voluntary or reflexive orienting and disengagement, attention filtering, and expectation (21). In ASD individuals, sustained, focused and visual search attention is stronger compared to normal individuals. Whereas ASD individuals are deficient in both orienting their attention toward non-social stimuli and in voluntary or reflexive disengagement. ASD individuals with no intellectual disability have normal attention filtering (22).

It has also been reported that ASD-ADHD diagnosed individuals have significantly more severe autistic symptoms (especially those related to social interaction) compared to those with ASD only (23). Additionally, the presence of psychomotor agitation in ASD individuals can be attributed to the disruptive mood dysregulation

disorder that is highly prevalent in ASD rather than to the presence of comorbid ADHD (24). A study compared the presence of selective attention in children with ASD and ADHD (both the inattentive type and the combined type). It reported that selective attention is significantly more common among autistic children compared to those with ADHD (25).

## 5. CHALLENGES WITH ASSESSMENT OF ADHD IN ASD

The co-occurrence of ADHD in ASD individuals should not be overlooked and must be assessed carefully. A study suggested that the attentional deficits in ASD children such as “not listening” and “difficulty in shifting focus” may be inherent to ASD itself rather than to the comorbidity with ADHD. This makes distinguishing between the two disorders very challenging (9).

Tests that revealed significant differences between ASD and ADHD are of great use to assess individuals with symptoms of both disorders. It has been reported that “the rapid letter naming task” did show significant differences between the two disorders as ASD children spent more time in the task but were performing better compared to ADHD children (26).

Many neuropsychological tests were used to evaluate higher cognitive functions such as attention and working memory in both ASD and ADHD children. However, they failed to distinguish between the performance of children with normal intelligence ASD and those with ADHD both the inattentive and the combined types (25). Also, neuropsychological evaluations of executive brain functions detected deficits that were shared by both ASD and ADHD (27), emphasizing the limits of higher cognitive functions tests to discriminate ASD from ADHD and suggesting the need of developing various tools to explore additional brain functions since treatment measures relies heavily on accurate assessments of the co-occurrence of ADHD in ASD.

## 6. CURRENT APPROACHES TO MANAGEMENT

While treating ASD individuals with ADHD might be challenging and time consuming, it has been reported that with effective interventions, these individuals may have a better quality of life. Despite similar symptoms between ASD and ADHD, treatment may differ between the two disorders. A recent study showed that compared to autism, children with ADHD-Combined were more likely to be prescribed ADHD medication, mostly stimulants. However, autistic children were most likely to be prescribed antipsychotics and selective serotonin reuptake inhibitors (SSRIs) compared to children with ADHD-Combined. The least likely medicated children were those with ADHD of the Inattentive type since they showed minimal impairment (28). In individuals with both ADHD and ASD, it is generally preferable to use psychopharmacological treatments to mainly reduce ADHD symptoms that lead to daily impairment. For example, if the ADHD symptoms were controlled in such patients, their therapists can focus on interventions

that target social and communication deficits. Both ASD and ADHD have great treatment needs. These treatment needs can be either in school and/or out-of-school services. This can be attributed to the finding that standard ADHD treatments, such as stimulants, are less effective in children with ASD when compared to children with ADHD only, suggesting the urgent need for additional treatments (29).

If ASD symptoms were not managed in ASD-ADHD children, this will lead to their deterioration in all aspects (social, emotional, physical, and educational) (30). Also, unfortunately, ADHD medication failed to provide additional benefit for children with ASD beyond managing the symptoms of ADHD (31). Hence, the need for effective psychosocial treatment such as behavioral therapies, parent training, and social skills training is of immense importance. However, current behavioral treatments for ASD are not effective in targeting the impairment related to ADHD symptoms. Alternatively, combining pharmacological and psychosocial treatments may be beneficial for children with both ADHD and ASD symptoms (32). Limited studies have realized the importance of addressing effective psychosocial interventions for children with both ASD and ADHD (33). Hence, more studies are needed to recommend effective interventions that reduce ADHD symptoms in children with ASD and improve their social and communication skills. In addition, extended psychoeducation of caregivers on the differences between ASD and ADHD behaviors is of great importance for the effective management of ASD children with ADHD.

## 7. CONCLUSION

Children with both ASD and ADHD require extreme attention from all members of society including researchers to figure out the most accurate diagnostic methods and the best therapeutic approaches. Therapeutic approaches for reducing ADHD symptoms in ASD individuals require modified psychosocial interventions tailored to the individuals' needs, as well as excellent psychoeducation to caregivers. Further studies are required to understand the co-occurrence of both disorders and to develop therapeutic approaches after accurate assessment. As seen by previous studies, if these children are left without intervention, they may deteriorate in all aspects, and their quality of life will drop tremendously. Hence it is recommended that all members of society, including those who can fund future research, work together to support such important members of our society.

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