Review article

Assessing dive fitness in individuals with autism spectrum disorder

Abraham L Querido[1,2], Thijs T Wingelaar[2,3]

[1] *Praktijk Querido, Hilversum, the Netherlands*
[2] *Dutch Society of Diving and Hyperbaric Medicine, Bilthoven, the Netherlands*
[3] *Royal Netherlands Navy, Diving Medical Center, Den Helder, the Netherlands*

Corresponding author: *Dr Abraham L Querido, Praktijk Querido, Veerstraat 25, 1211 HJ Hilversum the Netherlands*
ORCiD: *0009-0001-1988-0832*
bram@praktijkquerido.nl

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Abstract

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Scuba diving requires situational awareness, cognitive flexibility, and the ability to adapt to changing conditions. For individuals with autism spectrum disorder (ASD), these demands may pose unique challenges due to differences in executive functioning, sensory processing, and social cognition. This article explores the key considerations in assessing fitness to dive in individuals with ASD, including the impact of comorbidities, medication use, and cognitive abilities on diving safety. To provide a broader perspective, we examine research on ASD and high-risk activities such as driving, where similar cognitive and decision-making challenges exist. Additionally, we discuss the role of neuropsychological assessments in evaluating a diver's cognitive fitness and the limited but emerging evidence on scuba diving interventions for individuals with ASD. While ASD is not an absolute contraindication to diving, a careful, individualised assessment is essential to determine suitability. This review aims to provide guidance for diving professionals and medical examiners in making informed decisions regarding ASD and scuba diving.

Introduction

Evaluating fitness to dive in individuals with psychiatric conditions, such as autism spectrum disorder (ASD), is considered one of the more complex assessments in diving medicine. One Dutch study found that psychiatric conditions accounted for 9.6% of 291 cases presented to the board of experts over the decade-long analysis.[1] This highlights that while circulatory and respiratory diseases were the most prevalent, psychiatric issues also represented a significant portion of the cases encountered by medical examiners of diving (MEDs). While seemingly straightforward, this question quickly leads to further complexities. In the Netherlands, scuba diving is classified as an extreme sport by insurance providers; therefore, it is important to determine whether having ASD presents additional risks. ASD exists on a spectrum, meaning individual abilities and challenges vary widely, so if risks exist, do they apply universally or only to certain individuals?

ASD itself is not inherently a contraindication to diving, but certain risk factors, including impaired cognitive flexibility, comorbidities and medication use, play a significant role in determining fitness to dive. Individuals with impaired cognitive flexibility, for example, may struggle to adapt to unexpected situations or disengage from rigid thought patterns. This can be particularly problematic in diving, where rapid problem-solving and adaptability are crucial for safety. Given these considerations, an individualised evaluation is essential.

To provide colleagues who are less familiar with ASD with a clearer understanding of its complexities, we present a real-life case of a 13-year-old girl with ASD to illustrate key challenges, followed by a review of the literature on ASD and its implications for diving. The goal is to provide an evidence-based framework for evaluating whether individuals with ASD can safely participate in scuba diving.

Case example

The case is a 13-year-old girl diagnosed with ASD, attention deficit disorder (ADD), and Gilles de la Tourette syndrome, according to DSM-5 criteria. She is currently prescribed methylphenidate (a slow-release psychostimulant) 36 mg once daily for ADD and aripiprazole (antipsychotic) 12.5 mg once daily to manage tics. A comprehensive neuropsychological assessment provided critical insights into her cognitive functioning. While her overall intelligence falls within the average range, she presents with a disharmonic

intelligence profile, meaning significant discrepancies exist between her cognitive abilities. Specifically, she demonstrates notable impairments in attention, characterised by slow and inconsistent information processing speed; working memory, making it difficult for her to retain and manipulate information in real time; and executive functioning, leading to challenges in planning, impulse control, and cognitive flexibility.

These cognitive deficits make her highly susceptible to sensory overload, as she struggles to process and regulate external stimuli effectively. As a result, tension and anxiety escalate, causing her to miss critical information and struggle to respond appropriately. In overwhelming situations, she may become stuck in repetitive behaviours or experience a cognitive shutdown, further compounding her frustration. This, in turn, intensifies stress, anxiety, and feelings of insecurity. Given these cognitive and emotional vulnerabilities, the question arises: how do these factors influence her ability to engage in demanding activities such as scuba diving?

Methods

The protocol for the literature search strategy was prepared according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[2] A structured search of the literature was performed using PubMed up to 27 January 2025 to identify studies and case reports regarding diving and autism. A query involving diving and autism resulted in very few results, therefore, the keywords were expanded to include aviation and driving. Additionally, several handbooks on diving medicine that discussed psychiatry or psychology were screened for additional information. The full query was structured as: ((diving[Mesh] OR dive[tw] OR diving[tw] OR divers[tw] OR hyperbaric[tw] OR scuba[tw]) OR (aviation[mesh] OR flying[tw] OR altitude[tw]) OR (driving[mesh] OR driv*[tw] OR traffic[tw])) AND ((autism[Mesh] OR autism[tw])).

A systematic literature search conducted in January 2025 screened 2,417 studies. Of these, 59 were identified as potentially relevant, including two on water-based interventions, 23 on hyperbaric oxygen therapy (HBOT), and 34 on driving and ASD. After assessing titles and abstracts, 32 studies were deemed eligible for inclusion: two on water-based interventions, 10 on HBOT, and 20 on driving.

A total of 25 articles were excluded: 12 on driving and ASD, as well as 13 on HBOT for ASD, including two reviews due to quality concerns, and 11 clinical studies. A detailed discussion of clinical trials falls beyond the scope of this article. Additionally, many studies had methodological limitations that contributed to inconsistent findings.

The reference lists of the included papers were also used to identify additional studies. After carefully reading these articles, a total of nine of these papers were included in the present review. More details can be found in Figure 1.

Understanding ASD

ASD is a neurodevelopmental condition classified in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5).[3] It is characterised by deficits in social communication and interaction, as well as restricted or repetitive behaviours or interests. The severity and presentation of these traits vary widely among individuals,

Figure 1
PRISMA diagram for results of systematic literature search

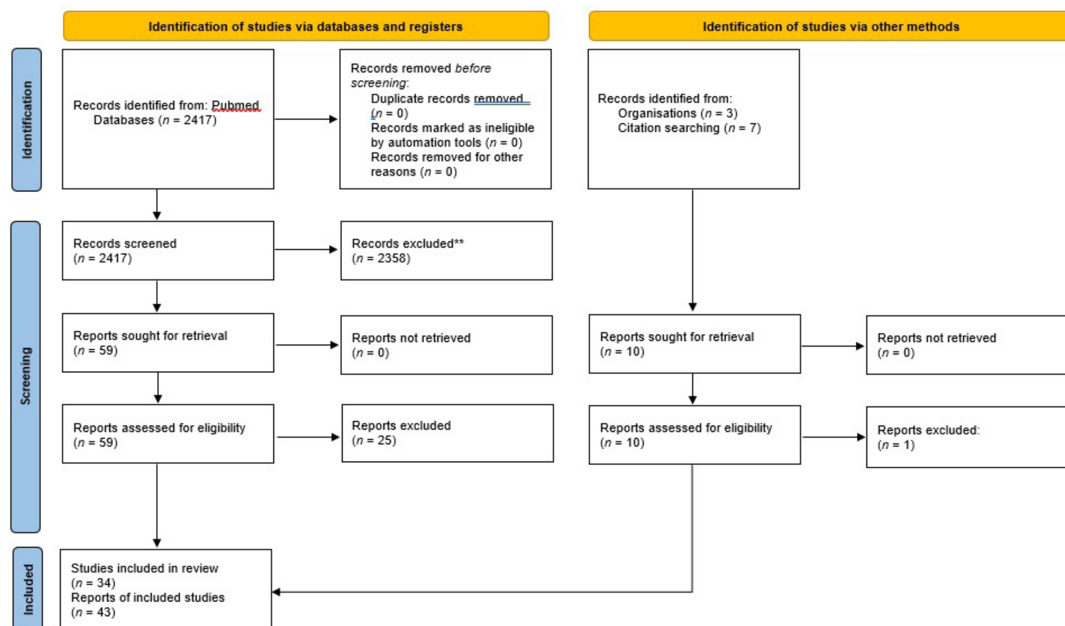

Table 1
Core features of autism spectrum disorder

Domain	Criteria
Social communication and interaction	1. Difficulties with social reciprocity 2. Difficulties in nonverbal communication used for social interaction 3. Deficits in developing and maintaining relationships with other people
Restricted and repetitive behaviour, interests, or activities	1. Stereotyped speech, repetitive motor movements 2. Rigid adherence to routines, ritualised patterns of verbal or nonverbal behaviours, and extreme resistance to change 3. Highly restricted interests with abnormal intensity or focus 4. Increased or decreased reactivity to sensory input or unusual interest in sensory aspects of the environment

the DSM-5 offers 3 levels severity (requiring support, substantial support or very substantial support). These core features of ASD are summarised in Table 1.

EXECUTIVE FUNCTIONS AND THEIR ROLE IN ASD

Executive functions are a set of cognitive processes essential for planning, organising, regulating, and adapting behaviour to achieve a specific goal. There are three core executive functions: working memory (ability to hold and manipulate information over short periods), inhibition (capacity to resist distractions, control impulses, regulate behaviour) and cognitive flexibility (ability switch between tasks, adapt to unexpected situations, and think creatively).[4,5] Executive functions continue to mature through childhood and into early adulthood. Cognitive flexibility begins to develop in early childhood, it continues to mature throughout adolescence and into early adulthood, influenced by brain development and various environmental factors.[6]

Executive function is commonly impaired in individuals with ASD.[7] Deficits in cognitive flexibility are particularly notable in ASD, making transitions, unpredictable events, and sudden environmental changes challenging. This difficulty in adjusting to new circumstances can be especially problematic in activities that require quick decision-making, such as driving, or diving.

Another key cognitive function affected in ASD is 'theory of mind', the ability to understand and interpret the thoughts, emotions, and intentions of others. Theory of mind is crucial for driving, as drivers must anticipate and respond to the actions of others to navigate safely. A study found that both theory of mind and executive function were strongly associated with driving performance in individuals with ASD, suggesting that better theory of mind and executive function skills correlate with safer driving behaviours.[8] Specifically, drivers with stronger executive function and theory of mind were better at recognising social hazards and making appropriate driving decisions. Given the cognitive demands of diving, assessing executive functioning, theory of mind and cognitive flexibility in individuals with ASD is crucial for determining fitness to dive. Standardised neuropsychological tests administered by a qualified mental health professional may be used to assess these cognitive domains, such as the Trail Making Test and the Wisconsin Card Sorting Test.

Comorbidities and their impact on diving

Comorbidity is highly prevalent among individuals with ASD. A large-scale study by Khachadourian et al., including over 42,000 individuals with ASD, found that 74% had at least one comorbid condition. Similarly, a systematic review by Bougeard et al., reported a comorbidity prevalence ranging from 54.8% to 94%. In a nationwide Swedish twin study, Lundström et al., found that 95% of individuals with ASD had at least one coexisting disorder, with more than half (50.3%) experiencing four or more comorbid conditions. These findings underscore the significant burden of comorbidities in ASD, emphasising the need for a comprehensive clinical approach.[9–11] Common comorbidities include psychiatric conditions, such as anxiety disorders, mood disorders, attention-deficit/hyperactivity disorder (ADHD) and neurological conditions like Gilles de la Tourette syndrome and epilepsy. Given the heterogeneity of language and cognitive abilities among individuals with ASD, it is important to tailor communication approaches during dive instruction and assessment. Where learning difficulties or language disorders are present, emphasising clear, positive instructions, focusing on what actions to take rather than what to avoid, may enhance understanding and safety.

Comorbidities can have important implications for diving safety. Epilepsy, characterised by unprovoked and recurrent seizures, is considered an absolute contraindication to diving due to the risk of seizures underwater, which could result in drowning.[12]

Gilles de la Tourette syndrome is a relative contraindication due to the potential risks associated with motor tics. Even

seemingly minor tics, such as coughing, throat clearing, or grunting, may obstruct airflow during ascent, increasing the risk of pulmonary barotrauma.[13]

Given the high prevalence of psychiatric and neurological comorbidities in ASD, a thorough medical evaluation is necessary to assess individual risks before determining diving fitness.

Medication use in ASD and considerations for diving

Certain medications are commonly used to manage behavioural symptoms in individuals with ASD, although no drug has been approved to target its core features. Aripiprazole and risperidone are the only medications approved by the U.S. Food and Drug Administration for treating irritability associated with ASD in children and adolescents.[14] However, no medications have been developed to target the core symptoms of ASD. In clinical practice, other medications are frequently prescribed off-label to manage specific symptoms.[15]

A study found that children with ASD were seven times more likely to use medications from major psychiatric drug classes (e.g., stimulants, antipsychotics, antidepressants, and mood stabilisers) and 21 times more likely to use multiple classes of these medications.[16] For example, stimulants are often used to enhance focus and reduce hyperactivity and antidepressants may help reduce irritability, aggression, and repetitive behaviours.[17]

DIVING CONSIDERATIONS AND PSYCHOTROPIC MEDICATIONS

Severe adverse effects of psychotropic medications are rare. Most individuals tolerate these drugs well and only experience mild side effects.[18] However, certain medications may increase sensitivity to nitrogen narcosis or oxygen toxicity, necessitating depth limitations.[19,20] Diving with psychotropic medication is often possible, but a careful risk assessment is required. Combining multiple medications may heighten the risk of side effects, making diving potentially unsafe.[21] Given these considerations, a thorough medical evaluation is essential for divers using psychotropic medication, particularly those on multiple drug regimens.

Scuba diving as an intervention for ASD

There has been increasing interest in water-based interventions, including scuba diving, for individuals with neurological disabilities, autism, and intellectual disabilities. However, evidence supporting the effectiveness of these interventions remains limited and of low quality overall.[22] A systematic review of water-based interventions found that only four studies met inclusion criteria, with just one study including individuals with ASD (three out of 23 participants).[23] These participants completed a specialised scuba training program provided by Disabled Divers International. While the review noted that participants generally enjoyed the experience and reported some improvements in self-concept, the quality of evidence was low, and no conclusive benefits were established. Further controlled studies are necessary to determine whether scuba diving has measurable therapeutic effects for individuals with ASD.

Although scuba diving may be a rewarding activity for some individuals with ASD, its safety and suitability should be assessed on a case-by-case basis, particularly in individuals with executive function challenges or sensory processing difficulties.

Hyperbaric oxygen therapy and ASD

Hyperbaric oxygen therapy (HBOT) has been proposed as a potential intervention for ASD, primarily based on neuroimaging findings indicating cerebral hypoperfusion in certain brain regions, particularly the temporal lobes.[24] This has led to the hypothesis that HBOT could increase oxygen delivery, potentially improving symptoms in individuals with ASD. Additionally, proposed pathophysiological mechanisms in ASD include inflammation, mitochondrial dysfunction, immune dysregulation, and oxidative stress factors that HBOT might theoretically modulate.[25]

However, scientific evidence does not support the routine use of HBOT for ASD. Multiple reviews have evaluated HBOT for ASD and consistently concluded that no solid evidence supports its effectiveness in improving core or associated symptoms.[26–32] The Undersea and Hyperbaric Medical Society (UHMS) does not recommend HBOT as a treatment for symptoms of ASD.[33]

Camouflaging in ASD

Camouflaging in individuals with ASD, particularly among women, though also observed in men, refers to the use of conscious coping strategies to conceal autism-related behaviours in social settings.[34] This includes efforts to appear socially adept and to mask or compensate for difficulties in communication and interaction. Camouflaging may also involve suppressing internal experiences such as anxiety and sensory overload, making it harder for others to detect distress.[35]

ASD and driving

Driving is a highly complex neuropsychological task that demands strong executive functioning, multitasking abilities, and a combination of psychomotor and cognitive skills, including attention, motor execution, memory, and navigation.[36,37]

Several studies indicate that drivers with ASD experience challenges in areas such as anxiety management, multitasking, decision-making in complex traffic situations, recognising

and responding to social hazards posed by other road users, environmental information processing, and coordination and timing.[37–43]

Individuals with ASD may experience attentional capture issues while driving, making it more difficult to focus on critical hazards.[44] They tend to notice hazards more slowly and may fixate longer on threats once detected, though not necessarily on the most relevant areas. Their attention distribution can be suboptimal, leading to delays in hazard recognition. Additionally, a high cognitive load or complex driving situations may further impair their ability to manage attention effectively, increasing safety concerns in rapidly changing traffic conditions.

Sheppard distinguished three specific areas of driving difficulty for autistic drivers regarding executive functioning (such as maintaining focus and handling multitasking while driving), cognition (interpreting traffic rules and understanding driving situations) and social awareness (interacting with other road users and understanding social cues while driving).[45]

Despite these challenges, research suggests that autistic drivers often adopt a cautious and structured driving style, demonstrating strengths in rule-following and adherence to traffic regulations. Compared to neurotypical drivers, they are less likely to engage in risky driving behaviours.[42,46–49]

A study on medical impairments in older drivers has suggested that ASD may contribute to crash risk, though its low prevalence in this population limits the reliability of these findings.[50] A recent review emphasises that while executive functioning and social awareness can present significant challenges, autistic drivers may compensate through careful planning and avoidance strategies, potentially contributing to safer driving outcomes compared to non-autistic drivers.[51]

Most studies that used driving simulators have reported higher accident rates and more driving difficulties among individuals with ASD compared to neurotypical individuals.[40,52–55] However, one study comparing newly licensed drivers with and without ASD, as well as experienced drivers, found that while ASD drivers performed worse in the simulator and were rated as less safe, fewer differences were observed during actual on-road driving.[56]

CASE EVALUATION: ASSESSING FITNESS TO DIVE IN A DIVER WITH ASD

We return to the 13-year-old girl diagnosed with ASD, attention deficit disorder, and Gilles de la Tourette syndrome described earlier.

Underwater situations involving unexpected challenges, such as equipment malfunction or abrupt environmental changes, require cognitive flexibility, and divers with impairments in this area may find it difficult to respond appropriately. Instead of adjusting their actions, they might become stuck in ineffective responses or fail to initiate an appropriate solution. This inability to shift strategies can result in sensory overload, escalating anxiety, and an increased risk of panic.

For this young diver, processing and regulating sensory stimuli is already challenging, particularly in complex, overstimulating environments. When overwhelmed, she may fail to extract relevant information, leading to rigid, repetitive behaviours or a complete cognitive shutdown. In such cases, frustration and distress may further impair her ability to respond appropriately, increasing the likelihood of maladaptive reactions.

A critical concern is the potential for panic-induced responses, such as bolting to the surface, a dangerous reaction that could lead to pulmonary barotrauma. Given these cognitive and emotional vulnerabilities, it is concluded that this young diver is not fit to dive. However, as executive functions continue to mature into early adulthood, her fitness to dive may warrant reassessment in the future. If her interest in diving persists, a reevaluation in a few years could be considered, taking into account potential improvements in cognitive flexibility, emotional regulation, and decision-making skills.

General considerations on ASD and diving (expert opinion)

ASD is not an absolute contraindication for diving, but individual risk factors must be carefully evaluated when assessing fitness to dive. A sufficient level of insight and awareness of one's condition is recommended for safe diving. Executive functioning, especially cognitive flexibility, is crucial for safe diving. Executive dysfunction is a common cognitive impairment in ASD. If concerns exist about executive function abilities, a neuropsychological assessment should be included as part of a comprehensive evaluation that considers cognitive, sensory, and physical abilities, as well as self-awareness and confidence in diving skills.[36]

Comorbidities are common in ASD; neurological conditions such as epilepsy constitute an absolute contraindication to diving, whereas Gilles de la Tourette syndrome is considered a relative contraindication. Additionally, comorbid anxiety disorders, mood disorders, and ADHD may present challenges and should be carefully evaluated. Ideally, this is done by a dive medicine professional with psychiatric expertise; however, when such professionals are not available, close collaboration between a psychiatrist and a dive medicine physician is encouraged.

When psychotropic medications are used for treatment, diving may be possible under certain conditions, such as the absence of side effects and adherence to a depth restriction. However, the use of multiple psychotropic medications is discouraged due to the increased risk of side effects.[21]

While there is no strict age limit for the diagnosis of ASD itself, in the context of assessing fitness for activities such as scuba diving, an age threshold of 18 years is often recommended due to the ongoing development of executive functions during adolescence.

Because camouflaging can obscure important signs of stress and difficulty, it may complicate the assessment of diving fitness. In high-stakes environments like diving where rapid decision-making, sensory processing, and clear communication are critical, these hidden challenges may go unnoticed by clinicians and instructors. A cautious, individualised approach is therefore recommended. Particular attention should be paid to sensory sensitivities, stress tolerance, and executive functioning, especially in women and others who may engage in camouflaging behaviours.

For individuals with ASD who have successfully obtained a driver's license and can navigate traffic safely, it is reasonable to expect that scuba diving may also be feasible. However, diving presents additional challenges due to the hyperbaric environment, where panic-induced reactions such as uncontrolled ascent pose significant risks. Additionally, coexisting conditions like epilepsy or severe anxiety may further complicate safety. As with driving, a careful, individualised assessment remains essential to determine whether diving is appropriate.

Conclusion

ASD is not an absolute contraindication to diving, but individualised assessment is crucial. Key factors to evaluate include executive functioning, cognitive flexibility, sensory processing, comorbidities, and medication use. Neuropsychological assessments may assist in determining cognitive suitability, particularly in cases where executive function deficits raise safety concerns. Further research is needed to establish evidence-based guidelines for diving with ASD and to explore potential adaptations or training strategies to enhance safety and accessibility.

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