



# A Review of Eating Disorders: Complications and Cognitive Aspects

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## Abstract

Anorexia nervosa, bulimia nervosa, binge eating disorder, pica, avoidant restrictive food intake disorder, and rumination disorder are eating disorders defined according to the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM V). Eating disorders have the second-highest case fatality rate among all mental illnesses. They are associated with numerous physical and psychological complications. These complications affect multiple systems, including the cardiovascular, dermatological, gastrointestinal, endocrine, and neurological systems, leading to serious health consequences. Nutritional deficiencies, gastrointestinal issues, and psychiatric disorders are particularly prevalent, and some complications may be irreversible. In addition, previous studies have shown that individuals with eating disorders have cognitive deficits compared to healthy individuals. Particularly in attention, memory, and cognitive flexibility. Leptin, an adipokine involved in energy regulation, neurogenesis, and learning, is also known to be reduced in individuals with eating disorders. Leptin deficiency is believed to be one of the underlying factors contributing to cognitive dysfunction in these individuals. Moreover, inadequate and unbalanced nutrition is a key factor driving cognitive impairments in individuals with eating disorders. Therefore, it is crucial to assess cognitive functions and examine nutritional habits in individuals with eating disorders. This review aims to provide an overview of eating disorders, discuss their complications, and synthesize research exploring the relationship between eating disorders and cognition.

**Keywords:** Cognition, complications, eating disorders.

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Eating disorders (ED) are serious psychiatric conditions defined by unusual eating habits that have a negative impact on an individual's physical and mental health. They are also characterized by individuals' attempts to control eating behavior. People with ED frequently experience excessive concern about what, when, and how they eat. These concerns tend to differ based on sex; men may focus on muscularity, whereas women are often more concerned with weight loss.<sup>[1]</sup> Additionally, individuals of both sexes engage in various compensatory behaviors to regulate their dietary intake, such as fasting, skipping meals, self-induced vomiting, and excessive exercise.<sup>[2]</sup>

ED has the second-highest case fatality rate among all mental disorders. Approximately 10,000 deaths each year are a direct result of an ED. The financial burden of ED in the United States (U.S.) is estimated at \$64.7 billion per year.<sup>[3]</sup> It is further estimated that 9% of the U.S. population will experience an ED in their lifetime. In terms of sex, women are five times more likely to be diagnosed with an ED than men and 1.5 times more likely to receive treatment for an ED.<sup>[4]</sup> Adolescents are also significantly affected by ED; a systematic review found that 22% of children and adolescents engage in unhealthy eating behaviors that may indicate or contribute to the development of an ED.<sup>[5]</sup>

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Both the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and the International Classification of Diseases (ICD-11) classify ED into six major categories. These include the diagnostic categories of anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED). In recent editions, avoidant restrictive food intake disorder (ARFID), pica, and rumination disorder, previously considered mostly childhood disorders, have also been included.<sup>[6,7]</sup>

ED is associated with numerous physical and psychological complications, affecting the cardiovascular, gastrointestinal, endocrine, and neurological systems. Furthermore, some studies have highlighted the differential effects of various ED on cognitive functioning.<sup>[8,9]</sup> The aim of this review is to examine the diagnosis and epidemiology of eating disorders, their complications, and their relationship with cognition.

## Diagnosis and Epidemiology

### Anorexia Nervosa

AN is an ED characterized by severe restriction of energy intake relative to the body's needs, leading to significantly reduced body weight. In addition to being unable to understand the seriousness of their significantly low body weight, patients have an intense fear of gaining weight and a distorted body image.<sup>[10]</sup> Clinicians specializing in the field report an increasing number of AN cases in their daily practice. Hoek (2006) noted a rise in AN incidence until the early 2000s, with the majority of cases occurring in women aged 15–24.<sup>[11]</sup> Lifetime occurrence rates of AN can be up to 4% in women and 0.3% in men.<sup>[12]</sup> A study conducted among 2,907 high school students in Türkiye reported a point prevalence of AN at 0.034%.<sup>[13]</sup>

A significant proportion of patients with AN have a poor prognosis and high mortality rates.<sup>[14]</sup> A 2021 study found that the standardized mortality rate among AN patients with severe malnutrition-related complications could reach 15.9% after five years of follow-up.<sup>[15]</sup>

AN is categorized into two subtypes: the restrictive type and the binge/purging type. A diagnosis of the binge/purging subtype requires the presence of recurrent episodes of binge eating or purging behaviors within the past three months. Conversely, the restrictive subtype is characterized by the absence of such episodes during the same time frame. In the restrictive type, weight loss is primarily achieved through methods such as strict dieting, prolonged fasting, and/or excessive physical activity.<sup>[6]</sup>

### Bulimia Nervosa

BN, most commonly observed in adolescent women, is a condition characterized by a tendency to overeat and

inappropriate compensatory behaviors to prevent weight gain. Compensatory behaviors are described as self-induced vomiting, misuse of laxatives, use of diuretics, excessive physical activity, and self-starvation.<sup>[16]</sup> According to diagnostic criteria, binge-eating episodes and compensatory behaviors must occur at least once a week for a minimum of three months to warrant a BN diagnosis.<sup>[17]</sup> Traditional diagnostic approaches primarily rely on patient self-reports of symptoms.

Prevalence estimates suggest that BN affects approximately 1%–1.5% of adults 3% of women and more than 1% of men suffer from BN in their lifetime.<sup>[6]</sup> A study conducted among 414 female university students in Türkiye reported a BN prevalence of 0.5%.<sup>[18]</sup> The highest incidence is observed among women aged 20–29 years, and BN is strongly associated with mood and anxiety disorders.<sup>[12]</sup> In particular, the level of suicidal tendencies of patients diagnosed with BN was found to be clinically concerning. Adolescents with BN report higher rates of suicidality than adults with BN and exhibit greater suicidality risk compared to youth diagnosed with other eating disorders.<sup>[19]</sup> One study reported a crude mortality rate for BN of 1.7 per 1000 person-years and a systematic mortality rate of 1.9.<sup>[20]</sup>

### Binge Eating Disorder

BED is a psychiatric condition characterized by the consumption of abnormally large quantities of food within a short period, accompanied by various psychological and physiological issues, significant impairment in daily functioning, and serious health consequences. Unlike bulimia nervosa (BN), BED is diagnosed based on the presence of recurrent binge-eating episodes occurring at least once per week for a minimum of three months.<sup>[21]</sup> Although BED is commonly observed in individuals with normal weight, overweight, or obesity, it is essential to distinguish BED from obesity.<sup>[6]</sup>

Prevalence estimates for BED vary significantly, ranging from 0.2% to 3.6% in women and 0.03% to 1.2% in men.<sup>[22]</sup> Studies in Türkiye have reported a BED prevalence of approximately 1%, with a higher incidence among women and an average onset age of 23 years.<sup>[13]</sup> A representative study conducted in the U.S. found that up to 23% of individuals diagnosed with BED had attempted suicide.<sup>[23]</sup> The estimated standardized mortality rate of BED ranges from 1.5 to 1.8.<sup>[24]</sup>

### Pica

Pica is defined by the DSM-5 as consuming non-nutritive, non-food substances for at least a month. For diagnosis, the eating behavior must not be a part of a socially or

culturally accepted practice, it must be inappropriate for the individual's developmental level, and it must persist for at least one month.<sup>[6]</sup> The true prevalence of pica is difficult to assess because most people do not report it and data collection methodology varies between populations, as does its definition.<sup>[25]</sup> A study conducted in Germany with 2,403 adults estimated the prevalence of pica to be 5.33%.<sup>[26]</sup> Similarly, a study conducted in Türkiye found that 9% of individuals diagnosed with iron deficiency anemia had a history of pica.<sup>[27]</sup>

Pica is frequently observed in individuals with neurodevelopmental conditions such as autism spectrum disorder. The condition involves the consumption of a wide range of non-nutritive substances, which are classified based on the specific item ingested. Common forms of pica include geophagy (soil consumption), pagophagia (ice consumption), rhizophagy (raw rice consumption), and amylophagia (starch consumption). Additionally, various other unusual forms of pica have been documented, including the ingestion of mothballs, eggshells, paper, and cardboard.<sup>[28]</sup> Pagophagia is common in the U.S., affecting 25% of patients with iron deficiency, whereas geophagia is more prevalent in other parts of the world. Geophagy, in particular, is considered an accepted cultural practice in certain regions, especially in Africa.<sup>[29]</sup>

### **Avoidant Restrictive Food Intake Disorder**

Avoidant/restrictive food intake disorder (ARFID) was first introduced into psychiatric terminology in 2013, replacing the concept of feeding disorder in infancy.<sup>[6]</sup> Over time, it became evident that ARFID, characterized by avoidant and restrictive eating patterns, could manifest at any stage of life. The DSM-5 identifies three specific presentations of ARFID, which may occur independently or in combination. Individuals in the sensory-sensitive category tend to avoid particular foods (commonly meat, vegetables, or fruits) due to an aversion to certain tastes, textures, or smells. Others may limit their food intake because of a lack of interest in eating or diminished appetite. Additionally, some individuals with ARFID avoid certain foods or cease eating entirely after experiencing a distressing event related to eating, such as choking, vomiting, or gastrointestinal discomfort.<sup>[30]</sup>

According to the literature, ARFID prevalence rates vary between 5% and 22.5%. There are currently no specific and up-to-date data on ARFID prevalence in Türkiye. However, preliminary studies in pediatrics, adolescent medicine, and ED clinics indicate that ARFID patient groups tend to be younger compared with patients with AN or BN.<sup>[31]</sup> While ARFID can occur at any age, it is most commonly

identified in children and adolescents. Studies conducted in ED clinics report that the average age of individuals diagnosed with ARFID ranges from 11.1 to 14.6 years.<sup>[32]</sup>

### **Rumination Disorder**

Rumination disorder is a functional gastrointestinal disorder defined as the effortless vomiting of recently digested food from the stomach into the oral cavity without any underlying organic disease.<sup>[33]</sup> The main clinical features are early postprandial regurgitation, effortlessly vomited material similar to swallowed food, and vomited material being spat out or re-swallowed. Rumination disorder is frequently misdiagnosed or overlooked, leading to prolonged symptoms and delayed treatment for affected individuals.<sup>[34]</sup>

Rumination disorder can occur in both children and adults. However, there is insufficient data on the incidence and prevalence of rumination disorder in adults. A recent global epidemiological study from the Rome Foundation found that the overall worldwide prevalence of rumination syndrome was 2.8%, with a slightly higher prevalence in women (3.1%) than in men (2.5%).<sup>[35]</sup>

The pathophysiology of rumination disorder is not yet fully understood, but imperceptible activation of the abdominal wall is thought to be an important pathogenic feature in the pathophysiological process of the postprandial period. It is also known that rumination disorder is associated with relaxation of the upper and lower esophageal sphincters during increased gastric pressure.<sup>[36]</sup>

### **Complications**

Weight loss and malnutrition contribute to various medical complications in AN. In patients with AN, nearly every body system is negatively affected by this progressive malnutrition state. From a cardiovascular perspective, patients are at risk of bradycardia and hypotension, arrhythmia, refeeding syndrome, and sudden death. Dermatologically, complications such as itching, dry skin and lanugo hair may occur due to starvation. Constipation, refeeding pancreatitis, acute gastric dilatation, and dysphagia are gastrointestinal symptoms seen in AN. In terms of endocrine and metabolic aspects, amenorrhea, infertility, osteoporosis, thyroid abnormalities, hypoglycemia, hypercortisolemia, and neurogenic diabetes insipidus are observed. Starvation-related pancytopenia, cerebral atrophy, lagophthalmos and respiratory failure are other complications that can also be observed.<sup>[37,38]</sup>

Patients with BN are prone to medical complications affecting multiple organ systems, with a notable impact on renal and electrolyte balance. Discontinuation of disordered eating

behaviors may reverse some, though not all, associated medical complications.<sup>[39]</sup> When the systems in BN patients are examined, sore throat, irregular menstrual bleeding, constipation, headache, fatigue, drowsiness, abdominal pain and bloating are observed. Frequent physical examination symptoms associated with BN include low blood pressure, dry skin, swelling of the parotid glands, calluses on the back of the hand, and dental erosion, which may also be associated with hair loss, edema, and epistaxis.<sup>[40]</sup>

Although obesity is linked to excessive calorie intake, individuals with obesity and BED are still at risk for nutritional deficiencies. Analyses of the nutritional composition during binge eating episodes reveal that calorie-dense foods are typically high in carbohydrates, sugar, and fat but low in protein. People with BED frequently report symptoms such as acid reflux, difficulty swallowing, bloating, abdominal pain, gastrointestinal urgency, diarrhea, and constipation. Furthermore, around 79% of individuals with BED are diagnosed with a psychiatric condition.<sup>[41]</sup> Common co-occurring disorders include specific phobias, social anxiety, post-traumatic stress disorder, and alcohol dependence or abuse.<sup>[42]</sup>

Pica, in contrast, is linked to adverse effects such as electrolyte imbalances (notably potassium disturbances), throat irritation, and gastrointestinal complications ranging from abdominal pain to obstructions and colonic ischemia. Bidirectional effects related to pica—conditions that both cause and result from it—include iron deficiency, parasitic infections, and heavy metal exposure (notably lead, mercury, and arsenic).<sup>[25]</sup> Additionally, complications such as liver and kidney damage are frequently observed in individuals with pica.<sup>[43]</sup>

As ARFID is a relatively newly recognized disorder, the number of medical studies examining its specific complications remains limited. ARFID impairs social functioning, prevents the individual from eating with others, and also causes wasting and micronutrient deficiencies.<sup>[44]</sup> Patients may be thought to be at greater risk for malnutrition than AN patients owing to their diets being low in protein and vegetables and high in processed foods. Additionally, malnutrition itself may be associated with gastrointestinal symptoms such as nausea or early satiety after meals and constipation. Diagnostically, children with ARFID often have a history of abdominal pain and infection before diagnosis.<sup>[45]</sup>

Rumination disorder can lead to both mental and physical problems that affect quality of life.<sup>[46]</sup> Frequent regurgitation can cause notable weight loss, particularly in adolescents, and result in complications such as electrolyte disturbances

and dental damage. Studies have shown that patients with rumination syndrome are often accompanied by anxiety, depression, and somatization.<sup>[33]</sup>

## Eating Disorders and Cognition

Cognitive differences have been reported between individuals diagnosed with ED and healthy individuals. Research has primarily focused on functions such as attention, memory, and cognitive flexibility in individuals with ED.<sup>[8,47,48]</sup>

AN has been shown to negatively affect cognitive functions, particularly in the domains of attention, processing speed, visual and verbal memory, and visuospatial abilities. In a study on individuals with AN, participants reported difficulties in retrieving details of autobiographical memories, despite an enhanced ability to recall salient, often negative events. It is thought that the underlying reasons for this situation may be decreases in hippocampal volume, high levels of attention bias related to food may reduce cognitive resources, fatigue and brain fog resulting from low body weight.<sup>[8]</sup> The results of a study show that performance in visual memory is lower in the long-term clinical ED group. Regarding the visual-perceptual difficulties found in the ED group, it is well known that these changes play a role in the body image distortions specific to these disorders.<sup>[49]</sup>

Pica is highly prevalent among patients with severe cognitive impairment. One study compared the cognitive and behavioral functions of individuals with pica and hyperorality who did not eat non-food items. More semantic memory impairment and fewer frontal oscillatory symptoms were found in the pica group. There was no meaningful difference between the two groups in terms of changes in eating behavior. Individuals in the pica group had a lesion in the posterior part of the middle temporal gyrus. These findings suggest that semantic memory impairments associated with temporal lobe damage may be linked to the development of pica.<sup>[50]</sup>

Working memory is the ability to hold information in mind and process it for short periods of time during complex cognitive tasks.<sup>[51]</sup> A meta-analysis examining executive function domains in individuals with binge eating disorder (BED) revealed poorer performance on working memory tasks compared to obese control participants.<sup>[52]</sup> Also, systematic reviews in BED have shown cognitive impairments in BED patients as assessed by neuropsychological tasks. Individuals with BED have been found to have poorer performance in decision-making, inhibitory control, and cognitive flexibility compared to healthy participants.<sup>[53]</sup>

Cognitive flexibility, the ability to adapt behavior in response to changing environmental demands, is a key neuropsychological function that is often impaired in individuals with ED. Research has consistently reported deficits in cognitive flexibility among individuals with ED, particularly those diagnosed with AN and BN. These individuals often exhibit rigid behavioral patterns, including maladaptive eating habits, which contribute to the persistence of the disorder.<sup>[48]</sup> Empirical evidence suggests that individuals with AN, as well as their unaffected sisters, demonstrate lower performance on tasks assessing set-shifting and central coherence.<sup>[54]</sup> Similarly, another study found that both AN and BN patients exhibited deficits across multiple domains of cognitive flexibility tasks. Notably, individuals in recovery from AN performed better than those who were acutely ill.<sup>[55]</sup> These findings suggest that impaired cognitive flexibility may hinder the ability to modify maladaptive eating behaviors that are no longer reinforcing.<sup>[56]</sup>

Leptin, an adipokine primarily involved in energy regulation, may also play a role in the cognitive deficits observed in ED. The quantity of fat stored in adipose tissue is indicated by this long-term satiety signal, which is released by fat cells. It exerts anorexigenic effects by regulating several hypothalamic neuropeptides.<sup>[57]</sup> The observed role of leptin in neurogenesis and learning brings into focus whether leptin deficiency mediates the cognitive deficits observed in AN. Furthermore, impairments in learning and memory in leptin-deficient mice were restored through leptin treatment.<sup>[58]</sup> For all these reasons, it is thought that one of the underlying reasons for the cognitive function changes seen in individuals with ED may be leptin deficiency.

The primary underlying cause of cognitive impairments in ED may be inadequate and unbalanced nutrition. Malnutrition is known to affect the functioning of the brain, leading to changes in cognitive abilities. Nutrient deficiencies in AN can impair brain metabolism, reduce the availability of amino acids required for neurotransmitter synthesis, and alter cell membrane structure, ultimately affecting neuronal function. In addition, hypoglycemia caused by starvation may affect blood glucose levels and alter acetylcholine release, resulting in negative effects on learning and memory.<sup>[59]</sup> In addition to inadequate nutrition, an unbalanced diet in individuals with eating disorders may also negatively affect cognitive functions. Individual nutrient deficiencies can significantly affect brain development and subsequent cognitive health. Several micronutrients, such as B vitamins and iron, play an important role in cognitive health.<sup>[60]</sup>

## Conclusion

ED varies in prevalence rates, diagnostic criteria, and associated medical complications. Despite being life-threatening mental illnesses with severe health consequences, they remain under-reported and under-researched, making it challenging to determine their true prevalence. Healthcare professionals must recognize the symptoms of EDs and ensure timely diagnosis, as delayed intervention can lead to severe, potentially fatal complications. Early diagnosis is crucial in preventing or mitigating these complications and improving disease prognosis. Furthermore, it is important to acknowledge that individuals with EDs often experience cognitive impairments, primarily in attention, memory, and cognitive flexibility. These deficits are largely attributed to inadequate and unbalanced nutrition resulting from EDs. Therefore, individuals diagnosed with EDs should undergo cognitive performance assessments, and their dietary habits should be carefully evaluated by specialists to enhance cognitive function and prevent further deterioration.

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