

Exploring the Link between the Obesity and ADHD

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Abstract:

Obesity is a chronic, multifactorial and recurrent disease. ADHD is a chronic neurodevelopmental disorder in early childhood. The core symptoms include attention deficit, hyperactivity/impulsivity and oppositional defiance. Research shows that there is a significant correlation between obesity and ADHD, and the probability of overweight and obese children suffering from ADHD is significantly higher than that of normal weight children. This paper discusses the association mechanism between ADHD and obesity from the perspectives of genetics, eating disorders, intestinal flora and poor physical exercise. At the same time, in view of the prevention and intervention of the comorbidity of ADHD and obesity, this paper also puts forward various means such as diet intervention, exercise prevention intervention and drug treatment. However, the relationship between obesity and ADHD is complex, and the comorbidity problem needs to be solved urgently. Establishing an effective early screening system, implementing targeted prevention and intervention measures, and strengthening public awareness and understanding of comorbidities are important ways to improve the quality of life of this group. Further research is needed in the future.

Keywords: Obesity; ADHD; relationship.

1. Introduction

Obesity is a chronic, multifactorial, recurrent disease characterized by overweight, defined as $BMI \geq 30.0 \text{ kg/m}^2$. It is characterized by excessive increase in the number and volume of fat cells in the body, abnormal increase in the percentage of body fat in body weight, and excessive deposition of body fat in some parts of the body. The latest research report released by the lancet shows that the global obesity population will reach more than 1 billion in 2022. Since 1990, the number of obese adults worldwide has more than doubled, and the number of obese children and adolescents (aged 5 to 19) has tripled. The data also showed that 43% of adults were overweight in 2022. Obesity can cause a series of pathophysiological and psychological changes in the body, especially the physical and mental health childhood. Childhood obesity is not only an independent health problem, but also may aggravate the core symptoms of attention deficit hyperactivity disorder (ADHD), such as distraction, impulsive behavior and hyperactivity, which will have a profound negative impact on children's social interaction ability and academic achievement [1,2]. And the double burden of these two diseases has increased the relevant medical expenses by nearly 2 times [3]. In depth study of the comorbidity mechanism of obesity and ADHD is of great significance to significantly improve the treatment effect of these two

diseases and relieve the burden of the quality of life of patients and their families. Therefore, this paper intends to explore the correlation between obesity and ADHD, in order to provide more theoretical basis for the prevention and treatment of disease.

2. Epidemiological characteristics of ADHD

ADHD is a common psychological disorder in children. It is a chronic neurodevelopmental disorder that starts in early childhood. Its core symptoms include attention deficit, hyperactivity/impulsivity and oppositional defiance. ADHD children will not only cause cognitive and learning disabilities and other psychological problems, such as anxiety, depression and difficulties in dealing with peer relationships, but also have bad emotions in daily life and work for a long time, secondary to emotional disorders, conduct disorders, destructive behavior disorders, etc. What's more, there will be antisocial personality disorder and criminal behavior. Global data show that about 5% of children suffer from ADHD, while in China, the prevalence of ADHD among school-age children is between 4.31% and 5.83%. It is worth noting that about 65% of these children will continue to adulthood, which will continue to affect their daily life and function [4].

3. The association between ADHD and Obesity

In one study, 130 overweight and obese children were selected to form the overweight and obesity group, and the same number of normal weight children were matched as the control group [5]. The study used Patient Satisfaction Questionnaire (PSQ) and SNAP-IV rating scale to quantify and compare the severity of psychological and behavioral problems between the two groups of children, and accurately identify and quantify ADHD and its related symptoms. The results showed that there were 20 children with ADHD, and the prevalence rate was 15.4%. Among the normal weight children, there were 8 children with ADHD, accounting for 6.2% of the control group. The probability of overweight and obese children with ADHD was significantly higher than that of the control group, and the difference was statistically significant. The results of a population-based longitudinal study showed that the probability of obesity in ADHD patients during the follow-up period was 1.56 times higher than that in non-ADHD children [6].

A meta-analysis of 42 studies showed that ADHD, particularly untreated, is strongly associated with obesity in children and adults [7]. Another recent meta-analysis of five studies of 492 patients referred for bariatric surgery found 20.9% had ADHD [8]. Other study even showed 27.4% of 215 patients being treated for obesity had ADHD and this rose to 42.6% for those with BMI >40 [9].

4. Association Mechanism between ADHD and Obesity

4.1 Genetic Mechanism

From the perspective of genetics, relevant studies have found that there is an overlap between obesity risk alleles and alleles related to ADHD, which further confirmed the close association between the two. At present, it is believed that fat mass and obesity associated genes are closely related to childhood obesity, and also participate in the pathogenesis of ADHD. There is evidence that the rs8050136 and rs9939609 alleles of FTO are related to the severity of ADHD core symptoms and executive dysfunction [10,11]. At the same time, the change of brain-derived neurotrophic factor (BDNF) may be another potential key factor to regulate weight and ADHD symptoms. The polymorphisms of BDNF gene rs12291186 and rs10835210 are related to the pathogenesis of ADHD; Foreign studies have confirmed that BDNF polymorphism may be a genetic determinant of obesity [12,13]

4.2 Mechanism of Eating Disorders

The symptoms of ADHD are closely related to overeating and unrestrained eating behavior. This bad eating habit has become an important risk factor for obesity [14]. In addition, the significant impairment of executive function in children with ADHD directly shows a significant correlation with the high incidence of binge eating behavior, indicating that this functional impairment may promote the formation of bad eating habits [15]. When ADHD is associated with obesity, the incidence of overeating is 3.97 times higher than that of obese children without ADHD [16]. These studies suggest that obesity in ADHD can be caused by the mechanism of eating disorders.

4.3 Mechanism of Intestinal Flora

Although there are many intestinal flora in human body, the bacteria directly related to obesity are limited. Related studies based on the analysis of intestinal flora characteristics of ADHD children, screened obesity related bacteria, specifically amplified and monitored their quantitative changes by qPCR technology and explored the role in the relationship [17]. The result showed that the activity of *Enterobacter faecalis* in obese children with ADHD was low, and previous human and animal studies showed that the reduced expression level of *Enterobacter faecalis* was associated with the increased risk of allergic rhinitis, asthma, eczema and other diseases, that is, its low expression status may be a contributing factor to the occurrence of these diseases, and the risk of ADHD complicated with obesity in allergic children will be significantly increased [18]. Therefore, the low abundance of *Enterobacter faecalis* significantly increased the incidence of allergic reactions, which may disrupt the balance of neurotransmitters, thereby increasing the risk of coexistence of obesity and ADHD.

4.4 Poor Physical Activity

About 30% to 50% of children with ADHD face the challenge of dyskinesia. These challenges are embodied in the backwardness of gross motor skills, the lack of dexterity of hands, the lack of fine motor ability such as hand coordination, and the instability of posture control. Another research found that inattention would largely affect the development of individual motor skills. The poor performance of exercise is often closely related to another core symptom of ADHD: hyperactivity/impulsive behavior.

A study investigated 45897 adolescents, focusing on obesity, physical activity level and sedentary behavior in patients with ADHD symptoms [19]. The results show that adolescents with ADHD have a higher risk of obesity than adolescents without ADHD. Further analysis found that the physical activity levels of adolescents with ADHD

were significantly lower than those without such disorders. In addition, adolescents with ADHD showed more sedentary behavior than other groups. Long term sedentary behavior has been proved to lead to the imbalance between energy intake and consumption in children and adolescents. This imbalance is closely related to obesity and abnormal lipid metabolism in children and adolescents and is an important factor in the increase of obesity risk.

5. Prevention and Intervention of Comorbidity of ADHD and Obesity

5.1 Dietary Intervention

A study included 60 children with ADHD and obesity and randomly divided them into two parallel groups: diet intervention group (n=30) and non-diet intervention group (n=30) [20]. Both groups received 12 weeks of toroxetine hydrochloride as standard therapy. On this basis, the diet intervention group additionally implemented a 12-week limited energy balanced diet model intervention. Before and after treatment, Conners' parents' symptom questionnaire was used to evaluate and quantify the improvement of ADHD symptoms, and height and weight were measured to calculate BMI-P (age specific weight index hundreds of quantiles), which was used to evaluate the change of weight status. The Conners scale score changes and BMI-P changes of the two groups before and after the intervention were compared and analyzed, in order to explore the effect differences of diet intervention combined with drug therapy in improving the symptoms and weight management of ADHD children compared with simple drug therapy, and then analyze the potential correlation between different intervention methods and the improvement of symptoms. The results of the study confirmed that reasonable dietary intervention can effectively limit the dietary composition and food intake of obese ADHD children, thus achieving significant weight loss, and then increasing the levels of DRD2 (dopamine receptor D2) and DRD4 (dopamine receptor D4), thus improving the pleasure experience threshold of children, weakening their strong desire for food, reducing excessive eating behavior, and further promoting the weight loss of children. The emotional problems of children with ADHD are partly due to the lack of DRD2 and DRD4 receptors, and weight loss seems to lead to the increase of these receptors, which may become an effective way to improve the emotional state of children with ADHD.

5.2 Exercise Intervention

Exercise intervention refers to the use of physical exercise to carry out the corresponding auxiliary treatment, so as

to achieve a certain therapeutic effect. The study found that, reasonable exercise can regulate the plasticity of dopamine neurons in the ventral tegmental area through insulin, leptin and DA metabolism, effectively improve the functional abnormalities of the food reward system in obese people, significantly alleviate obesity related over-eating behavior, and thus have a positive impact on the prevention and treatment of obesity and its complications [21].

5.3 Drug Treatment

Meta analysis showed that the incidence of obesity in patients with ADHD (attention deficit hyperactivity disorder) was significantly lower than that in patients without ADHD. At present, drug therapy has become the main intervention means of ADHD. Central nervous stimulants significantly enhance the executive function of the brain by accurately regulating the level of dopamine in the brain. This mechanism enables ADHD patients to more effectively observe and regulate their behaviors after taking central stimulants, including avoiding unhealthy behavior patterns such as emotional driven overeating, thus significantly reducing their risk of obesity [22].

6. Conclusion

The relationship between obesity and ADHD is complex and closely related. Genetic factors, dietary disorders and intestinal flora are considered to be important ways to cause the comorbidity of ADHD and obesity. The comorbidity of ADHD and obesity is an important public health problem that needs to be solved urgently. In clinical practice should establish an effective early screening system, identify the high-risk groups of ADHD and obesity as soon as possible, and implement targeted prevention and intervention measures, such as exercise therapy and diet management, in order to block the development process of the disease. At the same time, people should strengthen public awareness and understanding of the comorbidity of ADHD and obesity, improve social attention and support for patients, reduce discrimination and prejudice, and create a good social environment. Through various efforts, we can bring a better future for this group.

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