Causes of and Interventions for Adolescent Obesity

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Abstract. In recent years, the global prevalence of adolescent obesity has continued to rise, posing a major public health challenge. Obesity during adolescence not only increases the risk of chronic diseases but also affects long-term physical and psychological health. Although existing studies have extensively explored pharmacologic treatments for adolescent obesity, non-pharmacologic interventions remain relatively underexplored. This study focuses on adolescents and aims to investigate the causes of obesity and evaluate non-pharmacologic interventions in the areas of diet, physical activity, psychological well-being, sleep, and genetics. It will also examine policy measures implemented in schools and communities in other countries to prevent adolescent obesity and promote healthier lifestyles. While current research includes the role of brain insulin resistance in dietary-related obesity, further exploration is needed to understand the physiological mechanisms associated with psychological and physical activity-related obesity. This study hopes to provide evidence for targeted, region-specific intervention strategies, strengthen governmental support, and contribute to the realization of national health goals such as the "Healthy China" initiative.

Keywords: Adolescents, obesity, global public health challenges, diet.

1. Introduction

With the gradual improvement of economic level and quality of life, obesity, a chronic disease, has attracted extensive attention in the field of global bio-health. At present, the problem of adolescent obesity is regarded as a global public health problem due to the widespread sale of junk food, the serious lack of physical exercise among adolescents, and the irregularity of their daily diet. The World Health Organization (WHO), by citing a study written in the British journal The Lancet, has shown that the number of obese adolescents aged 5-19 years old around the world has increased dramatically during the period 1990-2022, and even the prevalence rate has increased threefold. In 2022, 12.5% of the world's population will be obese, and children and adolescents aged 5-19 years will account for 15.9% of the population [1]. Relevant data show that the problem of obesity among adolescents under the age of 18 in China is more serious than the world average; in the United States, 40% of adolescents in the age group of 12-19 years are also seriously jeopardized [2].

According to the Report on Nutrition and Chronic Diseases in China (2020), the obesity rate among adolescents varies according to gender and geography. Geographically, the obesity rate of adolescents aged 8-13 years in northern China is about 21%, much higher than that in the southern region, and the obesity rate of adolescents in most of the countries with diverse food resources in North and South America is generally higher than that in European countries. In terms of gender, the obesity rate of boys at any age is higher than that of girls. Obesity not only has an impact on a person's appearance and psychological condition, but also has a more serious impact on the cardiovascular system, endocrine system, respiratory system, etc., and even creates the risk of suffering from hypertension, hyperlipidemia, diabetes and other diseases. For example, Ningxia, China, surveyed 4,577 primary and secondary school students and found that the co-prevalence of obesity and hypertension among them was 1.07% [3]; the School of Public Health, Harbin Medical University, Heilongjiang Province, surveyed 2,689 people and found that 1,776 people suffered from obesity, with the prevalence of type 2 diabetes reaching 8.16% [4].China Economic Weekly shows that research predicts that by 2030 China will have incurred about 418 billion yuan in medical costs for treating obesity, and it can be seen that obesity may lead to the regression of China's economy [5]. Therefore, it is urgent to solve the problem of adolescent obesity. This study aims to refine the two parts of causes and interventions that lead to adolescent obesity by reviewing a large amount of

literature. First, this study further analyzes the causes into intrinsic and extrinsic factors. After a large number of expert studies, many clinical cases of pharmacologic treatment of adolescent obesity have been identified, while fewer studies have been conducted on non-pharmacologic treatments. Therefore, this study utilizes non-pharmacological interventions, such as specific dietary, exercise, psychological, and sleep measures, to intervene in this serious problem [6], which is widely disseminated in the society through a number of mediums, so that the general public can pay attention to this problem and take action to achieve the goal of "Healthy China", which is emphasized by China. The solution of this problem is not only conducive to the healthy growth of individuals, but also promotes the development of public health in the global society. In order to reduce the prevalence of obesity among adolescents, governments in some countries have already taken action, for example, Le Grand, as one of the founders of "The Children's Trust" in the UK, suggested that the UK government should subsidize children who ate properly and exercised regularly; governments in European countries require that students should have two hours of physical exercise per week [7].

This paper will be divided into three parts, the first part is the basic concept and classification of adolescent obesity, the second part is the causes of adolescent obesity, and the third part is the interventions for adolescent obesity.

2. Overview of Adolescent Obesity

2.1. Basic Concept of Adolescent Obesity

Adolescent obesity refers to a long period of time, teenagers through the dietary intake of the body's energy is much larger than the energy consumed by the exercise, so that the excess energy in the body accumulation of the results, this excess energy is fat. Obesity will lead to adolescents in the psychological aspect of anxiety, low self-esteem, depression and other problems, in the physical aspect will greatly increase the risk of suffering from hypertension, hyperlipidemia, diabetes and other serious diseases, and even due to the psychological problems are reluctant to communicate with parents, teachers, classmates and lead to a lower IQ than the average normal adolescents [8].

2.2. Types of Adolescent Obesity

Adolescent obesity can be broadly categorized into two types: simple obesity and secondary obesity. Simple obesity is a chronic metabolic disease and is the most common form among adolescents. With the improvement of economic conditions and changes in lifestyle, many adolescents experience excessive nutritional intake, leading to an abnormal accumulation of body fat. This over-nutrition is considered the primary cause of simple obesity. In addition, genetic predisposition and environmental factors during growth, such as sedentary habits and unhealthy dietary patterns, also contribute significantly to its development [6]. In contrast, secondary obesity in adolescents is less common and typically results from underlying medical conditions or the use of certain medications. Metabolic disorders such as hypothyroidism and diabetes mellitus, as well as the long-term use of corticosteroids or other hormone-related drugs, are known causes of secondary obesity [6].

3. Causes of Obesity in Adolescents

3.1. Intrinsic Causes

3.1.1. Psychological factors

The research of Prof. Liza Wu, et al. found that the poor psychological condition of mothers in the process of pregnancy increases the probability of their children to suffer from obesity, such as overweight gain due to psychological reasons, postnatal depression and so on [9]. In addition, psychological problems are very common among adolescents in today's society, such as emotional depression, academic anxiety, and rebelliousness. These psychological problems are often a more

abstract concept, and sometimes when others are unable to detect whether adolescents have psychological disorders and do not give any help to enlighten them, it may become the cause of obesity. When adolescents feel stressed due to academic pressure or difficulties in life, they may unconsciously consume a large amount of food to relieve their stress, especially junk food and high-calorie food. Professor Luo Huijuan's research shows that the co-occurrence of depression and obesity among secondary school students in Beijing is not optimistic, and some methods and means are needed to slow down this situation, indicating that depression and adolescent obesity are inextricably linked [10]. Therefore, psychological factors can indirectly lead to adolescent obesity, which needs to be paid extensive attention to.

3.1.2. Genetic factors

Obesity is defined as an inherited disease caused by multiple genes. In particular, adolescents are simply obese, so whether the parents are obese or not determines the probability of children suffering from obesity. The data obtained from Prof. Xu Guohong's research shows that one of the parents is obese than both parents are obese children have a much lower probability of disease. Further analysis of the former mother's obesity than the father's obesity genetic probability [6]. This genetic probability also varies according to gender and age. Prof. Ningning Zhao collected 65 obese children and 376 normal children's blood samples for a series of tests and comparisons to study the mitochondrial tRNA gene mutation and obesity found that there is a strong link between the two, and maternal inheritance is one of the important reasons why children suffer from obesity [11]. Therefore, genetic factors are also an important intrinsic cause that can’t be ignored.

3.1.3. Sleep factors

Related studies have shown that there is a close correlation between the length of sleep and adolescent obesity, and that lack of sleep is one of the most dangerous factors causing adolescent obesity. Zhu Hongru et al. conducted a questionnaire survey study on elementary school students in grades 1-4 in Tangshan City through stratified random whole cluster sampling method, and found that the prevalence of elementary school students with sleep time <9h was 34.3%, and the prevalence of obesity among elementary school students with sleep time ≥ 10h was 23.3%, which shows that the prevalence of elementary school students who do not have enough sleep is a bit higher [12]. Short sleep duration increases the number of times they eat, due to the fact that they are awake for a long time; however, sleep deprivation causes adolescents to be exhausted, which makes them reluctant to do a lot of physical exercise and leads to obesity [13]. Liu Feng et al. conducted a questionnaire survey and height and weight index test on 9864 primary and secondary school students in Urumqi, and found that the prevalence of obesity was lowest in students who slept more than 8h, and the prevalence of obesity gradually increased as the sleep time was shortened [14].

3.2. External Causes

3.2.1. Dietary factors

Long-term poor dietary habits become one of the key factors leading to obesity. By surveying parents of children aged 3-9 years old in an online and offline manner, Wang Minghe et al. found that there were significant differences between obese and normal children in terms of children's consumption of fast food, puffed food, consumption of sugary beverages, and frequency of consuming sweets, as shown in Table 1 [15]. Zhang Changzi et al. pointed out that adolescents' eating habits and love for certain flavors are cultivated from infancy, so some adolescents do not develop healthy eating habits at the beginning or do not persistently adhere to them after developing healthy eating habits, thus making high-sugar and high-fat foods accumulate into fat in the body leading to obesity [16]. In the physiological mechanism, the acquisition of glucose and the synthesis of lipids require the participation of insulin. If one is in a state of obesity, a large amount of insulin secretion is activated, which leads to the proliferation of adipose tissue until the capacity of storing triacylglycerol is saturated, and the rest of the lipids are either stored in other parts of the body, such as the liver and the brain. When lipids accumulate in hepatocytes, FFA and inflammatory factors

released from visceral fat led to disruption of hepatic metabolism, resulting in the production of diglycerides and ceramides. Glycerol diesters activate protein kinase Cε phosphorylation and inhibit insulin receptor activity, leading to reduced IRS-2 tyrosine phosphorylation. Chronic high-fat diet causes excessive accumulation of lipid droplets in the third ventricle of the hypothalamus in rats, which has an inhibitory effect on glucose and lipid metabolism in the hypothalamus regulating the central system, and cerebral insulin resistance occurs, as shown in Figure 1 [17]. Therefore, daily dietary habits are particularly important, and parents should cultivate good healthy dietary habits in their children from childhood, so that the risk of obesity can be reduced.

Table 1. Results of the survey on the relationship between daily eating behaviors and obesity [15]

Title	Option	Frequency/times		X2	P
		Obesity	Normal		
Frequency of the child's consumption of nuts	0-1 times/week	38	34	0.462	0.927
	2-3 times/week	30	21		
	4-5 times/week	7	6		
	6-7 times/week	4	3		
Frequency of the child's consumption of fast food	0-1 times/week	37	46	9.485	0.023
	2-3 times/week	36	16		
	4-5 times/week	5	2		
	6-7 times/week	1	0		
Frequency of the child's consumption of puffed food	0-1 times/week	31	31	10.190	0.017
	2-3 times/week	19	23		
	4-5 times/week	28	6		
	6-7 times/week	1	4		
Frequency of the child's consumption of sugary drinks	0-1 times/week	31	37	15.008	0.002
	2-3 times/week	20	15		
	4-5 times/week	28	9		
	6-7 times/week	0	3		
Frequency of the child's consumption of sweets	0-1 times/week	36	36	12.565	0.006
	2-3 times/week	21	23		
	4-5 times/week	21	4		
	6-7 times/week	1	1		

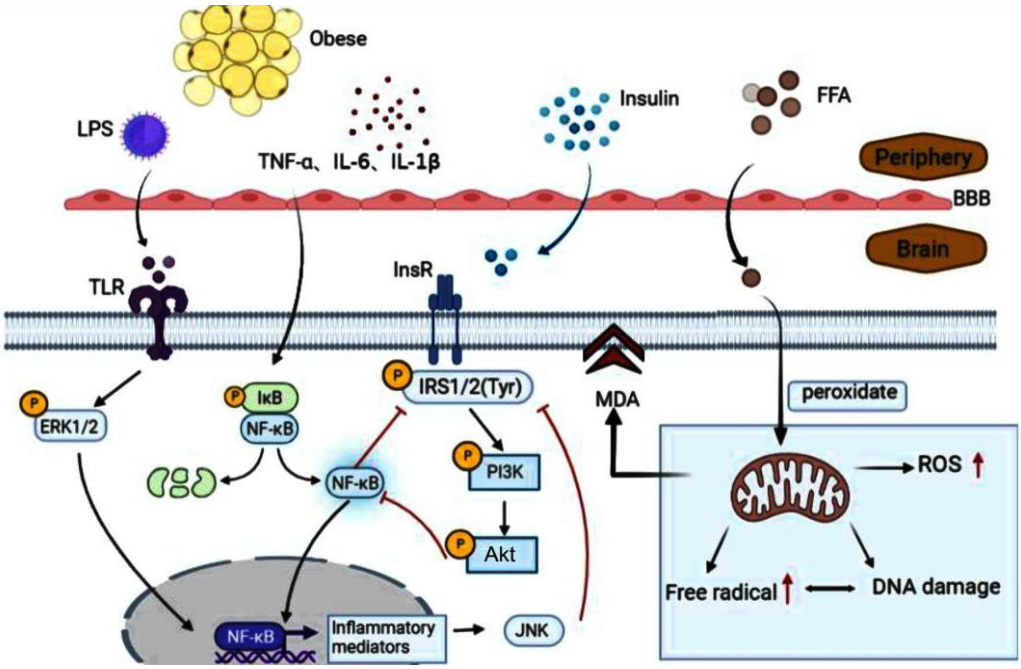

Figure 1. Mechanisms of obesity-induced cerebral insulin resistance [17]

3.2.2. Exercise Factors

Relevant studies show that adolescents living in big cities have a much higher proportion of obesity than rural adolescents. Due to the progress of science and technology, the rapid development of electronic equipment, a portion of adolescents addicted to games in the holiday period, resulting in sedentary time is too long serious lack of outdoor physical activity; China's primary and secondary schools in the ten minutes between classes is not enough to let the students to the playground activities, resulting in the amount of primary and secondary school students to reduce the amount of exercise; in the face of China's severe pressure of higher education, a part of the parents are only concerned about their children's academic performance, spend a lot of time and energy to test education cramming, thus ignoring the lack of physical activity of the child. In the face of China's severe pressure of schooling, some parents are only concerned about their children's academic performance, spend a lot of time and energy to carry out the examination education cramming, thus ignoring the lack of physical exercise of the child this status quo, the above reasons may lead to adolescents with obesity. Xu Guohong et al. showed that prolonged sedentary activity and reduced physical activity can lead to increased calorie intake and reduced calorie consumption, which may lead to obesity in adolescents [6].

4. Intervention Measures for Adolescent Obesity

4.1. Dietary Aspects

In order to solve the problem of adolescent obesity, the first thing to do is to improve their dietary structure and habits. Parents should choose for their children to eat more low-calorie foods, such as coarse grains, vegetables, fruits, all kinds of soy products, etc., which can not only enhance the stomach's digestive level, but also improve the children's intake of vitamins, minerals, and dietary fiber, and enhance the body's ability to resist epidemics in the spring and winter. And to control the intake of various staple foods as well as meat, you can list out some diet plans to supervise your children in order to develop their good dietary structure. Secondly, increase the frequency of chewing each time you take in food, so that you can secrete more salivary amylase and other digestive enzymes to fully digest and absorb the food, and enhance the feeling of satiety. A smaller amount of food should be ingested for dinner than for breakfast and lunch, as adolescents rarely choose to exercise after dinner, but will instead study sedentary after the meal, which is not conducive to the digestion and metabolism of food [8]. Wenzhou City has made a series of intervention programs to reduce adolescent obesity in junior high schools by using student electronic nutritionist software to design recipes for students that meet the requirements of a balanced diet, and conducting training for school cafeteria staff once a semester, with the main training content being the current status of student meals in primary and secondary schools and the principles of student meal preparation. The Ministry of Education distributes nutrition and health promotion materials to each school once a month and conducts related courses [18]. Many countries around the world, such as Italy, the United Kingdom, France, and Hungary, have reduced the number of people who buy sugary drinks by imposing a tax on sugary drinks, as shown in Table 2 [19], especially for soda, carbonated drinks, and so on, in order to reduce the rate of obesity in that country. Although China has not yet implemented the relevant policies, it has begun to pay attention to controlling the consumption of sugary drinks.

Table 2. Tax rates on public health products in Hungary in 2015 [19].

Product name	Tax rate
Soft drinks, syrups	200HUF/l
Other soft drinks	7HUF/l
Sugared cocoa powder	70HUF/kg
Pre-packaged unhealthy products	130HUF/kg
Savoury snacks	250HUF/kg
Flavourings	250HUF/kg
Flavoured beers	20HUF/l
Alcoholic soft drinks	20HUF/l
Jam	500HUF/kg

4.2. Exercise Aspect

To reduce the probability of adolescents suffering from obesity, it is indispensable to strengthen physical exercise, which requires the joint efforts of both families and schools. First of all, in the family, parents should lead their children to do simple physical exercise, such as running, jumping rope, cycling and so on, which can also enhance the relationship between parents and children. On the basis of good economic conditions, they can also arrange some ball sports courses for their children, such as basketball, volleyball, tennis, etc. This not only reduces the risk of obesity, but also helps to increase height and enhance the child's endurance. Try to guide children to spend their after-school time on sports instead of indulging in games. Second, schools should set up age-specific physical activity programs for students, such as increasing recess time and the number of weekly physical education classes. Schools also need to be equipped with sports equipment, and moderate physical exercise under the guidance of professional physical education teachers to prevent joint dislocation or injury due to excessive force [20]. A large number of studies have shown that reducing screen time for adolescents can reduce the rate of obesity, and according to the Healthy China Action (2019-2030), it is recommended that the cumulative total of non-learning use of electronic screen products by primary and secondary school students in China should not exceed 1 h per day [21].

4.3. Other Aspects

Widely publicizing the hazards of adolescent obesity and intervention measures is also an important part of reducing its prevalence. Communities and primary and secondary schools should post relevant notices on publicity boards and regularly invite adolescent health experts to carry out relevant thematic classroom education lectures to warn adolescents to take relevant measures to avoid obesity and to give those who suffer from the disease some specific measures to alleviate the symptoms of the disease. Let the general public pay attention to this problem and take action to achieve the goal of "Healthy China" emphasized by our country. Schools can also set up mental health counseling rooms, where mental health teachers can help students with psychological problems through exchanges or activities to help them come out of their difficulties, so as to avoid obesity caused by psychological factors. The government should utilize ways and means to reduce the sale of junk food to adolescents, such as increasing the price of such products, reducing the production of junk food, and reducing the number of stores selling junk food, so as to reduce the sources of obtaining such things to reduce the probability of illness.

5. Conclusion

This paper finds that there are many factors leading to adolescent obesity, among which the intrinsic causes include psychological factors such as over-eating caused by bad emotions, the influence of parental obesity on children in genetic factors and metabolic disorders triggered by sleep deprivation, etc.; while the extrinsic factors include poor dietary habits and lack of exercise. In the study of measures to intervene in adolescent obesity, emphasis was placed on dietary modification,

such as increasing the intake of fruits and vegetables and controlling staple foods and meat; strengthening physical exercise, and joint efforts between families and schools to promote the implementation of a series of programs; and also pointed out the importance of extensive publicity by members of the community, and the government's efforts to reduce the sale of junk food, and so on. This study not only analyzes the problems related to adolescent obesity in all aspects, but also conducts some physiological mechanism studies, such as brain insulin resistance, which can help to raise the public's attention to the problem of adolescent obesity. Further study should focus on the causes of obesity and intervention methods in different regions and individual differences, improve the pertinence and effectiveness of interventions, and increase the support and implementation of policies, so as to better protect the health of adolescents and help realize the goal of "Healthy China".

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