Inducing Factors of Obesity and Weight Management: Research Progress

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Abstract. The global prevalence of overweight/obesity is rapidly increasing, with approximately 48.9% of adults in China being overweight or obese. With the increase in body mass index, the risk of obesity related complications increases and imposes a heavy economic burden on patients. Overweight/obesity has become a global public health issue. Lifestyle intervention is the cornerstone of obesity management. With the rapid growth of global obesity incidence rate, new weight loss drugs are constantly coming out. Especially the new generation of weight loss drugs, with their significant weight loss efficacy, comprehensive metabolic benefits, and good safety characteristics, bring new hope for weight management in obese patients. Therefore, by combining weight loss measures (i.e. drugs and surgery) with scientific long-term weight management concepts and specific weight loss drug applications. This article aims to update and optimize the confirmation and management of obesity, providing some basic theoretical guidance for weight management of obesity in China and helping patients achieve scientific weight loss.

Keywords: Obesity, weight management, public health.

1. Introduction

Obesity refers to a condition in which the body contains more than 20% more fat than the ideal body weight. In the early days, the World Health Organization classified it as a disease and it is a chronic metabolic disorder that arises from the interaction of environmental, genetic, and other factors. A research report published in the British journal The Lancet shows that the number of people suffering from obesity worldwide reached 1 billion in 2022, with a prevalence rate of one eighth. The number of adults suffering from obesity has doubled, and the number of adolescents and children has increased by about three times. Moreover, obesity is the largest chronic disease worldwide, and the obesity rate among children and adolescents is increasing at a faster rate than that of adults. From this, the global problem of overweight and obesity is very serious. Therefore, it is very important to use scientific methods to intervene and alleviate the health problems caused by obesity.

Obesity has become a global health concern. According to the World Obesity Federation's 2023 obesity map data, there are 988 million obese people aged 5 and above worldwide, and the prevalence of overweight and obesity continues to rise. In terms of obesity related complications, fatty liver disease, pre diabetes, dyslipidemia and hypertension are the most common complications, with the detection rates of 34.9%, 27.6%, 24.9% and 17.6% respectively. Especially among obese individuals, the detection rate of fatty liver disease is as high as 81.8%, highlighting the strong correlation between obesity and liver health. The pathogenesis of obesity is complex, and changing lifestyle is the most important method for weight management, which is recommended as a first-line treatment method by guidelines including those in China [1]. Drug therapy is a second-line treatment option for obese patients who have failed lifestyle interventions. Appropriate use of medication can assist patients in achieving greater weight loss and maintaining weight loss. Weight loss surgery is currently considered the most effective treatment for obesity, which can reduce the weight of obese patients by about 15% to 30%. Although there may be a slight rebound in weight 2-3 years after surgery, postoperative weight loss can be maintained for 20-30 years. Weight loss surgery can significantly improve hyperglycemia and hypertension in obese patients, reduce cardiovascular or related cancer mortality rates by 30% and 23%, respectively, and increase life expectancy by 3 years [2]. Therefore, weight loss surgery can be considered as a preferred option for patients with severe obesity and

multiple complications. Weight loss surgery, as an invasive procedure, requires consideration of potential risks and adverse reactions such as gastrointestinal leakage, anastomotic stenosis, postoperative bleeding, as well as long-term postoperative risks such as weight rebound, malnutrition, vitamin and trace element deficiencies, and gallstones. Therefore, this article explores how to effectively prevent and control obesity by analyzing the triggering factors of obesity and weight management.

2. Risk factors leading to obesity

2.1. Genetic factors

The onset of simple obesity in humans has a certain genetic background. The report shows that if one parent is obese, the obesity rate of their children is about 50%; Both parents are obese, and the obesity rate of their children has increased to 80%. Human obesity is generally considered to be a polygenic inheritance, and genetics plays a susceptible role in its onset. The formation of obesity is also related to the interaction of lifestyle, feeding behavior, preferences, insulin response, and social psychological factors [3].

Research has found that the FTO gene is an allele associated with obesity. Its impact on human obesity is mainly attributed to its influence on gene expression. The FTO gene can remotely activate gene expression in a certain variant region, causing precursor adipocytes to differentiate into adipocytes, losing the ability to burn fat and produce heat, thereby causing energy imbalance in the human body and leading to overweight [4].

People carrying the FTO gene have a strong desire to eat, and normal "three meals a day" cannot eliminate the hunger of FTO gene carriers, leading them to constantly eat. Due to the lack of dietary control, high calorie and high-fat foods are extremely tempting to them, and when hungry, they tend to eat these types of foods.

In addition, FTO also inhibits people's metabolism, making it difficult to burn body fat to generate heat, and excess fat accumulates in the body, leading to obesity.

The United States conducted a two-year study to control the intake of protein and fat in adults and ensure that everyone's intake of trace elements maintains good health. The experimental results indicate that the population of FTO-AA may improve their food dependence if they adopt a high protein diet. On the other hand, it is important to constantly remind oneself of the deception of satiety. It is recommended that people with the FTO-AA genotype stop eating without overeating.

The MC4R gene encodes a receptor called the melanocortin 4 receptor, which is the most important sensor in the brain responsible for the "hunger center" and "satiety center". Research has found that hereditary severe obesity is caused by rare mutations in the MC4R gene. These mutations result in weakened or completely lost function of the MC4R gene, and its carriers always experience severe hunger. However, these mutations are relatively rare and only occur in a small proportion of patients with familial obesity.

For most people prone to obesity, they carry another type of MC4R risk variation, such as rs17782313 C allele (about 17% of Chinese). Their appetite is stronger than that of ordinary people. At the same time, they have a weak sense of satiety. They also prefer to eat high carbon staple foods such as rice, Mantou, noodles, and so on [5].

In 1977, scientists first discovered patients with congenital deficiency of leptin in humans. Mutations in a gene called LEPR in these patients can cause a series of related gene expression disorders, resulting in abnormal secretion of hormones such as leptin and melanocortin, ultimately leading to obesity and other problems. It can regulate human body weight, energy metabolism, and immunity. Meanwhile, the polymorphism in the LEPR gene is associated with levels of blood glucose, insulin, leptin, and triglycerides. Defects in the LEPR gene can also lead to obesity [6].

PPARG gene: PPARG is very sensitive to insulin regulation. SNP will lead to fat metabolism disorder, which will mostly develop into insulin resistance and type 2 diabetes (T2DM). According to statistics, approximately 25% of T2DM is related to PPARG [7].

2.2. Environment

Environmental factors are a very important factor that affects an individual's physical fitness. In most cases, immature plant fruits are generally green, while mature fruits are often yellow, red, and other colors. Human understanding of this pattern has also led to the influence of color on appetite. Therefore, natural foods with a redder color may contain higher levels of nutrients, while green foods often represent lower calories, which is the "color code" contained in food. The human visual system can adapt well to this natural law [8].

Cold colored foods can suppress appetite, and blue is considered the color that best suppresses appetite. Colors have been endowed with different types of specific taste information, such as the sweet taste psychology that red can evoke; Orange can create a sour and refreshing taste sensation in people; Yellow can create a soft taste psychology in people; Green is generally associated with sourness; Black gives a bitter taste.

Tableware also has a significant impact on taste perception. For example, people generally believe that coffee in a red cup has a stronger flavor than coffee in a transparent cup, because red enhances people's perception of food taste. When snacks are placed on a red plate or drinks have read labels, people will eat less. Compared to black plates, white plates can enhance the sweetness of strawberry ice cream; If the color of the cup is cool, then the beverage it holds is likely to be considered more thirst quenching.

The ambient light shining on food can also affect appetite. Studies have shown that yellow and white light shining on food can increase a person's food intake, while blue light can decrease it. In addition, the higher the brightness of light of the same color, the more it can stimulate appetite. According to research results, people dining in brightly lit restaurants are 16% -24% more likely to choose healthy food than those dining in dimly lit restaurants. Although many dimly lit restaurants have a good atmosphere, they are more likely to order high calorie meals and are more likely to lose control! This is because the brightness of light affects our alertness: in bright environments, we have a clear and sensitive sensory perception of food, making us more inclined to choose foods that are beneficial for long-term health. Such as vegetables and grilled fish or white meat. In dimly lit environments, there is a lack of vigilance towards food and a tendency to choose high calorie foods such as fried foods and desserts.

3. Criteria for Determining Obesity and Its Complications

3.1. Diagnostic Criteria

3.1.1. Diagnosis of obesity based on body mass index (BMI)

BMI is commonly used as a simple indicator for determining obesity in clinical practice. BMI (kg/m^2) = weight (kg)/height ^{2} (m^2). Table 1 shows the BMI (Body Mass Index) criteria used for diagnosing obesity, which categorize individual weight status into four categories. Firstly, when the BMI value reaches or exceeds 28.0 kg/m ², an individual is classified as obese, indicating that their weight significantly exceeds the healthy range; When the BMI value is between 24.0 and 27.9 kg/m^2, the individual is defined as overweight, although the weight exceeds the normal range, it has not yet reached the criteria for obesity. For individuals with normal weight, their BMI should be between 18.5 and 23.9 kg/m ², which is the ideal range for a weight to height ratio that meets health standards. If the BMI value is below 18.5 kg/m ², the individual is considered underweight and may face the risk of malnutrition or other health problems. This BMI classification system not only provides clear reference standards for the diagnosis of obesity, but also plays a key role in evaluating the impact of abnormal weight on health, and is widely used in clinical and public health fields [9].

Table 1. BMI Diagnostic Criteria for Obesity.

Classification	BMI Value (Kg/m^2)
Obesity	≥28.0
Overweight	24-27.9
Normal weight	18.5-23.9
Low body weight	<18.5

3.1.2. Diagnosis of central obesity based on waist circumference

Measuring waist circumference can diagnose central obesity and peripheral obesity. The waist circumference measurement method is to take an upright position and measure the circumference of the body at the horizontal position of the midpoint of the line connecting the rib arch and the iliac crest on the midaxillary line. Hip circumference refers to the circumference of the body at the horizontal position of the hip apex [10].

Table 2. Diagnosis of central obesity based on waist circumference.

Classification	Male waist circumference	Female waist circumference
Central type pre obesity	85-90	80-85
Central obesity	≥90	≥85

The more accurate diagnostic method of central obesity is to use CT or MRI, select the images of the fourth and fifth lumbar intervertebral planes, and measure the content of visceral fat area, as shown in Table 2. The visceral fat area of Chinese people ≥ 80 cm2 is defined as central obesity.

3.1.3. Diagnosis of obesity based on body fat percentage

Body fat percentage (BFR) refers to the proportion of body fat weight in the total body mass, also known as body fat percentage. The body fat percentage measured by bioelectrical impedance method can be used for the determination of obesity. Male body fat percentage>25%, female>30%, may be considered obese. However, the accuracy of bioelectrical impedance measurement is not high, and the measured values are only for reference.

3.2. Chronic Diseases

3.2.1. Diabetes

Among diabetes population, T2DM patients account for 90% or more. This population is mainly composed of middle-aged and elderly people over 45 years old, as well as obese individuals. The onset of T2DM is influenced by genetics and lifestyle, and its core pathophysiological mechanisms are insulin resistance and impaired beta cell function, which work together to promote the occurrence and development of T2DM. Obesity leads to two core pathological changes of T2DM, which in turn leads to the occurrence of diabetes. T2DM often occurs in adults, with the main causes being insulin resistance or insufficient secretion, or a combination of both. T2DM accounts for more than 95% of diabetes patients in China [11]. The typical symptom is obesity, especially abdominal (also known as cardiogenic) obesity, which can also manifest as polydipsia and polyuria. Implementing a balanced diet pattern to prevent insufficient or excessive intake of energy and various nutrients in the body, actively engaging in physical activity to achieve a balanced diet, maintaining a healthy weight to reduce the risk of overweight and obesity, is very important for reducing the risk factors of T2DM. It is an important means of primary prevention (etiological prevention) of T2DM.

3.2.2. Hypertension

The relationship between obesity and hypertension was discovered as early as the early 20th century. The Framingham Heart Study has shown that 78% of men and 65% of women with primary hypertension can be attributed to overweight or obesity. And for every 5% increase in weight, the risk of developing hypertension increases by 20% to 30% Excessive accumulation of visceral fat in and around the kidneys may cause physical compression on the kidneys. Similarly, excessive

accumulation of fat in the upper respiratory tract can lead to obstructive sleep apnea, thereby enhancing the response of the sympathetic nervous system and renin angiotensin aldosterone system, leading to hypertension. The main symptoms are dizziness and headache. The headache is mostly in the forehead area, and pain in the bilateral temporal head curtains and posterior occipital area can also occur. Pain in the forehead area is the most common. Severe hypertension can cause nausea and vomiting, which is caused by the disruption of the blood-brain barrier due to hypertension. For obese hypertensive patients, weight loss and lifestyle interventions are effective strategies for reducing weight and controlling blood pressure. One way to control blood pressure is to lose weight, control diet appropriately, eat more vegetables and fruits, eat less greasy foods, and eat less salt rich foods. Through the above lifestyle interventions, if blood pressure remains high for two months, some antihypertensive drugs can be used.

4. Treatment Methods and Measures

Obesity is a chronic disease characterized by excessive accumulation of fat in the body, mainly because the absorbed energy cannot be well consumed, and the remaining energy will be converted into fat, which will then form obesity. Regardless of whether it is hereditary obesity or not, the first thing to do is to ensure that the absorbed energy can be consumed to prevent obesity caused by fat accumulation, which is weight control. There are many ways to control weight, and this section will discuss the regulation of diet, exercise, and medication.

4.1. Diet

The significance of obesity diet management lies not only in reducing energy intake and effectively losing weight, but also in improving metabolic problems such as blood sugar, blood pressure, blood lipids, and insulin resistance. Limiting total calorie intake and maintaining a negative balance between body intake and expenditure are key factors in achieving clinically significant weight loss, while dietary structure, eating habits, and eating time are also important factors affecting weight loss. There are currently various forms of dietary patterns, such as energy limited diets, which can effectively reduce body weight, fat content, improve metabolic syndrome components such as insulin resistance, and reduce the risk of cardiovascular disease; Low carbohydrate diet can significantly reduce the weight of obese patients in the short term and effectively improve indicators such as blood sugar and blood lipids. However, the compliance with low carbohydrate diets is relatively low, and there are few studies evaluating their long-term weight loss effects and adverse consequences; A high protein diet can help reduce weight, improve cardiovascular disease risk factors such as blood sugar and blood lipids. Partial research evidence suggests that a high protein diet can weaken intestinal lipid absorption and prevent fat gain, making it an effective strategy to prevent weight regain; Intermittent dieting can achieve mild to moderate weight loss (a decrease of 3% to 8% from baseline) in a short period of time (8-12 weeks). Some studies suggest that intermittent dieting may improve cardiovascular metabolic risk factors such as blood pressure, blood lipids, insulin resistance, and glycated hemoglobin.

4.2. Exercise

For obese patients, there are two recommended types of exercise: aerobic exercise and strength training. Aerobic exercise such as brisk walking, jogging, swimming, cycling, etc. can help burn many calories and promote cardiovascular function. For beginners, it is recommended to start with low intensity and gradually increase the exercise time and intensity. Strength training such as weightlifting, squats, push ups, etc. can increase muscle mass and improve basal metabolic rate. Strength training can also improve body shape and enhance bone health.

Developing a long-term, progressive exercise plan is the key to success. Start with mild aerobic exercise, such as taking a 30-minute walk 3-4 times a week. At the same time, perform basic strength training such as simple stretching and core muscle exercises.

Increase the intensity and duration of aerobic exercise, such as brisk walking for 45 minutes, 4-5 times a week. In terms of strength training, weight and difficulty can be gradually increased. Start trying high-intensity aerobic exercises such as jogging or swimming, for 30 minutes each time, 3-4 times a week. Strength training continues to increase weight and difficulty to challenge the limits of the body.

During the implementation of the exercise plan, pay attention to arranging exercise time and frequency reasonably to avoid excessive fatigue. In addition, maintaining an appropriate diet is also very important, ensuring that the intake of calories can meet the body's needs without affecting the weight loss effect.

4.3. Medications

The approved indication for semaglutide in China is T2DM, but it has not yet been approved for simple overweight or obesity; The only weight loss drug currently approved for market in China is Orlistat.

4.3.1. Simeglutide

The preferred GLP-1 receptor agonist is semaglutide, rather than liraglutide. Because semaglutide only needs to be administered once a week. The mechanism of action of semaglutide for weight loss: it can delay gastric emptying (longer food stays in the stomach) and increase satiety; Acting on the central nervous system to suppress appetite, effectively reducing food intake and achieving weight loss. The FDA approves semaglutide for chronic weight management in overweight patients with a body mass index (BMI) ≥ 27kg/m2 and at least one weight related disease (such as hypertension, T2DM, or high cholesterol), or in adult obese patients with a BMI ≥ 30kg/m2. Subcutaneous injection of 2.4mg once a week resulted in an average weight loss of 12.8% after 44 weeks of treatment; Global (overweight/obesity, non-diabetes): the average weight loss after 68 weeks of 2.4mg subcutaneous injection once a week was 16.9%; Global (overweight/obesity, T2DM): An average weight loss of 10.6% was achieved after 68 weeks of subcutaneous injection treatment with 2.4mg once a week. Listed in China in April 2021, approved for T2DM indication, and approved for weight management indication in June 2024 [10].

A series of research results have shown that semaglutide can provide clinically effective weight loss for adults who are simply overweight/obese, and the weight loss effect can be comparable to that of surgical procedures. Therefore, it is also known as the "miracle drug for weight loss".

Although semaglutide has excellent weight loss effects, it is not suitable for everyone. The approved population for semaglutide includes patients with simple obesity and a body mass index (BMI) greater than 30kg/m ^{2}, as well as patients with at least one obesity complication (such as hypertension, hyperlipidemia, T2DM) and a BMI greater than 27kg/m ^{2}. Therefore, for beauty enthusiasts with BMI<27kg/m ^{2}, do not rashly use semaglutide for weight loss, as blind use may lead to adverse consequences such as gastrointestinal reactions and pancreatitis [12].

4.3.2. Orlistat

Orlistat is a long-acting and potent specific gastrointestinal lipase inhibitor that can inhibit the absorption of 30% triglycerides in ingested food by the gastrointestinal tract, thereby promoting negative energy balance and achieving weight loss. Orlistat is ineffective against the fat already formed in the human body. During use, it is recommended to strengthen exercise and control diet (especially carbohydrate intake) to achieve weight loss.

Orlistat and semaglutide are both FDA approved weight loss drugs. The weight loss effect of semaglutide is significantly better than that of orlistat. Although orlistat has existed for more than 20 years, its long-term weight loss effect is not good and should not be taken for a long time. As a long-term weight management medication, semaglutide is generally safe, with common side effects including gastrointestinal discomfort, bloating, nausea, constipation, diarrhea, etc. In May 2010, the FDA issued a warning that the use of orlistat may pose a serious risk of liver damage. In addition, if

used for a long time without following a strict low-fat diet, it may also cause the side effect of fat leakage (commonly known as oil pulling or oil leakage), which affects the weight loss effect [12].

Although both orlistat and semaglutide have weight loss effects, these two drugs have significant differences and different mechanisms of action. Therefore, it is recommended to use them under the guidance of a doctor, otherwise it may lead to various adverse reactions; Secondly, for the weight loss population, drug treatment is only a part, and it is easy to rebound after stopping medication. However, a reasonable diet and exercise are the key to weight loss. It is recommended that everyone develop a weight loss plan that is suitable for their own situation based on medication, so as to achieve the effect of treating both symptoms and root causes.

5. Conclusion

Overall, the prevalence of overweight and obesity has significantly increased in different age groups, genders, and regions worldwide, and China has become the country with the highest number of overweight and obese people in the world. The factors that lead to obesity include genetic factors, neurological and psychological factors, and environmental factors; In addition, there are relatively few weight loss drugs approved by Chinese regulatory authorities, and the acceptance of non-lifestyle intervention weight loss measures (i.e. drugs and surgery) is low; The weight loss measures of lifestyle intervention include diet and exercise, which require long-term persistence to achieve weight loss effects. This article has not yet mentioned some obesity prevention and control policies and plans that have been implemented in China, and currently these plans are not yet perfect. Governments at all levels, relevant social departments, and individuals should actively participate in the formulation of obesity prevention and control policies and plans. Currently, there is still an urgent need to explore an effective model for obesity prevention and control.

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