Review Paper

Systematic Approach to Understand Obesity and Chronic Weight Management

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ABSTRACT

Obesity is a chronic, multifactorial, multifaceted problem that has turned into a significant issue of global health care due to its strong association with cardiometabolic-related issues, worse quality of life and premature death and increased prevalence rate. The paper dwells on long-term weight management methods besides providing a comprehensive overview of epidemiology, pathophysiology, and health consequences of obesity. Obesity develops due to a complicated set of genetic predisposition, behavioral factors, influences of the environment, the regulation of the metabolic process, and social determinants. The review addresses the conventional options such as nutritional interventions, physical exercise, behavioral therapy and sleep management, as well as the new options, such as pharmacotherapy, bariatric surgery, digital health technologies, and personalized medicine. Other analysed are the financial cost, public health impact, the role of legislation, and the community-based strategies. Recent advances in incretin-based medications, gut microbiome research and genetics are altering the future of treating obesity. Everything taken into account, integrated, multidisciplinary and lifelong strategies that involve the combination of clinical treatment and population-wide preventive strategies are required in successful management of obesity. To tackle obesity epidemic in the world, research and equitable access to treatment will be needed.

INTRODUCTION

Obesity is one of the most pressing global public health problems in the twenty-first century [24,30]. The World Health Organization considers obesity to be a chronic disease that increases the risk of cardiovascular disease, type 2 diabetes mellitus, certain types of cancers and premature death. The long-term weight control process remains difficult due to physiological adjustments

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as well as the environmental conditions that promote the weight gain [15]. To be able to come up with sustainable approaches to obesity management, it is important to know that this is a chronic condition and not merely a lifestyle choice.

Defining Obesity

The most universal measure used to determine obesity is the body mass index (BMI) calculated as weight divided by height in kg/m^2. Obesity refers to a BMI of $30 kg/m^2$ or more, but is divided into severity subclassifications. Nevertheless, BMI is not at all indicative of the fat distribution or fat versus lean mass, so the additional values such as body composition analysis and waist circumference are employed [14].

Epidemiology of Obesity

Obesity has been increasing in the world since 1975. The consequences extend to both the high-income and low-to-middle-income countries, and the primary reasons are sedentary lifestyles, changes in diet, and urbanization. Socioeconomic position, age, gender and ethnic differences exist, which reflects the effect of social determinants of health [24, 30].

Pathophysiology of Obesity

There is a growing consensus that obesity is an energy homeostatic disorder that contains complex interactions between the liver, skeletal muscle, adipose tissue, gastrointestinal tract and central nervous system. One of the primary roles of the hypothalamus is integrating peripheral hormonal signals which include leptin, ghrelin, insulin, peptide YY and GLP-1. The lack of regulation of appetite, satiety and energy expenditure is caused by the disruption of these signaling pathways [25]. There is also impaired metabolic flexibility due to disturbed substrate oxidation and malfunction of the mitochondria. Obese individuals often have a reduced ability to switch between the metabolism of fat and carbohydrates, which causes the accumulation of lipids and the development of insulin resistance. Besides leading to adipocyte hypertrophy and hyperplasia, chronic positive energy balance also increases state of metabolic dysfunction [15].

Genetic and Epigenetic Factors

Based on the estimates of the heritability, 40-70% of the difference between body weights of individuals can be explained by heredity. Environmental exposures play upon a genetic variation that influences the adipogenesis, energy expenditure, and appetite control. Epigenetic changes due to early nutrition in life are also known to increase the risk of obesity [16].

Behavioral and Lifestyle Influences

The dietary habits that contribute to obesity are basically the high intake of ultra-processed foods, drinks that contain sugar, and saturated fats. Physical inactivity due to the change of technology and occupation compounds energy imbalance. The behavioral tendencies are often affected by the environmental restrictions and social norms [14].

Environmental and Socioeconomic Determinants

Obesity is directly associated with socioeconomic distress, food desert, and the built environment that inhibits physical activities. Financial insecurity is also a factor that leads to stress in the long term, which disrupts metabolic regulation [24].

Psychological and Cultural Contributors

Abnormal eating habits, depression and emotional eating are all factors that result in weight gain and

complicate weight loss. Cultural perceptions of body image affect the health behaviors and treatment seeking patterns [28].

Metabolic and Hormonal Dysregulation

Obesity has insulin and leptin resistance, which influences the glucose metabolism and appetite regulation. Adaptive thermogenesis reduces energy expenditure after weight loss resulting in the promotion of weight growth [15].

Inflammatory Mechanisms and Adipose Tissue Dysfunction

Obesity also leads to the activation of adipose tissue to secrete pro-inflammatory cytokines that stimulate insulin resistance and the systemic inflammation. This chronic low-grade inflammation is associated with obesity and cardiometabolic disorders [25].

Obesity-Related Comorbidities

Obesity increases the risk of cardiovascular disease, type 2 diabetes, nonalcoholic fatty liver disease, osteoarthritis, sleep apnea and various forms of cancer. These comorbidities significantly reduce life expectancy and life quality [24, 30].

Diagnostic Tools and Measurement of Obesity

BMI is not the only technique that can supplement assessment of fat distribution, and other techniques like imaging, bioelectrical impedance analysis and dual-energy X-ray absorptiometry (DEXA) can be used to improve the assessment of fat distribution and metabolic risk [14].

Public Health Implications

A few of the socioeconomic outcomes of obesity beyond medical costs include reduced productivity, increased disability, and health concerns in the generations to come. Due to the fact that obesity causes more hospitalization, prescription and management of chronic diseases, it significantly affects the cost of healthcare. The population-based prevention strategies should consider workplace wellness, education, urban planning, and food systems. To be sustainable, the collaboration between the public and the private sector in terms of schools, hospitals, and schools needs to be multi sectoral [24].

Traditional Weight Management Approaches

Nutritional Interventions

Small weight loss over time is clinically significant in low-carb, Mediterranean and calorie-restrained diets.

1. Physical Activity and Exercise

Regular workouts help to maintain weight and cardiometabolic fitness, especially during cases of mild weight loss [14].

2.Behavioral Therapy and Counseling

Cognitive-behavioral therapy improves adherence and resolves psychological issues related to weight management.

3. Role of Sleep and Circadian Rhythm

Sleep deprivation alters hunger hormone and increases the chances of obesity proving that sleep is a manageable variable [15].

Pharmacological Treatments

Mechanisms of Anti-Obesity Drugs

Pharmacotherapy is increasingly playing an important role in the management of obesity particularly in persons who cannot reduce sufficient weight through lifestyle change alone. Clinical guidelines recommend the use of anti-obesity drugs in any individual whose body mass index (BMI) is above 30 kg/m 2 or 27 kg/m 2 with obesity-associated comorbidities, including type 2 diabetes, hypertension, or dyslipidemia. The drugs

are used chronically and continuously since obesity is a chronic and recurrent disease [1,9,10]. The modern anti-obesity drugs are based on neurohormonal strategies of regulating the appetite, satiety, and energy balance. Many of these treatments reduce hunger and cravings of food by acting on the central nervous system. Semaglutide and liraglutide are glucagon-like peptide-1 (GLP-1) receptor agonists that mimic incretin hormones found naturally that cause an individual to eat less, empty the stomach slower, and feel fuller. The drugs are a major advancement in drug therapy and have produced substantial weight loss outcomes [2,9,4]. Also, it is important to have combination therapy. To curb food cravings and emotional eating, the naltrexone-bupropion combination will impact the reward pathways and hypothalamic controls of appetite. The other pharmaceutical approach entails reducing intake of nutrients. Though gastrointestinal adverse effects can limit the compliance, orlistat decreases the fat absorption in the gastro-intestinal system by blocking pancreatic lipase [7,11,12].

Surgical Options in Obesity Management

Bariatric Surgery: Types and Outcomes
A sleeve gastrectomy is one of the most widespread surgeries that are carried out all over the world. The procedure removes approximately 75-80 percent of the stomach leaving behind a smaller gastric sleeve that restricts the amount of food an individual can consume, reduces ghrelin production, a hunger hormone. Besides the positive effects of enhancing insulin sensitivity and cardiometabolic status, patients typically experience large-scale and sustained weight loss. Malabsorptive and restrictive mechanisms cooperate in the Roux-en-Y gastric bypass. The operation minimizes the absorption of calories by bypassing the small intestine and creating a small stomach pouch causing significant hormonal changes that enhances the metabolism of glucose. This technique is most effective with people with type 2 diabetes, and often it leads to rapid metabolic changes before dramatic weight loss takes place [26, 27].

Risks and Complications

Regardless of its effectiveness, bariatric surgery has immediate and long-term risks. Examples of early postoperative complications include anastomotic leakage, infection, pulmonary embolism, and hemorrhage. In spite of the fact that the number of these hazards has been significantly reduced through the advancements in the surgical practices and perioperative care, the careful selection of patients remains important. Long-term problems can arise because of the deficit of micronutrients, in particular, iron, vitamin B12, calcium, and fat-soluble vitamins.Some people develop gallstones, have dumping syndrome, or have gastrointestinal distress. In this way, routine clinical checkups and life-long nutritional supplements are necessitated. Psychological problems may also emerge after the surgery. Other individuals have problems with eating disorders, body self-image, and acclimatization to new eating habits. To achieve the long-term success, it is necessary to have multidisciplinary follow-up with doctors, psychiatrists, and dietitians [26].

Pediatric Obesity: Challenges and Strategies

Childhood obesity is associated with type 2 diabetes, hypertension, and psychological discomfort. Childhood obesity is strongly predicted by early adiposity rebound and excessive prenatal weight gain.It is necessary in parental involvement, physical education laws, and school nutrition programs. Early childhood intervention like promoting breast feeding and decreasing consumption of high sugar content beverages has been proved to have long term benefits [24].

Obesity in Older Adults

Sarcopenic obesity characterized by high fat and low muscle mass is a serious issue in the older populations. The primary objectives of weight loss programs should be resistance training and an adequate amount of protein intake to preserve muscle mass. The functional outcomes such as mobility, independence, and the risk of falls also need to be considered along with the weight loss goals [14].

Gender and Ethnic Disparities in Obesity

Women are the most susceptible to obesity due to social forces, reproductive life, and hormones. It is also widely known that metabolic risk and fat distribution is ethnically different. An example of such change is the BMI cutoffs, which have changed due to the fact that Asian individuals have metabolic issues at lower BMI levels [24, 30].

Health Policy and Preventive Strategies

The type of policies that have been shown to be effective include restrictions on the marketing of unhealthy food to children, labeling of food on the front package, taxes on sugar-sweetened beverages, urban planning that promotes active transport [24]. Monitoring and reviewing of policies in the long term are essential in establishing effectiveness and unintended consequences.

Community-Based Interventions

Access to wholesome foods and secure spaces for physical activity is enhanced by community health programs.Faith-based organizations, local governments, and businesses play an important role in offering long-term interventions [24].

Digital Health and Mobile Technologies

Digital health technologies have transformed the nature of care delivery in obesity through continuous monitoring, feedback, and scalable behavioral treatment [18]. These tools enable people to become actively involved in long-term weight management and they are used to bridge the gaps between clinic visits [20].

Obesity treatment through personalized Medicine.

Personalized medicine is a paradigm shift in the management of obesity because it is a therapy that depends on the biological, behavioral and environmental characteristics of the other person. The dissimilarity between the pathophysiological processes of obesity implies that there is a lot of discrepancy in the outcomes of the traditional methods that are a one-size-fits-all approach.

Variants linked to satiety signaling, appetite regulation, and metabolic efficiency can be discovered by genetic testing.Gene polymorphisms such as MC4R and FTO, such as those, are linked to an increased risk of obesity and could influence the efficacy of a treatment. Treatment choice is further narrowed by use of metabolic phenotyping that classifies individuals according to their energy expenditure, resting metabolic rate and insulin resistance. Some patients are better on low-carb diets, and others on Mediterranean or low-fat diets. Pharmacotherapy is also becoming personalized. Whereas insulin-resistant patients can be treated with medications that assist glucose metabolism, hyperphagic ones might respond more to the treatment based on appetite suppressants [17].

Gut Microbiota and Obesity

The gut microbiota has a great influence on the immune system, inflammation and energy metabolism. Research has revealed that the microbial composition and loss of microbial

diversity are common among obese individuals relative to lean individuals. The gut microorganisms have a number of effects on obesity:

• meal-derived energy extracting capacity. There is control of hunger hormones (ghrelin, PYY and GLP-1).

Short-chain fatty acid production (SCFA)

• Insulin-sensitivity and inflammatory-adaptation. Diet is one of the primary determinants of the microbiome composition. The diets rich in fats, sugar cause dysbiosis, and those rich in fiber, fruits, vegetables, and whole grains promote healthy microbial diversity [29].

Advances in Obesity Research

Pharmacotherapy Breakthroughs

There are two new incretin-based therapies called GLP-1 and dual agonists which have demonstrated previously unheard-of weight loss that matches with bariatric surgery [1].

Genomics and Systems Biology

Extensive genomic studies have demonstrated the association of hundreds of loci with obesity. Systems biology is the method that uses the combination of environmental, metabolic, and genetic data to obtain a better insight into the causes of the disease [2].

Metabolomic and Biomarkers

The new biomarkers can predict the effectiveness of the treatment and the disease process, and more timely and targeted interventions can be provided [3 -4].

Combination Therapies

Combinations medicine, lifestyle changes, and digital health tools are also likely to be included in future treatment strategies due to long-term weight management [3–4].

CONCLUSION

Obesity is a complex, multifaceted condition, and therefore needs long-term treatment as opposed to band-aid solutions. The evidence presented in this review shows that long-term weight regulation is not easy because of the combined effects of biological, behavioral, environmental, and psychosocial factors that cause obesity. Although the traditional lifestyle treatments remain fundamental, they are at times inadequate on their own. The emerging technology in the field of digital health, personalized medicine, bariatric surgery, and pharmacology has promising opportunities to lead to a better outcome in the long term.Efficient management requires a multidisciplinary and life-course approach that includes prevention, early intervention, and long-term treatment.The upcoming efforts need to focus on preventive care, personalised treatment, and continuous research on new treatment and biological mechanisms. As a measure to reduce the global cost of obesity and improve the health outcome, there is an urgent need to recognize obesity as a chronic disease and enact holistic and combined policies.

REFERENCES

1. Wilding JPH, Batterham RL, Calanna S, et al. Once-weekly semaglutide in adults with overweight or obesity. N Engl J Med. 2021;384(11):989-1002.
2. Lincoff AM, Brown-Frandsen K, Colhoun HM, et al. Semaglutide and cardiovascular outcomes in obesity without diabetes. N Engl J Med. 2023;389:2221-2232.
3. Ryan DH, Lingvay I, Colhoun HM, et al. Long-term weight loss with semaglutide in the SELECT trial. Nat Med. 2024.

4. Aronne LJ, Sattar N, Horn DB, et al. Tirzepatide vs semaglutide for obesity treatment (SURMOUNT-5). N Engl J Med. 2025.

5. Wharton S, Astrup A, Endahl L, et al. Oral semaglutide 25 mg for obesity (OASIS 4). N Engl J Med. 2025.

6. Bliddal H, Leeds AR, Christensen R, et al. Semaglutide in persons with obesity and knee osteoarthritis. N Engl J Med. 2024.

7. Moiz A, et al. Semaglutide for weight loss: systematic review and meta-analysis. Am J Cardiol. 2024.

8. Rodriguez PJ, et al. Semaglutide vs tirzepatide real-world effectiveness. JAMA Intern Med. 2024.

9. Rubino D, Greenway FL, Khalid U, et al. Continued semaglutide for weight maintenance. JAMA. 2021;325(14):1414-1425.

10. Chao AM, Wadden TA. Semaglutide for the treatment of obesity. Am J Med Sci. 2023.

11. Salvador R, et al. Role of semaglutide in obesity and comorbidities. Front Endocrinol. 2025.

12. Ruseva A, et al. Clinical outcomes of semaglutide 2.4 mg in obesity. Postgrad Med. 2025.

13. Celletti F, et al. GLP-1 therapies for obesity: clinical guideline. JAMA. 2025.

14. Hruby A, Hu FB. The epidemiology of obesity. Pharmacoeconomics. 2022.

15. Hall KD, Kahan S. Maintenance of lost weight. Med Clin North Am. 2022.

16. Loos RJF, Yeo GSH. Genetics of obesity. Nat Rev Genet. 2022.

17. Ordovas JM, Ferguson LR, Tai ES, Mathers JC. Personalized nutrition and obesity. BMJ. 2023.

18. Hutchesson MJ, et al. Digital interventions for weight management. Obes Rev. 2023.

19. Perkovic V, et al. Semaglutide and kidney outcomes in obesity. N Engl J Med. 2024.

20. Jeong JH, et al. Deep learning system for adolescent obesity prediction. IEEE Access. 2023.

21. Shen Z, Gao B. Multimodal sensing for remote obesity monitoring. arXiv. 2025.

22. Islam T, Ali MS. Ensemble learning for obesity risk prediction. arXiv. 2025.

23. Rota L, Argiento R. Spatio-temporal modeling of obesity prevalence. arXiv. 2025.

24. Swinburn BA, et al. The global obesity pandemic. Lancet. 2023.

25. Bray GA, Kim KK, Wilding JPH. Obesity as a chronic disease. Lancet. 2022.

26. Mingrone G, Panunzi S, et al. Bariatric surgery vs conventional therapy. N Engl J Med. 2022.

27. Arterburn DE, Telem DA. Benefits and risks of bariatric surgery. JAMA. 2023.

28. Puhl RM, Heuer CA. Obesity stigma and public health. Obesity. 2022.

29. Ley RE, et al. Gut microbiome and obesity. Nature. 2023.

30. Ng M, Fleming T, Robinson M, et al. Global prevalence of obesity. Lancet. 2022.