

The Reduction and Treatment of Obesity Via Appetite Control

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Abstract. In today's fast-paced era, people have extremely limited time. Most individuals engage in intense mental work throughout the day to make a living, leaving them seated at computers or in offices all day long. To improve work efficiency within limited time, they prefer foods that quickly provide high calories and a strong sense of satiety, thereby shortening mealtime. This has led to a widespread problem: obesity. Few health issues in the world are as prevalent and complex as obesity, which has been studied for many years. Scholars have conducted in-depth research on obesity from various perspectives. Against this background, this paper aims to analyze the possibility of curbing obesity from its fundamental source: appetite. It is widely known that obesity essentially results from energy intake exceeding energy expenditure, and reducing energy intake is fundamental to preventing obesity. Appetite, to a large extent, controls the amount of energy consumed. If appetite can be suppressed, the demand for energy intake will decrease accordingly. By analyzing existing experiments and research findings, this paper concludes that appetite can be suppressed by regulating gastrointestinal hormones, adjusting dietary patterns, and carrying out regular exercise, thus effectively reducing the risk of obesity.

Keywords: Appetite control, Obesity, CIM Model, Gut hormones, Hedonic feeding

1. Introduction

Weight loss seems to have become a trend. People pay close attention to their diets. Few health issues are as universal and complex as obesity. However, at present, there is still no low-cost and effective way to lose weight. Therefore, we may focus on appetite, one of the fundamental causes of obesity. As we all know, many cases of acquired obesity result from uncontrolled and unrestrained eating: people take in far more energy than their bodies require just to satisfy their appetite [1]. Intestinal hormones are key regulators of appetite, categorized as appetite-suppressing and appetite-stimulating types. Most are secreted by intestinal L cells, the pancreas, and other tissues, exerting their effects by binding to specific receptors. Some also participate in physiological processes such as gastrointestinal motility and hormone secretion [2]. This paper intends to analyze how these hormones control the appetite, strategies to inhibit obesity through appetite regulation, and other ways to suppress obesity. Furthermore, it also analyzes obesity and the possibility of its suppression from novel perspectives, conducts multi-faceted research on obesity inhibition, and explores new directions for the future development of appetite-suppression methods.

2. Appetite regulating system

Appetite-regulating hormones are divided into two categories: appetite-suppressing hormones (satiety signals) and appetite-stimulating hormones (hunger signals), which are core mediators in the gut-brain axis regulation of food intake. These complex and diverse hormones and systems work in concert to ultimately achieve the goal of appetite regulation. This paper will introduce one of the most well-known hormones.

2.1. PPY

PPY is a hormone that suppresses the appetite, which is secreted by the L cells of the ileum, colon, and rectum following a meal. There are two types of PPY, which are PPY1-36 and PPY3-36. It is initially released in the form of PYY₁₋₃₆, and PYY₃₋₃₆ is the major biologically active circulating form [1]. PYY₁₋₃₆ has affinity for all Y receptors, while PYY₃₋₃₆ exerts its effects mainly through the high-affinity hypothalamic Y2 receptor [2]. The secretion of PYY is closely associated with the regulation of satiety. PYY concentration is very low in the fasted state but rises rapidly after meals, and its release is positively proportional to calorie intake [3]. In addition, intravenous infusion of PYY₃₋₃₆ reduces food intake in both obese and lean subjects, with the observed plasma PYY₃₋₃₆ levels being roughly equivalent to the physiological levels after meals [2]. Therefore, studies have demonstrated that the function of PYY is to suppress appetite and reduce food intake.

2.2. GLP-1

GLP-1 is also an appetite-suppressing hormone secreted by intestinal L cells, and it collaborates with PYY to regulate nutrient intake. GLP-1 exerts its effects only when its receptor is activated. GLP-1 receptors are widely distributed in the human body, with particularly high abundance in the brain, gastrointestinal tract, and pancreas [2]. GLP-1 levels rise after meals and decrease during fasting. Studies have shown that intravenous infusion of GLP-1 reduces energy intake in both obese and lean subjects, though its effect is weaker in obese individuals [1]. In addition, GLP-1 can suppress glucagon secretion and stimulate insulin secretion [2], making it also applicable for the treatment of diabetes.

2.3. CCK

CCK is the first gut hormone discovered to be involved in appetite regulation, it is secreted by I cells in the small intestine and the duodenum and released into the bloodstream [4]. CCK has two distinct receptor subtypes: CCK-A receptors and CCK-B receptors. CCK-A acts mainly in the gastrointestinal tract, whereas CCK-B plays a more important role in the central nervous system. Studies show that intravenous injection of CCK in both humans and rats can not only reduce food intake, but also shorten meal duration, thereby exerting an appetite-suppressing effect [2]. CCK has an extremely short half-life of merely 1–2 minutes; thus, it only produces an effect when administered within a short time prior to meal intake [5].

2.4. Ghrelin

Ghrelin is the only known orexigenic hormone, which reflects its uniqueness. It is mainly secreted by X/A-like cells in the oxyntic glands of the gastric fundus [1]. Ghrelin concentrations rise during fasting and fall after food intake [2], so it is regarded as a physiological hunger hormone. Notably,

water intake does not affect its levels [1]. Studies have shown that fasting plasma ghrelin concentrations in the early morning are negatively correlated with adiposity index: obese subjects have lower ghrelin levels than lean subjects; plasma ghrelin levels increase in obese subjects following diet-induced weight loss [2]. These findings suggest that plasma ghrelin levels may represent a compensatory response to altered energy metabolism.

3. The carbohydrate-insulin model for the study of obesity etiology

Over the past few centuries, numerous theories and models have been developed to investigate the causes of obesity in humans, among which the energy balance model has been the most dominant. This model posits that the fundamental cause of obesity is positive energy balance: individuals consume excess calories from modern high-calorie processed foods and engage in prolonged sedentary behavior, such that energy intake exceeds energy expenditure. As a result, fat accumulates, ultimately leading to obesity. However, despite the widespread adoption of behaviors advocated by the energy balance model—reducing energy intake and increasing physical activity to expend energy—obesity rates remain persistently high worldwide. Under these circumstances, an alternative model has emerged: the carbohydrate-insulin model of obesity. The carbohydrate-insulin model proposes that obesity is not caused by fat gain resulting from positive energy balance. Instead, the true cause is a shift in substrate partitioning toward fat storage—that is, the body preferentially stores more fat, which in turn drives positive energy balance [6].

Glycemic load (GL) is a core indicator for predicting fat production. Its formula is: $GL = \text{total carbohydrates} \times \text{glycemic index (GI)}$. Foods can be classified as high-GI foods, middle-GI foods and low-GI foods based on the GI value. High-GI foods mostly include refined grains, tubers, and high-sugar products. Middle-GI foods include vegetables, meats, and others. Low-GI foods include fresh fruits, soy products, nuts, and others.

The core theory of the carbohydrate-insulin model (CIM) is that after consuming a high-glycemic load (GL) meal, glucose is rapidly absorbed, leading to increased insulin secretion and suppressed glucagon. The incretin response, dominated by GIP, promotes an anabolic state: muscle, liver, and adipose tissue take up large amounts of glucose, and lipogenesis is enhanced in the liver and adipose tissue [6]. Sometime after eating, even though nutrients have been fully absorbed, hormones remain in an anabolic state—glucose release from the liver and fatty acid release from adipocytes are blocked [6], causing a sharp drop in circulating metabolic fuel levels. The brain interprets this signal as energy deprivation in key tissues such as the liver and may trigger compensatory hormonal responses to this metabolic challenge [6]. These responses manifest as skyrocketing hunger, cravings for high-GL foods, and reduced energy expenditure, ultimately creating a vicious cycle that leads to obesity.

To validate the carbohydrate-insulin model (CIM) and confirm that fat storage is associated with the glycemic index (GI), researchers have conducted a specialized experiment in recent years. To ensure controlled variables, the experiment kept the macronutrient composition constant while only varying the GI of carbohydrates, to investigate the metabolic responses of healthy adults to meals with different GI carbohydrates. The subjects were divided into three groups with equal sample sizes: a high-GI group, a medium-GI group, and a low-GI group [7].

According to the experiment, if the CIM is valid, the magnitude of postprandial blood glucose rise is directly related to the glycemic index (GI) of the meal. A high GI stimulates greater insulin secretion, leading to a faster decline in blood glucose [7]. Eventually, the blood glucose pattern inverts relative to meal GI at a later postprandial stage: high-GI meals produce the highest glucose peak followed by the lowest levels, whereas low-GI meals show the lowest peak and the highest

subsequent values [5]. Circulating energy substrates—including glucose, β hydroxybutyrate, free fatty acids, and lactate—are lower in the late postprandial period after high-GI meals [7]. This is accompanied by stronger hunger, greater food intake at the next meal, and ultimately a vicious cycle that promotes obesity.

The experimental outcome measures included blood glucose, changes in insulin levels, subjective hunger ratings, food intake at the next meal, and the relationship between individual metabolic responses and food consumption [7].

According to the CIM theory, the expected experimental results were as follows: the higher the GI content consumed, the faster blood glucose rose, the more insulin was secreted, the stronger subjective hunger became, and the more food was eaten at the next meal. Furthermore, higher individual insulin levels would lead to greater food intake at the next meal (this is the core theory of CIM) [7]. However, according to the actual experimental results, researchers found that only changes in blood glucose and insulin fully conformed to the predictions of the CIM model. Specifically, the higher the GI content of the food consumed, the faster blood glucose rose [7]. Food intake at the next meal only partially supported CIM predictions: the highGI group and mediumGI group did consume more than the lowGI group, but there was no difference between the highGI and mediumGI groups. Subjective hunger did not match the CIM theory at all. Subjective hunger levels among the highGI, mediumGI, and lowGI groups showed no difference whatsoever over the 5hour period. Individuallevel analysis further refuted the core theory of CIM. The results showed no relationship between individual blood glucose levels and food intake. Instead, individual insulin levels were negatively correlated with food intake; that is, higher insulin levels were associated with less food consumption [7].

The experiments demonstrate that high-GI foods do cause dramatic fluctuations in blood glucose and insulin, but do not increase hunger or lead to greater food intake at the next meal. The core causal chain of the Carbohydrate-Insulin Model (CIM) is therefore not supported. This suggests that the validity of the CIM remains questionable and requires further detailed investigation in future studies.

4. Hedonic feeding

Food intake is driven by both homeostatic appetite and hedonic appetite. Homeostatic appetite refers to eating behavior that meets basic metabolism and maintains physiological energy levels, whereas hedonic appetite refers to eating driven purely by excitement and pleasure. Hedonic appetite is a major factor contributing to obesity, so considerable international research has been conducted on the factors that influence hedonic appetite [8].

In 2025, the team led by Jazmin Osorio-Mendoza conducted a study to elucidate how the circadian clock and leptin signaling jointly regulate homeostatic and hedonic appetite. Using leptin-knockout mice and multiple genetically edited control models, the team dissected the temporal gating mechanism underlying central leptin action [8].

The experimental results revealed that the core function of leptin is to selectively suppress hedonic eating, rather than merely regulating homeostatic hunger. The local brain circadian clock shapes the circadian pattern of hedonic appetite by driving rhythmic expression of the leptin receptor (ObRb), which creates pronounced daily differences in the sensitivity of the ventral tegmental area (VTA) — the brain's reward center— to leptin [8]. Specific deletion of core circadian clock genes in leptin-sensitive neurons significantly reduced mice's desire for palatable, high-calorie foods, flattened the circadian rhythm of hedonic feeding, and protected mice against diet-induced obesity:

these animals gained less weight initially and showed reduced adipocyte hypertrophy under high-fat feeding [8].

This study uncovered a central leptin-gating mechanism controlled by local circadian clocks, which serves as a key regulator of hedonic feeding rhythms and metabolic homeostasis. This novel finding explains why people tend to crave high-calorie foods more strongly at night or when sleep-deprived: the circadian clock weakens leptin's inhibitory effect on the reward system during nighttime, lowering restraint toward palatable foods [8].

The research also proposed a novel intervention strategy: targeting the circadian clock in leptin-sensitive neurons can specifically reduce hedonic appetite without disrupting normal energy requirements or homeostatic feeding, offering a precise, lower-side-effect approach for the prevention and treatment of obesity [8]. Furthermore, a long-term high-fat diet significantly alters hedonic feeding behavior, leading to a reduced hedonic value of high-calorie foods [9].

5. The inhibitory effect of exercise on appetite

Exercise is one of the most effective ways to suppress appetite for obese individuals. It can reduce appetite through multiple mechanisms. Exercise stimulates the release of lactic acid. As a signaling molecule and alternative fuel source, lactic acid can significantly suppress appetite after exercise. High-intensity exercise triggers massive lactic acid release from muscle tissue, thereby curbing appetite and energy intake [10].

Furthermore, exercise regulates feeding behavior through hormonal, neural and psychological dimensions: it reduces hunger by lowering ghrelin and increasing satiety hormones (GLP1, PYY, CCK); suppresses the brain's reward response to high-calorie foods, thereby reducing binge-eating impulses [10]; relieves stress and anxiety to decrease emotional eating; and modulates appetite neurons in the hypothalamus to stabilize food intake and meal frequency at the source.

Finally, exercise exerts a dose-dependent effect on gastric motility and gastric emptying. Low-to-moderate intensity exercise promotes gastric motility and accelerates gastric emptying to improve digestive efficiency. In contrast, high-intensity, prolonged exercise inhibits gastric motility and slows emptying via sympathetic activation and blood redistribution, prolonging gastric retention to enhance satiety and suppress food intake [10].

6. Conclusion

This paper presents a systematic review of obesity prevention and treatment based on appetite regulation, summarizing mechanisms including the gut-brain axis signaling, appetite-related hormones, hedonic feeding, circadian clock regulation, and exercise intervention. Studies indicate that the core cause of obesity is chronic energy intake exceeding expenditure, with abnormal appetite and hedonic feeding as key drivers of overeating. Pro-appetite and anorexigenic hormones secreted by the gut dynamically regulate hunger and satiety signals via the gut-brain axis, while the brain reward system and circadian clock further modulate preference for high-calorie foods, leading to circadian fluctuations in appetite. The carbohydrate-insulin model, a novel theory, fails to fully explain changes in appetite and requires further investigation, whereas hedonic feeding plays a more critical role in the development of obesity. Exercise effectively suppresses appetite, reduces food intake, and diminishes emotional binge eating through multiple pathways, including regulating metabolites and appetite hormones, blunting reward responses in the brain, and delaying gastric emptying, making it a safe and powerful intervention for obesity. Overall, obesity prevention and treatment should involve comprehensive strategies such as appetite control, inhibition of hedonic

eating, regular circadian rhythms, and consistent exercise to achieve long-term body weight management. In the future, scientific research will explore factors and methods for appetite suppression and obesity control in greater breadth and detail to achieve effective weight loss.

References

- [1] Suzuki, K., Jayasena, C.N., Bloom, S.R. (2012) Obesity and appetite control. *Experimental Diabetes Research*, 824305.
- [2] Yu, J.H., Kim, M.S. (2012) Molecular mechanisms of appetite regulation. *Diabetes & Metabolism Journal*, 36: 391-398.
- [3] Wynne, K., Stanley, S., McGowan, B., Bloom, S.R. (2005) Appetite control. *Journal of Endocrinology*, 184: 291-318.
- [4] Yu, M., Yu, B., Chen, D.W. (2024) The effects of gut microbiota on appetite regulation and the underlying mechanisms. *Gut Microbes*, 16: 2414796.
- [5] Austin, J., Marks, D. (2009) Hormonal regulators of appetite. *International Journal of Pediatric Endocrinology*, 141753.
- [6] Ludwig, D.S., Aronne, L.J., et al. (2021) The carbohydrate-insulin model: A physiological perspective on the obesity pandemic. *The American Journal of Clinical Nutrition*, 114: 1873-1885.
- [7] Liu, Y., Mei, H.H., Xue, L., Cheng, C.L., et al. (2025) Testing the carbohydrate-insulin model: Short-term metabolic responses to consumption of meals with varying glycemic index in healthy adults. *Cell Metabolism*, 37: 606–615.
- [8] Osorio-Mendoza, J., Kiehn, J.T., et al. (2025) Regulation of hedonic feeding rhythms by circadian clocks in leptin-receptive neurons. *Molecular Metabolism*, 100: 102221
- [9] Gazit Shimoni, N., Tose, A.J., et al. (2025) Changes in neurotensin signaling drive hedonic devaluation in obesity. *Nature*, 641: 1238-1247.
- [10] Razi, O., Zamani, N., de Moraes, C., Laher, I., Hadjicharalambous, M. (2025) Exercise suppresses appetite in obesity: A biochemical, metabolic, and molecular approach. *Applied Sciences*, 15: 6191.