

Reward Systems and Ultra-processed Foods

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Indeed, the prehistoric period was associated with chronic malnutrition, which was a fundamental rule of human history. Because of this, natural selection favored genetic patterns that could survive in these harsh conditions by storing fat. This is because the main function of body fat is to store food reserves for the body [1]. Feeding behavior could be an interaction of a physiologic need for food with the reward system that powerfully encourages excessive eating in some people. Neuroadaptations in the reward system happens when people eat too many tasty foods. This disconnects eating behavior from caloric needs and leads to uncontrollable overeating [2]. Over time, body fat became a major issue. However, the negative effects of being overweight were not recognized in medical literature until as late as the 18th century. Then, technological advancement and economic prosperity resulted in the comfortable availability and simple cost of high-calorie foods, which are palatable to a large segment of the population [3].

Many factors that were formed as a result of this technological development have become major contributors to the increase in the obesity epidemic, including the increased use of sugar substitutes, the addition of preservatives to foods, sugar-sweetened beverages, changing eating patterns, as well as the promotion of sedentary lifestyles [4].

Excess calories taken in comparison to calories burned from any source result in the accumulation of these calories as body fat. Obesity may be characterized in many ways: For starters, it is a condition in which excess body fat interferes with normal activity and health. Second, the weight is more than 20% greater than the ideal height and body size. Third, a body mass index (BMI) is over 30 [5].

By dividing the body weight in kilograms by the height in square meters and using the equation below, the body mass

index (BMI) can be calculated:

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight (kg)}}{\text{Square length(m)}}$$

The World Health Organization (WHO) divides weight status according to BMI into the following categories: [6] as shown in Table 1.

BMI z-scores are used for children and adolescents since BMI fluctuates with age and sex in this population (an index of relative weight that has been adjusted for child age and gender is known as the BMI z-score). Another frequently used statistic for assessing the distribution of adipose tissue is the waist-to-hip ratio (WHR) [7].

Obesity is exacerbated by many factors, including physical inactivity, sedentary behavior, socioeconomic status, sleep duration and intensity, combined with a high-caloric diet. The dietary profile of the population has become characterized by highly palatable foods with high energy density, with fiber-rich foods being replaced by fat- and sugar-rich products with a high level of processing [8]. Past studies have found that the rise in overweight and obesity over the last 30 years is due to gene-environment interactions, in which individuals with a genetic predisposition to store excess food energy as fat [9]. This is due to environmental factors such as the availability and widespread availability of high-calorie foods such as pizza, fried foods, ready meals, burgers, crackers, chips, baked goods, foods high in sugar, sauces, donuts, sweetened

Table 1. BMI chart based on WHO classifications.

BMI	Weight Status
Less than 18.50	Underweight
18.5 – 25	Healthy Weight
26 – 30	Over Weight
30 or more	Obese

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cereals, and so on. Obesity raises the risk of many medical conditions, including cardiovascular disease, impaired glucose tolerance/type 2 diabetes mellitus, malignancies, orthopedic problems, obstructive sleep apnea, in addition to psychological problems [10].

Simply processed food is a product that has been transformed from its original form into another form. In other meaning, the processing is any intentional alteration made to a food before it is fit for human consumption. This is based on what the International Food Information Council mentioned [10].

Ultra-processed food is those that are more available, inexpensive, low in nutrients, and also more appreciated and preferred. In addition, these foods are also known as junk foods, which are characterized by containing large amounts of calories, sugar, salt, saturated fats, trans fats, and few nutrients, including minerals, vitamins, dietary fiber, healthy fats, and proteins, as well as complex carbohydrates. Some examples of junk food include biscuits, cakes, fast foods (such as chips, pizzas, and burgers), sweet chocolate and desserts, processed meat, unhealthy snacks, and overly sweet drinks (such as Pepsi and 7up) [11].

Experiments have shown that ultra-processed foods cause high glycemic reactions and low satiety potential, as well as create a gut environment that favors microorganisms that promote inflammatory disease in many forms [11].

According to cross-sectional and longitudinal research [12], obesity, hypertension, cardiovascular and cerebrovascular illnesses, metabolic syndrome, and gastrointestinal disorders may become more widespread as a result of excessive consumption of these harmful foods. Ingestion of extremely appetizing and processed foods activates the reward neurocircuitry in the brain, the mesocorticolimbic dopamine system. Dopaminergic projections extend from the ventral tegmental area (VTA) and the substantia nigra (SN) to a network of brain areas with specific functions in reward processing [13]. A significant part of the ventral striatum, the nucleus accumbens (NAc) is a crucial structure in mediating passionate and motivational processing, altering reward and delight processing, as well as acting as a crucial limbic-motor interface [14].

The hippocampus is specialized for the formation of memories of stimulus reward, whereas the amygdala is only used for the input and processing of emotion. These two brain areas work together during emotional reactions to transform feelings into specific results. The decision-action and the anticipation of reward or punishment are organized by the orbitofrontal cortex (OFC). As shown in Figure 1, the prefrontal cortex (PFC) and anterior cingulate gyrus (CG) provide inhibitory control and emotional organization. Ontogenetically, the mesolimbic reward system evolved to drive creatures toward pursuing beneficial outcomes, possibly life- or kindred-sustaining motivations, such as a diet with high calories in times of lack, high-sugar, high-fat foods, and so on (repre-

senting the source of nontoxic energy), in addition to other rewards such as water, gender, social interactions, medications, and specific stimulants like cocaine may give the same this reaction [15].

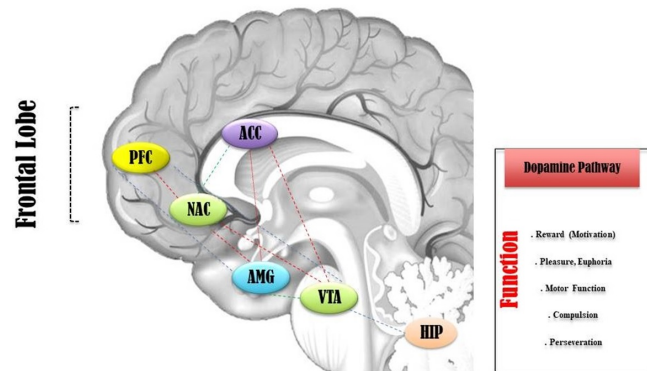


Figure 1. The brain regions and transmitters of the mesolimbic reward system. The reward system consists mostly of the mesolimbic pathway that expands from the ventral tegmental area - (VTA) to the nucleus accumbens - (NAC). It also includes structures like the amygdala - (AMG) and the hippocampus - (HIP).

ETHICAL DECLARATIONS

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Ethics Approval and Consent to Participate

Not required.

Consent for Publication

Not required.

Availability of Data and Material

All data were published.

Competing Interests

The author declares that there is no conflict of interest

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Authors' Contributions

Rezaieg NS has designed the study and wrote the manuscript. Rezaieg NS read and approved the manuscript.

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