Psychosocial Stressors Affecting Food Choices

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Abstract

Stress is defined as an individual's psychological and physical reaction to adapt to a mental or physical impact. When environmental stressors are added to a diet in which unhealthy food preferences are made, the negative effects of psychological stress on health are intensified. The food preferences of individuals are influenced by many factors including physiological, psychological, environmental, and sociocultural factors. The general tendency is that individuals who are exposed to stress reduce their intake of foods low in saturated fat and prefer to consume foods high in unhealthy fats in addition to healthy food groups. This study aims to comprehend the factors influencing individuals' dietary preferences, with a specific focus on delving deeper into how stress intricately affects these choices. Future research should focus on gaining a more comprehensive understanding of this intricate relationship, with the aim of revealing the effects of stress on eating habits in greater detail and contributing to more effectively guiding individuals towards healthier lifestyles.

Keywords: Food choice, Saturated fat, Health, Stress, Sugar.

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1. Introduction

Stress is a part of modern life and an increasing amount of evidence indicates that stress contributes to poor and unbalanced diets. Self-management theory suggests that when people are under stress, they are motivated to regulate their mood and deal with behavioral demands. As such, stress triggers various coping strategies, of which eating is a common one. It has been widely reported that stress and food consumption are related (Kim & Jang, 2017). It is known that while some people eat less when stressed, most people tend to eat more (Leng et al., 2017). In addition to its more general effects on appetite, stress can also cause poor health through unhealthy changes in diet (Mohamed et al., 2020). Besides aging-related diseases such as obesity, metabolic syndrome, type 2 diabetes (type 2 DM), cardiovascular disease, stroke, and Alzheimer's Disease (AD), chronic psychological stress also increases the risk of many common mental illnesses including depression and anxiety (Ginty et al., 2017; Kivimaki & Steptoe, 2018; Caruso et al., 2018). Attempts to decrease stress levels are usually not effective enough. Because it is difficult to control stressors and adapt to effective therapeutic treatments. Moreover, financial limitations of individuals may also reduce the impact of interventions. For these reasons, attempts to reduce the relationship between stress and health problems have not been successful. This situation implies that the factors that can positively affect the relationship between stress and health are not sufficiently understood (Hackett & Steptoe, 2017). The adverse health effects of psychological stress are intensified when environmental stressors are included in a diet of unhealthy food choices. Many individuals follow a Western-style diet with a high content of animal protein sources rich in saturated fat and ready-to-eat foods such as fast food, which are high in sugar and salt, leading to an increased risk of disease. However, observational studies have demonstrated that following the Mediterranean dietary pattern, which is characterized by a high intake of fruits, vegetables and vegetable protein, contributes to lower stress levels (Nguyen et al., 2017; Kye & Park, 2012; Crichton et al., 2013; Bonaccio et al., 2018). It has been determined that dietary habits with a high intake of simple sugars and saturated fats cause an increase in cortisol levels (Laugero et al., 2011; Jakulj et al., 2013).

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This study aims to review the literature on the effects of exposure to psychosocial stressors on food choices.

2. Stress Regulation

One of the most important causes of health problems in the 21st century is stress. Stress reactivity happens through multiple mechanisms. Stressors in humans refer to any threat to well-being or any real or perceived disruption of physiological homeostasis. Homeostasis is coordinated by multiple brainstem nuclei. Physiological stressors (for example injury, exercise) typically influence physiological set points such as temperature, blood volume, blood pressure, and pH. Psychosocial stressors (for example, public speaking) indirectly disrupt homeostasis by causing emotional instability, which then alters physiological responses (Davies, 2016).

Unlike disruptions in physiological homeostasis, responses to psychosocial stressors originate in brain regions such as the prefrontal cortex (PFC) and interconnected limbic nuclei. Despite this difference in origin, there is considerable overlap between the physiological systems and neurotransmitters that are involved in both physiological and psychosocial stress responses. Responses to stressors are produced by the sympathetic adrenomedullary (SAM) system and the hypothalamic-pituitary-adrenocortical (HPA) axis. The SAM system facilitates an immediate (within seconds) response to stressors through increased sympathetic nervous system (SNS) activation and decreased parasympathetic nervous system (PSS) activation. The SNS neurotransmitters most abundant in the body are norepinephrine (NE) and epinephrine (E), which activate adrenergic receptors and produce receptor subtype(s) and effector organ-dependent effects. Consistent acute responses include increased respiration, increased heart rate, blood pressure and pupil dilation. Unlike immediate SAM responses, HPA axis responses occur over minutes to hours. During HPA axis activation, glucocorticoids, particularly cortisol, are secreted from the adrenal cortex (Moses et al., 2023).

Cortisol is the main effector hormone of the HPA axis stress response system. Like the rest of the endocrine system, the HPA axis is also regulated by a negative feedback system, thanks to which the hypothalamus and pituitary gland have receptors that detect changes in cortisol levels. For instance, cortisol secretion is inhibited when circulating levels rise and when they rise, levels are lowered. But if the HPA axis is activated repeatedly, this triggers increased cortisol production and thus exposes body tissues to excessive concentrations of the hormone. Over time, this kind of repetitive activation can overload various body systems, including the HPA axis, resulting in tissue damage and contributing to future health problems (O'Connor et al., 2021). Long-term exposure to stressors leads to a sustained release of cortisol, causing a tense mood in individuals (Herhaus et al., 2020). With the stimulation of the hypothalamus, pituitary and adrenal (HPA) axis, the hormonal and metabolic process begins. Under stress, this axis increases the release of glucocorticoids. With the release of glucocorticoids, signaling through neuropeptides increases. Ghrelin, leptin and insulin are stimulated. Growth hormones, which act lipolytic, decrease with increased stress. In addition, there is a decrease in sex (gender) steroids. A decrease in lipolytic and sex hormones causes fat to accumulate and increase (Smith & Vale, 2022).

Another system activated in individuals under prolonged stress is the dopaminergic system, which is stimulated via the mesolimbic pathway. When the dopaminergic system is activated, the individual starts to feel a sense of reward for delicious foods. Corticosteroids increase dopamine synthesis through their peripheral effects. Stress in the brain caused by the effects of dopamine and glucocorticoids triggers an increase in dopamine. Consequently, the individual's food preferences and eating habits are shaped. When the dopamine receptors are stimulated, the individual's tendency towards delicious foods and consequently energy intake increases. But when combined dopaminergic receptors are stimulated, the opposite effect can be seen. Long-term stress leads to obesity by increasing unhealthy food preferences. A prolonged state of stress increases the choice of foods high in sugar and fat. In acute stress, not only overeating but also under-eating can be observed (Rasheed, 2017).

2.1. Acute and Chronic Stress

Acute stress influences cognition and behavior. In acute stress, excessive food consumption is initiated by stimulation of the hormone cortisol. Acute stress is a weak psychological emotion that stimulates the ego state of the individual. If this process is taken under control, the chronicization of stress is avoided by supporting the individual to motivate and adapt (Rasheed et al., 2010; Rasheed et al., 2012). Healthy food selection during the acute stress period reduces cortisol release and stress responses. In case the acute stress period cannot be managed, the risk of metabolic

disorders increases with excessive food consumption (Razzoli et al., 2017).

The physiological response to acute stress that can affect food intake has two distinct, but interacting pathways. One is the activation of the HPA axis with subsequent stimulation of the secretion of glucocorticoids (including cortisol) as described above. The other is the pathway of the sympathetic nervous system, which leads to an increase in arousal parameters such as adrenaline secretion, high blood pressure and diversion of blood flow from the gastrointestinal tract to skeletal muscles and the brain. This response is also known as the "fight or flight" response and often leads to a reduction rather than an increase in food consumption. Nevertheless, if the stressor is perceived as threatening to the ego, i.e. a threat to self-esteem or the social self, cortisol is released, thereby stimulating appetite and food intake (Hyldelung et al., 2022).

Chronic stress is related to chronic stimulation of the HPA axis, which involves neuroendocrine neurons in the hypothalamus regulating the secretion of adrenocorticotropic hormone (ACTH) from the anterior pituitary and glucocorticoid secretion from the adrenal gland. Over-secretion of glucocorticoids is related to obesity on several levels. The consumption of high-energy foods suppresses the hyperactivity of the HPA axis, leading to the so-called emotional eating (Maier et al., 2015)

Glucocorticoids stimulate behaviors that are mediated by the dopamine reward pathway, resulting in an increased appetite for tasty foods. Moreover, stress releases endogenous opioids that potentiate the consumption of tasty food and promote non-homeostatic eating. On the contrary, comfort food intake decreases HPA axis activity. So, if stress becomes chronic, then eating becomes a coping strategy (Leng et al., 2017).

Chronic stress affects adipose tissue. With the stimulation of the peripheral mechanism, fat and sugar intake causes visceral adiposity. According to a study carried out in the work environment of a state university, the increase in social stressors leads to an increase in BMI, especially in the female gender (Özcan & Kızıl, 2020).

3. Food Choice

Consuming food is generally conceptualized as a food choice. It is a complex activity with many dimensions. Food choice is multidimensional as it involves where, when, for how long, how, why, with whom, for whom and under what conditions food will or will not be eaten. Since physical, biological, psychological and sociocultural factors operate and interact simultaneously, food choice is multi-layered. Food choice becomes integrated as people combine multiple considerations to form specific eating activities. Food choice is diverse due to the wide range of different and unique eating activities (Sobal et al., 2014).

While food choices are thought to be formed early in life and continue into adulthood, they can develop and change throughout life (Anzman-Frasca et al., 2018). High salt, sugar and unhealthy fats, especially industrially processed foods, are known to increase unhealthy food choices. Processed products are highly tasty and attractive, have a long shelf life and can be consumed anytime, anywhere. Their formulations, presentation and marketing often encourage overconsumption (Monteiro et al., 2018).

When compared to naturally occurring foods, processed foods may have fiber, protein and water removed during processing. Ingredients can be used to soften the food (making it more likely to melt in the mouth and requiring less chewing). This enables over-processed foods to be consumed more quickly and increases the rate at which highly rewarding ingredients, such as refined carbohydrates, are absorbed by the system (Chan, 2015). For this reason, processed foods are designed to optimize not only the magnitude of the reward signal in the brain through high doses of energetic nutrients and additives but also the speed at which the reward is delivered (Gearhardt & Schulte, 2021).

Food choices of individuals vary and are shaped by many factors, especially physiological, psychological, environmental and sociocultural factors.

These multilevel factors interact to influence attitudes and beliefs about food. The interaction of the individual with the social and physical environment influences food choices and dietary behaviors. Food choices are determined by neurobiology. Primary tastes (sweet, sour, salty, bitter, and umami) and smell contribute to the overall perception of food flavor and are influenced by genes, physiology and metabolism. Certain foods cause strong sensory pleasure responses. The oral sensation of fat is extremely rewarding, especially in the presence of sugar. A combination of sugar and fat is linked to the stimulation of pleasure receptors in the brain. The food industry has been criticized for producing sweet, salty and high-fat foods to take advantage of innate biological predispositions. Biological mechanisms that regulate food intake may not match the available food supply, which provides

low-cost, tasty, energy-dense foods with high reward potential and limited nutritional value. Biological factors that control food intake can be moderated through learning, experience, or altered through disease states (Monterrosa et al., 2020). Research on the perceived taste intensity of salt, sour, bitter and sweet showed that the male gender perceived weaker taste intensity than the female gender. Participants who were older than younger individuals perceived stronger taste intensity (Fischer et al., 2013).

Interactions between the individual and food choices are important in shaping food choices. These interactions include familiarity and learned safety, conditioned food preferences and conditioned satiety. Specific foods that people like and their food acceptance patterns are learned largely through physiological conditioning acquired through the experience of exposure to foods. New foods gain preference through repeated exposure. Satiety feelings also change through physiological conditioning and emotional responses to the social context in which eating occurs. Parents largely shape the context in which children encounter food by providing, modeling, encouraging, restricting and rewarding food (Monterrosa et al., 2020). In one study, the aim was to systematically review empirical studies examining the influence of parents on children's food consumption behaviors in two contexts: One that is encouraging in nature (e.g., healthy food) and one that is preventive in nature (e.g., unhealthy food). It has been demonstrated that active guidance/education may be more influential for healthy foods, whereas restrictive guidance/rule-setting may be more influential for unhealthy foods. This study suggests that a range of parental behaviors have strong associations with child food consumption behavior (Yee et al., 2017).

Individual factors (e.g. attitudes, beliefs, motivations and values, personal meanings, knowledge and skills), social and cultural norms and interpersonal factors (e.g. family and social networks) also play an important role in shaping food choices. As individuals progress through life and are exposed to social and cultural norms, attitudes, beliefs, motivations and values, knowledge and skills develop. Such factors have an impact on the foods that individuals acquire and prepare for consumption. People adopt food-related identities, and this influences food choices. Family and social networks also shape food choices by observing what others choose, negotiating with others with whom food is shared, and the support or lack of support from others in making desirable food choices (Monterrosa et al., 2020). In one study, the eating choices of 12 low/middle-income mothers (26-53 years) were investigated. The mothers emphasized their identities related to food and eating when describing food-related decisions and activities. These identities influenced the food choices a mother made for herself and her children. Analysis showed that mothers with a more defined health identity made healthier choices for themselves and their children. They also displayed behaviors that positively influenced their children's food choices. On the other hand, mothers who had difficulty seeing themselves as healthy consumed more junk food and reported feelings of anxiety and guilt. The food choices of these mothers were found to be more disconnected from their children's choices. This emphasizes the importance of understanding how identities related to food and eating can influence food choices (Johnson et al., 2011).

Lastly, food supply, marketing, societal food and nutrition policies and programs cause broader environmental, mental and societal influences on food choices (Monterrosa et al., 2020). Genetic and environmental factors' contribution to individual differences in food preferences for different food clusters has been examined in 4 UK studies that represent 3 independent samples with sample sizes ranging from 331 to 2865 participants. Heritability of liking fruits and vegetables was found to be moderate, with estimates ranging from 36 to 54 participants. Estimates of heritability for meat and fish were slightly higher than for fruit and vegetable preference, ranging from 44 to 78. The heritability of snacks was reported to be low to moderate, ranging from 20 to 52 participants (Vink et al., 2020).

3.1. Food Choice and Stressors

It is known that energy intake increases in a large proportion of the population during stress. There are also health concerns that the higher intake is often due to unhealthy foods that are high in sugar and fat. This stress-induced change in food intake is likely a contributing factor to obesity. Actually, perceived stress is associated with higher BMI and several long-term studies have found that high psychological stress can lead to long-term weight gain (Mouchacca et al., 2013; Richardson et al., 2015; Roberts et al., 2014; Tryon et al., 2013).

Considering why energy intake increases during stress, many people presume that eating tasty, favorite foods relieves some of the negative aspects of stress. Based on pre-clinical studies, there is evidence that chronic exposure to high-fat foods suppresses the stress reaction. To be specific, rats that were given

access to tasty, unhealthy food for about a week and then exposed to a laboratory stressor exhibited a blunted stress response (Maniam & Morris, 2010; Ortolani et al., 2011).

A similar effect is possible in humans. Participants who described themselves as having high chronic stress had a blunted stress response and a high BMI. Researchers have suggested, based on pre-clinical research, that the blunted stress response may result from long-term intake of unhealthy nutrients (Tomiyama et al., 2011; Tryon et al., 2013).

As a result of the decrease in physical activity with the effect of stressors, eating disorders such as binge eating, emotional eating and metabolic diseases occur. Eating desires of obese women with binge eating disorders increase with an increase in hedonic desire under stress (Klatzkin et al., 2018).

The examination of study samples with differences in the levels of reaction types shows that reactions to stress may show individual differences. People with high levels of anxiety and worried mood and low levels of social support have an increased risk of hyperphagic reactions. Furthermore, it has been found that the level of restriction of unhealthy foods in the diet of individuals also improves the response to work stress (Long et al., 2021).

The eating behaviors of men and women in response to stress differ. For instance, in a study carried out in Saudi Arabia, it was found that stressed women were more likely to eat sweets and junk food, while men showed an increased preference for fast food and meat (Mohamed et al., 2020).

Finch and Tomiyama (2015) investigated the relationship between stress and comfort food eating in a sample of 2,379 young adult women. Findings indicated that negative life events experienced in the previous year and self-reported levels of psychological stress in the previous month were positively associated with comfort food eating, defined as how often participants reported eating when they felt stressed, sad, anxious, angry, or bored (Finch & Tomiyama, 2015).

Likewise, in a sample of 561 women, Groesz et al. (2012) reported that both perceived stress and exposure to chronic stress (i.e., the number of endorsed stressors) were linked to higher consumption of appetizing, non-nutritious foods such as chips and hamburgers. Involvement in stressful tasks created in an experimental environment has been associated with a variety of eating outcomes, particularly increased consumption of unhealthy snack foods (Groesz et al., 2012).

Royal and Kurtz (2010) studied the intake of snack foods after exposure to stress in 52 female university students who were exposed to high or low stress. Participants with high stress consumed more of these foods than participants with low stress (Royal & Kurtz, 2010).

In studies that examined the biological indicators of stress, it has been found that women with high cortisol reactivity to stress consume more calories under stress than women with low cortisol reactivity to stress (Herhaus et al., 2020).

In another study, 59 pre-menopausal women completed three stressful tasks that included puzzles, mental math and conversation. The participants were then left alone in a room with a variety of snacks (chocolate granola bars, potato chips, rice cakes and pretzels) to eat at leisure. Compared to women who showed higher cortisol reactivity, women who showed lower cortisol reactivity had more energy following stressful tasks (Tomiyama et al., 2011).

Keren et al. (2015) explained that the high preference for snack foods in stressful situations is due to their fast availability and palatability. They stated that the second reason why individuals choose such foods when they are in a stressful mood is the effect of the stress hormone cortisol on metabolism (Karen et al., 2015).

Food intake and stress interact in a two-way way. In the same way that stress and mood can cause eating behavior to change, a change in mood can result from intentional or unintentional food choices. Selecting to eat certain foods can alter mood through sensory or hedonic effects, relevant social context, cognitive expectations, psychological distraction, changes in appetite, or nutritional modulation of brain function. For instance, high-sugar, high-fat foods, and low-protein foods may reduce stress through better functioning of the serotonergic system (Finch et al., 2019).

Pre-clinical studies have also demonstrated that sweet-tasting foods can provide analgesic effects during acute stressors, increasing pain threshold latency and pain tolerance. Collectively, these findings demonstrate that comfort food has a general capacity to elicit desirable emotional responses in humans, which may function to reinforce stress-induced eating behavior (Zhang et al., 2023; Nuseir et al., 2022).

In general, eating when hungry is both pleasurable and rewarding. Food intake stimulates the release of

endogenous opiates and activates neural substrates similar to drugs of abuse (although there are important differences in degree). Conversely, opiate release may help protect an organism from the deleterious effects of stress by reducing the activity of the HPA axis and thus attenuating the stress response.

Within a reward-based model of stress eating, repetitive stimulation of reward pathways through stress-induced HPA stimulation, highly palatable food intake, or both, can lead to neurobiological adaptations that support the compulsive nature of overeating (Park et al., 2014).

As demonstrated by Maier et al. (2015), cortisol increases under acute stress are dually linked to a preference for palatable foods and reduced activation in brain regions associated with goal processing. Behavioral tendencies such as risk aversion may also interact with stress to increase these changes in brain activity. In the study, undergraduate students were shown photographs of food or nature during exam and non-exam periods and asked to answer questions about risk aversion using the Behavioral Inhibition Scale. Of the students studied, the exam period resulted in increased perceived stress, and for those who scored lowest on risk aversion, photos of high-energy foods were associated with increased activation in regions involved in reward processing and decreased activation in regions involved in goal processing (Maier et al., 2015).

Neurobiological research suggests that stress may increase sensitivity to the consumption of energy-dense, tasty foods by emphasizing hedonic rewards and reducing long-term consequences (Neseliler et al., 2017; Duff et al., 2018).

4. Conclusions

Stress can lead to unhealthy behaviors that create a risk of deterioration in mental health. The process becomes a vicious circle through mutually triggering factors such as stressful mood, cortisol reactivity, increased hunger, increased consumption of unhealthy foods, and increased BMI. Stress can affect mood as much as nutrients affect food preferences. It is believed that stress caused by various factors can affect the food choices of individuals and that this effect may be different in men and women in different ways and at different levels. To better understand the mechanisms between stress and food choices and to better manage the relationship between stress and nutrition, further studies are needed.

Declaration of Competing Interest

The authors declare that they have no financial or non financial competing interests

Author's Contributions

C. Erkul (0000-0003-0940-1129): Resources; methodology; writing –review and editing.
A. Ozenoğlu (0000-0003-3101-7342): Conceptualization; writing – original draft; methodology ; resources; review and editing.

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