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Research report

Sweet craving and ghrelin and leptin levels in women during stress ☆

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ABSTRACT

Ingesting sweet substances in excess may attenuate the effects of stress in women and impact leptin levels, which are also affected by alcohol dependence and overeating. Excess intake of sweet substances also influences ghrelin levels, involved in the onset of food intake and stress. This paper aimed to identify sweet craving (SC) in women with stress to assess how it impacts basal leptin and active ghrelin levels, anthropometric measurements, and body composition. This observational, transversal study included 57 women and used the Stress Symptoms Inventory Lipp in Adults (ISSL); it verified that 31 of the participants were stressed, whereas 26 were symptom-free. The Questionnaire for Assessment of Sweet Substance Dependence and Abuse helped to characterize SC. ELISA furnished leptin and active ghrelin serum levels. HOMA was also evaluated. Electrical bioimpedance provided body composition values. Among the women with stress, 77.42% had SC, and they behaved differently from women without SC. Women with SC exhibited significantly higher basal leptin levels ($P < 0.01$), but women with and without stress did not differ statistically in terms of leptin levels. Active ghrelin levels in stressed and non-stressed women and in women with and without SC were similar. A larger number of women with SC presented body fat percentage higher than 30% ($P < 0.04$). Stressed women had significantly higher waist circumference than non-stressed women ($P < 0.02$). Conclusion: Stressed women are more prone to SC, and this condition is associated with increased basal leptin levels, larger hip circumference, and altered body composition.

Introduction

Stress, a condition in which individuals see some events as threatening, can trigger psychological and behavioral responses that may increase appetite, alcohol intake, and abuse of other substances (McEwen & Wingfield, 2003). The way stress impacts individuals constitutes a biological response influenced by how they perceive personal experiences. Social inequities that involve income, education, working conditions, and lifestyle could promote stress (Buss & Pellegrini Filho, 2007).

The effects of stress on food consumption seem to be different in men and women. Zellner, Saito, and Gonzalez (2007) showed that non-stressed men eat more of unhealthy foods as compared with men in the stress group, probably because they reward themselves with a treat. As for women, they eat more healthily when they do not feel stressed, and they consume more sweet food when they are stressed, probably because stress is associated with relaxation of self-imposed food selection rules (Zellner et al., 2006). According to Weinstein, Shide, and Rolls (1997), this happens because women who are prone to disinhibited eating have more difficulty controlling their food intake during stressful situations. An investigation of European students examined whether nutritional habits were related with stress and depressive symptoms. The authors found that stressed women ingested more sweets/fast food and less fruit/vegetables than women without symptoms; in contrast, the authors did not verify this difference among men (Mikolajczyk, Ansari, & Maxwell, 2009).

Environmental factors promote behavior that may affect the human health negatively (Hill & Peters, 1998). From a biological standpoint, the preference for sweet flavor is innate (Beauchamp & Moran, 1982; Rozin, 1990); however, in practice, culture and lifestyle encourage the intake of sweet substances. The growing availability of sugar and its regular ingestion (Bleich, Wang, Wang, & Gortmaker, 2009; Levy, Claro, & Monteiro, 2009; Monteiro, Mondini, & Costa, 2000) may increase the consumption of sweet substances during stressful events (Roohafza et al., 2013).

Hedonic and physiological mechanisms as well as genetic factors regulate food intake and body weight (Hermsdorff, Volp, & Bressan, 2007). Sweet substances seem to stimulate the endogenous opioid

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system – they induce the release of ß-endorphins and enhance the affinity between opioids and their receptors, culminating in emotions such as pleasure. Various addictive drugs and sweet substances can elicit dependence: they raise the extracellular concentration of dopamine, reinforcing the repetitive use of a certain compound (Christensen & Brooks, 2006; Kampov-Polevoy, Eick, & Boland, 2004). Sweet Craving (SC) refers to a strong desire for or difficulty resisting to sweet-tasting food (Weingarten & Elston, 1991). It is more common in women, especially those with excess weight, pre-menstrual syndrome, stress, and/or depression (Kampov-Polevoy, Alterman, Khalitov, & Garbutt, 2006; Yen et al., 2010). Recognizing craving related to food intake is a matter of controversy. Some authors consider that food does not have tolerance levels like other drugs (Drewnowski & Bellisle, 2007). Others identify food craving on the basis of clinical manifestations of dependence (Fortuna, 2012).

Studies have shown that leptin, a hormone that regulates appetite and controls energy from a homeostatic viewpoint, functions as a hedonic component of satiety (Berthoud, 2007; Damiani, Damiani, & Menezes Filho, 2010). At normal levels, leptin promotes a feeling of reward and acts on the mesolimbic dopaminergic system, inducing reduced food ingestion (Fulton, Woodside, & Shizgal, 2000; Yamanaka et al., 2003). Leptin levels rise after a meal, stimulating the anorexigen neurons. Stimulation of these neurons suppresses the appetite and elevates energy expenditure. Hence, leptin operates as a physiological component of satiety and modulates the food intake behavior in the short term (Berthoud, 2007).

Overweight individuals present excess appetite even at high levels of circulating leptin, so they are probably resistant to the action of this hormone (Berthoud, 2007; Otto-Buczkowska & Chobot, 2012). According to Oswal and Yeo (2010), leptin attenuates the feeling of reward in the overweight. Therefore, they tend to consume food perceived as rewarding in excess, which keeps the circulating leptin levels high. Elevated leptin levels seem to alter its hedonic function in the mesolimbic dopaminergic system. In other words, leptin inhibits this system, diminishing the response to sweet-tasting food (Kawai, Sugimoto, Nakashima, Miura, & Ninomiya, 2000; Ninomiya et al., 2002). Recent studies have suggested that leptin modulates sweet taste – it acts on the receptors of the peripheral gustatory system and on the response to sweet taste (Kawai et al., 2000; Niki, Jyotaki, Yoshida, & Ninomiya, 2010).

The start of a meal is related to increased ghrelin levels, which in turn are associated with the perception of hunger (Mundinger, Cummings, & Taborsky, 2006). Ghrelin levels also help to regulate energy storage (Klok, Jakobsdottir, & Drent, 2006). Studies have shown increased plasma ghrelin levels in events of psychological stress and in mediation of stress-induced food reward (Schellekens, Finger, Dinan, & Cryan, 2012). Animal studies have revealed that ghrelin operates in the regulation of mood symptoms, which helps the animal to cope with stress by eliciting anxiolytic- and antidepressant-like behavioral adaptations (Lutter et al., 2008).

Exposure to stress increases plasma ghrelin levels, which is correlated with cortisol levels (Rouach et al., 2007). In turn, the latter is associated with overweight and visceral obesity as well as metabolic abnormalities like glucose intolerance and insulin resistance (Eckel, Grundy, & Zimmet, 2005; Räikkönen, Keltikangas-Järvinen, Adlercreutz, & Hautanen, 1996). Insulin and glucose constitute dynamic ghrelin modulators because hyperinsulinemia and hyperglycemia tend to reduce the circulating ghrelin level (Koliaki, Kokkinos, Tentolouris, & Katsilambros, 2010).

This study aimed to identify SC in women with stress, investigate how stress and SC affect the basal leptin and active ghrelin levels, assess the metabolic abnormalities that could influence ghrelin levels and that could be present in stress, and evaluate the body composition and fat distribution related with both stress and SC. Investigation of the socioeconomic characteristics, work environment, and quality of marital relationship helped to identify the social features of the stressed individual.

Casuistic and methods

Samples

The present study involved 57 women. The participants were divided into two groups, according to stress: 31 women presented stress symptoms, whereas 26 were symptom-free. To allocate the women into the group of individuals with stress or into the group of individuals that were stress-free, an interview using the Stress Symptoms Inventory Lipp (ISSL) (Lipp, 2000) was conducted with women aged between 20 and 45 years and with Body mass Index (BMI) ranging from 25.00 to 29.99 kg m^{-2}. The participants were recruited among individuals belonging to the university community (students and workers) and individuals attended at primary health care services linked to the University.

Exclusion criteria included weight gain or loss over 3 kg in the three previous months; obesity; pre-menstrual period (10 days prior to menstruation); nutritional guidance over the six previous months; use of sweeteners; expectant mothers; lactating women; disorders such as diabetes mellitus type II, polycystic ovary syndrome, cancer, and endocrine and food disorders; hormone replacement therapy; tobacco abuse; and use of corticosteroids, antidepressants, or any other medication that could interfere with the appetite and emotional status. Sample calculation was accomplished using 17% of the collected data, considering the presence of SC as the outcome.

The ISSL instrument was chosen because it has been validated for the Brazilian population, considers physical and psychological symptoms, and is easy to apply (Lipp & Guevara, 1994). The ISSL instrument comprises three parts. It allows interviewers to recognize the presence of symptoms (yes/no) as organized by time: presence of symptoms (12 physical and 3 psychological symptoms) in the last 24 h; presence of symptoms (10 physical and 5 psychological symptoms) over the previous week; and presence of symptoms (12 physical and 11 psychological symptoms) over the previous month. Each part furnishes a score that aids identification of the presence of stress as well as the stress phase: alertness (prevalence of symptoms in the last 24 h), resistance or near to exhaustion (prevalence of symptoms over the previous week), and/or exhaustion (prevalence of symptoms over the previous month) (Lipp, 2000).

The ISSL instrument takes physical symptoms into account; e.g., cold hands and feet, dry mouth, muscle tension, stomach knots, increased sweating, jaw clenching, gritting teeth, diarrhea, insomnia, tachycardia, difficulty in breathing, constant tiredness, hypertension, numbness or tingling in the hands and feet, forgetfulness, altered appetite, dermatological symptoms, dizziness, sexual difficulties, and ulcers. It also describes psychological symptoms like sudden rise in motivation, mood swings, desire to escape from everything, doubts about oneself, irritability, diminished sexual desire, sense of incompetence in all areas, daily anxiety, and lack of sense of humor. Initially, women were asked to report the symptoms that they had presented over the previous 24 h; next, they were invited to describe the symptoms they had experienced over the previous week and then over the previous month (Lipp, 2000).

During recruitment, if the women met all the inclusion criteria and agreed to participate in the study, they answered The Stress Symptoms Inventory Lipp. An appointment was made to collect data for the research; the participants were instructed about the need to fast prior to blood sample collection and body composition assessment. On the scheduled day, the patients had their blood collected and the electric bioimpedance and anthropometric measurements taken. They were then offered breakfast, which was followed by an interview. During the interview, the participants filled in a form that included information about their educational level,