HHS Public Access

Author manuscript

Curr Addict Rep. Author manuscript; available in PMC 2020 November 20.

Published in final edited form as:

Curr Addict Rep. 2019 ; 6: 191–199. doi:10.1007/s40429-019-00253-3.

Tobacco Smoking, Eating Behaviors, and Body Weight: A Review

Ariana M. Chao, PhD, CRNP[1,2], **Thomas A. Wadden, PhD**[2], **Rebecca L. Ashare, PhD**[2], **James Loughead, PhD**[2], **Heath D. Schmidt, PhD**[1,2]

[1]Department of Biobehavioral Health Sciences, School of Nursing, University of Pennsylvania, Philadelphia, PA, USA

[2]Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania Philadelphia, PA, USA

Abstract

Purpose of review: This narrative review provides an overview of the relationships among tobacco smoking, eating behaviors, and body weight. The aims are to (1) examine the concurrent and longitudinal associations between tobacco smoking and body weight, (2) describe potential mechanisms underlying the relationships between smoking and body weight, with a focus on mechanisms related to eating behaviors and appetite, and (3) discuss management of concomitant tobacco smoking and obesity.

Recent findings: Adolescents who smoke tobacco tend to have body mass indexes (BMI) the same as or higher than nonsmokers. However, adult tobacco smokers tend to have lower BMIs and unhealthier diets relative to nonsmokers. Smoking cessation is associated with a mean body weight gain of 4.67 kg after 12 months of abstinence, though there is substantial variability. An emerging literature suggests that metabolic factors known to regulate food intake (e.g., ghrelin, leptin) may also play an important role in smoking-related behaviors. While the neural mechanisms underlying tobacco smoking-induced weight gain remain unclear, brain imaging studies indicate that smoking and eating cues overlap in several brain regions associated with learning, memory, motivation and reward. Behavioral and pharmacological treatments have shown short-term effects in limiting post-cessation weight gain; however, their longer-term efficacy is limited.

Summary: Further studies are needed to identify the exact mechanisms underlying smoking, eating behaviors, and body weight. Moreover, effective treatment options are needed to prevent long-term weight gain during smoking abstinence.

Keywords

cigarettes; obesity; nicotine; relapse; smoking cessation; reward

Corresponding Author: Ariana M. Chao, PhD, CRNP University of Pennsylvania School of Nursing, 418 Curie Blvd, Philadelphia, PA 19104, arichao@nursing.upenn.edu Phone: 215-746-7183, Fax: 215-898-2878.

Human and Animal Rights and Informed Consent: This article does not contain any studies with human or animal subjects performed by any of the authors.

Introduction

Tobacco smoking and obesity are leading causes of morbidity and mortality worldwide [1, 2]. Globally, more than 1.1 billion people 15 years of age and older are tobacco users [3••]. Tobacco smoking is harmful to nearly every organ in the body, and approximately 12% of all deaths among those 30 years of age and older can be attributed to tobacco smoking [4]. With regard to obesity, 650 million adults around the world are obese, defined as a body mass index (BMI) ≥30 kg/m^2 [5]. Similar to tobacco smoking, obesity increases the risk of negative health outcomes including cardiovascular disease, type 2 diabetes, and cancer [1, 2]. Further, the co-occurrence of obesity and tobacco smoking increases mortality and morbidity above either condition alone [6–8]. The life expectancy of individuals who are obese and tobacco smokers is 13 years less than normal weight non-smokers [9]. Thus, tobacco smoking, obesity, and their comorbidity are significant public health priorities.

This narrative review provides an overview of the relationships among tobacco smoking, eating behaviors, and body weight. The aims are to (1) examine the concurrent and longitudinal associations between cigarette smoking and weight, (2) describe potential mechanisms underlying the relationships between smoking and weight, with a focus on those related to eating behaviors and appetite, and (3) discuss management of co-occurring cigarette smoking and obesity. The review focused on the most current literature (from 2013 to 2019).

Epidemiology of Tobacco Smoking and Body Weight

Smoking and Body Weight

Adolescents (11-17 years of age), particularly girls, frequently report initiating and continuing to smoke cigarettes for weight control [10]. Compared to girls in the 5th grade who had normal body weight, girls who were overweight or obese were more likely to initiate smoking through age 18 [11]. This relationship was not found for boys [11]. The average BMI for smokers under 18 years of age is typically the same as or higher than nonsmokers. A review of weight status and cigarette smoking in adolescents found that seven of 12 studies that examined boys found a positive association between body weight and cigarette smoking, whereas only five of 16 studies that examined girls found a positive association [12]. In a more recent study, data from 2,733 seventh, ninth, and 11th graders from the Texas Adolescent Tobacco and Marketing Surveillance system showed that compared to boys of normal weight, boys who were obese had a higher odds of past 30-day cigarette smoking (AOR=4.52, 95% CI=1.31, 15.51) [13]. No association was found between obese and normal weight girls. In a longitudinal study of 6,683 adolescents from the National Longitudinal Survey of Adolescent Health, in female adolescents, each two-unit increase in BMI z-score was associated with a 4-5% increase in the probability of smoking in adulthood [14•]. Adolescent females with obesity (BMI z-score of 2) had a 23.6% probability of becoming a smoker during adulthood, while those who were of normal weight (BMI z-score of 0) had an 18.3% probability. Among female cigarette smokers, adolescent BMI was also associated with smoking frequency in adulthood [14]. In contrast to female adolescent tobacco smokers, no significant associations between smoking behaviors and body weight were found in male adolescent smokers.

Starting at young adulthood, smokers tend to have lower body weight than nonsmokers. The National Longitudinal Study of Adolescent to Adult Health followed a nationally representative cohort of 13,361 adolescents (mean age of 15.5 years) into young adulthood (mean age of 28.4 years) [15•]. In the sample, 44% were nonsmokers, 23% were early establishers who started smoking before age 14, 21% were late establishers who started smoking after age 14, and 12% were former smokers. After approximately 12 years of follow-up, as compared to age-matched non-smokers, early establishers had a BMI −1.27 points lower (95% confidence interval (CI)=−1.56, −0.98), late establishers a BMI −0.84 points lower (95% CI=−1.16, −0.52), and former smokers a BMI −0.63 (−0.93, −0.34) points lower [15].

Cross-sectional data indicate that adults who are current tobacco smokers tend to have lower BMIs than never or former smokers [16, 17]. Moreover, current tobacco smokers are less likely to be obese than never smokers (OR=1.09, 95% CI 1.08, 1.11) [18]. However, among those who smoke cigarettes, 26.3% also have obesity [19]. Thus, while on average, adult smokers tend to have lower body weights compared to non-smokers, a substantial number of individuals who smoke are obese.

Smoking Cessation and Weight Gain

Weight gain is a frequently cited barrier to smoking cessation. Weight gain after cessation is associated with smoking relapse, and 52% of women and 32% of men who have had a previous quit attempt report that weight gain is one of the primary reasons for smoking relapse [20]. Smoking cessation is associated with a mean increase of 2.85 kg at 3 months and 4.67 kg in body weight after 12 months of abstinence [21]. Most post-cessation weight gain occurs during the first 3 months of a quit attempt [21]. Pooled results from a meta-analysis of 35 prospective cohort studies demonstrated that abstinent smokers gained 4.1 kg compared to active smokers who gained 1.5 kg over an average of 5.2 years of follow-up [22••]. There is significant variability in weight gain during smoking cessation ranging from 16% of untreated abstinent smokers losing weight to 13% of abstinent smokers gaining more than 10 kg of body weight [21]. Predictors of higher weight gain include being obese, black, under 55 years of age, and a heavy smoker (≥25 cigarettes smoked per day) [19, 23, 24]. A recent study of 12,204 adults from the National Health and Nutrition Examination Survey examined smoking cessation-induced weight gain (i.e., difference in body weight gain between abstinent smokers and active smokers) over 10 years [19••]. A total of 65.2% participants were never smokers, 25.3% were active smokers, and 9.5% were abstinent smokers. At 10 years, active smokers gained 3.5 kg versus 8.4 kg for abstinent smokers (a smoking cessation-induced body weight gain of 4.9 kg). There was a dose response relationship between cigarettes smoked per day and body weight gain. Smoking cessation-induced body weight gain for those who smoked 1-14, 15-24, and ≥25 cigarettes per day was 2.0, 6.0, and 10.3 kg, respectively.

Mechanisms Mediating the Effects of Tobacco Smoking and Smoking Cessation on Body Weight

Cigarettes contain more than 4,000 different chemicals including at least 70 compounds known to cause cancer [25]. A typical cigarette contains approximately 10-15 mg of

nicotine, a psychoactive molecule that reaches the brain about 10-20 seconds after inhalation [26]. Approximately 10% of nicotine contained in each cigarette is absorbed into the systemic circulation [27]. In addition to mediating the rewarding and reinforcing effects of tobacco, nicotine also plays a critical role in the effects of cigarette smoking on weight gain due to its ability to decrease appetite and increase metabolic rate [28, 29]. The mechanisms underlying smoking's effects on energy balance are not fully understood [30]. Below we summarize evidence of the underlying relationships between tobacco smoking and body weight as related to food intake and appetite.

Eating Behaviors

In preclinical studies, nicotine exposure suppressed food intake, decreased meal size, and resulted in longer inter-meal intervals [31, 32]. Moreover, nicotine has been shown to have anorexic effects and alter feeding patterns in animal models [33]. While it is commonly recognized that cigarette smoking is an appetite suppressant, the effects of smoking on appetite in humans have not always been observed. Compared to nonsmokers, smokers report equal or higher intakes of dietary energy, total and saturated fat, and energy dense foods [34•–36]. Relative to nonsmokers or abstinent smokers, current smokers also report more frequent cravings for high-fat foods and fast-food fats [36]. Smokers who are obese have reduced perceptions of fat and sweetness compared to normal weight smokers and nonsmokers [37]. Smoking cessation is associated with increased caloric intake. During acute abstinence, smokers consume 152 more calories during an *ad libitum* snack meal compared to the total calories consumed during a snack meal while actively smoking [38]. After 6 to 8 weeks of smoking cessation, abstinent smokers consume about 122-227 kcals more [39, 40]. Increases in food intake may be related to several mechanisms. Smoking may have been helping to control overeating and binge eating [41]. Individuals who quit smoking may also substitute eating for the 'hand-to-mouth' behavior of smoking. Smoking may have also been used to cope with stress and negative emotions, and to increase reward [42]. When individuals quit smoking, they may turn to food for comfort.

Metabolic Hormones

Preclinical and clinical studies have begun to elucidate the relationships between cigarette smoking and homeostatic and hedonic control of food intake [43, 44, 30]. Studies have indicated a role for various metabolic hormones in tobacco craving, smoking relapse, and the rewarding properties of tobacco [43, 44, 30]. For example, ghrelin is a peptide secreted from the stomach and peripheral tissues. Ghrelin regulates meal initiation and increased circulating ghrelin is associated with increased hunger and food cravings [45–47]. Ghrelin receptors are expressed throughout the brain including nuclei known to play critical roles in the rewarding and reinforcing effects of food and drugs of abuse (e.g., ventral tegmental area) [43, 48, 49]. In addition to the effects of ghrelin on hunger, it has been postulated that ghrelin also augments drug-seeking behaviors, potentially by activating the mesolimbic dopamine system and promoting craving-induced drug seeking [50, 43]. However, the relationships between circulating levels of ghrelin and tobacco smoking-mediated behaviors are mixed. In preclinical studies, rats exposed to cigarette smoke have significantly higher plasma acyl ghrelin compared to controls [51]. Some studies have found that plasma ghrelin levels do not differ between tobacco smokers and nonsmokers [52–54]. Other studies have

found that plasma concentrations of acetylated ghrelin, the active form of ghrelin that can bind to its cognate receptor growth hormone secretagogue receptor 1a [55], were significantly higher in smokers than nonsmokers [56, 57]. There are acute effects of smoking on ghrelin, and smoking cessation leads to decreased ghrelin levels [52]. Participants who smoked within 60 minutes prior to a blood sample had higher levels of ghrelin than those who had not smoked in the last 180 minutes [57], and ghrelin may continue to decline with longer-term smoking cessation [58]. Higher baseline ghrelin also predicts increased risk of smoking relapse at 4 weeks [59].

Results for other metabolic hormones have also been mixed. Glucagon-like peptide-1 (GLP-1) is secreted by the L cells of the small intestine and neurons in the nucleus tractus solitarius of the caudal brainstem.[60] This hormone helps to regulate food intake by inhibiting appetite centers in the brain, increasing satiety, and slowing gastric emptying [61]. GLP-1 pathways have roles in both homeostatic and hedonic food regulation [62]. GLP-1 receptor agonists have been shown to reduce nicotine-mediated behaviors in rodents such as nicotine-induced locomotion and nicotine consumption [63, 64••]. GLP-1 receptor knockout mice self-administer more nicotine than wild-type controls [64]. Collectively, these studies suggest that systemic administration of a GLP-1 receptor agonist may decrease the reinforcing and rewarding efficacy of nicotine.

Nicotine also leads to functional impairment and loss of β-cell function[65]. Smokers, compared to nonsmokers, have more insulin resistance, increased fasting plasma glucose, and decreased insulin sensitivity[66]. After smoking cessation, insulin sensitivity improves [67]. Leptin is an adipokine that suppresses food intake [68]. Serum leptin levels are lower in tobacco smokers compared to nonsmokers [69], but not after adjustment for BMI [70]. Leptin levels increase after smoking cessation [71, 72]. Plasma leptin is positively correlated with nicotine craving intensity during early nicotine abstinence [73, 74]. Further studies are necessary to clarify these inconsistencies and to investigate other metabolic and weight-regulating hormones that may be related to smoking behaviors, such as neuropeptide Y.

Neurobiological Pathways

The rewarding effects of food and nicotine are mediated, in part, by common neurobiological pathways [75, 76•]. This shared circuity suggests that nicotine exposure can influence food intake. Indeed, nicotine produces neuroadaptations that result in altered energy homeostasis and change the hedonic value of food [77]. Thus, nicotine may influence body weight by altering the reinforcing properties of food [78].

Neuroimaging studies have reported that brain regions involved in learning, memory, motivation, and reward such as the insula, amygdala, striatum, and orbital frontal cortex are activated by both food and smoking cues [79]. Smokers, relative to nonsmokers, had a greater neural response in the hypothalamus to a milk shake stimuli, suggesting that nicotine influences hypothalamic circuits [80]. Compared to adolescents who are never smokers, adolescents who were light smokers showed decreased activation to pleasurable foods in the insula, putamen, inferior frontal cortex, and Rolandic operculum [81]. Likewise, a study in adults found that smokers, relative to non-smokers, during exposure to favorite food cues, had diminished neural activation in the caudate, putamen, insula, thalamus, brainstem, and

cerebellum [82]. During exposure to favorite-food imagery, smokers compared to nonsmokers showed lower connectivity in the supramarginal gyrus, but greater connectivity between the supramarginal gyrus and the corticostriatal-limbic system [83]. These results suggest that smokers may be desensitized to natural food-related rewards in motivation-reward regions of the brain.

Several neurotransmitters and neurophysiological mechanisms contribute to nicotine relapse and may also underlie the relationship between tobacco smoking and weight changes. For example, nicotine's effects on the mesolimbic reward system and on dopamine transmission are known to mediate nicotine reinforcement [29]. Nicotine activates pro-opiomelanocortin (POMC) neurons, which help to control appetite and weight, through nicotinic acetylcholine receptors. Expression of POMC and subsequent activation of hypothalamic melanocortin 4 receptors were found to be critical to the anorectic effects of nicotine [84].

Smoking Treatments, Obesity, and Post-Cessation Weight Gain

Smoking cessation is associated with a number of benefits including decreased risks of mortality and smoking-related diseases [85]. Smoking cessation is typically recommended regardless of baseline weight. Guidelines also recommend that the primary emphasis is placed on smoking cessation and advise against simultaneously initiating weight loss and smoking cessation [86]. However, a major concern for many smokers is post-cessation weight gain [87]. Interventions such as lifestyle changes and pharmacotherapy may be effective during smoking cessation while also helping individuals achieve a healthier weight.

Lifestyle Interventions

Effects of smoking on lifestyle interventions.—Smoking appears to neither impede nor be beneficial to weight loss efforts based on lifestyle interventions. In the Look AHEAD study, participants in an intensive lifestyle intervention (ILI) who were current smokers had no differences in weight loss outcomes compared to never smokers and abstinent smokers [88•]. Participation in the ILI was not associated with compensatory smoking or a likelihood of quitting or relapsing. Similarly, in trials of other behavioral or dietary intervention strategies (low-carbohydrate, low-fat, Mediterranean), tobacco smokers and nonsmokers did not differ in weight loss [89, 90].

Effects of behavioral interventions to prevent post-cessation weight gain.—Lifestyle interventions combined with smoking cessation treatment have demonstrated some initial successes in reducing weight gain without impeding smoking abstinence. However, the long-term effects of these treatments are minimal [91]. A meta-analysis examined 10 randomized controlled trials that compared combined behavioral smoking treatment and behavioral weight control to behavioral smoking treatment alone [92]. Compared to smoking treatment alone, participants who received both smoking treatment and weight treatment showed increased abstinence (OR=1.29, 95% CI=1.01, 1.64) and reduced weight gain (g= −0.30, 95% CI=−0.63, −0.04) during short-term abstinence (<3 months) [91]. However, differences in abstinence and weight between combined interventions for smoking plus weight management and smoking treatment alone were not significant during long-term abstinence (>6 months). Study results suggest that a sequential treatment approach (i.e.,

weight management treatment after smoking treatment) is more effective for reducing weight gain following a quit attempt compared to simultaneous treatment or cessation treatment alone [93]. In addition, personalized weight management support appears to reduce post-cessation weight gain at 12 months (MD=−2.58 kg, 95% CI −5.11 to −0.55) without reducing abstinence [91]. Exercise interventions did not significantly reduce post-cessation weight gain at the end of treatment, but a significant reduction was found at 12 months (MD=−2.07 kg, 95% CI=−3.78, −0.36).[91]

Existing and Potential Pharmacotherapies

Effects of smoking cessation pharmacotherapies on body weight.—Clinical practice guidelines indicate that smoking cessation interventions should include tobacco dependence counseling, in addition to at least one FDA-approved medication (if feasible and not medically contraindicated) [94]. The first-line tobacco cessation pharmacotherapies include nicotine replacement therapies, a nicotinic acetylcholine receptor partial agonist (varenicline) and a norepinephrine & dopamine reuptake inhibitor/nicotinic acetylcholine receptor antagonist (bupropion) [95]. Compared to placebo, bupropion limited post-cessation weight gain at the end of treatment (treatment period ranged from 7-14 weeks; mean difference (MD)=−1.12 kg, 95% CI=−1.47, −0.77). However, results were not sustained at >6 months [91]. Varenicline, relative to placebo, significantly reduced post-cessation weight gain at the end of treatment (treatment period ranged from 6-12 weeks; MD=−0.41 kg, 95% CI=−0.63 to −0.19), but the effect was not maintained at 6 or 12 months [91]. Compared to varenicline, bupropion resulted in significantly less weight gain at the end of treatment (−0.51 kg, 95% CI=−0.93, −0.09). Nicotine replacement therapy, regardless of route of administration, resulted in less post-cessation weight gain at the end of treatment than placebo (median treatment length of 12 weeks; MD=−0.69 kg, 95% CI=−0.88, −0.51), but there was no evidence of an effect at 12 months [91]. A systematic review of 12 studies evaluated polydrug therapy (i.e., nicotine replacement therapy and either rimonabant, naltrexone, nicotine inhaler, bupropion, nortriptyline, selegiline, pralidoxime and ipratropium, or bupropion plus varenicline or naltrexone plus bupropion). In the short-term follow-up, 7 of the 12 studies had less post-cessation weight gain than those in the group of individual drugs or placebo [96]. The other studies showed no difference. The effect of combination therapy in the long-term was not well documented.

Obesity pharmacotherapies.

Currently, five medications are FDA-approved for chronic weight management when used as an adjunct to a reduced-calorie diet and physical activity. These include orlistat (a pancreatic and gastric lipase inhibitor), lorcaserin (a 5HT2c receptor agonist), phentermine-topiramate (a norepinephrine-releasing agent/gamma-aminobutyric acid receptor modulation agent), naltrexone-bupropion (an opioid antagonist/dopamine and norepinephrine reuptake inhibitor), and liraglutide (a GLP-1 agonist). These medications are approved for use in individuals with a BMI≥30 kg/m^2 or BMI≥27 kg/m^2 with an obesity-related co-morbidity such as hypertension or type 2 diabetes. Lorcaserin and naltrexone-bupropion have been tested in studies to limit post-cessation weight gain as will be discussed below.

Lorcaserin has demonstrated some efficacy at reducing post-cessation weight gain in short-term studies. An open-label, single arm, pilot study assessed the preliminary safety and efficacy of combining varenicline 1 mg twice daily and lorcaserin 10 mg twice daily among 20 individuals who were active tobacco smokers and overweight or obese. Smoking abstinence was 50% at week 12 and 30% at week 26. Among those with smoking abstinence, weight gain was +1.1±3.9 kg at week 12 [97•]. In a larger 12-week, randomized, double-blind placebo-controlled trial, 603 smokers with a BMI of 18.5 to 35 kg/m^2 who averaged at least 10 cigarettes/day were randomized to lorcaserin 10 mg once daily, lorcaserin 10 mg twice daily, or placebo. All participants received standardized smoking cessation counseling weekly. Abstinence rates for month 3 were 5.6%, 8.7% and 15.3% for placebo, lorcaserin daily, and lorcaserin twice a day, respectively [98•]. Changes in weight from baseline to week 12 were −0.01, −0.35, and −0.98 kg for the placebo, lorcaserin daily, and lorcaserin twice a day groups, respectively.

Bupropion combined with naltrexone has also been examined for post-smoking cessation weight gain. In an-open label study of naltrexone (32 mg/day) and bupropion (360 mg/day) plus behavioral counseling, 30 overweight or obese tobacco smokers had continuous abstinence rates of 40.7%. The average weight gain at week 24 was +0.4% of initial body weight at week 24, which was not significantly different from baseline [99]. A preliminary, open-label study compared naltrexone 25 mg/day combined with bupropion 300 mg/day to bupropion 300 mg/day alone. All participants received a psychosocial intervention. Continuously abstinent participants in the naltrexone bupropion group gained less weight (M=1.67 pounds) than those in the bupropion alone group (M=3.17 pounds), though the effect was not statistically significant [100]. Abstinence rates did not differ between groups. In a randomized, double-blind, parallel group design study, 121 treatment-seeking cigarette smokers were randomized to bupropion (300 mg/day) and naltrexone (50 mg/day) or bupropion (300 mg/day) and placebo. At 7 weeks, 54.1% of participants assigned to bupropion and naltrexone achieved abstinence, which was significantly greater than the 33.3% on bupropion placebo [101•]. However, this effect was not sustained at 6-months. There was no effect of medication, time, or their interaction on weight.

Bariatric Surgery

Bariatric surgery provides the most effective and durable treatment for obesity [102]. It also has benefits of improving obesity-related comorbidities such as type 2 diabetes, hyperlipidemia, and hypertension. Cigarette smoking is a predictor of poor post-surgical outcomes including serious complications, infection, prolonged intubation, and pneumonia [103, 104]. Hence, some bariatric surgery practices require smoking cessation prior to bariatric surgery. In a sample of 84 patients who had laparoscopic sleeve gastrectomy, at a median follow-up of 8.0 years, 46% of previously smoking patients successfully quit [105]. The 55.9% excess weight loss of the actively smoking participants did not differ significantly (p=0.16) from the 48.7% excess body weight loss among abstinent smokers.

Conclusion and Future Directions

Weight management in tobacco smokers is challenging, and further research is needed to examine mechanisms responsible for smoking cessation-related weight gain. In particular, studies are needed that examine the hormonal and neural mechanisms underlying these relationships. These studies may identify molecular substrates that could serve as targets for novel pharmacotherapies to treat nicotine addiction and post-cessation body weight gain. New medications are needed that are effective for promoting smoking abstinence and weight control. For example, testing other obesity medications for post-cessation weight gain (e.g., GLP-1 receptor agonists such as liraglutide) warrants further research as well as other integrated behavioral strategies that target smoking cessation and weight management.

Smokers often have poor dietary habits and are vulnerable to excess weight gain after smoking cessation. The underlying mechanisms linking smoking, eating behaviors, and weight regulation are not well understood. However, growing data support the potential of hormonal and neural mechanisms. Future studies are needed that examine these mechanisms as well as test novel treatments for co-occurring smoking and weight issues.

Acknowledgments

Funding: Dr. Chao was supported, in part, by the National Institute of Nursing Research of the National Institutes of Health under Award Number K23NR017209. Dr. Schmidt is supported by grants from the National Institutes of Health (R01 DA037897 and R21 DA039393) and a grant from NovoNordisk.

Disclosures: Dr. Chao reports grants from National Institute of Nursing Research, personal fees from WW International, Inc., grants and personal fees from Shire Pharmaceutical, outside the submitted work. Dr. Wadden reports grants and personal fees from Novo Nordisk, grants from Eisai Pharmaceuticals, personal fees from Weight Watchers, outside the submitted work. Dr. Ashare reports grants from National Institute on Drug Abuse, during the preparation of this paper and grants from Novo Nordisk, Inc, outside the submitted work. Dr. Loughead reports grants from National Institute on Drug Abuse, outside the submitted work. Dr. Schmidt reports grants from National Institute on Drug Abuse, during the conduct of the study; grants from Novo Nordisk, Inc, outside the submitted work.

References

1. US Department of Health Human Services. The health consequences of smoking: a report of the Surgeon General. US Department of Health and Human Services, Centers for Disease Control; 2004.
2. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health. 2009;9(1):88. [PubMed: 19320986]
••3. World Health Organization. WHO global report on trends in prevalence of tobacco smoking 2000–2025. 2018.This is an updated report on global trends in the prevalene of tobacco smoking.
4. World Health Organization. WHO global report: mortality attributable to tobacco. 2012. Geneva: World Health Organization 2012.
5. World Health Organization. Obesity and overweight. 2018 https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed January 10 2019.
6. Freedman DM, Sigurdson AJ, Rajaraman P, Doody MM, Linet MS, Ron E. The mortality risk of smoking and obesity combined. American Journal of Preventive Medicine. 2006;31(5):355–62. [PubMed: 17046405]
7. Ma J, Jemal A, Flanders WD, Ward EM. Joint association of adiposity and smoking with mortality among US adults. Preventive Medicine. 2013;56(3–4):178–84. [PubMed: 23276778]

8. Vurbic D, Harder VS, Redner RR, Lopez AA, Phillips JK, Higgins ST. Co-occurring obesity and smoking among US women of reproductive age: associations with educational attainment and health biomarkers and outcomes. Preventive Medicine. 2015;80:60–6. [PubMed: 26051199]

9. Peeters A, Barendregt JJ, Willekens F, Mackenbach JP, Al Mamun A, Bonneux L. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. Annals of Internal Medicine. 2003;138(1):24–32. [PubMed: 12513041]

10. Thomas RL, Kelly AB, Chan GC, Hides LM, Quinn CA, Kavanagh DJ et al. An examination of gender differences in the association of adolescent substance use with eating and weight loss attitudes. Substance Use & Misuse. 2018;53(12):1–7. [PubMed: 28742416]

11. Caria MP, Bellocco R, Zambon A, Horton NJ, Galanti MR. Overweight and perception of overweight as predictors of smokeless tobacco use and of cigarette smoking in a cohort of Swedish adolescents. Addiction. 2009;104(4):661–8. [PubMed: 19215597]

12. Potter BK, Pederson LL, Chan SS, Aubut J- AL, Koval JJ. Does a relationship exist between body weight, concerns about weight, and smoking among adolescents? An integration of the literature with an emphasis on gender. Nicotine & Tobacco Research. 2004;6(3):397–425. [PubMed: 15203775]

13. Delk J, Creamer MR, Perry CL, Harrell MB. Weight status and cigarette and electronic cigarette use in adolescents. American Journal of Preventive Medicine. 2018;54(1):e31–e5. [PubMed: 29132954]

•14. Fang M Association between adolescent body mass index and adulthood smoking. Nicotine & Tobacco Research. 2018:[e pub ahead of print].This study includes over 6,600 adolescents who were interviewed at baseline and follow-up to examine the associations between adolescents BMI and smoking status and frequency in adulthood.

•15. Patel M, Kaufman A, Hunt Y, Nebeling L. Understanding the relationship of cigarette smoking trajectories through adolescence and weight status in young adulthood in the United States. Journal of Adolescent Health. 2017;61(2):163–70.This study includes over 13,300 adolescents and examines the relationship of smoking trajectories in adolescence on weight status in young adulthood.

16. Plurphanswat N, Rodu B. The association of smoking and demographic characteristics on body mass index and obesity among adults in the US, 1999–2012. BMC Obesity. 2014;1(1):18. [PubMed: 26217505]

17. Munafò MR, Tilling K, Ben-Shlomo Y. Smoking status and body mass index: a longitudinal study. Nicotine & Tobacco Research. 2009;11(6):765–71. [PubMed: 19443785]

18. Dare S, Mackay DF, Pell JP. Relationship between smoking and obesity: a cross-sectional study of 499,504 middle-aged adults in the UK general population. PloS One. 2015;10(4):e0123579. [PubMed: 25886648]

••19. Veldheer S, Yingst J, Zhu J, Foulds J. Ten-year weight gain in smokers who quit, smokers who continued smoking and never smokers in the United States, NHANES 2003–2012. International Journal of Obesity. 2015;39(12):1727–1732. [PubMed: 26155918] This study examined long-term weight gain and smoking cessation attributable weight gain in a nationally respresntive sample of 12,200 adults.

20. Pisinger C, Jorgensen T. Weight concerns and smoking in a general population:: The Inter99 study. Preventive Medicine. 2007;44(4):283–9. [PubMed: 17222451]

21. Aubin H- J, Farley A, Lycett D, Lahmek P, Aveyard P. Weight gain in smokers after quitting cigarettes: meta-analysis. Bmj. 2012;345:e4439. [PubMed: 22782848]

••22. Tian J, Venn A, Otahal P, Gall S. The association between quitting smoking and weight gain: a systemic review and meta-analysis of prospective cohort studies. Obesity Reviews. 2015;16(10):883–901. [PubMed: 26114839] This systematic review and meta-analysis synthesizes data from 35 studies on the difference in weight gain between quitters and continuing smokers.

23. Williamson DF, Madans J, Anda RF, Kleinman JC, Giovino GA, Byers T. Smoking cessation and severity of weight gain in a national cohort. New England Journal of Medicine. 1991;324(11):739–45. [PubMed: 1997840]

24. Filozof C, Fernandez Pinilla M, Fernández-Cruz A. Smoking cessation and weight gain. Obesity Reviews. 2004;5(2):95–103. [PubMed: 15086863]
25. Stedman RL. Chemical composition of tobacco and tobacco smoke. Chemical Reviews. 1968;68(2):153–207. [PubMed: 4868017]
26. Le Houezec J Role of nicotine pharmacokinetics in nicotine addiction and nicotine replacement therapy: a review. The International Journal of Tuberculosis and Lung Disease. 2003;7(9):811–9. [PubMed: 12971663]
27. Benowitz NL, Henningfield JE. Reducing the nicotine content to make cigarettes less addictive. Tobacco Control. 2013;22(suppl 1):i14–i7. [PubMed: 23591498]
28. Collins LC, Walker J, Stamford BA. Smoking multiple high-versus low-nicotine cigarettes: impact on resting energy expenditure. Metabolism-Clinical and Experimental. 1996;45(8):923–6. [PubMed: 8769345]
29. Schmidt HD, Rupprecht LE, Addy NA. Neurobiological and Neurophysiological Mechanisms Underlying Nicotine Seeking and Smoking Relapse. Molecular Neuropsychiatry. 2018:1–21.
30. Audrain-McGovern J, Benowitz N. Cigarette smoking, nicotine, and body weight. Clinical Pharmacology & Therapeutics. 2011;90(1):164–8. [PubMed: 21633341]
31. Rupprecht LE, Smith TT, Donny EC, Sved AF. Self-administered nicotine suppresses body weight gain independent of food intake in male rats. Nicotine & Tobacco Research. 2016;18(9):1869–76. [PubMed: 27194544]
32. Miyata G, Meguid MM, Varma M, Fetissov SO, Kim H- J. Nicotine alters the usual reciprocity between meal size and meal number in female rat. Physiology & Behavior. 2001;74(1–2):169–76. [PubMed: 11564465]
33. Grunberg NE. The effects of nicotine and cigarette smoking on food consumption and taste preferences. Addictive Behaviors. 1982;7(4):317–31. [PubMed: 7183186]
•34. MacLean RR, Cowan A, Vernarelli JA. More to gain: dietary energy density is related to smoking status in US adults. BMC Public Health. 2018;18(1):365. [PubMed: 29614996] This study provides data on the association between cigarette use and dietary energy density.
35. Dallongeville J, Marecaux N, Fruchart J- C, Amouyel P. Cigarette smoking is associated with unhealthy patterns of nutrient intake: a meta-analysis. The Journal of Nutrition. 1998;128(9):1450–7. [PubMed: 9732304]
36. Chao AM, White MA, Grilo CM, Sinha R. Examining the effects of cigarette smoking on food cravings and intake, depressive symptoms, and stress. Eating Behaviors. 2017;24:61–5. [PubMed: 28038436]
37. Pepino MY, Mennella JA. Cigarette smoking and obesity are associated with decreased fat perception in women. Obesity. 2014;22(4):1050–5. [PubMed: 24415517]
38. Yannakoulia M, Anastasiou C, Zachari K, Sidiropoulou M, Katsaounou P, Tenta R. Acute effect of smoking and smoking abstinence on energy intake and appetite-related hormones blood concentrations. Physiology & Behavior. 2018;184:78–82. [PubMed: 29128523]
39. Stamford BA, Matter S, Fell RD, Papanek P. Effects of smoking cessation on weight gain, metabolic rate, caloric consumption, and blood lipids. The American Journal of Clinical Nutrition. 1986;43(4):486–94. [PubMed: 3962901]
40. Moffatt RJ, Owens SG. Cessation from cigarette smoking: changes in body weight, body composition, resting metabolism, and energy consumption. Metabolism-Clinical and Experimental. 1991;40(5):465–70. [PubMed: 2023532]
41. White MA, Peters EN, Toll BA. Effect of binge eating on treatment outcomes for smoking cessation. Nicotine & Tobacco Research. 2010;12(11):1172–5. [PubMed: 20889472]
42. Sinha R, Jastreboff AM. Stress as a common risk factor for obesity and addiction. Biological Psychiatry. 2013;73(9):827–35. [PubMed: 23541000]
43. Engel JA, Jerlhag E. Role of appetite-regulating peptides in the pathophysiology of addiction: implications for pharmacotherapy. CNS Drugs. 2014;28(10):875–86. [PubMed: 24958205]
44. Tweed JO, Hsia SH, Lutfy K, Friedman TC. The endocrine effects of nicotine and cigarette smoke. Trends in Endocrinology & Metabolism. 2012;23(7):334–42. [PubMed: 22561025]

45. Cummings DE, Purnell JQ, Frayo RS, Schmidova K, Wisse BE, Weigle DS. A preprandial rise in plasma ghrelin levels suggests a role in meal initiation in humans. Diabetes. 2001;50(8):1714–9. [PubMed: 11473029]
46. Cummings DE, Frayo RS, Marmonier C, Aubert R, Chapelot D. Plasma ghrelin levels and hunger scores in humans initiating meals voluntarily without time-and food-related cues. American Journal of Physiology-Endocrinology and Metabolism. 2004;287(2):E297–E304. [PubMed: 15039149]
47. Chao AM, Jastreboff AM, White MA, Grilo CM, Sinha R. Stress, cortisol, and other appetite-related hormones: Prospective prediction of 6-month changes in food cravings and weight. Obesity. 2017;25(4):713–20. [PubMed: 28349668]
48. Valassi E, Scacchi M, Cavagnini F. Neuroendocrine control of food intake. Nutrition, Metabolism and Cardiovascular Diseases. 2008;18(2):158–68.
49. Perello M, Dickson S. Ghrelin signalling on food reward: a salient link between the gut and the mesolimbic system. Journal of Neuroendocrinology. 2015;27(6):424–34. [PubMed: 25377898]
50. Panagopoulos VN, Ralevski E. The role of ghrelin in addiction: a review. Psychopharmacology. 2014;231(14):2725–40. [PubMed: 24947976]
51. Tomoda K, Kubo K, Nishii Y, Yamamoto Y, Yoshikawa M, Kimura H. Changes of ghrelin and leptin levels in plasma by cigarette smoke in rats. The Journal of Toxicological Sciences. 2012;37(1):131–8. [PubMed: 22293417]
52. Kokkinos A, Tentolouris N, Kyriakaki E, Argyrakopoulou G, Doupis J, Psallas M et al. Differentiation in the short-and long-term effects of smoking on plasma total ghrelin concentrations between male nonsmokers and habitual smokers. Metabolism. 2007;56(4):523–7. [PubMed: 17379011]
53. Kaabi YA, Khalifa MA. Acute one-cigarette smoking decreases ghrelin hormone in saliva: a pilot study. International Journal of Endocrinology. 2014;2014.
54. Mutschler J, Graf N, Spanaus KS, Rössler W, Hergan K, Binkert CA et al. Circulating ghrelin levels are not associated with craving and withdrawal symptoms in acute nicotine withdrawal. Psychiatria Danubina. 2012;24(2):229–30. [PubMed: 22706426]
55. Tong J, Dave N, Mugundu GM, Davis HW, Gaylinn BD, Thorner MO et al. The pharmacokinetics of acyl, des-acyl, and total ghrelin in healthy human subjects. European Journal of Endocrinology. 2013;168(6):821–8. [PubMed: 23482590]
56. Koopmann A, Bez J, Lemenager T, Hermann D, Dinter C, Reinhard I et al. Effects of cigarette smoking on plasma concentration of the appetite-regulating peptide ghrelin. Annals of Nutrition and Metabolism. 2015;66(2–3):155–61. [PubMed: 25896493]
57. Fagerberg B, Hultén LM, Hulthe J. Plasma ghrelin, body fat, insulin resistance, and smoking in clinically healthy men: the atherosclerosis and insulin resistance study. Metabolism. 2003;52(11):1460–3. [PubMed: 14624407]
58. Lee H, Joe K- H, Kim W, Park J, Lee D-H, Sung K-W et al. Increased leptin and decreased ghrelin level after smoking cessation. Neuroscience Letters. 2006;409(1):47–51. [PubMed: 17010518]
59. al'Absi M, Lemieux A, Nakajima M. Peptide YY and ghrelin predict craving and risk for relapse in abstinent smokers. Psychoneuroendocrinology. 2014;49:253–9. [PubMed: 25127083]
60. Burcelin R, Gourdy P. Harnessing glucagon-like peptide-1 receptor agonists for the pharmacological treatment of overweight and obesity. Obesity Reviews. 2017;18(1):86–98. [PubMed: 27636208]
61. Holst JJ. The physiology of glucagon-like peptide 1. Physiological Reviews. 2007;87(4):1409–39. [PubMed: 17928588]
62. Reddy IA, Stanwood GD, Galli A. Moving beyond energy homeostasis: new roles for glucagon-like peptide-1 in food and drug reward. Neurochemistry International. 2014;73:49–55. [PubMed: 24140429]
63. Egecioglu E, Engel JA, Jerlhag E. The glucagon-like peptide 1 analogue Exendin-4 attenuates the nicotine-induced locomotor stimulation, accumbal dopamine release, conditioned place preference as well as the expression of locomotor sensitization in mice. PloS One. 2013;8(10):e77284. [PubMed: 24204788]

••64. Tuesta LM, Chen Z, Duncan A, Fowler CD, Ishikawa M, Lee BR et al. GLP-1 acts on habenular avoidance circuits to control nicotine intake. Nature Neuroscience. 2017;20(5):708. [PubMed: 28368384] This preclinical study demonstrated that nicotine activates GLP-1 neurons in the nucleus tractus solitarius and GLP-1 agonists decreased nicotine intake in mice.

65. Stadler M, Tomann L, Storka A, Wolzt M, Peric S, Bieglmayer C et al. Effects of smoking cessation on β-cell function, insulin sensitivity, body weight, and appetite. European Journal of Endocrinology. 2014;170(2):219–27. [PubMed: 24179100]

66. Facchini FS, Hollenbeck CB, Jeppesen J, Chen Y- DI, Reaven G. Insulin resistance and cigarette smoking. The Lancet. 1992;339(8802):1128–30.

67. Bergman BC, Perreault L, Hunerdosse D, Kerege A, Playdon M, Samek AM et al. Novel and reversible mechanisms of smoking-induced insulin resistance in humans. Diabetes. 2012;61(12):3156–66. [PubMed: 22966072]

68. Collins S, Kuhn CM, Petro AE, Swick AG, Chrunyk BA, Surwit RS. Role of leptin in fat regulation. Nature. 1996;380:677. [PubMed: 8614460]

69. Wynne K, Stanley S, McGowan B, Bloom S. Appetite control. Journal of Endocrinology. 2005;184(2):291–318. [PubMed: 15684339]

70. Nicklas BJ, Tomoyasu N, Muir J, Goldberg AP. Effects of cigarette smoking and its cessation on body weight and plasma leptin levels. Metabolism-Clinical and Experimental. 1999;48(6):804–8. [PubMed: 10381158]

71. Perkins KA, Fonte C. Effects of smoking status and smoking cessation on leptin levels. Nicotine & Tobacco Research. 2002;4(4):459–66. [PubMed: 12521405]

72. Lemieux A, Nakajima M, Hatsukami DK, Allen S, al'Absi M. Changes in circulating leptin levels during the initial stage of cessation are associated with smoking relapse. Psychopharmacology. 2015;232(18):3355–61. [PubMed: 26156634]

73. von der Goltz C, Koopmann A, Dinter C, Richter A, Rockenbach C, Grosshans M et al. Orexin and leptin are associated with nicotine craving: a link between smoking, appetite and reward. Psychoneuroendocrinology. 2010;35(4):570–7. [PubMed: 19828259]

74. Al'Absi M, Hooker S, Fujiwara K, Kiefer F, Von Der Goltz C, Cragin T et al. Circulating leptin levels are associated with increased craving to smoke in abstinent smokers. Pharmacology Biochemistry and Behavior. 2011;97(3):509–13.

75. Volkow ND, Wang GJ, Tomasi D, Baler RD. Obesity and addiction: neurobiological overlaps. Obesity Reviews. 2013;14(1):2–18. [PubMed: 23016694]

•76. Criscitelli K, Avena NM. The neurobiological and behavioral overlaps of nicotine and food addiction. Preventive Medicine. 2016;92:82–9. [PubMed: 27509870] This review highlights preclinical and clinical research on the neurobiological and behavioral overlaps among nicotine, highly palatable food intake, and obesity.

77. Stojakovic A, Espinosa EP, Farhad OT, Lutfy K. Effects of nicotine on homeostatic and hedonic components of food intake. Journal of Endocrinology. 2017;235(1):R13–R31. [PubMed: 28814527]

78. Morganstern I, R Barson J, F Leibowitz S. Regulation of drug and palatable food overconsumption by similar peptide systems. Current Drug Abuse Reviews. 2011;4(3):163–73. [PubMed: 21999690]

79. Tang D, Fellows L, Small D, Dagher A. Food and drug cues activate similar brain regions: a meta-analysis of functional MRI studies. Physiology & Behavior. 2012;106(3):317–24. [PubMed: 22450260]

80. Geha PY, Aschenbrenner K, Felsted J, O'malley SS, Small DM. Altered hypothalamic response to food in smokers–. The American Journal of Clinical Nutrition. 2012;97(1):15–22. [PubMed: 23235196]

81. Rubinstein ML, Luks TL, Dryden WY, Rait MA, Simpson GV. Adolescent smokers show decreased brain responses to pleasurable food images compared with nonsmokers. Nicotine & Tobacco Research. 2011;13(8):751–5. [PubMed: 21454914]

82. Jastreboff AM, Sinha R, Lacadie CM, Balodis IM, Sherwin R, Potenza MN. Blunted striatal responses to favorite-food cues in smokers. Drug and Alcohol Dependence. 2015;146:103–6. [PubMed: 25444233]

83. Garrison KA, Sinha R, Lacadie CM, Scheinost D, Jastreboff AM, Constable RT et al. Functional connectivity during exposure to favorite-food, stress, and neutral-relaxing imagery differs between smokers and nonsmokers. Nicotine & Tobacco Research. 2016;18(9):1820–9. [PubMed: 26995796]

84. Mineur YS, Abizaid A, Rao Y, Salas R, DiLeone RJ, Gündisch D et al. Nicotine decreases food intake through activation of POMC neurons. Science. 2011;332(6035):1330–2. [PubMed: 21659607]

85. Rigotti NA. Treatment of tobacco use and dependence. New England Journal of Medicine. 2002;346(7):506–12. [PubMed: 11844853]

86. National Heart L, and Blood Institute,. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. Bethesda, MD: National Institutes of Health1998 Contract No: NIH Pub. No. 98–4083.

87. Veldheer S, Yingst J, Foulds G, Hrabovsky S, Berg A, Sciamanna C et al. Once bitten, twice shy: concern about gaining weight after smoking cessation and its association with seeking treatment. International Journal of Clinical Practice. 2014;68(3):388–95. [PubMed: 24471797]

•88. Murphy CM, Rohsenow DJ, Johnson KC, Wing RR. Smoking and weight loss among smokers with overweight and obesity in Look AHEAD. Health Psychology. 2018;37(5):399. [PubMed: 29698015] This study examines the association between participation in an intensive lifestyle intervention and smoking.

89. Greenberg I, Stampfer MJ, Schwarzfuchs D, Shai I, Group D. Adherence and success in long-term weight loss diets: the dietary intervention randomized controlled trial (DIRECT). Journal of the American College of Nutrition. 2009;28(2):159–68. [PubMed: 19828901]

90. Jeffery R, Sherwood N, Brelje K, Pronk N, Boyle R, Boucher J et al. Mail and phone interventions for weight loss in a managed-care setting: Weigh-To-Be one-year outcomes. International Journal of Obesity. 2003;27(12):1584. [PubMed: 14517547]

91. Farley AC, Hajek P, Lycett D, Aveyard P. Interventions for preventing weight gain after smoking cessation. Cochrane Database Syst Rev. 2012;1.

92. Spring B, Howe D, Berendsen M, McFadden HG, Hitchcock K, Rademaker AW et al. Behavioral intervention to promote smoking cessation and prevent weight gain: a systematic review and meta-analysis. Addiction. 2009;104(9):1472–86. [PubMed: 19549058]

93. Spring B, Doran N, Pagoto S, Schneider K, Pingitore R, Hedeker D. Randomized controlled trial for behavioral smoking and weight control treatment: effect of concurrent versus sequential intervention. Journal of Consulting and Clinical Psychology. 2004;72(5):785. [PubMed: 15482037]

94. US Department of Health and Human Services. A clinical practice guideline for treating tobacco use and dependence: 2008 update: a US public health service report. American Journal of Preventive Medicine. 2008;35(2):158. [PubMed: 18617085]

95. Fiore M Treating tobacco use and dependence: 2008 update: Clinical practice guideline. DIANE publishing; 2009.

96. Yang M, Bhowmik D, Wang X, Abughosh S. Does combination pharmacological intervention for smoking cessation prevent post-cessation weight gain? A systemic review. Addictive Behaviors. 2013;38(3):1865–75. [PubMed: 23305808]

•97. Hurt RT, Croghan IT, Schroeder DR, Hays JT, Choi D- S, Ebbert JO. Combination varenicline and lorcaserin for tobacco dependence treatment and weight gain prevention in overweight and obese smokers: A pilot study. Nicotine & Tobacco Research. 2016;19(8):994–8.This pilot study examined the safety and effectiveness of combination varenicline and lorcaserin in prevention post-cessation weight gain in 20 cigarette smokers with overweight or obesity.

•98. Shanahan WR, Rose JE, Glicklich A, Stubbe S, Sanchez-Kam M. Lorcaserin for smoking cessation and associated weight gain: a randomized 12-week clinical trial. Nicotine & Tobacco Research. 2016;19(8):944–51.This was a 12-week randomized controlled trial tested the effect of lorcaserin 10 mg daily, 10 mg twice daily, or placebo on smoking abstience and associated weight change.

99. Wilcox CS, Oskooilar N, Erickson JS, Billes SK, Katz BB, Tollefson G et al. An open-label study of naltrexone and bupropion combination therapy for smoking cessation in overweight and obese subjects. Addictive Behaviors. 2010;35(3):229–34. [PubMed: 19926400]

100. Toll BA, Leary V, Wu R, Salovey P, Meandzija B, O'Malley SS. A preliminary investigation of naltrexone augmentation of bupropion to stop smoking with less weight gain. Addictive Behaviors. 2008;33(1):173–9. [PubMed: 17587504]

•101. Mooney ME, Schmitz JM, Allen S, Grabowski J, Pentel P, Oliver A et al. Bupropion and naltrexone for smoking cessation: A double-blind randomized placebo-controlled clinical trial. Clinical Pharmacology & Therapeutics. 2016;100(4):344–52. [PubMed: 27213949] This randomized controlled trial tested the efficacy of buproprion (300 mg/day) + placebo) versus buproprion (300 mg/day) + naltrexone (50 mg/day) on smoking abstinence.

102. Heymsfield SB, Wadden TA. Mechanisms, pathophysiology, and management of obesity. New England Journal of Medicine. 2017;376(3):254–66. [PubMed: 28099824]

103. Finks JF, Kole KL, Yenumula PR, English WJ, Krause KR, Carlin AM et al. Predicting risk for serious complications with bariatric surgery: results from the Michigan Bariatric Surgery Collaborative. Annals of Surgery. 2011;254(4):633–40. [PubMed: 21897200]

104. Haskins IN, Amdur R, Vaziri K. The effect of smoking on bariatric surgical outcomes. Surgical Endoscopy. 2014;28(11):3074–80. [PubMed: 24902816]

105. Kowalewski PK, Olszewski R, Walędziak MS, Janik MR, Kwiatkowski A, Paśnik K. Cigarette smoking and its impact on weight loss after bariatric surgery: A single center, retrospective study. Surgery for Obesity and Related Diseases. 2018:1163–6. [PubMed: 29929857]