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Author manuscript

*Curr Opin Endocrinol Diabetes Obes.* Author manuscript; available in PMC 2019 March 11.

Published in final edited form as:

*Curr Opin Endocrinol Diabetes Obes.* 2018 October ; 25(5): 298–302. doi:10.1097/MED.000000000000434.

## Food Cravings and Body Weight: A Conditioning Response

Candice A. Myers, Corby K. Martin, and John W. Apolzan

Pennington Biomedical Research Center, Louisiana State University System, 6400 Perkins Road, Baton Rouge, LA, 70808

### Abstract

**Purpose of review:** To provide current information on interventions that alter food cravings. Specifically, dietary, physical activity, pharmacologic, and bariatric surgery interventions are examined. Lastly, the effects of social determinants and current controversies on food cravings are outlined.

**Recent findings:** Dietary, pharmacologic, and bariatric surgery weight loss interventions decrease food cravings. Physical activity interventions also decrease cravings. There is potential to see differential responses in food cravings in different demographic and socioeconomic groups, but more research is needed.

**Summary:** Food cravings influence body weight. Food craving reductions are due to reductions in the frequency of consuming craved foods, independent of energy content, but further research is warranted. Most findings continue to support the conditioning model of food cravings.

### Keywords

food craving; eating behavior; body weight; obesity; social determinants

### Introduction:

Food craving is typically defined as frequent, intense desires to consume a particular type of food. Until recently, there was a debate about whether food cravings are reduced following energy restriction and if the conditioning model of cravings is valid. The conditioning model of food cravings states that cravings can develop from pairing consumption of certain foods with external (e.g., watching television) or internal (e.g. feeling sad) stimuli. Food cravings are believed to account for up to 11% of the variance in eating behavior and weight gain (1\*) and are positively associated with BMI (2). Thus, food cravings have the potential to be a modifiable predictor of body weight. This review will summarize and critique the most relevant areas of current food craving research.

Corresponding Author: John W. Apolzan, Pennington Biomedical Research Center, Louisiana State University System, 6400 Perkins Rd, Baton Rouge, LA 70808; John.Apolzan@pbrc.edu, Office Phone: 225-763-2827; Fax: 225-763-3022

Conflicts of interest: There are no conflicts of interest.

## Dietary:

Recently, the manuscript authored by Apolzan and colleagues utilized food intake and Food Craving Inventory (FCI) data from The POUNDS Lost multi-site weight loss randomized controlled trial (RCT) (3) to examine the association between change in FCI food item consumption and change in food cravings. Decreasing the frequency of consuming food items was associated with decreases in cravings for those items during weight loss (4\*\*). To the authors' knowledge, this was the first time that it was demonstrated that food cravings are reduced following a reduction in individual FCI food item consumption during a RCT. Furthermore, the amount of energy consumed per FCI food item did not affect results. Additionally, while food cravings were positively associated with body weight changes during weight loss, the same was not found during a period of weight maintenance. These findings suggest that during weight loss interventions participants should decrease the frequency of consuming craved foods instead of lessening the amount consumed. However, the authors concluded that this hypothesis should be directly tested.

Secondly, a meta-analysis by Kahathuduwa et al. found that with energy restriction overall food cravings, as well as the sweets, high-fats, carbohydrates/starches, and fast food subscales, decrease in weight loss studies over 12 weeks (5\*\*). It should be noted that the majority of the participants were female, and 10 out of 13 studies included in the meta-analysis utilized the FCI opposed to other validated measures of food cravings. The results are important as they further validate that food cravings are due to a conditioned association between consumption of a specific type of food with a stimulus, further suggesting cravings are a result of classical conditioning.

Recently, Richard et al. tested associations similar to those found by Apolzan and colleagues. Persons with high and low trait chocolate cravings were instructed to abstain from chocolate consumption during a period of weight maintenance. After two weeks, the high cravers, but not the low cravers, reduced cravings (6\*\*). A similar response was found with snacking by the same group (7). However, even after the reduction the high cravers had double the score on the State version of the Food Craving Questionnaire (FCQ-State), thus floor effects were likely seen in low trait chocolate cravers (6\*\*). Thus, persons must be 'cravers' in order to have a reduction in cravings following a reduction in craving item consumption. This study again confirms classical conditioning of food cravings in those that regularly consume chocolate, but further suggests conditioning may also extend to periods of weight maintenance.

It is unclear whether results that support the conditioning model of food cravings are found in commercial weight management programs. An online questionnaire including the Control of Eating Questionnaire (CoEQ) was provided to persons attending a group based weight management program (8\*). Craving control and craving for sweet was lower in those dieting compared to those watching what they ate (8\*). Persons not dieting had higher craving control, craving for savory, and craving for sweet foods compared to the dieting and watching what they were eating groups. These results align well with the conditioning model of food cravings and the frequency of consumption manuscript (4\*\*). After controlling for age and BMI, nearly 5% of weight change variance was attributed to food cravings with the

CoEQ. In participants no longer dieting, an association between cravings and body weight was no longer demonstrated. During weight maintenance in the POUNDS Lost manuscript, a similar result was found suggesting food cravings tend to be more tightly correlated with change in body weight during active weight loss. While this study suggests the conclusions of the conditioning theory are pragmatic, further research is needed to confirm the results that utilizes an RCT design.

### **Physical Activity/Inactivity:**

With lifestyle interventions, participants are told to restrict energy consumption and to perform physical activity. It is clear that weight loss results in decreased food cravings but more investigation is needed into physical activity. It is thought that physical activity results in less weight loss than expected due to increased energy intake (9), which may lead to increased food cravings.

Bergouignan et al. found that walking 5 minutes out of every hour reduced food cravings before lunch compared to the continuous sitting intervention using the FCQ (10\*). Using data from the Energy Balance study, Drenowatz et al. discovered that meeting the physical activity recommendations was associated with less frequent craving for savory foods (11). Self-report data suggest that a decrease in the amount of physical activity was associated with an increase in cravings for sweet foods using the CoEQ. However, more resistance training was associated with a reduced likelihood to eat (11). Rocha et al. found that after 12 weeks of supervised aerobic exercise total cravings, and cravings of high-fat foods, fast food fats, and carbohydrates/starches decreased (12\*). Thus, food cravings are not increased with exercise and most studies demonstrate a reduction.

### **Pharmacotherapy:**

Since food cravings are associated with body weight, several obesity drugs have been examined to understand their effect on food cravings. During a weight loss study that incorporated Medifast® meal replacements, participants consuming phentermine lost more weight (~3.3%) with a greater reduction in the fat and sweets subcategories of the FCI (13\*). Lorcaserin (Belviq) (10 mg 2x/daily) with and without phentermine (15 g 1 or 2x/daily) improved food cravings in a dose dependent manner (14\*). Recently semaglutide, a GLP-1 analogue, that is similar to liraglutide was investigated (15\*). It was provided for 12 weeks and decreased hunger and food cravings based on the CoEQ. Liraglutide (Saxenda) and naltrexone and bupropion (Contrave) have demonstrated similar reductions in cravings, thus they may be viable therapeutic targets (16). Importantly, pharmacologic therapies have been shown to decrease cravings.

Recently, Dalton et al. examined the effects of food craving in persons undergoing pharmacotherapy for weight loss (17\*\*). Using the CoEQ, early predictors of weight loss were tested. Craving control was the most significant predictor of BMI slope. Furthermore, craving control was examined by responder and non-responders. By 8 weeks (the first time point tested) there was a significant difference in weight loss between the groups. This continued for 56 weeks. While speculative, craving control may be a potential modifier for

those that are less successful with weight loss during the initial weight loss period (17\*\*). Many obesity drugs reduce cravings, thus are a viable target for those with high cravings trying to lose or maintain weight. However, understanding how the conditioning theory of food cravings and the mechanism(s) of action for food craving reduction with these drugs needs to be further elucidated. Likely, persons are reducing frequency of consumption of craved foods, but this is clearly a critical area of future exploration.

### **Bariatric Surgery:**

Currently, sleeve gastrectomy (SG) and Roux-en-Y-gastic bypass (RYGB) are the most common forms of weight loss surgery. Nance et al. recently examined cravings in patients undergoing SG and RYGB procedures (18\*). They found that both groups had decreased cravings on the high-fat, carbohydrates/starches, sweets, and fast food subscales of the FCI. There were only 8 patients in the SG group so the study was underpowered to examine differences in procedures, but results indicate that both procedures decreased cravings with energy restriction. Cushing et al. performed an elegant statistical analysis on a sample of adolescents that underwent RYGB surgery (19\*\*). Cravings were reduced in a nonlinear trajectory over 24 months. After 18 months, the trajectory flattened. The first 6 months saw the greatest reduction in cravings. Surprisingly, Sudan et al. did not find a similar reduction in cravings (2). There was no change in the FCI. A reduction was found 2 weeks after surgery, but cravings returned to baseline thereafter. This is the only recent study where the conditioning model of food cravings is not validated. This could be an anomaly or it could suggest that surgery evokes different mechanisms of food craving reductions than other targets (i.e. diet).

### **Social Determinants:**

Most food craving research has been concentrated in weight loss studies with relatively homogeneous samples in regard to demographic and socioeconomic characteristics, which is not uncommon among weight loss studies. As reported for POUNDS Lost, the study sample was largely white (79%) and married (70%), had high educational attainment (90% some college or college graduate or beyond) and an annual household income over \$50,000 (75%) (3). These descriptives highlight a sample primarily composed of non-minority, well-educated, high-resource individuals. Given this, secondary analyses of the POUNDS Lost study (4\*\*, 20) provide a somewhat restricted examination of food cravings that largely focuses on socioeconomically advantaged individuals to the exclusion of those who obtain dissimilar demographic and socioeconomic characteristics, i.e., less advantaged and socially vulnerable groups with low income, less education, and fewer resources.

Surveying recent food craving studies does produce some empirical work that has more broadly focused on diverse samples outside of weight loss interventions. Malika and colleagues undertook a qualitative study that focused on the perception and conceptualization of food craving in low-income women, specifically those with less than 4 years of college and who were eligible for federal medical and social assistance (21\*). They concluded that food craving was not viewed aversively in their sample of low-income women and that popular food craving questionnaires and obesity interventions may miss the

target with underserved populations. Standard assessments that frame food craving as problematic and subsequent weight loss treatments that target the resistance of food cravings may not be particularly effective for low-income women.

Chao and colleagues have carried out a number of cross-sectional and prospective analyses using community-based samples to investigate associations between food cravings and multiple nutrition and health indicators, such as body weight, stress, and appetite-related hormones (22–26\*\*). Among their results, compared to those who never smoked, current smokers reported more frequent cravings for high-fat foods and fast-food fats using the FCI, as well as greater consumption of these craved foods (24\*\*). This finding is particularly relevant given the higher prevalence of smoking found in populations with lower socioeconomic status. These studies highlight a need for further research that targets samples of low resource and disadvantaged populations to better understand how food cravings present in these populations and potential associations with diet, body weight, and other health behaviors.

When considering the importance of food craving to diet and weight status, an emergent social determinant of health is food insecurity, which is the lack of sufficient food in both quantity and quality. As noted by Apolzan and colleagues in their analysis of POUNDS Lost data, consumption of food items on a craving inventory is associated with cravings. This finding has specific implications for those who report being food insecure given that food insecurity is often cyclical with episodes of food adequacy and food shortage. Often associated with the receipt of monthly federal food assistance, food insecure persons are thought to experience a ‘feast/famine cycle,’ which is posited to be associated with increased body weight. Thus, food insecure persons with intermittent access to highly palatable, energy dense foods (i.e. increased frequency of consumption) could experience increased food cravings. Moreover, research indicates that food insecure persons report higher levels of binge eating and eating disorder pathology (27), which is important as Chao and colleagues (23\*\*) found that food cravings were associated with binge eating behavior and global eating disorder psychopathology. This confluence of potentially higher food cravings and disordered eating could perturb appetite regulation and body weight maintenance in food insecure individuals.

The implications of the conditioning model of food cravings are far reaching. Specifically, as socioeconomically disadvantaged populations with fewer resources suffer from poorer dietary intake, data is needed to understand the implications for conditioning of food cravings to findings drawn from traditional weight loss samples. More research is warranted to establish how cravings present in low-income and food insecure populations, if the traditional model of conditioning is corroborated in these groups, as well as potential perturbations of food craving and associated disordered eating.

### **Controversies:**

The FCI, which may have the most robust food craving findings, was developed and validated in the southern United States (US). While foods used in this questionnaire are fairly standard, it is unknown if the results translate uniformly across the US. Others have

suggested this hypothesis (25), and it is supported in the recent analysis by Apolzan and colleagues using the POUNDS Lost study, which found that Baton Rouge, LA, had a higher change in food craving with the change in frequency of FCI food item consumption compared with Boston, MA (4). In this case, it is unknown if geographic location or study site could potentially act as a proxy for other important confounding or unmeasured covariates, such as geographic differences in social determinants (e.g., education, income, etc.).

Another issue in the field of food cravings is the lack of consistency among findings. This may be due to the use of different questionnaires, including the FCI, FCQ-S, FCQ-T, and the CoEQ. The NIH has recently made a push for consistency with self-report instruments due to similar reasons and concerns. These aforementioned questionnaires examine different craving constructs, such as state vs. trait cravings, and therefore could produce different results. Standardizing craving questionnaire(s) for trait and state measures would be a positive step in future studies.

## Conclusion:

Food cravings account for 7–11% (1\*, 8\*) of variance in body weight, which is far more than genetics currently explains (28). Food cravings are important to consider when examining body weight outcomes and more research is needed to understand the mechanism(s) underlying this association. Stepwise designs could be utilized to examine early changes in food cravings and body weight and based on these assessments a more targeted study design could be developed to improve weight loss outcomes. Also, increased and/or decreased craved items should be directly consumed to determine if cravings are truly independent of energy content and follow the conditioning model of food cravings. Similar studies should be performed with dietary, pharmacologic, and physical activity interventions to ensure the theory is supported. Lastly, current research has convincingly set the stage for further studies to better elaborate relationships between various social determinants of health (e.g., socioeconomic position and food insecurity) and food craving. Since the field is still in a state of relative infancy, there are a number of topics to be elucidated, but the conditioning model of cravings continues to be supported.

## Acknowledgments:

Financial Support and Sponsorship: Supported in part by U54 GM104940 from the National Institute of General Medical Sciences of the National Institutes of Health, which funds the Louisiana Clinical and Translational Science Center (CAM), and a NORC Center Grant # P30DK072476 entitled “Nutrition and Metabolic Health through the Lifespan” sponsored by NIDDK (CKM). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Papers of particular interest, published within the annual period of review, have been highlighted as:

\* of special interest

\*\* of outstanding interest



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- 4\*\*. Apolzan JW, Myers CA, Champagne CM, Beyl RA, Raynor HA, Anton SA, et al. Frequency of Consuming Foods Predicts Changes in Cravings for Those Foods During Weight Loss: The POUNDS Lost Study. *Obesity (Silver Spring).* 2017;25(8):1343–8. [PubMed: 28618170] This study found that frequency of consuming craved food items is positively associated with cravings but changing the amount of food consumed doesn't seem to alter cravings thereby supporting the conditioning model of food cravings.
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provided all participants with Medifast® meal replacement system while examining the effects of phentermine vs. placebo on food cravings over 12 weeks and found that the Food Craving Inventory (FCI) fat and sweet subscales were reduced in the phentermine vs. placebo group.

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**Key Points:**

- Food cravings influence eating behavior and body weight.
- Food cravings decline during periods of energy restriction, regardless of treatment.
- Little is currently known about potential differences in food cravings owing to social determinants.
- Recent findings suggest that the conditioning model of food cravings continues to be supported.