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Problematic intake of high-sugar/low-fat and high glycemic index foods by bariatric patients is associated with development of post-surgical new onset substance use disorders

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ABSTRACT

Bariatric or weight loss surgery (WLS) patients are overrepresented in substance abuse treatment, constituting about 3% of admissions; about 2/3 of such patients deny problematic substance use prior to WLS. It is important to advance our understanding of the emergence of substance use disorders (SUDs) – particularly the New Onset variant – after WLS. Burgeoning research with both animal models and humans suggests that "food addiction" may play a role in certain forms of obesity, with particular risk conferred by foods high in sugar but low in fat. Therefore, we hypothesized that WLS patients who reported pre-WLS problems with High-Sugar/Low-Fat foods and those high on the glycemic index (GI) would be those most likely to evidence New Onset SUDs after surgery. Secondary data analyses were conducted using a de-identified database from 154 bariatric surgery patients (88% female, $M_{age} = 48.7$ yrs, $SD = 10.8$, $M_{time\ since\ surgery} = 2.7$ yrs, $SD = 2.2$ yrs). Participants who endorsed pre-surgical problems with High-Sugar/Low-Fat foods and High GI foods were at greater risk for New Onset SUD in the post-surgical period. These findings remained significant after controlling for other predictors of post-surgical SUD. Our findings provide evidence for the possibility of addiction transfer among certain bariatric patients.

1. Introduction

An estimated 68.0% of American adults are classified as overweight or obese, including 33.8% classified as obese (Flegal, Carroll, Ogden, & Curtin, 2010). Even more alarming, the prevalence of clinically severe "morbid" obesity is increasing most rapidly, with the most associated serious health complications (Sturm, 2007). Bariatric surgery, or weight loss surgery (WLS), has produced the most effective weight loss outcomes for the morbidly obese, both in terms of significant excess weight loss and long-term weight loss maintenance (Miras & Le Roux, 2010).

Although surgery is certainly effective, some bariatric patients have suboptimal weight loss outcomes, and weight regain occurs over time (Maggard et al., 2005). Moreover, New Onset substance use disorders (SUDs) have been documented after WLS, and some have suggested that bariatric patients may undergo addiction transfer, substituting one form of addiction for another (McFadden, 2010; Reslan, Saules, Greenwald, & Schuh, 2014; Wiedemann, Saules, & Ivezaj, 2013). While we know little about the processes undermining successful weight loss, there remains an even more profound lack of research on post-WLS SUDs.

WLS patients – primarily those who have had the Roux-en-Y bariatric (RYGB) procedure – are overrepresented in SUD treatment programs, constituting roughly 3% of admissions (Ostlund et al., 2013; Saules et al., 2010; Wiedemann et al., 2013). Furthermore, recent reports suggest that roughly two-thirds of post-WLS SUD cases are of the New Onset variant, i.e., with no evidence of pre-surgical SUD (Ivezaj, Saules, & Wiedemann, 2012; Reslan et al., 2014; Wiedemann et al., 2013). To identify risk factors for post-WLS SUD, Reslan et al. (2014) surveyed RYGB patients ($N = 141$) and observed that post-WLS SUD cases had stronger cognitive and behavioral responses to food, providing some support for the theory of behavioral substitution (or "addiction transfer").

Burgeoning evidence suggests that alterations in both alcohol metabolism and gene expression in brain reward pathways (Davis et al., 2013) may be involved, at least for the RYGB procedure. Thanos et al. (2012) demonstrated increased ethanol intake consumption for obese rats following RYGB, and Polston et al. (2013) demonstrated that this effect persists even when alcohol is administered intravenously, thereby ruling out the possibility that alcohol's rewarding effects are necessarily due to altered absorption post-RYGB. Davis et al. (2012) reported that alcohol intake is *attenuated* post-RYGB for alcohol preferring rats, but

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alcohol intake *increases* among initially alcohol non-preferring rats (Davis et al., 2013), suggesting that very different subgroups may exist. Because brain pathways that are activated by natural rewards are also those activated by addictive substances, the concept of "food addiction" warrants empirical study (Avena, Rada, & Hoebel, 2008).

Animal models have demonstrated that, under certain conditions, there is evidence for sugar dependence (Avena et al., 2008). Specifically, High Sugar intake in the absence of a High Fat diet may be the most likely to yield addictive features (Avena, Bocarsly, & Hoebel, 2012). Therefore, we hypothesized that those who find foods with High Sugar but Low Fat problematic pre-WLS would be those most likely to display addiction transfer post-surgery and specifically at greater risk for New Onset SUD.

Another candidate for addictive qualities is the glycemic index (GI), which quantifies blood glucose response after consumption of foods containing carbohydrate (Jenkins et al., 1981). It has been demonstrated that elevations in insulin levels associated with specific food types produce increased hunger and food intake, as well as heightened levels of perceived sweetness (Holt, Brand Miller, & Petocz, 1997). For the present study, consumption of high GI foods was hypothesized to contribute to the addictiveness of food and its potential to transfer into post-WLS SUD.

2. Materials and methods

After gaining IRB approval, secondary data analyses were conducted using a de-identified database from 154 WLS patients (from Ivezaj, 2011). The sample was predominantly White (94.2%) and female (88.4%), with a mean age of 48.7 ($SD \pm 10.8$) and BMI of 32.3 ($SD \pm 6.7$). The majority of patients underwent RYGB (92.9%) and the mean number of years since surgery was 2.7 ($SD \pm 2.2$).

2.1. Measures

The Michigan Assessment Screening Test for Alcohol and Drugs (MAST-AD; Westermeyer, Yargic, & Thuras, 2004) consists of 24 "yes" or "no" questions, and scores of 5 or more indicate probable SUD. Using the MAST-AD cutoff score of 5 or greater, 18.8% of participants met criteria for post-surgical SUD, and 21.4% met pre-WLS SUD criteria. The following four SUD groups were created using a pre- and post-surgery cut-off score of 5: No Problematic Use (66.2% of participants), Recovered (14.9%), Relapsed (6.5%), and New Onset SUD (12.3%).

The Yale Food Addiction Scale (YFAS; Gearhardt, Corbin, & Brownell, 2009) is the current standard for assessing "addiction" to food. The present study utilized the "Problematic Foods" list included in the YFAS to measure pre-surgical problematic food types using retrospective recall.

2.2. Analytic plan

To classify the nutrient content of the 28 problematic foods listed on the YFAS, estimates of per serving grams of fat, sugar, carbohydrates, and milligrams of sodium were retrieved from the United States Department of Agriculture, Agricultural Research Service (2012) based on standard serving sizes outlined by Western Michigan University (WMU). Serving sizes listed by the manufacturer were used in the absence of standards from WMU. Grams were converted to calories, and the percentage of total calories from each specific macronutrient was computed. The percentage of calories from sugar only included added sugars, and the percentage of calories from carbohydrates did not include these added sugars.

Standards devised by the USDA and the National Academy of Science were used to classify foods as "High-Fat" or "High-Sugar." Specifically, a food was classified as "High-Fat" if it contained more than 35% of calories from fat and "High-Sugar" if it contained more than 25% of calories from added sugars (National Academy of Science, Institute of Medicine, 2005; USDA, 2004). If a serving contained at least 5% (120 mg) of the 2400 mg daily recommended value for sodium for adults, it was considered "High-Sodium", assuming that more than one serving would be consumed for these self-reported "problem foods". Lastly, foods that contained more than 55% of calories from added, nonsugar carbohydrates were classified as "High-Carb." Several foods, specifically pizza and hamburgers, which did not meet the formal criteria for "High-Fat" but were within several percentages, were classified as "High-Fat" because participants were primed to conceptualize these foods as "fatty" by the YFAS.

The GI for each food was determined from the Sydney University GI Research Service (2011). Accordingly, a food was classified as Low GI if its GI was <55, Medium GI if it was between 56 and 69, and High GI if it was >70. This classification table is available by request from the first author.

3. Results

Relative to the Non-Users, the New Onset SUD group endorsed more problematic High GI foods ($F(3, 150) = 4.880$, $p = .003$, $\eta^2 = 0.089$) and foods that were High-Sugar/Low-Fat in combination ($F(3, 150) = 3.257$, $p = .023$, $\eta^2 = 0.061$), with medium effect sizes (Cohen, 1988). Notably, endorsement of High-Sugar foods alone did not differ significantly among groups ($F(3,150) = 1.853$, $p = .140$). See Fig. 1 for the breakdown of mean percentage of problem food endorsement, namely High GI or High-Sugar/Low-Fat, for each of the four groups.

All macronutrients significantly associated with SUD classification at the bivariate level (i.e., percentage of High-Sugar/Low-Fat foods ($r = .240$, $p = .003$) and High GI foods ($r = .283$, $p = .000$) endorsed) were entered into a logistic regression model. After controlling for other potential SUD predictors, i.e., family history of SUD and pre-surgical BMI (Ivezaj, 2011), participants were at significantly greater risk for New Onset SUD if they endorsed a higher percentage of problematic High GI foods (OR = 1.027, $p = .019$) or High-Sugar/Low-Fat foods (OR = 1.018, $p = .032$). See Table 1.

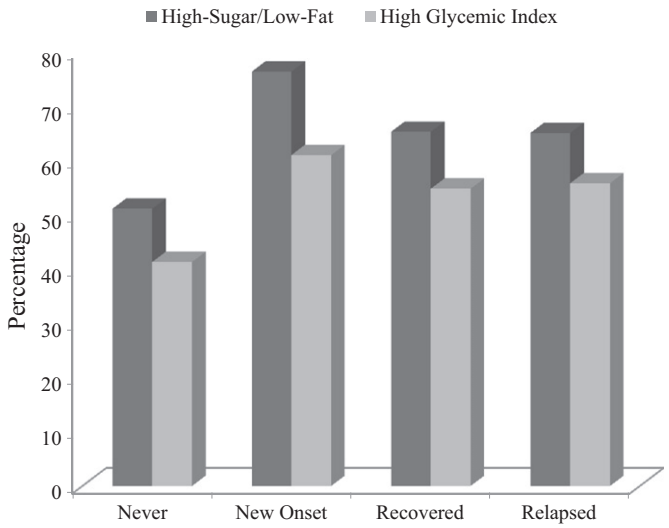

Fig. 1. Mean percentage of High-Sugar/Low-Fat foods and High Glycemic Index foods endorsed as problematic by Never, New Onset, Recovered, and Relapsed SUD groups. *Differences in means are significant at the .01 level. LSD post-hoc multiple comparisons yielded significant differences for Never vs. New Onset groups for High-Sugar/Low-Fat foods ($p = .006$) and for High GI foods ($p = .002$).