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The Significance of Dietary Macronutrients in Diagnosis of Food Addiction

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The authors have no conflicts of interest to declare.

Introduction

Within the Western society, and indeed across all areas of the world, obesity rates are rising at an unprecedented pace. In 2011, it was reported by the Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group that measures of body mass index (BMI) are increasing in men and women from various regions of the globe [1]. According to Statistics Canada’s 2013 *Health Profile*, 52.3% of Canadians are overweight or obese [2]. Obesity has many causes, including genetics, environment, endocrinology, behavior, and nutrition. It is well-documented that overeating and dietary patterns are closely linked to obesity, with different foods have differing impacts on weight. The increased availability of food, along with the transition from traditional foods (rich in nutrients and low in calories) to those rich in fat and sugar has been coined the “westernization” of diet and has been observed in populations across Canada [3].

There is increasing support behind the notion that there are behavioral and neurobiological parallels between overeating and addiction to various drugs, giving rise to the idea of food addiction [4]. This is a fairly new conceptual view of obesity, meaning there is still much research to be done in this area. There has been some evidence found for such an addiction in animal studies, with rats showing behavioral signs of addiction when access to sugar is manipulated [5]. Limited research has been done in human studies to assess what role macronutrients play in terms of the composition of addictive foods. Knowing what kinds of foods are most often involved in compulsive overeating may be critical to understanding the difference between those who classify as food addicted and those who do not. Therefore, it was the purpose of this project to analyze previously collected data from food-addicted individuals and draw any conclusions from patterns of addiction correlated with various macronutrient intake levels. Specifically, this research has examined the correlation between the composition of food-addicted obese people's diets and the clinical symptom counts of food addiction, as described by the Yale Food Addiction Scale.

Methods

This project used data obtained by the lab of Dr. Guang Sun as part of a larger study on food addictions. Data had been previously collected on 771 participants (477 females, 294 males) recruited from the province of Newfoundland & Labrador [6, 7]. Participants were recruited through advertisements, posted flyers, and word of mouth. Inclusion criteria demanded that the participants be at least 19 years old, be born in Newfoundland & Labrador with family who have lived here for at least three generations, be healthy without metabolic, endocrine, or cardiovascular diseases, and not be pregnant. Measurements were taken after a 12-hour fasting period and included body weight, height, and waist/hip circumference. Subjects were classified as overweight/obese if BMI was greater than 25.00, as defined by the WHO criteria. In addition, whole body composition measurements, including fat mass and lean body mass, were obtained using dual-energy X-ray absorptiometry (DXA; Lunar Prodigy; GE Medical Systems), allowing total percent body fat and percent trunk fat to be determined. Other lifestyle data (smoking status, physical activity, etc.) was also collected [6, 7].

A diagnosis of food addiction was made using the Yale Food Addiction Scale (YFAS). The YFAS is a 27-item survey that assesses eating patterns over the past 12 months [8]. It uses the Diagnostic and Statistical Manual IV (DSM-IV) substance dependence criteria to measure eating behavior, assessing factors of food addiction including withdrawal symptoms, loss of control of eating, impact on social/recreational activities, tolerance, etc. The Likert scoring option is used for food addiction symptom counts (such as tolerance and withdrawal), which ranges from 0 to 7 symptoms. The criteria for being classified as food addicted are met when a person has three or more symptoms of the scale and clinically significant impairment or distress is present.

Statistical Analysis

Statistical examination of the participants' diets focused on intake of macronutrients, including carbohydrates, fats, and protein. Data on macronutrient subcomponents was also examined, such as unsaturated/saturated/polyunsaturated fat intake, as well as intake of different kinds of sugars, including glucose, sucrose, fructose, galactose, lactose, and maltose. As previous research indicated fats and carbohydrates to be most implicated in food addiction, data analysis concentrated on these two macronutrients. Partial correlation coefficients were calculated to evaluate the relationship between various measures of dietary macronutrients and clinical symptom counts of obesity. Factors controlled for included age, sex, smoking status, and physical activity. Data trends were also evaluated between sexes, as well as between pre-menopausal and post-menopausal women. All statistical analyses were completed using SPSS version 23. Partial correlation analyses were two-sided and the alpha level was set at 0.05.

Results

Breakdown of Macronutrient Intake

Table 1 shows general data about the dietary intake of macronutrients of the study participants. Most calories were obtained from carbohydrate sources, followed by fat and protein.

Table 1. Breakdown of dietary macronutrient intake of study participants.

	Mean	Std. Deviation	N
Symptom Count	1.39	1.30	771
% of calories from carbohydrates	54.36	8.39	721
% of calories from fats	24.27	7.11	721
% of calories from proteins	18.03	3.87	721
Calories from carbohydrates	1111.50	607.35	721
Calories from fats	501.83	383.25	721
Calories from proteins	364.36	198.31	721
Carbohydrates (g)	282.75	154.08	721
Fat (g)	56.67	42.93	721
Protein (g)	92.62	50.06	721
Sugars (g)	111.99	63.50	721
Sucrose (g)	11.68	7.50	721
Fructose (g)	21.10	17.64	721
Galactose (g)	0.08	0.14	721
Glucose (g)	17.04	13.14	721
Starch (g)	34.99	19.85	721
Saturated fats (g)	18.76	20.90	721
Trans fats (g)	0.07	0.07	721
Trans monoenoic fats (g)	0.01	0.01	721
Trans polyenoic fats (g)	0.0083	0.0085	721
Polyunsaturated fats (g)	10.68	6.34	721
Cholesterol (mg)	256.65	197.00	721
HDL	1.41	0.36	764
LDL	3.05	0.94	764
Maltose (g)	0.57	0.44	721
Monounsaturated fats (g)	21.08	15.09	721
Lactose (g)	9.78	10.72	721
Calories	2044.35	1058.95	721

Correlation Between Symptom Counts of Food Addiction and Macronutrient Intake

Table 2 summarizes the partial correlation coefficients calculated between clinical symptom counts of food addiction and various measurements of fat and protein intake, controlling for age, sex, smoking status, and physical activity. These correlations were calculated for the entire cohort, as well as between sexes and between pre-menopausal and post-menopausal women. As expected, several measures of fat intake were found to be significantly correlated with symptom counts of food addiction, including calories of fat consumed (particularly in postmenopausal women), grams of fat consumed (postmenopausal women), saturated fats (postmenopausal women), trans fats (premenopausal and postmenopausal women), and polyunsaturated fats (premenopausal women). In addition, cholesterol intake was significantly correlated with symptom counts in postmenopausal women. Values relating to protein intake did not significantly correlate with symptom counts. This was expected due to the lack of literature support for protein being implicated in food addiction.

Table 3 summarizes the partial correlation coefficients calculated between clinical symptom counts of food addiction and various measurements of carbohydrate/sugar intake, controlling for age, sex, smoking status, and physical activity. These correlations were calculated for the entire cohort, as well as between sexes and between pre-menopausal and post-menopausal women. Compared to the data for fat intake, carbohydrate intake was less significantly correlated with symptom counts. Values that were significant included maltose and starch intake in premenopausal women.

Table 2. Partial correlation coefficients calculated between clinical symptom counts of food addiction and various measurements of fat and protein intake, controlling for age, sex, smoking status, and physical activity.

Control Variables		Entire Cohort	Males	Females	Premenopausal	Postmenopausal
% of calories from fats	Correlation	.174	.167	.186	.136	.198
	Significance (2-tailed)	.000	.008	.000	.044	.016
% of calories from proteins	Correlation	-.051	-.059	-.059	-.098	.063
	Significance (2-tailed)	.175	.355	.210	.147	.444
Calories from fats	Correlation	.143	.089	.159	.135	.217
	Significance (2-tailed)	.000	.158	.001	.045	.008
Calories from proteins	Correlation	.065	-.023	.090	.070	.173
	Significance (2-tailed)	.086	.720	.056	.300	.035
Fat (g)	Correlation	.143	.089	.160	.136	.218
	Significance (2-tailed)	.000	.162	.001	.044	.008
Protein (g)	Correlation	.064	-.024	.089	.070	.173
	Significance (2-tailed)	.088	.705	.056	.298	.035
Saturated fats (g)	Correlation	.115	.120	.118	.093	.251
	Significance (2-tailed)	.002	.057	.012	.165	.002
Trans fats (g)	Correlation	.147	.066	.190	.273	.283
	Significance (2-tailed)	.000	.294	.000	.000	.000
Trans monoenoic fats (g)	Correlation	-.007	-.013	-.019	-.104	.085
	Significance (2-tailed)	.850	.837	.680	.121	.302
Trans polyenoic fats (g)	Correlation	-.009	-.046	.005	-.109	.113
	Significance (2-tailed)	.809	.467	.923	.105	.169
Monounsaturated fats (g)	Correlation	.148	.081	.173	.155	.194
	Significance (2-tailed)	.000	.203	.000	.021	.018
Polyunsaturated fats (g)	Correlation	.155	.056	.195	.215	.179
	Significance (2-tailed)	.000	.380	.000	.001	.029
Cholesterol (mg)	Correlation	.050	-.028	.084	.033	.246
	Significance (2-tailed)	.184	.659	.073	.628	.003
HDL	Correlation	-.109	-.234	-.076	-.150	.014
	Significance (2-tailed)	.003	.000	.102	.025	.861
LDL	Correlation	.030	-.014	.057	.103	-.048
	Significance (2-tailed)	.425	.829	.225	.124	.555

Table 3. Partial correlation coefficients calculated between clinical symptom counts of food addiction and various measurements of carbohydrate/sugar intake, controlling for age, sex, smoking status, and physical activity.

Control Variables		Entire Cohort	Males	Females	Premenopausal	Postmenopausal
% of calories from carbohydrates	Correlation	-.097	-.083	-.112	-.060	-.148
	Significance (2-tailed)	.010	.190	.017	.377	.072
Calories from carbohydrates	Correlation	.053	-.025	.073	.074	.072
	Significance (2-tailed)	.157	.694	.121	.271	.380
Carbohydrates (g)	Correlation	.053	-.026	.073	.075	.073
	Significance (2-tailed)	.158	.678	.119	.264	.377
Sugars (g)	Correlation	.073	-.032	.109	.110	.103
	Significance (2-tailed)	.052	.618	.019	.104	.209
Sucrose (g)	Correlation	-.022	-.086	.004	-.005	.059
	Significance (2-tailed)	.555	.176	.927	.947	.478
Fructose (g)	Correlation	.036	-.008	.071	.052	.118
	Significance (2-tailed)	.335	.900	.130	.442	.150
Galactose (g)	Correlation	-.022	-.061	-.002	-.019	.084
	Significance (2-tailed)	.559	.337	.960	.779	.309
Glucose (g)	Correlation	.048	-.001	.085	.075	.128
	Significance (2-tailed)	.205	.985	.068	.266	.121
Lactose (g)	Correlation	-.043	-.079	-.032	-.019	-.131
	Significance (2-tailed)	.253	.211	.492	.778	.111
Maltose (g)	Correlation	.128	.051	.163	.243	.051
	Significance (2-tailed)	.001	.422	.000	.000	.534
Starch (g)	Correlation	.153	.094	.175	.252	.049
	Significance (2-tailed)	.000	.137	.000	.000	.549

Discussion/Conclusion

In general, there was more support for a correlation between clinical symptom counts of food addiction and dietary fat content, as opposed to carbohydrate content. Protein content showed no correlation to symptom counts. The measures of fat intake found to be significantly correlated included calories of fat consumed, grams of fat consumed, saturated fats, trans fats, and polyunsaturated fats, with cholesterol intake also being significantly correlated. The support for carbohydrates included correlations between symptom counts and intake of starch and maltose.

These results somewhat mirror current literature in food addictions. Across multiple studies, intake of fats has consistently been found to be implicated in the likelihood of being food addicted [6,7,9-11]. As found previously by our lab, when the diets of obese subjects were compared between those who were food addicted and those who weren't, the diet of food-addicted obese subjects contained a higher percentage of calories from fats, with the food-addicted obese taking in more fat per kilogram of body weight than their non-addicted counterparts [6,7]. In addition, just as total carbohydrate and sugar intake was not found to be strongly correlated to food addiction symptom counts in our current analysis, Pursey *et al.* have reported dietary intake of total carbohydrates and sugars to not be significantly associated with food addiction diagnosis [10]. This may show that there is not a clear-cut consensus on the role of carbohydrates in their contribution to food addiction.

Studies examining food cravings have provided an in-depth look at which specific foods were often rated by participants as problematic. Foods that were rated as most addictive were often high in both fat and carbohydrate content, as shown in a Turkish study of children/adolescents that listed their top five addictive foods as chocolate (70%), carbonated beverages (59%), ice cream (58%), French fries (57%) and white bread (55%) [12]. Another study, consisting of 120 undergraduate student participants at the University of Michigan, focused on processed foods and foods with a high glycemic load [11]. The top five addictive foods listed through this study were chocolate, ice cream, French fries, pizza, and cookies, with the top 13 listed foods all being processed. The authors attribute this to both added fats and refined carbohydrates, and concluded that level of processing was a large, positive predictor for the likelihood that a food would be associated with "addictive-like eating problems". Glycemic load of the foods, which is a measure of how quickly a spike in blood sugar occurs after consumption, was also a large, positive predictor for whether a food was associated with addictive-like eating. Interestingly, it was found to be more predicative than sugar or net carbohydrate content, suggesting that the rate of absorption of energy into the body may be important in food addiction.

It is worth noting that the correlations between macronutrient intake values and symptom counts were significant in female study participants, as opposed to males. This may indicate that macronutrient intake and food addiction are more closely correlated in females than males. It may also be related to the fact that an overwhelming majority of current food addiction studies show a significantly higher number of female food-addicted participants than male, with some exclusively containing female subjects (as discovered in a recent literature review I have performed). This may be due to a selection bias of some sort, or food addictions may simply be more present in the female population. However, this cannot be claimed without further including males as participants, which future studies should endeavour to do.

In summary, literature examining the role of macronutrients in food addiction is scarce. Food addictions are a relatively new concept that have not gained much attention until recent years. Nonetheless, it is fairly well-proven that foods high in fat and sugar are most problematic, their consumption being associated with higher likelihood of food addiction diagnosis through the YFAS. Future studies should address whether it is the levels of macronutrients or the glycemic load which is most implicated in food addictions.

Funding Statement

This study was funded by a CIHR operating grant and CFI equipment grant to Dr. Guang Sun. The funders had no role in study design, data collection, associated publications, or preparation of this manuscript.

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