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Yogurt Consumption: Influence of Body Mass Index and Dietary Restraint - Cross-Sectional Analysis of the Infogene Study

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Received Date: March 25, 2016, **Accepted Date:** April 26, 2016, **Published Date:** May 09, 2016.

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Abstract

Background: Factors such as dietary restraint and the avoidance for fattening foods could possibly guide consumer towards yogurts with a smaller milk fat percentage (% MF). However, a growing body of evidence has linked high-fat dairy food intakes with a lower prevalence of obesity thus showing divergences with the actual dietary guidelines.

Aim: The objective of the present study was to determine whether dietary restraint and the avoidance for fattening foods moderated the relationship between body mass index (BMI) and the preference for fat-free, low-fat or high-fat yogurts.

Methods: A 91-items food frequency questionnaire was administered to 664 subjects from the INFOGENE study. Yogurt consumption was evaluated based on their fat content. Restrained eating and the avoidance for fattening foods were valuated using the three-factor eating questionnaire.

Results: An interaction was observed between BMI and the dietary restraint status ($p = 0.02$). Positive correlations were observed between the score of dietary restraint, the score of the avoidance for fattening foods and fat-free yogurt consumption, independently of the BMI status. When groups were stratified according to the median of the score for the avoidance for fattening foods, lean individuals with the highest scores consumed less fat-free yogurt than overweight/obese individuals with the highest scores and more high-fat yogurt. Moreover, when groups were stratified according to the dietary restraint score allowing the dichotomization of restrained and unrestrained eaters, unrestrained and lean individuals consumed significantly more high-fat yogurts (in daily servings) than restrained and lean individuals and overweight/obese individuals.

Conclusion: Preferences and consumption of a particular type of yogurt with different % MF may vary depending on behavioral factors such as dietary restraint and the avoidance for fattening foods.

Keywords: Yogurt; Body Mass Index; Dietary Restraint; Behavioral Factors

List of Abbreviations

% MF: Milk Fat Percentage; BMI: Body Mass Index; TFEQ: Three-Factor Eating Questionnaire; FFQ: Food Frequency Questionnaire; GLM: General Linear Model.

Introduction

Each day, consumers are tackled with several decisions related to nutrition, thus directly impacting on macro and micronutrient intakes. These decisions are driven in part by internal cues such as hunger and satiety, but also by cognitive behavioral factors such as dietary restraint, disinhibition and the avoidance for fattening foods.

Over the last decade, yogurt food supply has widened. According to Johansen, et al. [1], the most important drivers for choosing calorie-reduced dairy products such as yogurt are: 1) the fat content, 2) healthiness, 3) tastiness, 4) weight management and 5) nutrition [2].

The milk fat percentage (% MF) of yogurts goes from 0% MF to more than 11%. Still, yogurt is considered a low-fat and healthy product. However, a growing body of evidence has linked high-fat dairy food intakes with a lower prevalence of obesity [3-6]. Indeed, overall yogurt consumption may be associated with lower values of adiposity in addition to decreased fasting plasma triglyceride and insulin levels in healthy individuals [3,4,7,8].

According to Paquette [9], who reviewed the literature on the perceptions of healthy eating over the last 20 years, the public's perceptions of healthy eating seem to be heavily influenced by dietary guidance, which recommends vegetables and fruits, meat, limitations of fat and salt, variety and moderation. Moreover, the recommendations of Canada's food guide are to select lower fat milk alternatives and to compare the Nutrition Facts table on yogurts or cheeses to make wise choices, which are to choose products that contain less fat, saturated fat, trans fat, sugar and sodium [10].

In a recent study, we have reported that lean individuals had more daily servings of high-fat yogurt and less daily servings of fat-free yogurt compared to overweight/obese individuals [8]. Furthermore, no significant differences were reported between lean and overweight/obese individuals in the low-fat yogurt subcategory, thus strengthening the presence of a dichotomy between fattening foods even within the same product category. Behavioral factors such as restraint and disinhibition may drive consumers towards lower-fat alternative foods.

The objective of the present study was to determine whether dietary restraint and the avoidance for fattening foods moderated the relationship between body mass index (BMI) and the preference for fat-free, low-fat or high-fat yogurts.

Based on these previous findings [8], we hypothesized that dietary restraint and the avoidance for fattening foods scores are associated to yogurt consumption and that these associations moderate the relationship between BMI and the preference for fat-free, low-fat or high-fat yogurts. More specifically, we hypothesized that restrained eaters consume more daily servings of fat-free yogurts and that this association is stronger in overweight/obese individuals than in lean individuals.

Methods

Study design

The complete study design has been previously reported [8]. Briefly, 664 unrelated subjects from the Quebec City metropolitan

area were recruited between May 2004 and April 2006. Subjects had to be aged between 18 and 55 years. All study participants completed a questionnaire on socio-demographic characteristics, a three-factor eating questionnaire (TFEQ) and a validated food frequency questionnaire (FFQ) administered by a registered dietitian [11]. Data obtained from FFQ were analyzed using the Nutrition Data System for Research software v.2011, developed by the Nutrition Coordination Center (University of Minnesota, Minneapolis, MN). Yogurt consumption was divided into three categories on the basis of their milk fat percentage (% MF): fat-free yogurt (0% MF); low-fat yogurt < 2% MF); and high-fat yogurt (≥ 2% MF). Individuals who have consumed yogurt according to the validated FFQ data were classified as "consumers of yogurt", and those reporting no consumption of yogurt were classified as "non-consumers of yogurt". Finally, we excluded non-consumers of yogurt, thus bringing the cohort down to 564 individuals. The Ethics Committee of Laval University has approved the study.

Three-factor eating questionnaire

The TFEQ is a 51-item questionnaire widely used to quantify three different concepts capturing internal cues that could possibly affect food intake such as dietary restrain, disinhibition, and hunger. Participants having a dietary restraint score higher than 11 were classified as restrained eaters. Under TFEQ's dietary restraint section, one specific item was evaluating the avoidance for fattening foods. We then grouped participants according to the median score, thus leading to two categories: (a) Low scores of avoidance of fattening foods and (b) High scores of avoidance of fattening foods. The dietary restraint score was available for 560 subjects.

Statistical analysis

Data were analyzed with SAS statistical software V9.2 (SAS Institute, Cary, NC, USA). Normal distribution was evaluated using the box-plot, as well as skewness and kurtosis ranges. When needed, variables non-normally distributed were $\log_{10}$-transformed. Statistical analyses were performed on 564 individuals from the INFOGENE study. Only consumers of yogurt were retained for statistical analysis. The General Linear Model (GLM) procedure with the type-III sum of squares (for unbalanced study design) was used and confounding factors such as age, sex, BMI or energy intake were included in the model. Analyses were stratified on the basis of BMI status (lean individuals (BMI < 25 kg/m^2) vs. overweight/obese individuals (BMI ≥ 25 kg/m^2)) and on a pre-established cut-off of the dietary restraint score or the median of the avoidance for fattening foods score. Pearson correlations with partials for age, sex, BMI and/or total energy intake were used to show correlations between yogurt consumption and TFEQ's behavioral factors. Statistical significance was defined as $p \leq 0.05$.

Results

Characteristics of the study participants have been previously reported [8]. Briefly, 564 individuals were yogurt consumers (211 lean individuals and 353 overweight/obese individuals). The mean consumption of yogurt was 0.47 ± 0.48 servings/day and restrained eaters ate significantly more servings of yogurt compared to unrestrained eaters (Table 1). As shown in Table 1, more women were considered as restrained eaters when compared to men ($p < 0.0001$).

As shown in Figure 1, a significant interaction ($p = 0.02$) was observed between BMI as a continuous variable and the dietary restraint status (restrained eaters vs. unrestrained eaters) thus moderated total yogurt consumption expressed as daily servings. As shown in Table 2, there was no difference in total daily energy and fat intakes between lean and overweight/obese individuals.

Parameter	Total cohort	Restrained eaters	Unrestrained eaters	*p-value*
	Mean ± SD	Mean ± SD	Mean ± SD	
Age, years[1]	37.7 ± 11.3	40.4 ± 11.2	36.0 ± 11.2	< 0.0001
Yogurt consumption[2]				
Daily servings (175 g)	0.47 ± 0.48	0.63 ± 0.50	0.50 ± 0.44	0.02
	n (%)			
Sex[3]				
Men	219 (38.8)	59 (10.5)	158 (28.2)	< 0. 0001
Women	345 (61.2)	154 (27.5)	189 (33.8)	
Education[3]				
High School	65 (11.6)	29 (5.2)	36 (6.4)	0.22
College	186 (33.0)	62 (11.1)	123 (22.0)	
University	312 (55.4)	122 (21.8)	187 (33.5)	
Matrimonial status[3]				
Single	219 (38.9)	70 (12.5)	149 (26.7)	0.05
Married/Common law	297 (52.7)	120 (21.5)	173 (31.0)	
Divorced/Separated/Widowed	47 (8.4)	22 (3.9)	25 (4.5)	
Personal income[3]				
< $12,000	136 (24.4)	42 (7.6)	93 (16.8)	0.28
$12 000 to < $20,000	65 (11.7)	28 (5.1)	36 (6.5)	
$20 000 to < $30,000	56 (10.1)	18 (3.3)	38 (6.9)	
$30 000 to < $40,000	111 (19.9)	45 (8.1)	65 (11.8)	
$40 000 to < $50,000	63 (11.3)	23 (4.2)	40 (7.2)	
$50,000 and above	126 (22.6)	54 (9.8)	71 (12.8)	

1. *p-values* were obtained using the unadjusted GLM procedure.
2. *p-values* were obtained using the GLM procedure adjusted for the effects of age and sex
3. *p-values* were obtained using a chi-square test

Table 1: Subjects' characteristics of the INFOGENE study (n = 564)

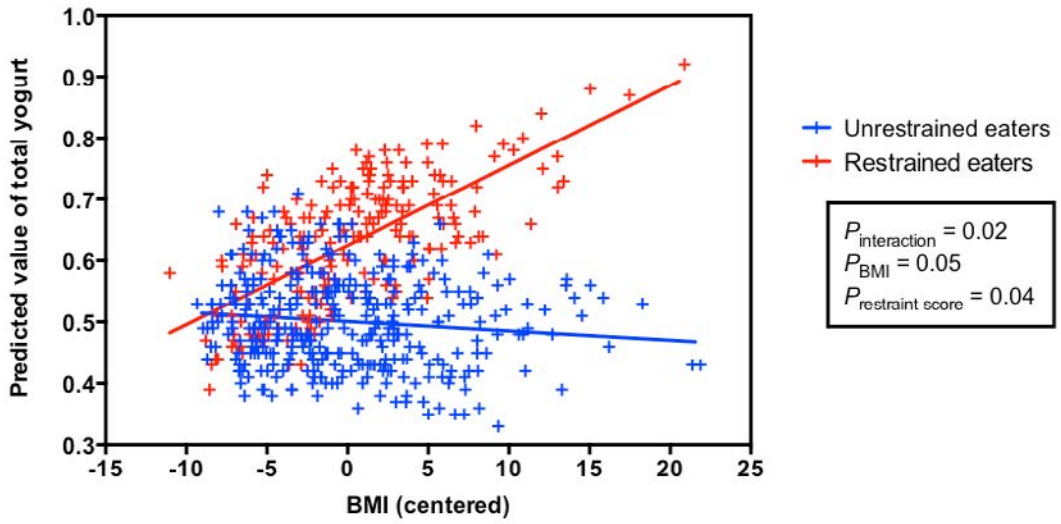

Figure 1: Interaction between BMI and dietary restraint on total yogurt consumption (in servings/day)

		Total cohort (n = 564)	Lean Individuals (n = 211)	Overweight/Obese Individuals (n = 353)	*p-value*[2]
		Mean[1] ± SD	Mean[1] ± SD	Mean[1] ± SD	
Energy	kcal	2440 ± 700	2394 ± 714	2467 ± 691	0.65
Total daily fat intake	g	90.6 ± 32.9	87.4 ± 34.3	92.5 ± 32.0	0.18
	% of TEI	33.1 ± 5.3	32.4 ± 5.4	33.5 ± 5.2	0.06
Fat intake from yogurt	g	1.3 ± 1.9	1.5 ± 2.1	1.1 ± 1.8	0.01
	% of TEI	0.47 ± 0.16	0.55 ± 0.76	0.43 ± 0.70	0.02
	% of Total fat	1.49 ± 0.51	1.66 ± 2.50	1.05 ± 1.59	0.009

TEI: Total Energy Intake
1. Unadjusted means
2. ANOVA adjusted for sex, age and TEI (for variables expressed in g) and are adjusted for sex and age (for variables expressed in % of TEI). The *p-value* indicates significant differences between lean individuals and overweight/obese individuals using the Type-III sum of squares for the "Obesity" variable included in the statistical model

Table 2: Differences in energy and fat intakes (total and from yogurt) between lean and overweight/obese individuals

		Total cohort[1] (n = 560)	Lean Individuals[2] (n = 209)	Overweight/Obese individuals[2] (n = 351)
Dietary restraint	Free-fat yogurt	R = 0.2840 *p < 0.0001*	R = 0.2936 *p < 0.0001*	R = 0.2745 *p < 0.0001*
	Low-fat yogurt	NS	NS	NS
	High-fat yogurt	R = -0.1286 *p = 0.002*	NS	R = -0.1320 *p = 0.01*
Avoidance for fattening foods	Free-fat yogurt	R = 0.2912 *p < 0.0001*	R = 0.2443 *p = 0.004*	R = 0.3058 *p < 0.0001*
	Low-fat yogurt	NS	NS	NS
	High-fat yogurt	R = -0.1252 *p = 0.003*	NS	R = -0.1544 *p = 0.004*

NS stands for "Non-Significant"
1. *p-values* were obtained using the Pearson correlation procedure with partial for age, sex, BMI and total energy intake
2. *p-values* were obtained using the Pearson correlation procedure with partial for age, sex and total energy intake

Table 3: Correlations of dietary restraint and avoidance of fattening foods with yogurt consumption according to fat content stratified by BMI status

However, lean individuals had significantly more fat (g/d (*p = 0.01*), % of TEI (*p = 0.02*) and % of total fat intake (*p = 0.009*)) coming from yogurt than overweight/obese individuals.

Table 3 shows positive correlations between the dietary restraint and the avoidance for fattening food scores and fat-free yogurt consumption in the total cohort, in lean individuals as well as in overweight obese individuals. For high-fat yogurt consumption, significant negative correlations were observed only in overweight/obese individuals, but not in lean individuals (Dietary restraint: r = -0.13, *p= 0.01*; Avoidance for fattening foods: r = -0.15, *p = 0.004*).

As shown in Table 4, when groups were stratified by BMI and at the median of the avoidance for fattening foods score, lean

	Lean Individuals (n = 209)		Overweight/Obese Individuals (n = 351)		
Avoidance for fattening foods	**Low Score (n = 133)**	**High Score (n = 76)**	**Low Score (n = 175)**	**High Score (n = 176)**	***p-value*[1]**
Fat-Free Yogurt (daily servings)	0.14 ± 0.24	0.30 ± 0.44	0.21 ± 0.38	0.43 ± 0.51	< 0.0001
Low-Fat Yogurt (daily servings)	0.13 ± 0.26	0.10 ± 0.24	0.12 ± 0.27	0.14 ± 0.35	0.31
High-Fat Yogurt (daily servings)	0.19 ± 0.36	0.19 ± 0.38	0. 15 ± 0.32	0.09 ± 0.32	0.0001
Dietary restraint	**Unrestrained Eaters (n = 136)**	**Restrained Eaters (n = 73)**	**Unrestrained Eaters (n = 211)**	**Restrained Eaters (n = 140)**	***p-value***
Fat-Free Yogurt (daily servings)	0.15 ± 0.32	0.30 ± 0.35	0.25 ± 0.40	0.43 ± 0.52	< 0.0001
Low-Fat Yogurt (daily servings)	0.13 ± 0.25	0.10 ± 0.26	0.13 ± 0.28	0.13 ± 0.35	0.27
High-Fat Yogurt (daily servings)	0.22 ± 0.38	0.13 ± 0.32	0.12 ± 0.29	0.12 ± 0.35	0.0002

1. *p-values* were obtained using the GLM procedure adjusted for age and sex and between groups comparisons were made using the least squares means procedure in SAS statistical software. Results are significantly different from each other if they do not share the same letter.
Grouping was based according to median of the score for the avoidance for fattening foods and using a cut-off of 11 for the restraint score.

Table 4: Comparisons of yogurt consumption (in daily servings) in individuals stratified by BMI and TFEQ outcomes

individuals with the highest scores consumed less fat-free yogurt than overweight/obese individuals with the highest scores (0.30 ± 0.44 servings/day vs. 0.43 ± 0.51 servings/d, $p < 0.0001$) and more high-fat yogurt (0.19 ± 0.38 servings/day vs 0.09 ± 0.32 servings/day, $p = 0.0001$).

Moreover, when groups were stratified by BMI and as restrained or unrestrained eaters, lean unrestrained eaters consumed significantly less fat-free yogurt than lean restrained eaters and overweight/obese individuals. Overweight/obese restrained eaters consumed significantly more daily servings of fat-free yogurt than overweight/obese unrestrained eaters (0.43 ± 0.52 servings/day vs. 0.25 ± 0.40 servings/day, $p = 0.0001$). For high-fat yogurts, lean unrestrained eaters consumed significantly more daily servings than any other groups (Table 4).

Discussion

This study aimed at determining whether dietary restraint moderated the relationship between BMI and the preference for fat-free, low-fat or high-fat yogurts. The rationale behind looking at the studied population stratified according to BMI was coming from previous results from our laboratory showing that there was a difference in yogurt consumption with different % MF in lean vs. overweight/obese individuals [8].

In the present study, there was no difference in dietary restraint between lean and overweight/obese individuals as measured by TFEQ's restraint score. The inconsistent association between restraint and BMI status could be partly explained by the fact that increased dietary restraint has been associated with increased disinhibition [12,13], just as our findings revealed (data not shown). However, significant correlations with the restraint score and yogurt consumption (categorized by their fat content) were observed in the total cohort, in lean and in overweight/obese individuals, suggesting that restraint may modulate yogurt intake along with the % MF chosen by an individual. Nevertheless, Lahteenmaki, et al [14], have shown that yogurt consumption was independent of dieters' dietary restraint score, while consumption of high-fat dairy products such as cheese and butter decreased with higher dietary restraint scores.

Yogurt consumption is often associated with a reduced body weight. A study from Mozaffarian, et al. [3], on three large cohorts of participants revealed that yogurt was associated with the greatest weight loss over a four year follow-up period. In this study, total yogurt consumption was evaluated and it was not broken down according to the total fat content. It seems that lipid intake from yogurt may exert beneficial effects on weight management. In accordance, consumption of high-fat yogurt was associated with changes in waist circumference and higher probability for reversion of abdominal obesity in an elderly population in the PREDIMED study [15]. Also, Martinez-Gonzalez, et al. [6], has shown that high consumption of total and high-fat yogurt was associated with a lower risk of overweight/obesity. Based on this knowledge, the fat content of yogurt becomes interesting in the context of obesity as it highlights the low-fat paradigm. But, dietary choices could be driven by cognitive behavioral factors such as dietary restraint, disinhibition and the avoidance for fattening foods, thus affecting an individual's choice towards low-fat or high-fat products.

Cavanagh, et al. [16], have shown that labeling foods as low calorie may create a halo effect, which may lead to over consumption of these foods in restrained eaters. There are possible drifts regarding desirable behaviors observed in overweight/obese individuals and particularly in restrained eaters when choosing a particular type of yogurt with different % MF or labeled as fat-free or low-fat. As shown in Table 4, lean individuals having a low restraint score consumed significantly more high-fat yogurts and less fat-free yogurts than the other groups while overweight/obese individuals with a high restraint score consumed less high-fat yogurts and more fat-free yogurts. The same tendency was observed with the avoidance for fattening foods sub-question. We thus observed an interaction of the BMI and the restraint behavior. According to Tuschl RJ, et al., [17] restrained eaters showed a strong tendency to avoid fat, to consume artificial sweeteners (often found in low-fat yogurts) and to choose calorie-reduced foods. In accordance with findings from the present study (Table 4), Tuschl RJ, et al., [17] have shown that when dairy products are broken down according to their fat content, restrained and unrestrained eaters did not differ in their consumption of medium-fat products, but restrained eaters selected defatted products twice as often as did unrestrained subjects, whereas the opposite was true for high-fat products. In addition, Hoefling A, et al. [18], have shown that restrained eaters' attitudes towards palatable foods, often referred to as high-fat food products, is less optimistic than that of unrestrained eaters because their attitudes also reflect the conflict between palatable foods and their goal of dieting and choosing low-fat products. In addition, Cavanagh, et al. [16], have shown that restrained eaters are focused on reducing the amount of fat and calories they consume, rather than the healthfulness of their snack, possibly leading to a larger proportion of low-fat or fat-free products, including yogurt, in their typical diet. Moreover, in addition to calories, Kruja [19], has shown that fat content is thought to affect restrained eaters' intake by interacting with dieting status to influence food perception.

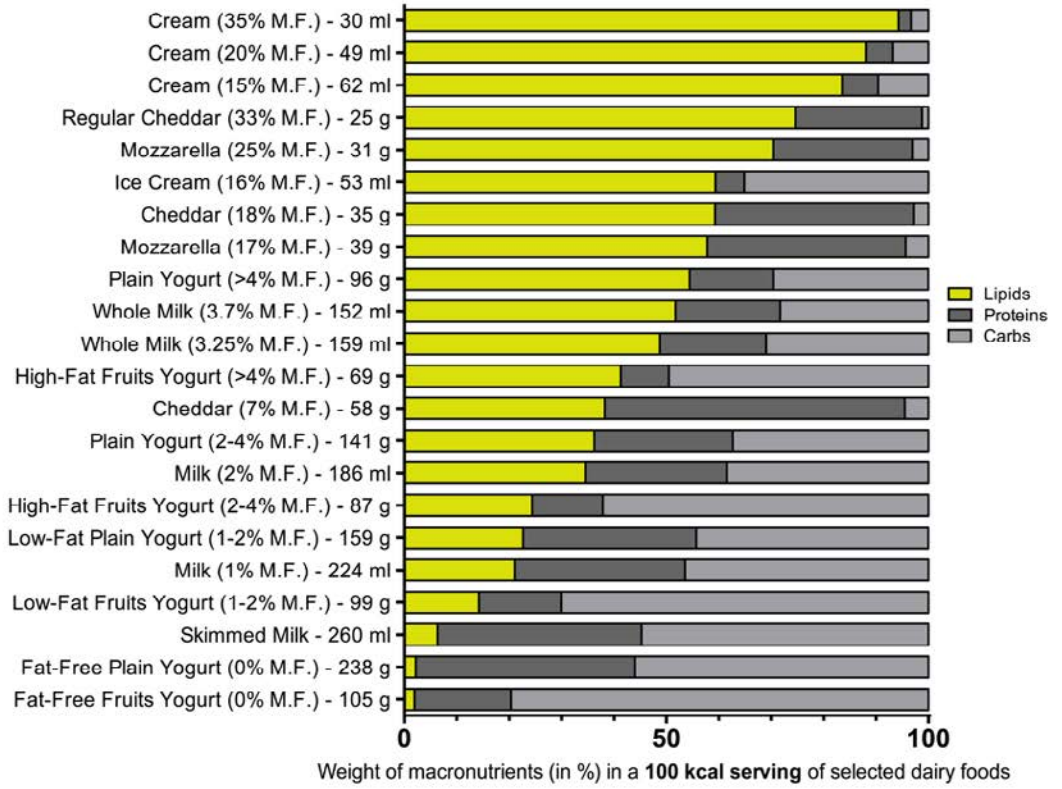

Figure 2: Relative fat content for a range of dairy products based on a 100 kcal serving size

However, for yogurt, the classification of "high-fat" vs. "low fat" is arbitrary, and the fat content remains low compared to other dairy products such as cheese, butter or cream. Figure 2 shows the relative fat content for a range of dairy products based on a 100 kcal serving size. Along with milk, all types of yogurt offer a relatively smaller proportion of lipids in line with bigger serving sizes. By taking into account the low energy density of yogurt and its complex food matrix (proteins, bioactive peptides, calcium, vitamin D, and branched-chain amino acids), yogurt consumption should be encouraged, independently of the fat content.

The population often perceives yogurt as a nutritious food choice. Indeed, Darmon, et al. [20], categorized foods based on their nutrient profiles and yogurt was included in the "Class 1" category, referring to the healthiest food choices alongside with fruits and vegetable. As we previously reported [8], yogurt (all types, independently of their fat content) is a contributor to the Prudent dietary pattern altogether with vegetables, fruits, nuts, non-hydrogenated fats, legumes, fish and other seafood.

In the present study, even if overweight/obese individuals consumed more daily servings of fat-free yogurts, thus resulting in significant smaller fat intakes from yogurt, there was no difference observed in daily fat intakes compared to lean individuals. However, when stratified on the basis of dietary restraint, significantly smaller daily fat intakes were observed in restrained eaters, independently of their BMI status (data not shown). These results highlight the low-fat paradigm and perceived deprivation commonly observed in restrained eaters. Restrained eaters are more likely to experience perceived deprivation because they sometimes avoid eating the amount of food, or the types of food, such as high-fat food products, they would like to eat [21]. Lowe, et al. [22], described this phenomenon as perceived deprivation (or namely hedonic hunger) that consists of eating less than wanted rather than less than needed. Succinctly, Markowitz, et al. [23], found that, in normal weight individuals, the relationship between perceived deprivations with restraint was due to perceived limits on what type of food was eaten rather than how much food was eaten. These findings are highly relevant in the context of yogurt consumption, because yogurt is perceived as an overall healthy food, but people still have to choose yogurt on the basis of their fat and/or sugar content.

Conclusions

Preferences and consumption of a particular type of yogurt with different % MF may vary depending on behavioral factors such as dietary restraint and the avoidance for fattening foods. There is an interaction between dietary restraint and the BMI thus influencing yogurt consumption. Restrained eaters are often trying to resist against appetitive drives, and more specifically in overweight/obese restrained eaters. Restrained eaters will preferentially choose fat-free yogurts, even in lean individuals. This choice remains questionable, as there is no difference in total daily fat intakes between lean individuals and overweight/obese individuals, but this result seems to contribute to food preferences and may be driven by the halo effect of fat-free yogurts. This may be part of their strategies to manage their body weight.

Acknowledgments

We express our gratitude to the participants involved in the study for their time and involvement. We thank Marie-Eve Bouchard, Steve Amireault, Diane Drolet, and Dominique Beaulieu for their collaboration in the recruitment of the participants, the study coordination and data collection. Hubert Cormier is the recipient of the Frederick Banting and Charles Best Canada Graduate Scholarships Doctoral Awards from the Canadian Institutes of Health Research (CIHR). Angelo Tremblay holds a Canada Research Chair in Environment and Energy Balance. Marie-

Claude Vohl holds a Canada Research Chair in Genomics Applied to Nutrition and Health.

Authors' Contributions to Manuscript

Hubert Cormier and Alexandra Laliberte wrote the paper. Marie-Claude Vohl designed research. Louis Perusse, Alexandra Laliberte, and Marie-Claude Vohl provided essential materials. Hubert Cormier performed statistical analysis. Hubert Cormier analyzed data. Hubert Cormier and Marie-Claude Vohl had primary responsibility for final content. All authors have read and approved the final manuscript.

Conflict of Interest and Funding Disclosure

All authors are independent from funders. On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Received Date: March 25, 2016, **Accepted Date:** April 26, 2016, **Published Date:** May 09, 2016.

Citation: Cormier H, Laliberté A, Tremblay A, Pérusse L, and Vohl MC (2016) Yogurt Consumption: Influence of Body Mass Index and Dietary Restraint - Cross-Sectional Analysis of the INFOGENE Study. J Food Nutri Diete 1(2): 106.