Associations between eating patterns, dietary intakes and eating behaviors in premenopausal overweight women

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Word counts: text only: 2121 words; abstract: 224 words
Number of tables: 2

This research project was supported by the Canadian Institutes of Health Research (MOP-64226) and Danone Institute.

Abbreviations: Body mass index (BMI); Three-Factor Eating Questionnaire (TFEQ).

Abstract

The regulation of energy intake is complex and many biological, psychosocial and environmental influences have been identified. To our knowledge, no study has yet investigated how eating patterns could mediate associations between eating behaviors and self-reported energy intake in premenopausal overweight women. Therefore, objectives of this study were to examine associations between eating behaviors and eating patterns in premenopausal overweight women and to test if

Eat Behav. 2012 Apr;13(2):162-5. doi: 10.1016/j.eatbeh.2011.12.002.
PMID: 22365804

eating patterns could mediate the associations between eating behaviors and self-reported energy intake. Women completed a 3-day food record and the Three-Factor Eating Questionnaire was used to assess eating behaviors (dietary restraint, disinhibition, hunger). In the total sample of women, flexible restraint was negatively (r= -0.18; p=0.03) and binge eating severity was positively (r=0.24; p=0.004) associated with self-reported energy intake. Moreover, flexible restraint was positively associated with the proportion of energy intake at breakfast (r=0.24; p=0.004), whereas disinhibition and binge eating severity were positively associated with the proportion of energy intake from snacks consumed after 5:00 pm (r=0.22, p=0.007 and r=0.22, p=0.01, respectively). In addition, mediational analyses showed that proportion of energy intake from snacks consumed after 5:00 pm explained 24.1% of the association between binge eating severity and self-reported energy intake. In conclusion, these results suggest that eating patterns are important factors to consider in order to explain the associations between eating behaviors and self-reported energy intake.
Keywords : Eating behaviors, eating patterns, dietary intakes, body weight.

1. Introduction

Several studies have demonstrated that eating behaviors, more precisely dietary restraint and disinhibition, are associated with energy intake and adiposity (Fedoroff, Polivy, & Herman, 1997; Provencher, Drapeau, Tremblay, Despres, & Lemieux, 2003). Previous studies reported that dietary restraint, more specifically flexible restraint (defined as a gradual approach to eating, dieting, and weight) (Westenhoefer, Stunkard, & Pudel, 1999), is associated with a decrease in energy intake and body mass index (BMI) (Fedoroff, Polivy, & Herman, 1997; Le Barzic, 2001). Inversely, disinhibition has been associated with an increase in energy intake and BMI (Le Barzic, 2001). Eating patterns refers broadly to occasions of eating and the context of eating occasions (de Castro, 2009). Recent studies found that eating patterns could be associated with energy intake (de Castro, 2004) and others suggested that eating patterns might influence body weight (Fabry, Hejl, Fodor, Braun, & Zvolankova, 1964; Keim, Van Loan, Horn, Barbieri, & Mayclin, 1997).

Accordingly, we have reasons to hypothesize that the association between eating behaviors and energy intake is partly explained by specific eating patterns. To our knowledge, no study has yet investigated associations between eating behaviors and eating patterns, and how eating patterns could mediate associations between eating behaviors and self-reported energy intake in premenopausal overweight women. The first objective of this study was therefore to examine associations between eating behaviors and eating patterns in overweight women. As a second objective, we tested if eating patterns could mediate the associations between eating behaviors and self-reported energy intake.

2. Methods

2.1 Participants

This study was conducted among 143 premenopausal overweight or obese women. Inclusion and exclusion criteria have been previously reported (Provencher et al., 2007). Women who participated in the present study were recruited between September 2003 and January 2005, as previously described (Provencher et al., 2007). Women were tested during the follicular phase of their menstrual cycle to control for potential impact of hormonal variation on dietary variables. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Laval University Research Ethics Committee. Written informed consent was obtained from all women prior to their participation in the study.

2.2 Eating Behaviors

The Three-Factor Eating Questionnaire (TFEQ) is a 51-item validated questionnaire (Stunkard & Messick, 1985; Laessle, Tuschl, Kotthaus, & Pirke, 1989; Lluch & Mejean, 1995) which assesses three factors that refer to cognitions and behaviors associated with eating: dietary restraint (conscious control of food intake with concerns about shape and weight), disinhibition (overconsumption of food in response to a variety of stimuli associated with a loss of control on food intake), and hunger (food intake in response to feelings and perceptions of hunger). More specific subscales can also be derived from these three general eating behaviors (Westenhoefer, Stunkard, & Pudel, 1999; Bond, McDowell, & Wilkinson, 2001): rigid restraint, flexible restraint, habitual susceptibility to disinhibition, emotional susceptibility to disinhibition, situational susceptibility to disinhibition, internal hunger, and external hunger, as previously described (Provencher et al., 2007). The Binge Eating Scale is a 16-item validated questionnaire (Gormally, Black, Daston, & Rardin, 1982) which assesses binge eating severity.

2.3 Dietary Variables

Self-reported dietary intakes (including foods and drinks) were assessed by a 3-day weighed food record, which included two weekdays and one weekend day (Tremblay, Sévigny J, Leblanc C, & Bouchard C, 1983). Each subject had to report quantities of foods and drinks as accurately as possible, and to identify the time of the day and the location for each eating occasion. Dietary intakes were evaluated using version 4.03 of the Nutrition Data System for research software (Schakel, Sievert, & Buzzard, 1988).

2.4 Eating Patterns

The combined information about the time, the type and quantities of foods and drinks consumed at each eating occasion from the 3-day food record allowed the setting of eating patterns (de Castro, 2004). Globally, a meal was represented by breakfast, lunch or dinner and constituted of an eating occasion taken at regular hours, and according to the order of the subject's description in the food record. A snack was represented by any other eating occasion that occurred during the day, evening or night, and usually constituted of an eating occasion taken at irregular hours. To determine the influence of the time of the day on total daily food intake, some interval periods were established to capture peak intake (e.g., meals and/or snacks consumed before and after 5:00 pm).

2.5 Anthropometric and Physiological variables

Anthropometric measurements were performed according to standardized procedures (Lohman, Roche, & Artorel, 1988) and have been previously described (Provencher et al., 2007). Measurement of resting metabolic rate was done according to a procedure previously described (Provencher et al., 2004).

2.6 Statistical Analyses

Pearson's correlation analyses were conducted to test for univariate associations between variables. In order to consider possible underreporting, cut-off limits were used, as proposed by Goldberg et al. (Goldberg et al., 1991), and as described by Provencher et al. (Provencher et al., 2004). We performed analyses with and without underreporters. Multiple regression analyses were performed to test the mediational model proposed with the most fitting predictors of eating behaviors and eating patterns with self-reported energy intake, according to Baron & Kenny conditions (Baron & Kenny, 1986): 1) the independent variable (eating behavior) significantly predicts the mediator (eating pattern), 2) the independent variable significantly predicts the dependent variable (self-reported energy intake), 3) the mediator significantly predicts the dependent variable, and 4) the entry of the mediator in the regression equation completely (full mediational model) or substantially (partial mediational model) reduces the strength of the link between the independent variable and the dependent variable. All analyses were performed using SAS statistical software (version 9.1, SAS Institute Inc., Cary, NC), with the probability level for significance set at an α level of $p<0.05$.

3. Results

Characteristics of women included in the study are presented in Table 1. Several associations between eating behaviors and self-reported energy intake, and also between body weight and self-reported energy intake were observed. Dietary restraint and flexible restraint were negatively

associated with self-reported energy intake (r= -0.19; r= -0.18, respectively, $p \leq 0.03$). Situational susceptibility to disinhibition, hunger, and binge eating severity were positively associated with total self-reported energy intake (r=0.21; r=0.23; r=0.24, respectively, $p \leq 0.01$). Similarly, body weight was positively associated with self-reported energy intake (r=0.28; p=0.0008). When excluding underreporters from the analyses, dietary restraint and flexible restraint were no longer significantly associated with self-reported energy intake (r= -0.09, p=0.37; r= -0.13, p=0.20, respectively). On the other hand, correlations of situational susceptibility to disinhibition, hunger, binge eating severity and body weight with self-reported energy intake were of similar magnitude after removing underreporters ($0.18 \leq r \leq 0.38$).

Some associations were also found between eating patterns and dietary intakes. In fact, proportion of energy intake from breakfast was negatively associated with total self-reported energy intake, and with protein and lipid intakes (r= -0.23; r= -0.20; r= -0.20, respectively, $p \leq 0.02$) whereas proportion of energy intake from snacks was positively associated with total self-reported energy intake (r=0.27; p=0.001), as well as with carbohydrate and lipid intakes (r=0.22; r=0.28, respectively, $p \leq 0.01$). The proportion of total energy intake from snacks consumed after 5:00 pm was also associated with total energy, carbohydrate and lipid intakes (r=0.30; r=0.29; r=0.25, respectively, $p \leq 0.003$). When excluding underreporters, correlations were of similar magnitude as the ones observed in the total sample ($0.18 \leq r \leq 0.35$).

Table 2 presents associations between eating behaviors and eating patterns. A positive association was found between flexible restraint and the proportion of energy intake consumed at breakfast whereas a negative association was observed between flexible restraint and the proportion of energy intake at lunch. Moreover, dietary restraint was negatively associated with the proportion of energy intake consumed after 5:00 pm. In addition, it was found that disinhibition, habitual susceptibility to disinhibition, emotional susceptibility to disinhibition as well as binge eating severity were all positively associated with the proportion of energy intake from snacks consumed after 5:00 pm. When excluding underreporters dietary restraint was no longer correlated with the proportion of energy intake consumed after 5:00 pm (r= -0.13; p=0.22) and emotional susceptibility to disinhibition was no longer correlated with the proportion of energy intake from snacks consumed after 5:00 pm (r=0.15; p=0.14). All other associations remained significant.

Additional analyses were performed to test whether eating patterns could mediate the associations between eating behaviors and self-reported energy intake. When considering the required conditions, we were allowed to test 4 models. All subjects were included in the mediational

analyses because the strength of univariate correlations between eating behaviors and eating patterns included in mediational models were not altered when excluding underreporters. Model 1 tested the association between binge eating severity and total self-reported energy intake. When the mediator (proportion of energy intake from snacks consumed after 5:00 pm) was entered into model 1, the ß coefficient decreased from 0.24 to 0.18, a 24.1% reduction (Sobel test=2.04; p=0.04). For the final model, the overall percentage of explained variance was 12.2%. Similar results, although weaker, were obtained for model 2 testing the mediating effect of the proportion of energy intake from snacks on the association between binge eating severity and total self-reported energy intake. Finally, the Sobel test was not significant for model 3 testing the mediational effect of the proportion of energy intake from breakfast on the association between situational susceptibility to disinhibition and total self-reported energy intake, and also for model 4 testing the mediational effect of the proportion of energy intake from breakfast on the association between binge eating severity and total self-reported energy intake.

4. Discussion

Our results suggest that eating behaviors, more specifically dietary restraint and binge eating severity, are associated with overall self-reported energy intake, but also with some eating patterns. In addition, mediational analyses suggest that proportion of energy intake from snacks consumed after 5:00 pm partially mediates the association between binge eating severity and total self-reported energy intake.

Our results suggest that women with higher level of flexible restraint were consuming higher amount of energy earlier in the day, and had lower total daily energy intake which is concordant with results reported by de Castro (de Castro, 2004). This suggests that women who have a higher self-reported energy intake in the morning have a lower total daily energy intake, which might be in part explained by lower lipid and protein intakes, which were also negatively associated with the proportion of energy intake from breakfast (data not shown). In regards to disinhibition and binge eating severity, we observed that women with higher values for these variables reported a higher proportion of energy intake from snacks consumed after 5:00 pm. Also, a higher binge eating severity was associated with higher daily energy intake. Our results related to disinhibition and binge eating severity suggest that these eating behaviors seem to be related to a loss of control possibly more prevalent later in the day. This loss of control later in the day can be related to the fact that satiety properties seem to decline over the course of the day (de Castro, 1987; de Castro, 2007), supporting the fact that eating in the morning might be beneficial to control total energy intake. Moreover, other factors such as fatigue (Zimmerman et al., 2011) and daily stress (Woods,

Racine, & Klump, 2010) could also influence eating behaviors and be more prevalent at the end of the day.

Mediational models showed that the association between binge eating severity and total self-reported energy intake was partially mediated by the proportion of energy intake from snacks consumed after 5:00 pm, and similar results were observed for the model testing the association between binge eating severity, proportion of energy intake from snacks and total self-reported energy intake. These results suggest that other factors are possibly involved in the association between binge eating severity and total self-reported energy intake, such as usual portion size and lipid content (Blomquist et al., 2010; Siega-Riz et al., 2008), and possibly some psychosocial variables such as diurnal anxiety (Sassaroli et al., 2009).

Some limitations of the study need to be mentioned. First, the use of self-reported measures to assess eating behaviors and dietary intakes may not be sufficient to grasp all dimensions of behavioral aspects of eating and may be influenced by potential desirability bias. Also, inconsistencies in the literature about meal and snack definitions (Gatenby, 1997), and about assessment methods (e.g., the way of determining two distinct eating occasions) (Summerbell, Moody, Shanks, Stock, & Geissler, 1995; Drummond, Crombie, Cursiter, & Kirk, 1998) make comparisons between studies more difficult.

In summary, our results showed that eating patterns are important factors to consider in order to explain the associations between eating behaviors and self-reported energy intake and might potentially influence energy balance in premenopausal overweight women.

Table 1. Characteristics of women included in the study (n=143)

	Means	SD	Minimum	Maximum
Age (years)	42.6	5.6	28.0	51.0
Body weight (kg)	80.3	9.7	57.7	106.5
BMI (kg/m^2)	30.5	3.1	25.0	37.5
Energy intake (kcal)	2014	443	871	3482
Lipid (% energy)	34.2	5.0	20.8	46.6
Carbohydrate (% energy)	47.3	5.4	34.5	62.8
Protein (% energy)	17.4	3.4	9.1	30.5
Alcohol (% energy)	3.3	3.4	0	16.8
Fibers (g)	20.6	6.8	8.8	51.9
Calcium (mg)	889	333	280	2291
Sodium (mg)	3060	938	1089	7414
Meal frequency (n/d)	2.9	0.3	2.0	3.7
Snack frequency (n/d)	2.5	1.8	0	10.3
Energy from breakfast (% energy)	20.3	7.2	2.6	40.7
Energy from lunch (% energy)	26.5	7.9	7.2	56.3
Energy from dinner (% energy)	36.5	9.6	0	60.9
Energy from snacks (% energy)	16.2	11.7	0	75.0
Energy after 5:00 pm (% energy)	42.5	9.8	14.6	61.7
Energy from snacks after 5:00 pm (% energy)	7.7	7.4	0	45.2

* SD, standard deviation.

Table 2. Pearson correlation coefficients for the associations between eating behaviors and eating patterns (n=143)

	Energy breakfast (% energy)		Energy lunch (% energy)		Energy dinner (% energy)		Energy snacks (% energy)		Energy after 5:00 pm (% energy)		Energy from snacks after 5:00 pm (% energy)	
	r	***p***	r	***p***	r	***p***	r	***p***	r	***p***	r	***p***
Dietary restraint	0.15	0.07	-0.16	0.06	-0.06	0.48	0.05	0.56	-0.17	0.04	-0.08	0.31
Rigid restraint	0.08	0.32	-0.15	0.07	-0.03	0.74	0.07	0.38	-0.08	0.32	-0.01	0.88
Flexible restraint	0.24	0.004	-0.17	0.04	-0.07	0.40	0.008	0.92	-0.15	0.08	-0.03	0.71
Disinhibition	-0.14	0.10	-0.02	0.84	-0.02	0.77	0.12	0.16	0.12	0.16	0.22	0.007
Situational susceptibility to disinhibition	-0.20	0.02	-0.06	0.48	0.05	0.59	0.12	0.15	0.13	0.12	0.15	0.07
Emotional susceptibility to disinhibition	-0.04	0.64	0.09	0.29	-0.08	0.33	0.04	0.59	0.04	0.65	0.19	0.02
Habitual susceptibility to disinhibition	-0.08	0.36	-0.08	0.35	-0.07	0.41	0.16	0.06	0.09	0.27	0.23	0.006
Hunger	-0.15	0.07	-0.02	0.78	-0.05	0.54	0.14	0.10	0.05	0.56	0.13	0.11
Internal hunger	-0.13	0.13	-0.02	0.82	-0.07	0.38	0.14	0.09	-0.009	0.92	0.14	0.09
External hunger	-0.11	0.18	-0.01	0.86	-0.007	0.93	0.08	0.36	0.08	0.37	0.06	0.49
Binge eating severity	-0.23	0.005	-0.11	0.20	0.05	0.57	0.18	0.03	0.15	0.08	0.22	0.01

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