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**Examination of associations between chaos in the home environment, serum cortisol level,
and dietary fat intake among parents of preschool-age children**

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Guelph Family Health Study

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Abbreviations: CHAOS (Confusion, Hubbub, and Order Scale); HPA (Hypothalamic-Pituitary-Adrenal Axis); BMI (Body Mass Index); SD (Standard Deviation); CI (Confidence Interval)

Abstract

This research investigated associations between home environment chaos, fat intake, and morning serum cortisol level in 44 parents of preschool-age children. Chaos was measured using the Confusion, Hubbub, and Order Scale, and fat intake was quantified using the Block fat screener. Linear regression analyses demonstrated that chaos and cortisol were both associated with fat intake ($\hat{\beta} = 0.53$, $p = 0.001$; $\hat{\beta} = 0.03$, $p = 0.0002$), and there was a non-significant association between chaos and cortisol.

Keywords: Chaos; Cortisol; Diet; Parent; Stress

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Introduction

Nearly two thirds of Canadian adults and one third of Canadian children are overweight or obese (SOCHI, 2016). To develop effective interventions for obesity, it is important to identify key modifiable risk factors. One modifiable factor that has gained interest in recent years is the influence of stress on dietary intake.

Stress can contribute to the development of obesity by promoting unhealthy dietary patterns and eating behaviours (Sominsky & Spencer, 2014). A stressful situation activates the hypothalamic-pituitary-adrenal (HPA) axis, which results in an increased production of cortisol (Spencer & Tilbrook, 2011). Cortisol is known to stimulate appetite and enhance the rewarding nature of foods that are high in sugar and fat content, which in chronic stress situations can promote weight gain (Sominsky & Spencer, 2014).

Evidence supporting the need for obesity prevention programs that include stress management is increasing (Campbell, 2015). However, influences of particular types of chronic stress on dietary intake have rarely been investigated. The Confusion, Hubbub, and Order Scale (CHAOS) is a validated measure of noise, crowding, and routines in the family home environment (Matheny *et al.*, 1995). Two studies have demonstrated positive associations between home environment chaos, as measured using the CHAOS survey, and obesity-related behaviours, including poor sleep and emotional overeating in children (Boles *et al.*, 2016; Lumeng *et al.*, 2014). It is not known, however, what effect chaos may have on behaviours that increase obesity risk in parents. This is important to investigate, because children's eating habits are learned from their parents and are established early in life (Patrick & Nicklas, 2005; Savage, Fisher, & Birch, 2007). If parents are modeling stress-related eating habits, these behaviours may be passed on to their children. It has been demonstrated that fat intake correlates with BMI

(Hooper et al. 2015). Therefore, the objective of this research was to examine associations between home environment chaos, serum cortisol levels, and dietary fat intake among parents of the Guelph Family Health Study, a family-based cohort study. The primary hypothesis was that home environment chaos would be positively associated with fat intake, and the secondary hypothesis was that cortisol would have a mediating influence on this relationship.

Methods

Participants

There were 79 parents from 44 families who participated in the pilot phase of the Guelph Family Health Study. Inclusion criteria were families who had at least one child between the ages of 18 months and 5 years, and who lived in the Guelph-Wellington area. Baseline data for home environment chaos, cortisol, and fat intake were available for 45 parents from 30 families. One participant's cortisol value was considered an outlier, as it was greater than three standard deviations above the mean. Data from this participant were not included in the current analyses. Excluding participants who were non-fasted for their blood sample collection did not yield substantively different results, and therefore both fasted and non-fasted participants were included. The final sample size was 44 parents from 30 families, with 10 of those parents being non-fasted participants. The study was approved by the University of Guelph Research Ethics Board (RCT 02223234). Parents provided written informed consent to participate in this research.

CHAOS

One parent from each family completed the survey to provide a CHAOS score for their household (Matheny *et al.*, 1995). This 15-item measure assesses the presence of noise, clutter, and routines within the home. Participants ranked, on a scale of 1 to 4, how strongly they agreed

that the statement described their home. A total CHAOS score was then calculated for each family.

Diet

Parents' fat intake was quantified using the Block fat screener (Block, Gillespie, Rosenbaum, & Jenson, 2000). Participants ranked on a scale of 1 (*once per month or less*) to 5 (*5 or more times per week*) how often they consumed 16 high-fat food items. A total fat screener score was calculated for each participant by summing the responses.

Cortisol

Blood samples were collected from participants in the morning by Lifelabs Medical Laboratory Services in Guelph. Serum cortisol levels were also analyzed by Lifelabs using the Siemens Advia Centaur cortisol assay, a competitive immunoassay with chemiluminescent detection. Lifelabs did not require participants to fast for this test.

Data for covariate analyses

Data for participant sex, household income, and family size were collected through participant self-report. Participants reported their total annual household income on a scale of 1 to 12, with 1 being less than \$10,000 and 12 being \$150,000 or more. Income category midpoints for levels 1 to 11 and minimum for level 12 were used to create a quantitative income variable. Family size was a three level categorical variable defined as either three, four, or more than four people living in the household.

Statistical Analyses

Data analysis was performed using SAS version 9.2. Linear regression analyses were performed to investigate associations among dietary fat, home environment chaos, and cortisol. Robust standard errors were computed via the use of generalized estimating equations in order to

account for dependent observations within families (Zeger & Liang, 1986). First, the association between home environment chaos and fat intake was investigated. Second, a mediating effect of cortisol was investigated by examining associations between home environment chaos and cortisol, and between cortisol and fat intake. Cortisol was also investigated as a covariate in a model examining the association between home environment chaos and fat intake. Adjusted models included participant sex, household income, and family size. A significance level of 0.05 was used.

Results

Participant Demographics

The participant demographics are outlined in Table 1. There were 23 females and 21 males, with a mean age of 34.6 years. The BMI scores of the participants ranged from normal weight (19.0 kg/m²) to obese (47.2 kg/m²), with a mean BMI of 28.4 kg/m². There was a wide income distribution amongst the families (\$30,000 to ≥\$150,000), and the median household income was \$90,000. A majority (84%) of the participants were White, with the remainder of the participants identifying as South Asian, Chinese, and Latin American.

Linear Regression Analysis Results

Associations between chaos in the home environment, dietary fat, and cortisol are presented in Table 2. Significant positive associations were observed between home environment chaos and parents' fat intake ($\hat{\beta} = 0.53$ (CI= 0.21-0.85), $p = 0.001$), as well as between parents' cortisol levels and fat intake ($\hat{\beta} = 0.03$ (CI= 0.02-0.05), $p = 0.0002$), based on models that adjusted for participant sex, household income, and family size. Over 80% of the families were two-parent families, and so models that adjusted for number of children in the household instead of family size were also run. These models yielded similar results (results not shown). There was a

non-significant positive association observed between home environment chaos and parents' cortisol levels ($\hat{\beta} = 2.86$ (CI= -1.92-7.65), $p = 0.24$).

Including cortisol in the adjusted model of the association between home environment chaos and fat intake resulted in a decrease in the coefficient estimate for chaos from 0.53 to 0.44 (CI= 0.11-0.77). The association between home environment chaos and fat intake remained significant after this adjustment ($p = 0.01$).

Discussion

The results supported our primary hypothesis that home environment chaos would be positively associated with parents' fat intake. This is the first study to investigate the association between home environment chaos and parents' dietary intake. Past research has demonstrated that parents have an important influence on the eating habits that their children develop (Patrick & Nicklas, 2005; Savage *et al.*, 2007). Therefore, if parents from more chaotic homes are modelling high-fat eating habits, this could have a negative influence on their own health as well as the health of their children.

Previous research has been inconclusive with regards to how the association between stress and dietary intake may differ by sex (O'Connor *et al.* 2008, Tan and Chow 2014). The results of the current research demonstrated that the association between home environment chaos and fat intake was independent of participant sex, suggesting that the dietary intake of both males and females can be influenced by home environment chaos.

Individuals living in low-income households tend to be at a greater risk for chronic stress and poor quality diets (Darmon and Drewnowski 2008). However, our results indicated that home environment chaos was associated with parents' fat intake independent of household

income. Furthermore, home environment chaos was associated with parents' fat intake independent of family size. Thus, our results suggest that families of varying size and socioeconomic status would benefit from interventions designed to reduce the level of chaos within the home.

Our results showed that parents with higher serum cortisol levels were more likely to have a diet high in fat, and this was true independent of participant sex, household income, and family size. This finding is consistent with the hypothesized role of cortisol in promoting intake of energy-dense foods. The proposed mechanism for this response involves cortisol's interaction with appetite-stimulating and reward-enhancing areas of the brain (Sominsky & Spencer, 2014).

Adding cortisol to the model of the association between home environment chaos and fat intake resulted in a slight decrease in the coefficient estimate for chaos. This lends support to the hypothesis that participants' cortisol levels may have an influence on the relationship between home environment chaos and fat intake. However, due to the lack of a significant association between home environment chaos and cortisol, we did not demonstrate a mediating influence of cortisol on the relationship between home environment chaos and fat intake.

While it is possible that home environment chaos and cortisol were each independently associated with parents' fat intake, it is also possible that our non-significant finding between home environment chaos and cortisol is due to the fact that our measure of cortisol may not be an accurate reflection of participants' chronic stress levels. Serum cortisol only measures the level of circulating cortisol at the point of sampling. Circulating cortisol levels can be influenced by factors such as recent exercise (Hill *et al.* 2008), sleep quality (Gonnissen *et al.* 2013), and acute stress (Foley and Kirschbaum 2010). We did not collect data on these variables at the time of blood collection, which is a limitation of our study design. An interesting future direction for this

research would be to analyze cortisol concentrations in scalp hair samples, which have been demonstrated to reflect participants' average exposure to cortisol over a period of months (Russell *et al.*, 2012), and explore the potential mediating influence of cortisol on the association between home environment chaos and fat intake.

Strengths of this research include the use of both male and female participants, inclusion of a physiological and a subjective measure of stress, and the novelty of investigating an association between home environment chaos and dietary intake in parents of preschool-age children. There are also limitations, including a small sample size, the use of serum cortisol rather than a chronic measure of physiological stress, and a lack of data available on other aspects of the parents' diets. Our measure of fat intake was based on frequencies, not on quantity of fat consumed. However, the Block fat screener is a validated survey that has been shown to correlate with fat intake data collected from four-day food diaries (Block *et al.* 1989). Finally, in this study only one parent provided information on the level of chaos in the home. It is possible that, in two-parent homes, the parents have different interpretations of how chaotic their home is, which could influence their response to the level of home environment chaos. Future research should consider the use of hair cortisol analysis, assessment of home environment chaos from both parents in two-parent homes, and the collection of more complete dietary data.

Conclusion

Our results demonstrated a significant positive association between home environment chaos and fat intake among parents of preschool-age children after adjusting for covariates. However, our secondary hypothesis that cortisol would have a mediating influence on this relationship was not supported. While additional research is needed to elucidate the influence of chaos in the home environment on stress and dietary intake, these results suggest that chaos in

the home may be an important consideration when exploring dietary risk factors for obesity among families with preschool-age children.

Conflict of Interest

The authors report no conflicts of interest associated with this manuscript.

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Table 1. Characteristics of parents (n=44) from 30 families in the Guelph Family Health Study

Variable	n (%), or mean (SD)
Sex	
Male	21 (48%)
Female	23 (52%)
Age (years) mean (SD)	34.6 (3.3)
BMI (kg/m²)	
Normal weight (18.5-24.9)	20 (45%)
Overweight (25-29.9)	10 (23%)
Obese (≥ 30)	14 (32%)
Household Income	
\$30,000-\$49,999	6 (14%)
\$50,000-\$69,999	9 (20%)
\$70,000-\$99,999	10 (23%)
\geq \$100,000	19 (43%)
Family Size	
Families with 3 members	8 (27%)
Families with 4 members	17 (57%)
Families with >4 members	5 (16%)
Ethnicity	
White	37 (84%)
Other	6 (14%)
No response	1 (2%)
Fat Screener Score [range: 16-80] mean (SD)	38.4 (7.4)
CHAOS Score [range: 15-60] mean (SD)	31.1 (6.2)
Cortisol (nmol/L) mean (SD)	300.0 (104.4)

Table 2. Unadjusted and adjusted associations among fat screener score, CHAOS score, and cortisol

Association	Unadjusted			Adjusted for sex, income, and family size		
	Unstandardized Coefficient Estimate	95% Confidence Interval	p-value	Unstandardized Coefficient Estimate	95% Confidence Interval	p-value
Fat Intake vs. CHAOS	0.43	0.23-0.64	<0.0001	0.53	0.21-0.85	0.001
Fat Intake vs. Cortisol	0.03	0.01-0.05	0.002	0.03	0.02-0.05	0.0002
Cortisol vs. CHAOS	2.67	-1.75-7.10	0.24	2.86	-1.92-7.65	0.24

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