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CHILD SEXUAL ABUSE RESEARCH

Pilot Study on Childhood Sexual Abuse, Diurnal Cortisol Secretion, and Weight Loss in Bariatric Surgery Patients

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Childhood sexual abuse increases risk for adult obesity. A potential contributing factor is altered cortisol secretion. In this pilot study, relationships among childhood sexual abuse, diurnal salivary cortisol secretion, and weight loss were explored in 17 bariatric surgery patients. Measurement points were before surgery (baseline) and 3 and 6 months after surgery. Childhood sexual abuse was measured by the Childhood Trauma Questionnaire. The results showed moderate but nonsignificant positive correlations between the childhood sexual abuse subscale score and baseline morning cortisol, evening cortisol, and daily mean cortisol. An unexpected positive correlation was noted between the Childhood Trauma Questionnaire total score and weight loss at six months. Diurnal cortisol secretion did not change over time after surgery nor correlate significantly with weight loss at six months.

KEYWORDS *childhood sexual abuse, survivors of childhood sexual abuse, diurnal cortisol, HPA axis, childhood abuse, survivors of childhood abuse, obesity, bariatric surgery*

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Children who experience sexual abuse have an increased risk for obesity as adults when compared to the rest of the population (Hemmingsson, Johansson, & Reynisdottir, 2014; Noll, Zeller, Trickett, & Putman, 2007; Williamson, Thompson, Anda, Dietz, & Felitti, 2002). The health implications of increased risk for obesity are significant. Obesity reduces quality of life (Wyatt, Winters, & Dubbert, 2006); increases the risk for numerous acute and chronic diseases (National Heart, Blood, and Lung Institute, 2000); and decreases life expectancy by 6 to 14 years (Peeters, Bonneux, Nusselder, De Laet, & Barendregt, 2004). Therefore, it is important to identify contributing factors to the relationship between child sexual abuse (CSA) and obesity in adulthood for intervention development. One hypothesized contributing factor is long-lasting changes in hypothalamic-pituitary-adrenal (HPA) axis regulation and glucocorticoid hormone secretion, engendered by the stress of CSA (Noll et al., 2007; Pervanidou & Chrousos, 2012). If true, individuals who experienced CSA may represent a distinct subset of the obese population, which has implications for the outcomes of obesity treatment.

The HPA axis is a major neuroendocrine mediator of the stress response and regulates the secretion of cortisol, the powerful glucocorticoid hormone found in humans. Animal models of developmental stress have demonstrated that stressors applied to the immature animal can program lifelong changes in HPA axis regulation (Caldji, Hellstrom, Zhang, Diorio, & Meaney, 2011). CSA is an exemplar of developmental stress in humans. This supposition is empirically supported by changes in HPA axis regulation in children who experience CSA (Cicchetti & Rogosch, 2001; De Bellis et al., 1994; Duval et al., 2004; King, Mandansky, King, Fletcher, & Brewer, 2001) and in adults with a history of CSA (as reviewed by Hulme, 2011).

Obesity is the physical manifestation of excess energy stored as fat (Redinger, 2009). The brain finely controls energy balance by regulating (a) the drive to eat (i.e., appetite) and food-related behaviors, (b) spontaneous physical activity, and (c) metabolism (Gao, Miyata, Bhaskaran, Derbenev, & Zsombok, 2012; Pfluger et al., 2011; Vianna & Coppari, 2011). Animal studies suggest that chronic stress may initiate a pathway to obesity by increasing appetite for calorie-rich “comfort” foods (Dallman, 2010). Elevated glucocorticoid hormones and intense emotional responses to stressful stimuli have been shown to accompany each other. Both elevated glucocorticoid levels and distressing emotions appear to be modulated by the consumption of calorie-rich foods (Dallman, 2010; Dallman, Pecoraro, & la Fleur, 2005). Once initiated, this neuroendocrine-behavioral response to chronic stress can become a habit and contribute to weight gain (Adam & Epel, 2007; Dallman, 2010; Dallman et al., 2005). Additional animal research suggests that prolonged exposure to elevated levels of glucocorticoid hormones increases deposition of fat in the intra-abdominal area (Dallman, Akana, Bhatnagar, Bell, & Strack, 2000).

Based on these briefly summarized research findings mentioned previously, it is reasonable to hypothesize that elevated glucocorticoid hormones in humans (i.e., cortisol) due to the stress of CSA can alter regulation of the HPA axis and favor excess eating behaviors, even after the CSA has terminated. We conducted a pilot study to test this hypothesis using a clinical population of obese individuals scheduled for bariatric surgery. About one-third of bariatric surgery patients report a history of CSA (Grilo, White, Masheb, Rothschild, & Burke-Martindale, 2006; Wildes, Kalarchian, Marcus, Levine, & Courcoulas, 2008) when measured by the Childhood Trauma Questionnaire (Bernstein & Fink, 1998). In contrast, less than one-fifth of patients belonging to health maintenance organizations report CSA when measured by the same instrument (Arnow, Blasey, Hunkeler, Lee, & Hayward, 2011; Walker et al., 1999).

If one pathway to obesity is a neuroendocrine-behavioral response to the stress of CSA that became habitual, then it is possible that a history of CSA could negatively affect weight loss following bariatric surgery through the same mechanisms. Study results on the relationship between sexual abuse and weight loss in bariatric surgery patients are mixed (Steinig, Wagner, Shang, Dolemeyer, & Kersting, 2012), but to date no reports have been published on the role of HPA axis regulation on weight loss outcomes in individuals who experienced CSA.

To assess the relationships among CSA, HPA axis regulation, and weight loss following bariatric surgery, we chose diurnal patterns of cortisol secretion as our marker for HPA axis regulation. Our methods for measuring diurnal patterns of cortisol secretion were refined in a previous study on stress in medical students (Hulme, French, & Agrawal, 2011). Diurnal cortisol secretion is regulated by the circadian "clock" system and the HPA axis (Nader, Chrousos, & Kino, 2010). Typically, the diurnal pattern consists of an upward spike during the first half hour of awakening (the cortisol awakening response) and then a gradual drop over the course of the day, with a leveling off in late evening (Nader et al., 2010).

Therefore, the first aim of this pilot study was to explore relationships among measures of (a) self-reported CSA, (b) diurnal patterns of cortisol secretion, and (c) weight loss at three measurement points: at baseline (one to two weeks before surgery) and at three and six month intervals after surgery in a convenience sample of bariatric surgery patients. If obese individuals who experienced CSA are characterized by long-lasting changes in HPA axis regulation and cortisol production, then we would expect CSA and diurnal patterns of cortisol secretion at baseline to correlate in our obese sample. If these changes in HPA axis regulation and cortisol production formed a pathway to obesity in these individuals, then we would expect that these changes would also impede weight loss following bariatric surgery, as demonstrated by (a) a negative relationship between CSA and weight loss and (b) a relationship in either direction between diurnal patterns of cortisol secretion at baseline and weight loss.

The second aim of this pilot study was to examine diurnal patterns of cortisol secretion across the three measurement points, using the entire set of data points for analysis. The objective of the second aim was to determine if bariatric surgery itself affects diurnal patterns of cortisol secretion. Only a few studies have examined HPA axis regulation before and after bariatric surgery, and the results suggest that bariatric surgery may affect HPA axis regulation (Guldstrand et al., 2003; Manco et al., 2007; Valentine et al., 2011).

METHOD

Sample and Participants

Nineteen bariatric surgery patients agreed to participate in the study and signed informed consent forms. Patients were recruited from an academic Bariatric Center of Excellence clinic located in the Midwest. Inclusion criteria included (a) scheduled for primary bariatric surgery at the academic health center, (b) at least 19 years old, and (c) willingness to follow the study protocol. The study was framed as an investigation on stress over the lifetime, stress hormones, and bariatric surgery outcomes. Recruitment took place after the patients' visits with their surgeons or physician assistants. The timing for recruitment was adjusted early in the pilot study to maximize recruitment. Approaching patients at the final visit before surgery proved to be the most successful, resulting in a 50% recruitment rate (Hulme, Land, & McBride, 2012).

Two of the 19 recruited patients did not submit any usable saliva samples and were thus eliminated from the sample. The final sample consisted of 17 participants, whose ages ranged from 29 years to 66 years ($M = 44.8$, $SD = 11.4$). The majority of the sample was female (82%, $n = 14$) and Caucasian (88%, $n = 15$). Types of bariatric surgery included gastric bypass (47%, $n = 8$), sleeve gastrectomy (35%, $n = 6$), and gastric band (18%, $n = 3$).

Measures

Diurnal cortisol secretion

Participants were instructed to sample their saliva nine times over the course of the day for three consecutive days at each measurement point. Sample collection times were at awakening and one-half hour after awakening to measure the cortisol awakening response and then at two-hour increments from 10:00 a.m. to 10:00 p.m. Participants were given a diary (see Hulme et al., 2011) to note times they collected saliva samples, awakening times, and bedtimes. A Cadex medication reminder wristwatch, set to beep every two hours from 10:00 a.m. to 10:00 p.m., was provided to participants as an aid for timely saliva sample collection. Of the 1,377 saliva samples requested from the 17 participants altogether, a total of 1,142 usable saliva specimens were received (83% return rate).

The saliva specimens were assayed at the Endocrine Bioservices Laboratory at the University of Nebraska at Omaha with a cortisol enzyme-linked immunoassay specific for saliva. The assay has been validated for human salivary cortisol (Elverson, Wilson, Hertzog, & French, 2012; Minton, Hertzog, Barron, French, & Reiter-Palmon, 2009). Intra-assay and inter-assay coefficients of variation for high and low concentration saliva pools were 6.1% and 3.9%, and 12.7% and 17.2%, respectively. All samples from individual participants were measured in one assay run to minimize procedural variation. Cortisol levels were calculated as nanomoles per liter (nmol/L).

Childhood sexual abuse

CSA was measured by the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998). The CTQ contains subscales for sexual abuse, emotional abuse, physical abuse, emotional neglect, and physical neglect before age 18, with 5 items for each subscale. Scale response choices range from 1 (*never true*) to 5 (*very often true*). Evidence of factorial validity for the 5 subscales, measurement invariance, and convergent validity with a structured interview and therapists' ratings has been demonstrated in research (Bernstein & Fink, 1998; Bernstein et al., 2003). Scher, Stein, Asmundson, McCreary, and Forde (2001) reported internal consistency to be .91 and support for all of the subscales in a confirmatory factor analysis. Both the raw CSA subscale score and the raw CTQ total score were used to explore relationships among CSA, diurnal patterns of cortisol secretion, and weight loss. For the present study, Cronbach's alphas for the CSA subscale and total CTQ were .81 and .89, respectively.

Weight loss

Weight loss was operationalized as the percent of weight loss at three and six months after surgery, a preferred method for assessing weight loss in bariatric surgery patients. Percent of weight loss was calculated as (initial weight minus current weight) divided by initial weight × 100 (Hatoum & Kaplan, 2013). Clinical records were the source for weight and height data. The data were extracted from the clinic's BOLD electronic database, a national database used by Bariatric Centers of Excellence.

Procedures

Institutional review board (IRB) permission for the study was in place before recruitment began, and informed consent was obtained following IRB regulations. Details on methods beyond those described here can be found in Hulme and colleagues (2012).

Statistical Analysis

Bivariate Pearson correlations were conducted to meet the objectives of the first aim. First, four aggregate measures of diurnal patterns of cortisol secretion were calculated. These aggregate measures were the three-day means at each measurement point for (a) the morning cortisol peak (highest cortisol level before 12:00 p.m.), (b) evening cortisol (cortisol level at 10:00 p.m.), (c) daily mean cortisol (average of all cortisol levels collected over the course of the day), and (d) cortisol awakening response (area-under-the-curve with respect to increase or AUC_i). Calculating the cortisol awakening response as AUC_i captures the extent of fluctuation in diurnal cortisol secretion during the first half hour after awakening, when levels normally rise rapidly (Smyth, Hucklebridge, Thorn, Evans, & Clow, 2013).

For the second aim, mixed models for change (i.e., multilevel models) were used to analyze diurnal patterns of cortisol secretion. Multilevel models provide a framework for analyzing longitudinal data that accounts for the nested nature of the data (times within days within participants) and can accommodate varying intervals between time points and varying amounts of available data. Maximum likelihood estimation was used so that all available data could be utilized. To account for variability in times of awakening, time was reflected as hours since awakening using the times reported in participant diaries. Interactions between (a) phase and (b) linear and quadratic slopes were modeled to determine if diurnal patterns varied from baseline to three and six months after surgery. Due to the non-normal distribution of cortisol levels, a log transformation was applied.

RESULTS

Sample Description

Twenty-four percent (n = 4) of participants reported moderate to severe CSA, while 47% (n = 8) reported at least one form of moderate to severe childhood abuse or neglect of any kind, according to subscale cut points established by Bernstein and Fink (1998). The mean CSA subscale score was 7.53 (SD = 5.11). The mean CTQ total score was 40.53 (SD = 11.33). To help place these scores in context, normative data established by Scher and colleagues (2001) from a community sample (n = 1,007) are included here. In these normative data, mean CSA subscale scores were 5.20 (SD = 1.41) for men and 5.71 (SD = 2.60) for women. Mean CTQ total scores were 31.71 (SD = 9.13) for men and 31.77 (SD = 11.20) for women (Scher et al., 2001).

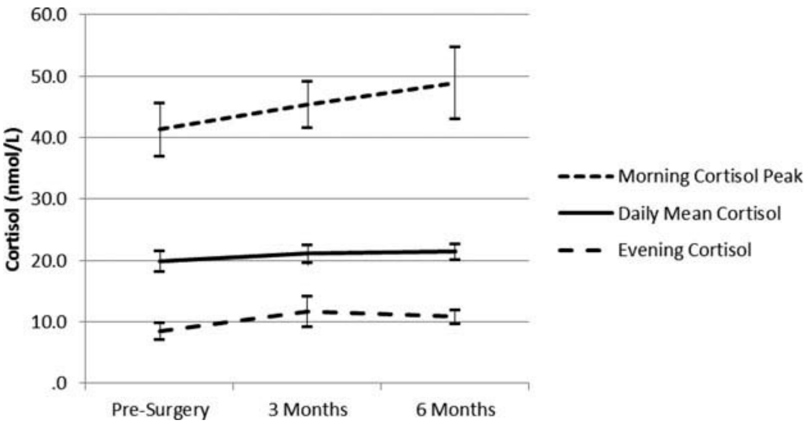

FIGURE 1 Three-day means of morning cortisol peak, daily mean cortisol, and evening cortisol levels (salivary) in bariatric surgery patients (n = 17) at 3 measurement points: pre-surgery (baseline) and 3 and 6 months after surgery. Error bars are ± 1 standard error.

Values for morning cortisol peak, daily mean cortisol, and evening cortisol at each measurement point for the entire sample are found in Figure 1. Morning cortisol peak levels increased over time, but the change was not significant (F (2,21) = 0.71, p = .50). Neither daily mean cortisol levels nor evening cortisol levels changed noticeably or significantly over time. The cortisol awakening response (data not shown) also did not change significantly over time.

Mean body mass index (BMI) before surgery for all participants was 43.2 kg/m^2 (SD = 5 kg/m^2). Mean weight before surgery was 123.9 kilograms (SD = 16.1 kilograms). Mean weight loss at 3 and 6 months from baseline was 19.9 kilograms (SD = 6.4 kilograms) and 26.9 kilograms (SD = 9.7 kilograms), respectively. Mean percent of weight loss was 16% (SD = 5%) at 3 months and 22% (SD = 7%) at 6 months.

Relationships among CSA, Diurnal Cortisol Secretion, and Weight Loss

Correlation coefficients among the CSA measures, the aggregate diurnal cortisol measures at each measurement point, and percent of weight loss at six months are found in Table 1. Congruent with predictions made in the introduction, our main interest was in three sets of correlations: (1) the CSA measures and the aggregate diurnal cortisol measures at baseline, (2) the CSA measures and percent of weight loss, and (3) the aggregate diurnal cortisol measures at baseline and percent of weight loss. Beginning with the first set of correlations, positive moderate—but nonsignificant—correlations were observed between the CSA subscale score and baseline levels of the morning cortisol peak (r = 0.43, p = .11), evening cortisol (r = 0.49, p = .07), and daily mean cortisol (r = 0.47, p = 0.08). In contrast, the significant

TABLE 1 Correlation Coefficients (*p* values) among Measures of Childhood Sexual Abuse, Diurnal Cortisol Secretion, and Weight Loss in Bariatric Surgery Patients ($n = 17$)

Measure	CSA subscale	CTQ total	%WL: 6 months
CSA subscale	1		
CTQ total	0.450 (0.070)	1	
%WL: 6 months	0.257 (0.319)	.501* (0.041)	1
Morning cortisol[a] baseline	0.430 (0.110)	0.223 (0.423)	0.057 (0.840)
Morning cortisol[a] 3 months	0.317 (0.231)	−0.261 (0.329)	−0.122 (0.651)
Morning cortisol[a] 6 months	0.035 (0.904)	0.104 (0.724)	0.060 (0.839)
Evening cortisol[b] baseline	0.489 (0.065)	0.030 (0.916)	−0.149 (0.597)
Evening cortisol[b] 3 months	−0.270 (0.331)	−0.425 (0.114)	−0.232 (0.406)
Evening cortisol[b] 6 months	−0.044 (0.886)	0.324 (0.280)	0.092 (0.766)
Daily mean cortisol baseline	0.471 (0.076)	0.138 (0.625)	−0.002 (0.996)
Daily mean cortisol 3 months	−0.054 (0.848)	−0.617* (0.014)	−0.297 (0.283)
Daily mean cortisol 6 months	0.011 (0.971)	−0.306 (0.309)	−0.255 (0.401)
Cortisol awakening response[c] baseline	−0.339 (.217)	−0.524* (.045)	−0.242 (.386)
Cortisol awakening response[c] 3 months	0.179 (.523)	−0.355 (.194)	0.036 (.898)
Cortisol awakening response[c] 6 months	−0.127 (.680)	0.246 (.418)	0.198 (.516)

Note. CSA subscale = raw Childhood Sexual Abuse subscale score from the Childhood Trauma Questionnaire (Bernstein & Fink, 1998); CTQ total = raw total score from the Childhood Trauma Questionnaire (Bernstein & Fink, 1998); %WL = percent of weight loss; baseline = 1 to 2 weeks before bariatric surgery; 3 months = 3 months after surgery; 6 months = 6 months after surgery.

[a]Highest salivary cortisol level before 12:00 p.m. [b]Salivary cortisol level at 10:00 p.m. [c]Area under the curve with respect to increase.

*Correlation is significant at the .05 level (2-tailed).

relationship between the CTQ total score and the baseline cortisol awakening response was in the opposite direction ($r = -.52$, $p = .04$).

For the second set of correlations of interest, the relationship between the CTQ total score and percent of weight loss at six months was significant, but the direction was unexpectedly positive ($r = 0.50$, $p = 0.04$). Finally, for the third set of correlations of interest, there were no significant relationships between the aggregate diurnal cortisol measures at baseline and percent of weight loss at six months.

Several of the remaining correlation results presented in Table 1 deserve mention. To begin, the value for the correlation coefficient between the CSA subscale and the total CTQ score ($r = 0.45$, $p = 0.07$) suggests a relationship between the two without redundancy. A second observation is that the moderate relationships between the CSA subscale and the aggregate diurnal cortisol measures at baseline were greatly diminished at six months after surgery. Third, the CTQ total score, which was not related to any of the aggregate diurnal cortisol measures at baseline, negatively and significantly correlated with daily mean cortisol ($r = -0.62$, $p = 0.01$) at three months after surgery. Finally, while none of the aggregate diurnal cortisol secretion measures at baseline correlated to percent of weight loss, small effect sizes (Cohen, 1992) were observed between percent of weight loss and evening cortisol at three months ($r = -0.23$, $p = 0.41$), daily mean cortisol at three months ($r = -0.30$, $p = 0.28$), and daily mean cortisol at six months ($r = -0.26$, $p = 0.40$).

Gastric band patients lose weight slower than other bariatric surgery patients (O'Brien & Dixon, 2005), so we conducted further analysis of non-gastric-band participants only ($n = 14$). Using this subsample did not result in meaningful changes in effect sizes; therefore, the results are not presented here. We also explored an analysis of female participants exclusively ($n = 14$) and found no meaningful differences in results.

Diurnal Patterns of Cortisol Secretion Before and After Bariatric Surgery

The mixed models showed no significantly different diurnal patterns of cortisol secretion across the three measurement points. The linear and quadratic slopes of cortisol throughout the day were compared, and no differences were found between baseline, three months, and six months after surgery ($p > .05$). As reported, morning cortisol peak levels as an aggregate measure increased over time, but the change was not significant.

DISCUSSION

Obese individuals who experienced CSA may constitute a special subset of the obese population, as distinguished by lifelong changes in HPA axis regulation. Bariatric surgery patients are not representative of the obese population as a whole, but they did provide access to a population of obese individuals scheduled to undergo surgery to lose weight. We explored relationships among CSA, diurnal patterns of cortisol secretion (our measure for HPA axis regulation) before and after surgery, and weight loss. CSA was measured by the CSA subscale from the CTQ and by the CTQ total score (Bernstein & Fink, 1998). Diurnal patterns of cortisol secretion were assessed by nine salivary cortisol specimens collected daily for three consecutive days at each measurement point. Weight loss data were obtained from the clinic database.

Despite higher scores on the CSA subscale than normative data for the general population, the proportion of our sample that fell into the moderate to severe CSA categories (about a quarter) was less than the one-third found in other studies of bariatric surgery patients that used the CTQ (Grilo et al., 2006; $n = 137$; Wildes et al., 2008; $n = 230$). One major difference between these studies and our study (other than sample size) was the considerably higher mean BMIs of their samples before surgery (BMI = 51 kg/m^2 vs. 43 kg/m^2 in the present study). Rates for CSA could be higher in heavier populations of bariatric surgery patients, although we are unaware of any studies on the topic.

Results for our first aim suggested that higher CSA subscale scores were associated with greater baseline cortisol levels. Although the correlations were nonsignificant, their positive direction is consistent with evidence that elevated glucocorticoid hormones are a factor in stress-related eating and weight gain (Adam & Epel, 2007; Dallman, 2010; Dallman et al., 2005). At the same time, greater CTQ total scores were associated with lower baseline cortisol awakening responses. Research suggests the cortisol awakening response is independent of other measures of diurnal cortisol secretion (Smyth et al., 2013). It is possible the cortisol awakening response is more a marker of developmental stress (e.g., Meinlschmidt & Heim, 2005) than a marker for a potential biological pathway to obesity. Taken together, our findings of moderate relationships between the measures of CSA and diurnal cortisol secretion at baseline provide preliminary support for the hypothesis that obese individuals who experienced CSA are characterized by long-lasting changes in HPA axis regulation and cortisol secretion.

The significant positive relationship between the CTQ total score and weight loss was not expected. Rather, we expected the reverse relationship between our measures of CSA and weight loss. As a preliminary result derived from a relatively small sample, this finding may have been a result of chance rather than a true correlation. If a future fully powered study supports the existence of a true positive correlation, the fact that individuals with a higher CTQ total score lose weight at a faster rate may not necessarily reflect a desirable outcome for bariatric surgery. Bariatric surgery patients can develop an eating disorder or other eating problem that manifests as refusing to eat adequately following surgery, resulting in malnourishment and loss of mean muscle mass (Ayad & Martin, 2007).

Finally, no significant relationships between diurnal cortisol secretion at baseline and weight loss emerged from the study findings. If altered HPA axis regulation and changes in cortisol production related to the stress of CSA favor weight gain, then it is reasonable to suspect they would interfere with weight loss. However, the findings did not support these expectations. On the other hand, a couple of small correlation effect sizes were found among measures of diurnal cortisol secretion *after surgery* and weight loss. Small effect sizes found in pilot studies like ours with a small sample size are liable to have a positive bias (Hertzog, 2008). Nonetheless, a true small population effect size between diurnal cortisol secretion and weight loss, corroborated by a fully powered study, would be clinically relevant given the many other factors that are associated with body weight and weight loss.

It is notable that in several cases, CSA subscale score correlation coefficients differed markedly from CTQ total score correlation coefficients when correlated with the same measures of diurnal cortisol secretion. For example, there were positive relationships between the CSA subscale score and baseline morning, evening, and daily mean cortisol levels, but no discernable relationships between the CTQ total score and the same baseline cortisol levels. Higher CTQ total scores can be interpreted as a function of both (a) greater frequency of abuse and neglect and (b) the experience of multiple forms of abuse and neglect. Therefore, these contrasting results may be explained by the other CTQ abuse and neglect subscales and their relationships with the diurnal cortisol measures, a topic for further research.

Our second aim was designed to determine the effect of bariatric surgery itself on diurnal patterns of cortisol secretion for the entire sample and thus lend further insights into the findings of the first aim. Statistical power was optimized by using a mixed model approach to take advantage of the more than 1,000 salivary cortisol samples collected. No differences were found in diurnal patterns of cortisol secretion, which reflects either a null effect or high variability. The latter possibility merits further investigation because one of the aggregate diurnal cortisol measures—morning cortisol—did show a small, nonsignificant rise following surgery. Valentine and colleagues (2011) also found a rise in morning cortisol after surgery, which was significant for their sample ($n = 24$). A higher morning cortisol could be interpreted as an improvement in physiological health following bariatric surgery, as evidenced by a steepening of the downward curve of diurnal cortisol secretion. This is because a flatter curve is often associated with chronic health disorders, including obesity (Kumari, Chandola, Brunner, & Kivimaki, 2010; Lasikiewicz, Hendrickx, Talbot, & Dye, 2008).

The limitations of this pilot study need to be considered. First is the limited generalizability of the findings due to the use of a convenience sample. Generalizability is also limited by the low percent of men (18%) and non-Caucasian individuals (12%) included in the sample. Another limitation is the use of retrospective self-report for CSA measurement. Recall and reporting biases are major concerns when retrospective self-reports of childhood abuse and neglect are used in research (Widom, Raphael, & DuMont, 2004). Yet retrospective self-report is a practical necessity when research participants are adults and the variable of interest is CSA. Therefore, the use of a psychometrically proven retrospective self-report measure, like the CTQ, is vital, but such instruments are not immune from reliability and validity concerns (Hardt & Rutter, 2004).

Additional limitations of this pilot study include small sample size, reliance on self-collected salivary cortisol specimens, and prospective data collection to only six months after surgery. These limitations can each be addressed in future studies by (a) a large enough sample for a fully powered study to determine the extent to which the preliminary findings of this present study are upheld, (b) the use of electronic chips on the caps of the saliva containers to verify timing of saliva specimen collection, and (c) weight loss measurement extended to at least one year after surgery. Future fully powered studies also need to statistically control for measures of diet, physical activity, and current stressors. Furthermore, it is important to have a large enough sample to analyze and, if necessary, to control for the effect of potential moderating variables like gender, type of bariatric surgery, and indicators of mental and physical health. Additional potential moderating variables include those that can affect resilience and healthy coping such as parental bonding, response to any disclosures, and counseling.

In conclusion, the results from this pilot study suggest that CSA is associated with long-lasting changes in diurnal patterns of cortisol secretion in bariatric surgery patients. These results are consistent with research in other populations of adults who experienced CSA. In addition, bariatric surgery in itself did not affect diurnal patterns of cortisol secretion during the first six months after surgery in the pilot study sample. However, the results on CSA and diurnal patterns of cortisol secretion when correlated with weight loss were not as straightforward. Fully powered studies based on the methods used for this pilot study are needed to corroborate and clarify these preliminary findings. Evidence that altered HPA axis regulation is a contributing factor to increased risk for adult obesity in those who experienced CSA could lead to novel interventions to prevent and treat obesity in these individuals.

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