

Increased salivary and hair cortisol and decreased salivary alpha-amylase concentrations in obese prepubertal girls

Chrysanthe Papafotiou¹, Eirini Christaki², Erica L.T. van den Akker³, Vincent L. Wester⁴, Filia Apostolakou⁵, Ioannis Papassotiriou⁵, George P. Chrousos² and Panagiota Pervanidou¹

¹University of Athens Medical School, Athens, Greece, ²University of Athens, School of Medicine, Athens, Greece, ³Erasmus MC, ⁴Erasmus MC, Rotterdam, Netherlands, ⁵Aghia Sophia Children's Hospital, Athens, Greece

Introduction

Obesity has been associated with perturbations of both the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system (SNS). Scalp hair cortisol has been recognized as a reliable index of long-term cortisol concentrations.

Objective

The aim of this study was to compare indices of HPA axis and SNS activities, such as, respectively, the salivary cortisol and alpha-amylase diurnal patterns, and their relations in obese and normal weight prepubertal girls. Furthermore, we compared cortisol concentrations in scalp hair between groups and investigated whether they are correlated with salivary cortisol concentrations

Participants

50 prepubertal girls completed the study

- Obesity Group (OG): 26 obese girls (BMI 24.6 ± 3.3 kg/m²)
- Normal Weight Group (NG): 24 normal weight girls (BMI 16.9 ± 1.6 kg/m²)
- Matched for age

Exclusion criteria:

- Tanner Stage > 1
- Syndromic obesity
- Use of medication or recent infection

Methods

- Five saliva samples were collected serially over a weekend day (at 9:00, 12:00, 15:00, 18:00, 21:00 hours)
- Cortisol and alpha-amylase concentrations were measured by electrochemiluminescence immunoassay and kinetic-reaction assay, respectively
- Areas Under the Curve with respect to ground (AUCg) for cortisol and alpha-amylase were calculated
- Cortisol and alpha-amylase linear correlations were investigated in each group
- Hair samples from the posterior vertex of the scalp were cut as close to the scalp as possible and analyzed for cortisol with LC-MS/MS-based method
- Cortisol was extracted overnight in methanol, followed by solid phase extraction. Quantification of cortisol was performed using a Waters Xevo TQ-S LC-MS/MS system
- BMI z-scores were calculated based on the contemporary Greek growth charts

Table 1. Basic population comparisons by group

	Obesity Group	Normal Weight Group	P value
Age (years)	7.4 (1.3)	7.8 (1.1)	0.206
BMI (kg/m ²)	24.6 (3.3)	16.9 (1.6)	<0.001**
BMI z-score	2.9 (1.3)	-0.1 (0.5)	<0.001**
Hair Cortisol (pg/mg hair)	4.1 (5)	1.2 (0.6)	0.008*

Student's t-test
Mann-Whitney for Hair Cortisol

Results

- Hair cortisol levels were higher in the obese than the normal-weight girls (p<0.05)
- A positive linear correlation between hair cortisol and BMI z-score was found (rho=0.319, p<0.05)
- Hair cortisol correlated positively with salivary cortisol at 12:00 (rho=0.417, p<0.05), salivary cortisol at 18:00 (rho= 0.338, p<0.05) and AUCg (rho=0.311, p<0.05)
- Significantly higher salivary cortisol concentrations at all time points and Area Under the Curve (AUCg) were observed in the OG (p<0.05)
- Inversely, salivary alpha-amylase at 12:00 & 15:00, as well as Area Under the Curve (AUCg) were significantly lower in the OG
- Negative linear correlations between cortisol and alpha-amylase were found (p<0.05) only in the obesity group

Figure 1. Hair cortisol concentrations between groups (p=0.008_)

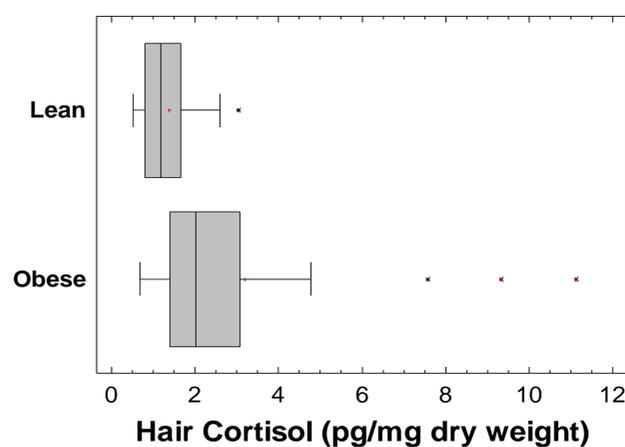


Table 2. Hair Cortisol correlations

BMI z-score	r=0.319	p=0.037*
Salivary Cortisol 12:00	r=0.417	p=0.008*
Salivary Cortisol 18:00	r=0.338	p=0.033*
Salivary cortisol AUCg	r=0.311	p=0.048*
Spearman's rho		*p<0.05

Figure 2. Salivary cortisol at each time point in obese and normal weight girls (p<0.05 for both groups (Anova-repeated measures))

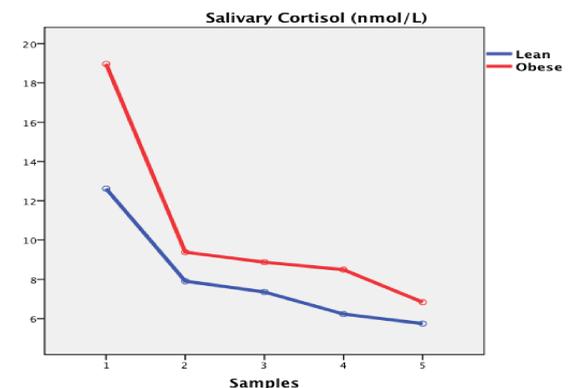
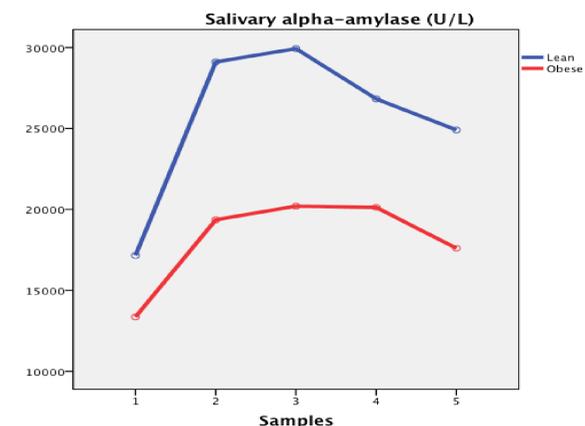


Figure 3. Salivary alpha-amylase at each time point in obese and normal weight girls p<0.05 for sAA at 12:00 and 15:00



Conclusions

- Obese prepubertal girls demonstrated changes in both salivary cortisol and alpha-amylase diurnal secretions compared to normal weight controls
- These results suggest altered stress system function in the obese group
- Increased hair cortisol concentrations and positive correlations with salivary measurements suggest chronic stress-related activation of the HPA axis in obese girls
- Hair cortisol appears to be a sensitive measure of hypercortisolism in obesity.

References

- Chrousos GP. Stress and disorders of the stress system. Nature reviews Endocrinology. 2009;5(7):374-81
- Veldhorst MA, Noppe G, Jongejan MH, Kok CB, Mekic S, Koper JW, et al. Increased scalp hair cortisol concentrations in obese children. The Journal of clinical endocrinology and metabolism. 2014;99(1):285-90.
- Pervanidou P, Bastaki D, Chouliaras G, Papanikolaou K, Laios E, Kanaka-Gantenbein C, et al. Circadian cortisol profiles, anxiety and depressive symptomatology, and body mass index in a clinical population of obese children. Stress. 2013;16(1):34-43
- Pervanidou P, Chrousos GP. Metabolic consequences of stress during childhood and adolescence. Metabolism: clinical and experimental. 2012;61(5):611-9

Sources of research support

The authors declare that there are no conflicts of interest. This study received no private or corporate financial support. This work was supported by University of Athens and the "Aghia Sophia" Children's Hospital in Athens, Greece

