Baseline cortisol concentrations are negatively associated with the resulting oxidative stress from an acute exercise bout, in pre- and early pubertal boys

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Abstract

Background: Little data exist regarding the hypothalamic – pituitary- adrenal (HPA) axis activation following an acute aerobic exercise bout in children, while virtually no data exist regarding the interplay between the HPA axis and markers of pro- and anti-oxidation in children

Objective and hypothesis: To investigate the association of HPA axis with markers of pro- and anti-oxidation at baseline and their change and correlations during acute aerobic exercise in normal weight and obese pre- and early-pubertal boys.

Method: 76 healthy pre- and early-pubertal, normal weight and obese boys, underwent a baseline blood sampling followed by an aerobic exercise bout until exhaustion at 70% VO_2max and a subsequent (post-exercise) sampling for the measurement of pro-oxidation markers (TBARS, PCs); anti-oxidation markers (GSH, GSSG, GPX, Catalase, TAC) and hormones (ACTH and cortisol).

Results: No difference was found between baseline and post exercise ACTH and cortisol concentrations in all subjects groups. Baseline pro-oxidation markers were greater in obese than normal weight subjects, whereas the reverse was true for anti-oxidation markers. Post-exercise concentrations of pro- and anti-oxidation markers, were significantly different compared to baseline in all subjects groups. Baseline cortisol concentration was the best predictor of post exercise catalase concentrations ($P<0.05$; $b=0.47$). Waist circumference followed by baseline cortisol concentrations were the best predictors positive and negative respectively, of post exercise TBARS concentrations ($P<0.05$; $b=0.74$ $b=-0.37$)

Conclusion: Aerobic exercise bouts of greater duration and/or intensity are required to activate the HPA axis than the one employed in the present study. Furthermore the negative association of baseline cortisol with post-exercise oxidative stress might imply the association of the anti-inflammatory hormone in keeping the organism in an adaptive state.

Introduction

Oxidative stress: defines a state of imbalance between pro- and anti- oxidation within the cell. Oxidative stress in humans has been associated with obesity and resulting co-morbidities. Childhood obesity has been associated with oxidative stress even before co-morbidities occur.

Pro-oxidation: refers to mitochondrial and non-mitochondrial mechanisms, which generate reactive oxygen and nitrogen species (RONS).

Anti-oxidation: refers to the adaptive activation of enzymatic and/or non-enzymatic mechanisms, which scavenge pro-oxidants and their products within cells and in extracellular body fluids.

Obesity: A modern day epidemic characterized by increased pro- and reduced anti-oxidation, even in children

Exercise: A potent stimulus of pro- and anti-oxidation mechanisms, and the HPA axis.

Aim of the study was to investigate the pro- and anti-oxidation mechanisms in pre- and early puberty regarding the presence of obesity as well as their possible association with the HPA axis, seventy-six pre- and early pubertal normal weight and obese boys were studied at baseline and after an acute bout of aerobic exercise at 70% of maximal oxygen consumption (VO_2max). Markers of the hormonal axes, of pro- and anti- oxidation were measured.

Methods

Subjects and Methods

Protocol

The study was approved by the Institutional Review Board and was conducted in accordance with the Declaration of Helsinki as revised in 1996. Informed written consent was obtained from the parent/guardians of each child while children gave verbal consent to participate in the study. The protocol was performed in two visits separated by two weeks in a university ergophysiology laboratory.

First visit (subject selection and maximal oxygen consumption measurement)

Exclusion criteria: a) exercise additional to that included in the school time-table, b) nutritional intervention within the six months preceding this study, c) history of diabetes, insulin resistance, dyslipidemia, cardiovascular disease, and hypertension or other known chronic pathology.

Obesity: BMI calculation and comparing to the standard BMI curves for the greek pediatric population, according to the International Obesity Task Force (IOTF) criteria. Subjects were considered normal weight or obese when their projected BMI value for the age of 18 years was lower than 25 kg/m^2 or between 30 and 35 kg/m^2, respectively.

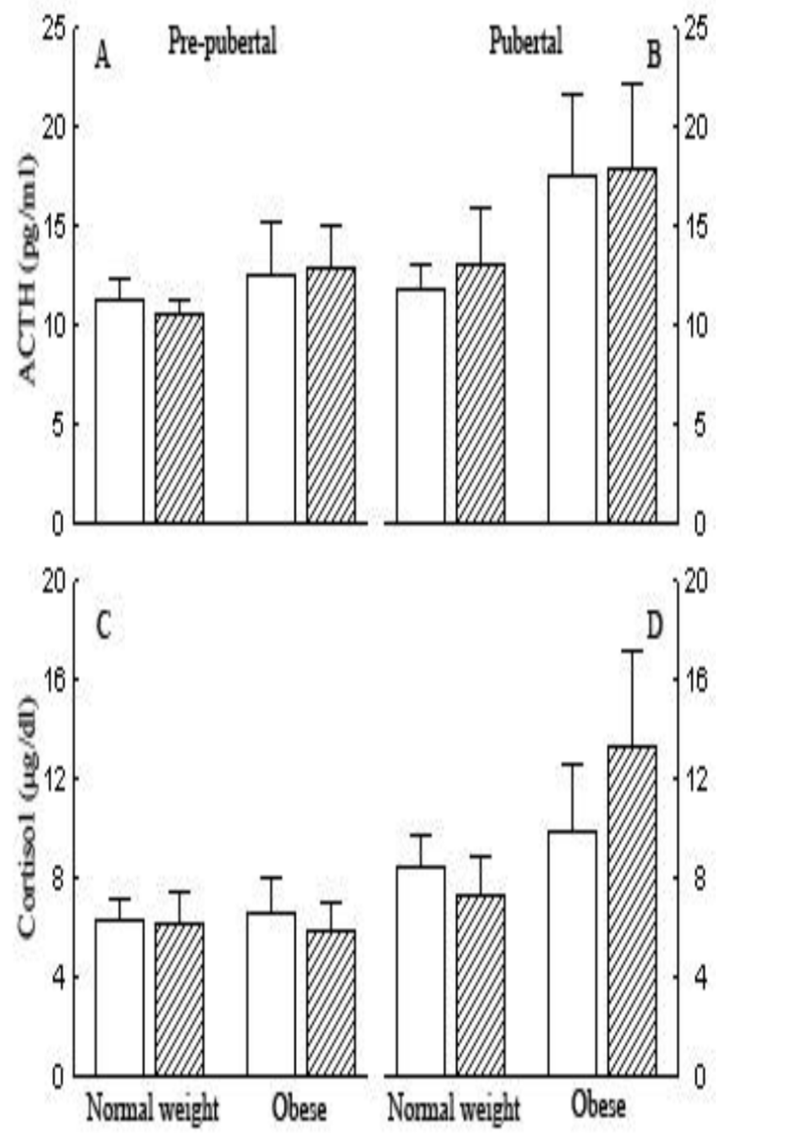
Puberty: Subjects with at least 3-4ml testicular volume and testosterone concentration greater than 0.2 ng/ml were considered as early pubertal.

Maximal oxygen consumption (VO_2max): Participants had their maximal oxygen consumption (VO_2max) measured, by performing a graded exercise test until maximum exercise tolerance on a stationary cycle ergometer (Monark 834E, Sweden. Open-circuit spirometry *via* continuous breath-by-breath analysis (averaged every 30s) was used to measure VO_2max with an automated online pulmonary gas exchange system (SensorMedics 2900c, SensorMedics Corporation, USA). Heart rate, 12-lead electrocardiogram, blood pressure and ratings of perceived exertion were monitored continuously throughout testing and during recovery. VO_2max was attained if: a) subject reached exhaustion (a pedaling rate <60revolutions/min), b) respiratory exchange ratio was ≥1.10, c) a VO_2 plateau was observed (<2mL/kg/min) despite further increases of the workload, d) heart rate exceeded 200 beats/min.

Second visit (Baseline sampling, aerobic exercise bout and post-exercise sampling)

During their second visit, a baseline blood sampling was performed and following that all participants completed successfully an acute bout of aerobic exercise on a stationary cycle ergometer (Monark 834E, Sweden) until exhaustion (a pedalling rate < 60 revolutions/min) at an intensity corresponding to 70% of their VO_2max. After the exercise bout a second (post-exercise) blood sampling was performed.

Results



Results: Pro- and anti-oxidation data have already been published (1). No difference was found between baseline and post exercise ACTH and cortisol concentrations in all subjects groups. Baseline pro-oxidation markers were greater in obese than normal weight subjects, whereas the reverse was true for anti-oxidation markers. Post-exercise concentrations of pro- and anti-oxidation markers, were significantly different compared to baseline in all subjects groups.

Predictors: Baseline cortisol concentration was the best predictor of post exercise catalase concentrations ($P<0.05$; $b=0.47$). Waist circumference followed by baseline cortisol concentrations were the best predictors, positive and negative respectively, of post exercise TBARS concentrations ($P<0.05$; $b=0.74$ $b=-0.37$)

Conclusions

In the present study after an acute bout of aerobic exercise, no change of ACTH or Cortisol were noted, while the concentrations did not differ between normal-weight and obese or pre- and early- pubertal boys. Aerobic exercise bouts of greater duration and/or intensity are required to activate the HPA axis than the one employed in the present study (2-3). Furthermore the negative association of baseline cortisol with post-exercise oxidative stress might imply the association of the anti-inflammatory hormone in keeping the organism in an adaptive state.

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Adrenals and HPA Axis
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