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 1989. Informed consent was obtained from the parents of each child and children gave verbal consent to participate in the study. The protocol was performed in two visits separated by two weeks in a university in exprophanology 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, nephropathy, cardiovascular diseases, and hypertension or other known chronic pathologies.

Obesity: BMI calculation and comparing to the standard BMI curves for the Greek pediatric population, according to the International Obesity Task Force (IFT) criteria.

Subjects were considered normal weight or obese if their projected BMI value for age of 18 years or lower was below 20 kg/m² or between 20 and 30 kg/m², respectively. To investigate the pro-oxidation mechanisms, the GH axis (potentiated along puberty) and various components of the HPG axis.

Subjects characteristics are shown in Table 1.

Growth hormone axis (GH).

In all subjects taken as a single group, forward stepwise multiple regression analysis was performed to identify independent predictors of the post-exercise concentrations of TAC, and of IGF1/IGFBP3 ratio, LH and testosterone, and the oxidized glutathione (GSSG) concentrations and glutathione (GSH).

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). Open circuit spirometry via continuous breath-by-breath analysis (averaged every 3 s) was used to measure VO₂max with an automated online pulmonary gas exchange system (SensorMedics 2900, SensorMedics Corporation, USA). Heart rate, 12-lead electrocardiogram, blood pressure and profiles of glycemic exercise were monitored continuously throughout testing and during recovery. VO₂max was obtained if: a) subject reached exhaustion (a pedaling rate of 120–150) and B) respiratory exchange ratio was 1.0 and post-exercise (at 5 min) was observed (<0.75) until further increases of the workload, d) heart rate exceeded 200 beats/min, respectively.

Discussion

Following an acute bout of aerobic exercise both pro- and anti-oxidation mechanisms are stimulated in normal weight and obese pre- and early pubertal boys. The anti-oxidant capacity of the organism improves with the onset of puberty. This might be related to the finding that GH is positively associated with anti-oxidation at baseline and post-exercise. Obese subjects demonstrate greater and lower pro- and anti-oxidation mechanisms, respectively, than normal-weight subjects, while also demonstrating lower GH concentrations. These observations provide on one hand a conceptual link between early pubertal obesity and increased pro-oxidation, highlighting the deleterious potential of obesity, on the other hand they suggest the implication of pubertal physiological mechanisms in the maturation of anti-oxidation.

In conclusion, moderate acute aerobic exercise is a good model for the study of pro- and anti-oxidation mechanisms in children and adolescents. The suggested maturation of the anti-oxidation mechanisms during the transition to early puberty in humans should be studied further. Therefore, studies in the future need to investigate the interplay between exercise-related, onset of puberty and energy consumption and storage, especially regarding the increasing prevalence of obesity in the pediatric population.