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Oxidative Stress Index Levels in Asian Adolescents with Exogenous-Constitutional Obesity

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Abstract

The aim of this research was to evaluate the integral oxidative stress index (OSI) level in Asian girls and boys with exogenous-constitutional obesity.

Methods and Results: A total of 170 Asian adolescents aged 12-18 years were examined: 26 girls and 28 boys with constitutional obesity (main group, MG); 59 girls and 57 boys - healthy adolescents (control group, CG). The levels of lipid peroxidation (LPO) products and antioxidant defense (AOD) parameters were detected using spectrophotometric and fluorometric methods. The level of LPO products and AOD components in the studied groups were assessed to calculate the integral OSI.

Significant increases in the levels of primary LPO products (conjugated dienes by 2.18 times) and secondary LPO products (ketodienes and conjugated trienes by 2.48 times) in the obese Asian girls, compared with the control values, were observed. We found a significant decrease in the parameters of the AOD system in the obese Asian girls, compared with the control values: α-tocopherol (by 1.41 times; P=0.0262), retinol (by 1.12 times; P=0.0306), and SOD activity (by 1.28 times; P=0.0004). In the obese Asian boys, increased values of LPO components were found, compared to controls: conjugated dienes (by 2.13 times; P<0.0001), ketodienes and conjugated trienes (by 3.4 times; P<0.0001), final thiobarbituric acid reactants of LPO (by 1.24 times; P=0.0358). They showed a statistically significant decrease in the level of α-tocopherol (by 1.49 times; P=0.01), compared with the control values. According to the obtained data, OSI in the group of Asian girls with obesity was 15.68 units, in the group of Asian boys with obesity - 22.89 units. The OSI in the group of Asian boys was significantly higher (by 1.46 times; P=0.0492) than in the obese girls.

Conclusion: Certain OSI levels are consistent with the presence of antioxidant insufficiency in exogenous-constitutional obesity and allow us to specify and evaluate the ethnic aspect of the severity of the pathological process more reliably.(**International Journal of Biomedicine. 2022;12(1):142-146.**)

Key Words: adolescents • obesity • lipid peroxidation • oxidative stress index

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Abbreviations

AOD, antioxidant defense; **BMI, b**ody mass index; **CDs,** conjugated dienes; **GSH,** reduced glutathione; **GSSG,** oxidized glutathione; **KD-CT,** ketodienes and conjugated trienes; **LPO,** lipid peroxidation; **OS,** oxidative stress; **OSI**, oxidative stress index; **SOD,** superoxide dismutase; **TBARs**, thiobarbituric acid reactants; **WHO,** World Health Organization.

Introduction

Obesity is a chronic disease, heterogeneous according to etiology and clinical data, and has a progressive course, characterized by excessive deposition of adipose tissue in the organism.[1] It has been established that in adolescents with obesity, this diagnosis persists into adulthood in 90% of cases. Various comorbid pathologies are associated with obesity,

including cardiovascular disorders and diabetes mellitus.[2,3] The complications of obesity in childhood and adolescence are no less severe and include disorders of carbohydrate and lipid metabolism, liver morphological changes (fatty hepatosis), arterial hypertension, sexual development disorders, etc.[4]

According to WHO data, about 41 million children under 5 years of age are overweight or obese; 340 million children from 5 to 19 years of age are obese.[1] This trend is equally characteristic for children and adolescents of both sexes.[5] In Russia, more than 500,000 adolescents with obesity have been registered at the present time.[6] There is also a direct correlation between the incidence of obesity and territorial and ethnic factors.[7-11] Thus, the level of adolescent obesity is high in the Volga, Southern, Siberian, Central, and Northwestern Federal Districts.[6] The largest number of obesity cases in rural areas is in the Republic of Adygea, while in the Republic of Mari El, the share of obese children is very low (0.4%).[5] According to the Federal State Statistics Service of the Russian Federation for 2016, the prevalence of obesity in the Siberian Federal District is 14.8 per 1000, in the Republic of Buryatia - 13.8 per 1000, in the Irkutsk region - 18.8 per 1000 population.[12]

The study of the molecular mechanisms of obesity formation in adolescence is topical.[13] One of the pathogenetic mechanisms of obesity is the activation of OS reactions and the decrease of antioxidant defense (AOD) activity.[14-16] The increased content of products of the lipid peroxidation (LPO) process can have a multilateral damaging effect on different cellular structures and contribute to a more severe course of the disease. The calculation of integral index has recently been considered the most optimal way to assess disorders in this system.[10,14] The study of OS reactions in indigenous peoples of the Russian Federation adolescents with obesity is interesting.

The aim of this research was to evaluate the integral oxidative stress index (OSI) level in Asian girls and boys with exogenous-constitutional obesity.

Materials and Methods

A total of 170 Asian adolescents aged 12-18 years were examined: 26 girls and 28 boys with constitutional obesity (main group, MG); 59 girls and 57 boys - healthy adolescents (control group, CG). The WHO classification of obesity in children and adolescents was used.[17] All participants belonged to the Buryat ethnic group and were examined, including anamnestic data collection, physical examination, anthropometric data analysis, laboratory analysis. Body mass index (BMI) was calculated using the Quetelet's formula. The quality, quantity, and regularity of food intake were evaluated. We considered the heredity in relatives of such diseases as type 2 diabetes, obesity, ischemic heart disease, arterial hypertension, and the presence of concomitant diseases. No patients took vitamins during the blood sampling period. Blood was taken from the ulnar vein in accordance with the existing requirements in the morning after an overnight fast.

The study complied with the ethical principles of World Medical Association Declaration of Helsinki (1964, ed. 2013) and it was approved by the Ethic Committee of Scientific Centre for Family Health and Human Reproduction Problems and all patients involved or their parents signed the informed consent agreement to participate in the study.

Blood samples (5 ml) were collected from the ulnar vein in standard vacuum tubes with EDTA. The erythrocyte population was separated from the other blood components by centrifugation at 1500 *g* for 5 min, at 4°C. The erythrocyte pellet was washed 3 times with a 0.9% (wt/vol) NaCl solution. Aliquots of plasma and washed erythrocytes were used immediately or kept frozen at -40°C, not exceeding one month. We estimated the LPO-AOD parameters by plasma concentrations of primary/secondary products of LPO (CDs, KD-CT, and TBARs) and *antioxidant parameters* (SOD activity, GSH, GSSG, α-tocoferol, and retinol). The concentration of CDs and KD-CT was detected at 232nm in plasma heptane extracts.[18] For conversion of absorption units to μmol/L, we used the coefficient of molar absorption ($K=2.2\cdot10^5 M^{-1}C^{-1}$). TBARs levels were detected by fluorometry[19] and estimated in μmol/L. α-tocopherol and retinol levels were detected in plasma by fluorometry. Plasma levels of GSH, GSSG, α-tocopherol and retinol, as well as SOD activity in hemolysate were detected by fluorometry.[20-22] The measurements were conducted with a Shimadzu RF-1501 spectrophotometer (Japan) consisting of two blocks: a UV-1650PC spectrophotometer and a RF-1501 spectrofluorimeter. The level of LPO products and AOD components in the studied groups were assessed to calculate the integral OSI.[14] To measure the intensity of OS, the integral OSI) was calculated (the ratio of the LPO-AOD system indicators in the MG to average indicators in the CG).

Statistical analysis was performed using the Statistica 8.0 software package (Stat-Soft Inc., USA). For descriptive analysis, results are presented as mean±standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. Differences of continuous variables departing from the normal distribution, even after transformation, were tested by the Mann-Whitney *U*-test. A probability value of $P<0.05$ was considered statistically significant.

Results and Discussion

The level of LPO products and AOD components in the studied groups were assessed to calculate the integral OSI.

Significant increases ($P<0.0001$) in the levels of primary LPO products (CDs by 2.18 times) and secondary LPO products (KD-CT by 2.48 times) in the obese Asian girls, compared with the control values, were observed (Figure 1). We found a significant decrease in the parameters of the AOD system in the obese Asian girls, compared with the control values: α-tocopherol (by 1.41 times; $P=0.0262$), retinol (by 1.12 times; $P=0.0306$), and SOD activity (by 1.28 times; $P=0.0004$) (Figure 1).

In the obese Asian boys, increased values of LPO components were found, compared to controls: CDs (by 2.13 times; $P<0.0001$), KD-CT (by 3.4 times; $P<0.0001$), final TBA-active products of LPO (by 1.24 times; $P=0.0358$) (Figure 2). They showed a statistically significant decrease

in the level of α-tocopherol (by 1.49 times lower; *P*=0.01), compared with the control values.

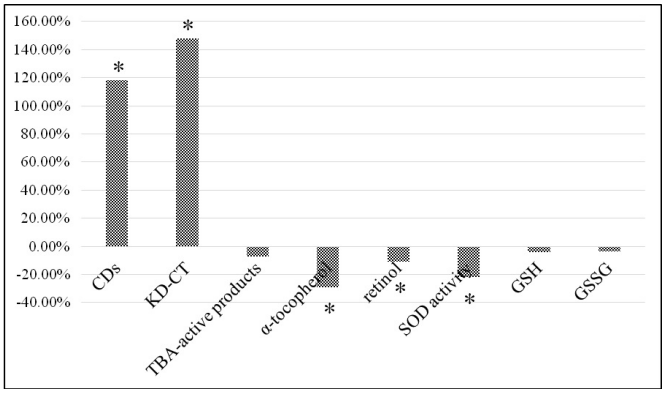

Fig. 1. *Changes in LPO-AOD parameters in the obese Asian girls.*
**-P<0.05 between the obese Asian girls and control values.*

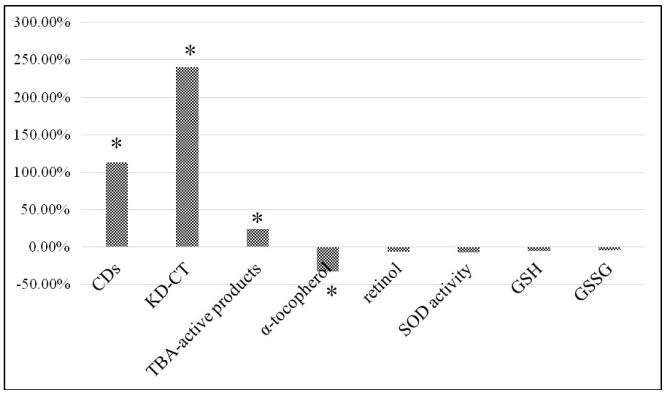

Fig. 2. *Changes in LPO-AOD parameters in the obese Asian boys.*
**-P<0.05 between the obese Asian boys and control values.*

Analysis of changes in LPO products in the adolescents with obesity confirmed the high activity of pro-oxidant reactions in this pathology. Taking into consideration the significance of LPO products as mediators of intercellular interactions, as well as adaptation mechanisms, the increased concentrations of these parameters can also be considered as a factor of disadaptation.[23] The indicated changes were similar to those in obese Caucasians, which we noted in earlier studies.[8,10,15]

In Asian adolescents with obesity, the decrease in AOD factors was also similar to that of Caucasians, with a lower content of fat-soluble vitamins. Obviously, the deficiency of any vitamin, and the combined insufficiency of a number of antioxidants, disturbs the activity of enzymatic processes and depends on the physiological functions that hinder the course of adaptive reactions. Especially, negative consequences can have insufficient antioxidant vitamins in adolescent girls because of the known diverse effects of these factors on the female reproductive system.[24] The important role of antioxidant vitamins as regulators of tissue growth and morphological differentiation is noted, so it is an extremely important registered high tension in this link of metabolism in adolescents with adiposity. Analysis of activity in the enzymatic part of the AOD system showed a decrease in the activity of the antioxidant enzyme SOD in Asian girls with obesity. This enzyme acts at the initial stage of superoxide anion radical neutralization and is the most important factor of the initial effect of the AOD system.[21] A decrease in its activity can be regarded as a factor of more intensive development of antioxidant deficiency.

Several mechanisms for the OS development in obesity have currently been established: an increase in proinflammatory cytokines and free fatty acids as substrates for LPO, and the involvement of biologically active adipokines in the development of pathological processes.[16,23] Activation of LPO reactions in obesity is also associated with a deficiency in exogenous antioxidants, occurring on the background of excessive intake of fats and carbohydrates.[27] Because of the above-mentioned processes, there is an increase of LPO products in the obese patient's blood, which we observed in the Asian adolescent groups.

Due to the frequently occurring, multidirectional changes in the LPO-AOD system in the development of various pathological conditions, it seems optimal to use the integral OSI. For this purpose, we applied the formula to calculate the OSI in our modification.[14] This formula takes into account not only the accumulation of LPO products at various stages but also the activity of various parts of the AOD system.

According to the obtained data, OSI in the group of Asian girls with obesity was 15.68 units, in the group of Asian boys with obesity - 22.89 units (Figure 3). The OSI in the group of Asian boys was significantly higher (by 1.46 times; *P*=0.0492) than in the obese girls.

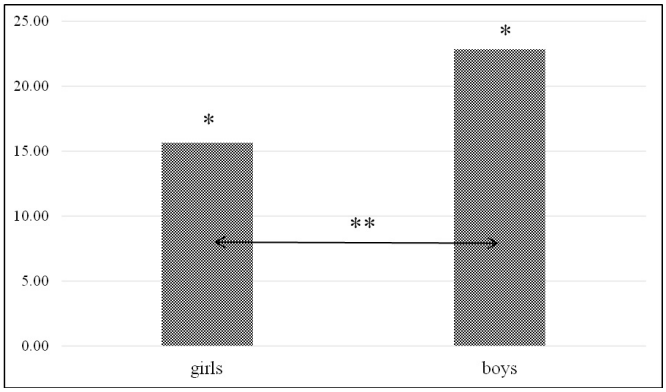

Fig. 3. *OSI in the obese Asian girls and boys*
**-P<0.05 between the obese Asian boys/girls and control values; **-P<0.05 between the obese Asian boys and girls; control group data are taken for 0.*

These results confirm the presence of a pronounced AOD insufficiency against the background of the activation of pro-oxidant factors in obese Asian girls and boys. The revealed differences in the levels of metabolites of the LPO-AOD system in Asians may be associated with general trends in the health status of the indigenous ethnic group of

the Baikal region. Thus, according to our data, an increasing tendency to an increase in body weight has previously been registered among Asian adolescents, especially those living in rural areas.[28] In addition, the metabolic changes can be associated with changes in the diet of the Asian ethnic group, one of the physiological features of which has so far been the protein-lipid nature of the diet.[29] With this type of diet, there are peculiarities of enzymatic reactions at the level of the gastrointestinal tract, liver, and fat depots, and a corresponding increase in concentrations of total cholesterol and atherogenic lipoprotein fractions.[29,30] However, one can state that the nutritional structure of this indigenous population has undergone significant changes in recent decades. Undoubtedly, this can entail a drastic disturbance of established metabolic mechanisms and, consequently, destabilization of the population's health. As a consequence, an excess level of alimentary-dependent nosologies, particularly obesity, has been registered among Asians living in this territory, compared to the average Russian level.[30,31]

In conclusion, certain OSI levels are consistent with the presence of antioxidant insufficiency in exogenous-constitutional obesity and allow us to specify and evaluate the ethnic aspect of the severity of the pathological process more reliably. In the complex treatment of exogenous and constitutional obesity in adolescents, in addition to the normalization of lipid metabolism parameters, the appropriateness of prescribing a complex of antioxidant drugs according to the patient's ethnicity has been shown.

Competing interests

The authors declare that they have no competing interests.

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