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Adrenal Gland Hormones in Primary School Children

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It was found that in 8-9-year-old children, the hormonal part of the sympathoadrenal system more rapidly develops in boys, while the transmitter part develops more rapidly in girls. The androgenic and glucocorticoid function of the adrenal cortex matures earlier in girls. To the end of the school year, excretion of epinephrine and norepinephrine decreased, which attests to the development of fatigue.

Key Words: *adrenal gland cortex; primary school children; school year*

The sympathoadrenal (SAS) and pituitary–adrenal systems are the basic elements of the adaptive mechanisms in humans [2,3]. Hans Selye (1961) considered catecholamines as an important element of the stress reaction and the pituitary–adrenocorticotropic hormone–adrenal cortex axis as the key regulation system of the stress-reaction. Glucocorticoids hormones are essential regulators of the protein, lipid, and carbohydrate metabolism; androgens control physiological and sexual development and play an important role in adaptation to stress.

In 7-9-year-old children, hormonal regulation plays more important role in view of immaturity of the nervous regulation. It was found that the adrenal cortex response in the bicycle test depends on the baseline tone of the autonomic nervous system in children and is adequate to the baseline excretion of hormonal metabolites [4]. However, the interactions between catecholamines, glucocorticoids, and androgens in this age group under stress conditions determined by the beginning of school education (mental and emotional stress and hypokinesia) are poorly studied.

Here we evaluated age-related shifts in the concentrations of catecholamines, glucocorticoids, and androgens in 7, 8, and 9-year-old children during the school year.

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MATERIALS AND METHODS

The studies were carried out in general education schools Nos. 143 and 95 in Kazan in the beginning of the school year (in October) and in the end of it (in May). The study included 7-9-year-old children (59 girls and 64 boys; health groups I and II); the consent of parents and teachers was obtained. Daily urea was collected at home under parents' control. Catecholamines (epinephrine and norepinephrine) in 24-h urea were measured fluorometrically. Fluorescence was recorded on a BIAN-130 (M-800) fluorometer. Catecholamine standards (Sigma) were used. Catecholamine concentrations were calculated with consideration of diuresis. The level of 17-corticosteroids (17-CS) in the urea was measured by a colorimetrical method based on Zimmermann reaction in modification of M. A. Krekhova. Optical density of the solution was measured on a FEC-56PM photoelectrocolorimeter. The concentration of the 17-hydroxycorticosteroids (17-HCS) in urea was measured using Porter–Silber reaction in modification of N. A. Yudaev and M. A. Krehova on an SF16 spectrophotometer.

The data were processed statistically using a test based on the Student's *t* test.

RESULTS

Epinephrine excretion changes insignificantly in 7- and 8-year-old boys and more markedly increases by the age of 9 years (Table 1). Daily norepinephrine

TABLE 1. Excretion of Catecholamines and Androgen and Glucocorticoid Metabolites in 7-9-Year-Old Boys and Girls (*M±m*)

Age, years	Epinephrine, μg/day	Norepinephrine, μg/day	Norepinephrine/ epinephrine	17-CS, μmol/day	17-HCS, μmol/day
Boys					
7	7.37±0.32	18.87±1.61	2.10	11.73±1.24	4.26±0.88
8	7.01±0.27	17.20±1.56	2.45	12.50±1.65	4.58±0.48
9	8.18±0.37*	20.71±1.60	2.53	13.79±1.08	5.66±0.51
Girls					
7	7.26±0.44	14.46±1.21	1.99	8.73±1.56	4.04±0.21
8	6.52±0.62	13.68±1.62	2.09	8.52±2.12	3.93±0.25
9	6.89±0.53	19.86±1.81*	2.83	15.96±1.38*	6.97±0.66*

Note. *$p<0.05$ in comparison with younger age group. Age dynamics was evaluated by the data obtained in the beginning of the school year (October).

excretion in boys gradually increases. In 7-year-old girls, epinephrine excretion did not differ from that in boys of this age and even somewhat decreases by the age of 8-9 years, which attests to more rapid development of the hormonal part of the SAS in boys. Norepinephrine excretion in girls significantly increases during the period between 8 and 9 years, which attests to higher activity of the transmitter part of the SAS in girls.

The increase in the norepinephrine/epinephrine ratio reflects activity of the transmitter part of the SAS. This parameter significantly increases in girls during the period between 8 and 9 years, while in boys it changes gradually (Table 1).

The functional status of the adrenal cortex can be evaluated by the excretion of metabolites 17-CS (for androgens) and 17-HCS (for glucocorticoids). In boys, the excretion of 17-CS gradually increases during the period between 7 to 9 years (Table 1). It is known that androgens produce an anabolic effect. Body weight gain (7.95 kg) in boys was also found during this period, especially at the age of 8-9 years). In girls, body weight gain was significantly lower (3.84 kg), which can be explained by the catabolic effect of glucocorticoids.

The excretion of 17-CS in girls dramatically increases (from 8.73±1.56 to 15.96±1.38 μmol/day) to the age of 9 years, which confirms the key role of androgens in physical and sexual development of female organism [5]. The excretion of 17-HCS in girls significantly increases during the period between 8 and 9 years. Therefore, maturation of the androgenic and glucocorticoid function of the adrenal cortex occurs earlier in girls than in boys.

TABLE 2. Excretion of Catecholamines and Androgen and Glucocorticoid Metabolites in 7-9-Year-Old Boys and Girls at the Beginning and End of the School Year (*M±m*)

Age, years	Epinephrine, μg/day		Norepinephrine, μg/day		17-CS, μmol/day		17-OCS, μmol/day	
	October	April	October	April	October	April	October	April
Boys								
7	7.31±0.32	6.67±0.34	15.52±1.20	13.10±1.01	11.13±1.24	6.81±1.00*	4.26±0.88	3.86±0.71
8	7.01±0.27	6.53±0.21	17.20±1.56	12.75±1.12	12.50±1.65	14.81±1.8	4.58±0.48	5.04±0.94
9	8.18±0.37	6.70±0.26*	20.71±1.60	15.04±1.42*	13.79±1.08	15.97±1.42	5.66±0.51	5.60±0.67
Girls								
7	7.26±0.44	6.94±0.22	14.62±0.92	12.50±1.22	8.73±1.56	9.24±1.50	4.04±0.21	3.96±0.92
8	6.52±0.62	6.50±0.54	13.68±1.62	11.32±1.00*	8.52±2.12	9.00±1.96	3.93±0.25	3.83±0.27
9	6.89±0.53	6.62±0.40	19.86±1.81	12.75±1.34*	15.96±1.38	16.82±2.09	6.97±0.66	4.60±0.44*

Note. *$p<0.05$ in comparison with the corresponding parameters in October.

By the end of the school year, epinephrine excretion gradually decreases, especially in 9-year-old boys (Table 2). Norepinephrine excretion during the year decreases more significantly, which attests to the development of the fatigue in primary school children during their adaptation to school. The same trend was found for epinephrine and norepinephrine excretion levels in girls. High functional activity of SAS was described for 7-9-years-old girls in the beginning of the school year, which probably reflects seasonal variations in SAS activity. Excretion of androgen metabolites significantly decreased to the end of the school year, which contradicts the age tendency and confirms fatigue development in 7-year-old boys. In 8- and 9-year-old boys, we found an increase in 17-CS excretion adequate to their age. The tendency to increase on 17-CS level remains in 7-9-year-old girls.

There were no significant changes in 17-HCS excretion. Only in 9-year-old girls, 17-HCS excretion significantly decreased during the school year (Table 2). Inhibition of glucocorticoid function of the adrenal cortex protects girls from catabolic influence of these hormones. A kind of synchronism can be found in the shifts of sympathetic elements of SAS and glucocorticoid function of adrenal gland cortex. The decrease in norepinephrine excretion to the end of the school year attests to stress related to school education, while relatively stable rates of 17-HCS reflect higher stress-resistance of the pituitary–adrenal gland system in primary school children [1]. The only exception was 9-year-old girls, in whom the decrease in norepinephrine excretion was accompanied by a decrease in 17-HCS excretion, which attests to imperfection of the adaptive mechanisms in prepubescence.

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