Urinary chloride in adolescents: gender-related differences and relation to blood pressure

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To find gender-related differences in blood pressure (BP) and urinary chloride excretion as well as a relation between them, we monitored diurnal, overnight, and 24-h urinary chloride as well as BP hourly in 22 adolescent males and 22 adolescent females. To show a possible influence of sexual hormones on chloride excretion and BP, we also monitored 15 adolescent females during different phases of their menstrual cycle. To analyse urinary chloride, sodium, and potassium, we applied the method of ion-selective electrodes, using an EML-105 electrolyte analyser. Arterial BP was monitored with an automatic outpatient BP monitor (AUTO-CUFF).

The overnight systolic and pulse BP was significantly higher in males than in females. The diurnal pulse BP was significantly higher in males than in females at the beginning of follicular phase. The diurnal systolic, diastolic, and mean BP was significantly higher than nocturnal in all the groups studied. The overnight urinary chloride level in females at the beginning of the follicular phase was significantly lower than during ovulation. Urinary chloride level during luteal phase was comparable with that during ovulation. The total 24-h urinary chloride in the general group of males was significantly higher than in females at the beginning of follicular phase. In the general group of females, diurnal urinary chloride excretion negatively correlated with diastolic and mean BP, but such a correlation was absent in males. Overnight, on the contrary, the correlation between urinary chloride excretion and BP was absent in females, but it was positive in males. The diurnal and overnight urinary chloride excretion exhibited a negative correlation with BP in females during luteal phase. A correlation between overnight chloride excretion and mean BP was positive in males, but negative in females during luteal phase.

BP, urinary chloride excretion, and relation between them in adolescents are gender- and circadian cycle-related. Sexual hormones may play a role both in regulation of BP and urinary chloride excretion.

Key words: urinary chloride, blood pressure, adolescents, gender-related differences

INTRODUCTION

The findings on gender differences of hypertension risk have been confirmed by the results of studies performed during the last century. Men manifest a more marked predisposition to hypertension than women do (1, 2). Furthermore, it was suggested that genes on Y chromosome might contribute to gender-related variations in blood pressure (3).

In at least some "sensitive" individuals, NaCl can result in a significant increase of blood pressure. Clinical and experimental observations suggest the possible gender-related differences in the response of blood pressure to dietary NaCl due to the intermediate effects of the sex hormone pattern and genetic factors. The blood pressure changes evoked by the high dietary intake of NaCl are gender-related in children. An increase in mean blood pressure of 5 mm Hg or more, resulting from a high NaCl supplement (150 mmol/24-h for 10 days) was found in 31% of boys and in 18% of girls (4).

There are numerous data indicating that Cl^- anion metabolism, Cl^- transport across the cell

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membrane are related to blood pressure (2, 4, 5). Clinical and experimental observations suggest a possible difference in the female and male response to dietary NaCl (6, 7). Cl^- is an anion which, when given in excess in the diet, results in hypertension in salt-sensitive patients (8). Blood pressure increases in response to dietary NaCl loading, but not to equimolar sodium citrate (9), bicarbonate (10) or sodium phosphate loading (11).

A significant gender difference was shown in intracellular chloride level, Cl^- transport activity in vascular smooth muscle cells of male and female rats (12).

The purpose of our study was to reveal differences in chloride excretion in adolescent girls and boys, and particularly differences in Cl^- excretion with relationship to arterial blood pressure. This is important because salt sensitivity has been linked to chloride rather than to sodium, and because there has been very little studies of chloride metabolism as an insight into sex-related differences.

MATERIALS AND METHODS

We monitored the diurnal, overnight, and 24-h urinary chloride, sodium, and potassium in adolescents 14–17 years old (males n = 30, females n = 37).

In adolescent males (n = 22) and females (n = = 22), we also monitored BP hourly for 24 h. Mean BP = (systolic BP + 2 × diastolic BP)/3, pulse BP = = systolic BP – diastolic BP. The females were monitored irrespectively on the phase of their menstrual cycle.

To show a possible influence of sexual hormones on chloride excretion and BP, we monitored 15 adolescent females during different phases of their menstrual cycle. The monitored days included day 5 (follicular phase, (A) serum estrogens and progesterone are close to minimal), day 13 (ovulation, (B) serum estrogens are maximal), and day 20 (luteal phase, (C) serum progesterone is close to maximal).

Overnight urine was collected during first urination once after awakening in the morning and during awakenings at night if necessary. Diurnal urine was collected during all day, including last urination before bed. According to the protocol, the study persons were asked to bed at 10–11 p.m. and to rise at 7–8 a.m.

To analyse urinary chloride, sodium, and potassium, we applied the method of ion-selective electrodes using an EML-105 electrolyte analyser (Radiometer, Denmark). Arterial BP was monitored with an automatic AUTO-CUFF outpatient BP monitor (model *ABP-1001*, *Biotrac*, USA). We used average diurnal and overnight BP for calculations.

We investigated the relation of chloride excretion with sodium and potassium excretion as well as with BP, using correlation analysis. To show the statistical significance of difference between two means, we used the Student's t test.

Diurnal diuresis was 0.61 ± 0.3 l in adolescent males (n = 30) and 0.53 ± 0.27 l in the general group of adolescent females (n = 37). Overnight diuresis was 0.34 ± 0.17 l and 0.29 ± 0.15 l, respectively. 24-diuresis was 0.95 ± 0.37 l and 0.82 ± ± 0.34 l, respectively. When measured during different phases of menstrual cycle in adolescent females, diuresis was 0.51 ± 0.24 l (phase A), 0.6 ± ± 0.35 l (phase B), and 0.58 ± 0.31 l (phase C). Overnight diuresis was 0.33 ± 0.17 l, 0.25 ± 0.13, and 0.27 ± 0.14, respectively. 24-h diuresis was 0.84 ± 0.29 l, 0.85 ± 0.4 l, and 0.85 ± 0.4 l, respectively.

RESULTS

Urinary excretion of chloride

Table 1 presents data on the level of chloride and total chloride in diurnal, overnight, and 24-h urine. The overnight urinary chloride level in females during phase A of their menstrual cycle was significantly lower than during phase B. The urinary chloride level during phase C was comparable with that during phase B, and the difference between phases A and C was insignificant. Total diurnal and 24-h urinary chloride in the general group of boys was significantly higher than in girls during phase A. Other gender- and menstrual cycle-related differences in the diurnal, overnight, and 24-h urinary chloride level and total urinary chloride were insignificant.

Blood pressure

Table 2 presents data on diurnal and overnight BP. The overnight systolic and pulse BP was significantly higher in boys than in girls. This difference was noted between the general groups and persisted during all menstrual phases in girls. Diurnal pulse BP was significantly higher in boys than in girls during phase A of their menstrual cycle. Diurnal systolic, diastolic, and mean BP was significantly higher than nocturnal one in all investigated groups. The other gender- and menstrual phase-related differences in BP were insignificant. Circadian changes in pulse BP were insignificant also.

Correlation of total urinary chloride with total urinary sodium and potassium

Urinary chloride exhibited a strong correlation with urinary sodium (diurnal $r = 0.91$, $p < 0.05$ in ma-

Table 1. **Diurnal, overnight, and 24-h urinary level of chloride and total chloride**

Groups	Sample	Urinary chloride level (mmol/l)	Total urinary chloride (mmol)
Adolescent males	Diurnal	174 ± 65	99 ± 49
(n = 30)	Overnight	141 ± 60	45 ± 26
	24-h	164 ± 58	145 ± 53
Adolescent females,	Diurnal	167 ± 61	86 ± 47
irrespective of menstrual phase	Overnight	137 ± 63	40 ± 30
(n = 37)	24-h	155 ± 55	126 ± 65
Adolescent females,	Diurnal	148 ± 49	70 ± 29
menstrual phase A	Overnight	115 ± 54	35 ± 19
(n = 15)	24-h	129 ± 40	105 ± 38
Adolescent females,	Diurnal	158 ± 62	87 ± 41
menstrual phase B	Overnight	157 ± 48	39 ± 20
(n = 15)	24-h	157 ± 54	125 ± 53
Adolescent females,	Diurnal	150 ± 75	81 ± 41
menstrual phase C	Overnight	161 ± 98	39 ± 21
(n = 15)	24-h	151 ± 78	120 ± 59

Table 2. **Diurnal and overnight blood pressure**

Groups	Sample	Blood pressure (mm Hg)			
		Systolic	Diastolic	Mean	Pulse
Adolescent males	Diurnal	114 ± 9	77 ± 5	89 ± 6	37 ± 7
(n = 22)	Overnight	105 ± 9	65 ± 6	77 ± 6	40 ± 8
Adolescent females,	Diurnal	110 ± 9	76 ± 8	87 ± 8	34 ± 6
irrespectively on menstrual phase (n = 22)	Overnight	100 ± 6	66 ± 5	77 ± 5	34 ± 4
Adolescent females,	Diurnal	108 ± 9	77 ± 6	87 ± 6	32 ± 7
menstrual phase A (n = 15)	Overnight	98 ± 7	64 ± 4	75 ± 4	33 ± 6
Adolescent females,	Diurnal	109 ± 7	75 ± 5	86 ± 5	34 ± 7
menstrual phase B (n = 15)	Overnight	99 ± 6	64 ± 5	75 ± 5	34 ± 5
Adolescent females,	Diurnal	109 ± 8	74 ± 6	85 ± 7	34 ± 5
menstrual phase C (n = 15)	Overnight	97 ± 6	65 ± 5	76 ± 6	32 ± 5

les and $r = 0.95$, $p < 0.05$ in females; overnight $r = 0.91$, $p < 0.05$ in males and $r = 0.98$, $p < 0.05$ in females). The gender-related difference in the correlation between urinary sodium and chloride was insignificant. The correlation between urinary chloride and potassium usually was also strong (diurnal $r = 0.87$, $p < 0.05$ in males and $r = 0.85$, $p < 0.05$ in females, overnight $r = 0.45$, $p < 0.05$ in males and $r = 0.78$, $p < 0.05$ in females). The correlation between urinary chloride and potassium was significantly weaker in males overnight.

Correlation between urinary excretion of chloride and BP

In adolescent females, diurnal urinary chloride excretion negatively correlated with BP (systolic $r = –0.42$, NS; diastolic $r = –0.53$, $p < 0.05$; mean $r = –0.51$, $p < < 0.05$). In adolescent males such a correlation was absent (systolic $r = –0.14$, NS; diastolic $r = 0.11$, NS; mean $r = 0.00$, NS). The gender-related difference in the correlation between diurnal urinary chloride excretion and diastolic BP was significant (Fig. 1). Overnight, on the contrary, no correlation between urinary chloride excretion and BP was noted in adolescent females (systolic $r = –0.01$, NS; diastolic $r = –0.10$, NS; mean $r = –0.07$, NS), but it was positive in adolescent males (systolic $r = 0.54$, $p < 0.05$; diastolic $r = 0.38$, NS; mean $r = 0.52$, $p < 0.05$). The gender-related difference in correlation between overnight urinary chloride excretion and systolic BP is shown in Fig. 2.

Sexual hormones have some impact on renal excretion of electrolytes. To evaluate their role in chlo-

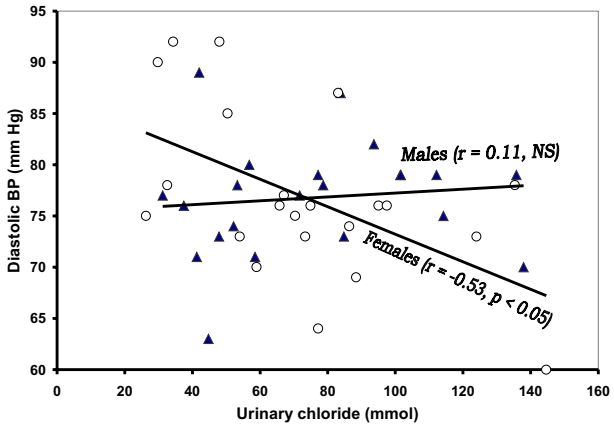

Fig. 1. Diurnal correlation between urinary chloride excretion and diastolic blood pressure (▲- males, ○ – females).

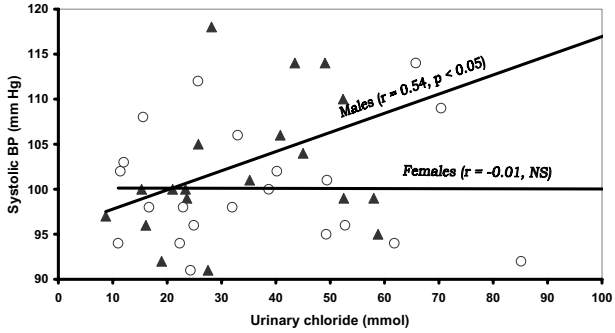

Fig. 2. Overnight correlation between urinary chloride excretion and systolic blood pressure (▲- males, ○ – females).

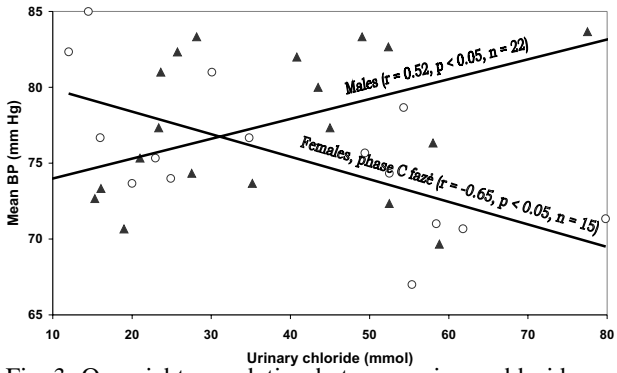

Fig. 3. Overnight correlation between urinary chloride excretion and mean blood pressure

ride excretion and BP regulation, we also monitored 15 adolescent females during different phases of their menstrual cycle. Diurnal urinary chloride excretion exhibited a negative correlation with BP during phase C of the menstrual cycle in adolescent females (systolic r = –0.73, p < 0.05; diastolic r = –0.72, p < 0.05; mean r = –0.75, p < 0.05). This correlation was insignificant during phases A and B (phase A: systolic r = = –0.39, NS; diastolic r = –0.36, NS; mean r = –0.41, NS, phase B: systolic r = –0.25, NS; diastolic r = = –0.41, NS; mean r = –0.40, NS). Overnight urinary chloride excretion correlated with BP during phase C of menstrual cycle (systolic r = –0.26, NS; diastolic r = –0.75, p < 0.05; mean r = –0.65, p < 0.05). The correlation between overnight urinary chloride excretion and BP was insignificant during phases A and B (phase A: systolic r = –0.20, NS; diastolic r = –0.27, NS; mean r = –0.28, NS; phase B: systolic r = –0.16, NS; diastolic r = –0.30, NS; mean r = –0.27, NS).

Table 3. **Correlation of total urinary chloride and BP with height, body weight, and body mass index**

Investigated groups / Related parameters		Adolescent males (n = 22)			Adolescent females (n = 22)		
		Height	Body weight	Body mass index	Height	Body weight	Body mass index
Cl excretion	Diurnal	–0.10	–0.02	0.08	–0.21	0.12	0.24
Cl excretion	Overnight	0.23	0.08	–0.11	–0.25	–0.09	0.02
Cl excretion	24-h	0.07	0.04	0.00	–0.27	0.02	0.16
Systolic BP	Diurnal	0.58*	*0.60**▼	*0.39*▼	0.13	*–0.26*▼	*–0.38*▼
Systolic BP	Overnight	0.38	0.40	0.32	0.18	–0.03	–0.14
Diastolic BP	Diurnal	0.40	0.39	0.28	–0.04	–0.16	–0.17
Diastolic BP	Overnight	0.46*	0.49*	0.34	0.04	0.04	0.02
Mean BP	Diurnal	0.55*	*0.55**▼	0.37	0.02	*–0.21*▼	–0.26
Mean BP	Overnight	0.49*	0.52*	0.38	0.10	0.01	–0.05
Pulse BP	Diurnal	0.37	*0.41*▼	*0.25*▼	0.26	*–0.22*▼	*–0.39*▼
Pulse BP	Overnight	0.12	0.13	0.14	0.24	–0.09	–0.23

* Significant (p < 0.05) correlation.
▼ Significant (p < 0.05) gender-related difference in correlation.

Figure 3 shows a significant difference in the correlation of overnight chloride excretion and mean BP between adolescent males and adolescent females during phase C of their menstrual cycle.

No correlation between urinary chloride/creatinine ratio and BP was found.

Correlation of urinary excretion of chloride and BP with height, body weigh, and body mass index

Height and body weight significantly correlated with BP in boys only. The correlation of BP with body weight and body mass index exhibited gender-related differences. No significant correlation of total urinary chloride with height, body weight, and body mass index was found (Table 3).

DISCUSSION

Chloride anion transport and Cl^- excretion are closely related to Na^+ ion transport via $Na^+/K^+/2Cl^-$ cotransport (13), Na-Cl symport and indirectly via Na^+/H^+ exchanger (14) linked to Cl^-/HCO_3^- exchanger (5, 15). $Na^+/K^+/2Cl^-$ cotransport, Na^+/H^+ exchange and Cl^-/HCO_3^- exchange are related to an increase in arterial blood pressure (5, 13–17).

Total diurnal and 24-h urinary chloride excretion in boys was significantly higher than in girls at the beginning of follicular phase. The overnight urinary chloride level in females at the beginning of follicular phase was significantly lower than during the ovulation phase. This data show a lower chloride excretion in adolescent females at the beginning of follicular phase. The beginning of the follicular phase is characterised by the lowest estrogen and progesterone levels in blood serum. Thus, estrogen and progesterone levels can influence Cl^- handling in the body.

The obtained results on Cl^- excretion can also reflect the peculiarities of Na^+ excretion. Other investigators show that the 24-hour-to-overnight Na^+ excretion ratio was significantly lower in women than in men (18). Healthy male students showed a significantly higher urinary Na^+ excretion than female ones (19). Urinary NaCl excretion in women and girls was lower than in men and boys by approximately 20–25% (20).

In the general groups the Cl^- concentration in diurnal urine was evidently higher than in nocturnal urine. Our earlier studies have shown that the concentration of divalent cations, *e.g.*, of Mg^{2+}, is inverse: it is higher in nocturnal and lower in diurnal urine (21).

The observed differences in Cl^- anion concentration can influence the gender-related blood pressure differences. The diurnal systolic, diastolic, and mean BP was significantly higher than the nocturnal one in all groups of both sexes. Diurnal pulse BP was significantly higher in boys than in girls at the beginning of follicular phase. Thus, the higher arterial blood pressure in the daytime can cause a higher Cl^- excretion in urine. The overnight systolic and pulse BP was significantly higher in boys than in girls. This difference was noted between the general groups and persisted during all menstrual phases in girls.

The higher 24-h and diurnal Cl^- excretion in boys than in girls at the beginning of follicular phase can be in part explained also by the data on the correlation of urinary Cl^- excretion with Na^+ and K^+. It is well known that Na^+ excretion is highly dependent on arterial blood pressure and kidney perfusion. Also, known are gender-related differences in kidney haemodynamics. The female kidneys tend to be smaller, have a lower glomerular filtration rate (22).

Urinary chloride in girls and boys exhibited a strong correlation with urinary sodium in diurnal as well as in overnight urine. Gender-related differences in the correlation between urinary sodium and chloride were insignificant. A correlation between urinary chloride and potassium was also usually strong in diurnal and in overnight urine in both sexes of adolescents. However, a correlation between urinary chloride and potassium was significantly weaker in males overnight. To elucidate this aspect of potassium excretion, our investigations are in progress.

The differences observed in urinary Cl^- excretion can be related also to the activity of the Cl^- transport mechanism, whose differences are also known. The mean value of $Na^+/K^+/2Cl^-$ cotransport in red blood cells was higher in men than in women by 26–46%. The cotransport activity in erythrocytes was lower in women during their follicular phase than in men (23). The $Na^+/K^+/2Cl^-$ cotransport was found to reach the lowest rates in ovulatory women and the highest ones in men (24). In contrast, other authors showed that the $Na^+/K^+/2Cl^-$ cotransport was not changed during the menstrual cycle (25).

The Na^+/H^+ antiport system is involved in the regulation of intracellular pH (pH_i). Na^+/H^+ activity and Cl^-/HCO_3^- activity are coupled. Intracellular pH regulation is under Cl^-/HCO_3^- exchanger also (15). Tokudome et al. showed gender-related variations in the pH_i set point of activation of the Na^+/H^+ antiport: men demonstrated an alkaline shift in the pH_i set point for activation of the Na^+/H^+ antiport in lymphocytes as compared with women (26).

The Na^+/H^+ exchange in mouse renal brush-border membranes exhibited marked gender-related differences, the Na^+/H^+ exchange activity in males having been higher than in females. The castration of male mice led to a decrease in Na^+/H^+ exchange,

down to the values found in female mice. Treatment of the castrated mice with estradiol had no effect. In contrast, the treatment with testosterone increased the rate of exchange by more than 100% (27).

We showed gender differences in Cl^- transport in vascular smooth muscle cells of rats: chloride influx and efflux were faster in male *versus* female rat aortic cells. The intracellular Cl^- concentration was found significantly higher in male VSMC than in female, also (12).

The data of our studies show that the relation between Cl^- excretion and arterial blood pressure in boys and girls differs. The circadian differences in this dependence are especially evident. In the common adolescent female group, diurnal urinary chloride excretion significantly negatively correlated with diastolic and mean BP. In adolescent males such a correlation was absent. Gender-related differences in the correlation between diurnal urinary chloride excretion and diastolic BP were significant.

On the contrary, the correlation between overnight urinary chloride excretion and BP was absent in adolescent females, but it was significantly positive in adolescent males for systolic and mean BP. Gender-related differences in the correlation between overnight urinary chloride excretion and systolic BP were found significant.

Diurnal urinary chloride excretion exhibited a significant negative correlation with BP during the luteal phase of menstrual cycle in adolescent females with systolic, diastolic and mean BP. This correlation was insignificant at the beginning of follicular phase and in ovulation. It is possible to hypothesise that sexual hormones have some impact on the renal excretion of chloride.

Overnight urinary chloride excretion in adolescent girls significantly negatively correlated with BP during the luteal phase of their menstrual cycle with diastolic, mean BP. A correlation between overnight urinary chloride excretion and BP was insignificant both at the beginning of follicular phase and in ovulation. A significant difference was found in the correlation of overnight chloride excretion and diastolic BP between adolescent males and adolescent females during the luteal phase of their menstrual cycle.

The peculiarities of Cl^- excretion in relation to arterial BP observed in girls can be determined by progesterone. Pregnancy markedly altered chloride transport parameters in rat female vascular smooth muscle cells, making them more similar to male cells. Resting intracellular chloride levels in these cells were markedly increased, as were chloride efflux and influx (12). However, the role of progesterone in chloride metabolism was not specifically tested in the studies.

The nocturnal fall in the 24-h mean, systolic and diastolic blood pressure of young women was preserved in both groups during follicular and luteal phases (29). In normotensive postmenopausal women, physiological doses of estradiol amplified the nocturnal decline of blood pressure. Daytime blood pressure was not modified: estradiol magnified the nocturnal decrement of systolic, diastolic and mean blood pressure (29).

Other investigators showed a significant inverse relationship between daily Na^+ excretion and systolic blood pressure, as well as between daily Na^+ excretion and diastolic blood pressure in premenopausal women. Such a relationship disappeared after the menopause (30). The menopause status could confound the association between Na^+ excretion and blood pressure, and menstruation can have a protective action against the pressor effect of Na^+. The association between urinary Na^+ excretion and blood pressure tended to be more pronounced in older persons and postmenopausal women than in young menstruating women and young men (31, 32).

Known is a gender-related BP regulation depending on NaCl dietary intake. A high dietary NaCl intake did not significantly increase the daytime or nighttime MAP in SHR and WKY female rats, but did increase the daytime and nighttime MAP in male SHR rats. The dietary NaCl supplementation has been associated with reduction in the daytime blood pressure in female WKY rats (33).

The mechanisms of variations in such a gender-dependent circadian Cl^- excretion relation to BP are not yet clear. These investigations should be continued, since Cl^- but not other anions (of bicarbonates, citrates, phosphates) influence the regulation of arterial BP. We may suggest that a harmonised action of numerous factors predetermine such gender-related peculiarities of Cl^- excretion. Furthermore, height and body weight significantly correlated with BP in boys only. The height in boys and not in girls is known to be related to the risk of arterial hypertension (34, 35). Elucidation of the separate factors and their effects on Cl^- metabolism as well as on changes in arterial BP related to the altered Cl^- metabolism would allow a better understanding of health and the pathogenesis of essential hypertension in both men and women.

Received 12 October 2001
Accepted 12 December 2001

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CHLORIDAS PAAUGLIŲ ŠLAPIME: SU LYTIMI SUSIJĘ SKIRTUMAI IR RYŠYS SU ARTERINIU KRAUJOSPŪDŽIU

S a n t r a u k a

Norėdami nustatyti su lytimi susijusius arterinio kraujospūdžio (AKS) ir chlorido išsiskyrimo skirtumus bei ryšį tarp jų, paaugliams (22 vaikinams ir 22 merginoms) tyrėme chlorido koncentraciją šlapime ir (kas valandą) matavome AKS. Norėdami nustatyti galimą lytinių hormonų įtaką chlorido išsiskyrimui ir AKS, stebėjome 15 paauglių merginų skirtingų menstruacinio ciklo fazių analogiškus rodiklius. Chlorido, natrio ir kalio koncentraciją šlapime tyrėme jonams selektyvių elektrodų metodu elektrolitų analizatoriumi EML-105. AKS matavome automatiniu ambulatoriniu AKS monitoriumi AUTO-CUFF.

Vaikinų nakties sistolinis ir pulsinis AKS buvo aukštesnis negu merginų. Vaikinų dienos pulsinis AKS buvo aukštesnis negu merginų folikulinės fazės pradžioje. Visų tirtų grupių sistolinis, diastolinis ir vidutinis AKS dieną buvo aukštesnis negu naktį. Chlorido koncentracija merginų nakties šlapime folikulinės fazės pradžioje buvo mažesnė negu ovuliacijos metu, o geltonkūnio fazėje – panaši kaip ovuliacijos. Chlorido kiekis paros šlapime bendroje vaikinų grupėje buvo didesnis negu merginų folikulinės fazės pradžioje. Bendroje merginų grupėje chlorido kiekis dienos šlapime atvirkščiai koreliavo su diastoliniu ir vidutiniu AKS, o vaikinams tokios koreliacijos nenustatyta. Naktį, priešingai, koreliacija tarp chlorido kiekio šlapime ir AKS merginoms nenustatyta, o vaikinams ji buvo tiesioginė. Chlorido kiekis merginų dienos ir nakties šlapime geltonkūnio fazėje atvirkščiai koreliavo su AKS. Koreliacija tarp chlorido kiekio ir vidutinio AKS naktį vaikinams buvo tiesioginė, o merginoms geltonkūnio fazėje – atvirkštinė.

Paauglių AKS yra susijęs su chlorido kiekiu šlapime. Šių rodiklių ryšiui įtakos turi lytis ir nuo paros ritmo priklausantys pokyčiai organizme. Lytiniai hormonai gali dalyvauti reguliuojant AKS ir chlorido išsiskyrimą su šlapimu.

Raktažodžiai: chlorido kiekis šlapime, arterinis kraujospūdis, paaugliai, su lytimi susiję skirtumai