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## **The Influence of Physical Exercise on Excretion of 19-Norandrosterone in Bodybuilders' Urine**

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### **Introduction**

During the last two years, 26 urine samples with 19-norandrosterone, above acceptant limits in doping analyses of Department of Anti-doping Research Warsaw Poland were detected. 21 samples (81%) during “in competition” testing and 5 samples (19%) in “out of competition” period were collected. During these years relationship between all samples “in” and “out of competition” anti-doping testing as 60 to 40% respectively were collected. Correlation coefficient  $r=0.393$  between concentrations of 19-norandrosterone ( $5\alpha$ -estran- $3\alpha$ -ol-17-one) in urine samples collected during in competition period and concentration of  $[H^+]$  values in the same urine samples was detected. Above data suggested that concentration of 19-norandrosterone in urine samples collected in the competition may be related to concentration of  $[H^+]$  values.

### **Aim of study**

- Verification of hypothesis that among people using nandrolone, excretion of one of metabolites (19-norandrosterone) under the influence of the physical exercise will be increased [1-6].
- Discussing the influence of various factors on modifications in excretion of 19-norandrosterone after the physical exercise among the people using Anabolic-Androgenic Steroids (AAS) for a long time.

### **Material and method of the study**

A group of 17 members of bodybuilders club from Warsaw has agreed to participate in medical examination in the Outpatients Clinic of Institute of Sport in Warsaw. We have got also the permission from the Ethical Commission of Institute of Sport to conduct this study.

Among all of the bodybuilders who participated in our study the urine collection during twenty-four-hours was completed. The metabolites of anabolic-androgenic steroids and profile of steroids of endogenous androgens in the urine samples collected before and after the exercise test on cycle ergometer accordingly too recommended procedures of Olympic Movement Anti-Doping Code were performed.

## Results and discussion

A group of bodybuilders has been divided into two subgroups on the ground of the results of anti-doping analysis of their urine samples (Tab. 1). The first group defined as a "positive" one consisted of 9 subjects. In their urine samples we have discovered the presence of metabolites of anabolic-androgenic steroids. In 8 cases we have discovered the presence of 19-norandrosterone in the urine samples.

In urine samples of members of the second group defined as "negative" one and consisting of 8 people we have not discovered the presence of any metabolites of anabolic steroids.

*Table 1. Anthropometric characteristics and years of abuse of 17 body builders separated into two groups "positive" (with presence) and "negative" subjects (absent) anabolic androgenic steroids metabolites in urine samples and exercise tests results (mean and  $\pm$  sd).*

Parameter	Positive subjects	Negative subjects	p
Subjects tested	9	8	p>0.05
Age [years]	27.6 $\pm$ 4	27.3 $\pm$ 6	p>0.05
Height [cm]	176 $\pm$ 3	179 $\pm$ 6	p>0.05
Body mass [kg]	101 $\pm$ 11*	88.9 $\pm$ 15	p<0.04
BMI*	33.2 $\pm$ 3*	27.6 $\pm$ 3	p<0.001
Years of AAS abuse	6.8 $\pm$ 3	4.6 $\pm$ 5	p<0.05
Number of cycles	14 $\pm$ 13	10 $\pm$ 13	p<0.05
Declared cycles „on” or „off”	3 „on” 6 „off”	8 „off”	-
VO <sub>2</sub> max/l/min.	3.7 $\pm$ 0.5	3.5 $\pm$ 0.6	p>0.05
VO <sub>2</sub> max ml·kg <sup>-1</sup>	37.8 $\pm$ 5.5	40.1 $\pm$ 6.3	p>0.05
LA** before effort	2.8 $\pm$ 0.7	2.4 $\pm$ 0.6	p>0.05
LA** after effort	13.9 $\pm$ 2.2	13.2 $\pm$ 3.6	p>0.05
$\Delta$ LA**	11.2 $\pm$ 1.6	10.8 $\pm$ 3.6	p>0.05
Time of exhaustion [min]	11.6 $\pm$ 2	11.6 $\pm$ 2	p>0.05
Blood pH	7.40 $\pm$ 0.2	7.39 $\pm$ 0,18	p>0.05
LH in urine	1.0 $\pm$ 1.7	1.1 $\pm$ 1.1	p>0.05

\* BMI - body mass index

\*\*Lactate mmol·l<sup>-1</sup>

We have also analyzed: full, quantitative profile of steroids of endogenous androgens and the level of excretion of metabolites of 19-nandrolone during 24 hours of urine collection (Tab. 2 and Tab. 3; Fig. 1, Fig. 2 and Fig. 3). We have analyzed the influence of results of VO<sub>2</sub>max/l/min and VO<sub>2</sub>max/kg//min, maximum concentration of lactates (LA) and pH of blood on the changes in excretion of 19-norandrosterone in urine, too (Tab. 4).

All of the statistic analyses after the logarithmic transformation of date were performed with acceptance of p<0.05 as a limit of statistical significance.

Table 2. Results of concentration of nandrolone metabolites (ng/ml) and same of parameters of steroids profile before and after exercise in 6 "positive" subjects (mean and  $\pm$ sd).

Parameter	Results before exercise	Results after exercise	p*
Density of urine	1.023	1.024	p>0.05
[H <sup>+</sup> ] of urine	0.00000024	0.0000069	p<0.009
PH of urine	6.41	5.16	p<0.006
19-norandrosterone [19-NA]	98 $\pm$ 111	115 $\pm$ 133	p<0.015
19-noretiocholanolone [19-NE]	22 $\pm$ 34	23 $\pm$ 34	p>0.05
Testosterone [T]	43.5 $\pm$ 42.4	59,1 $\pm$ 49.8	p<0.02
Epitestosterone [Et]	11.8 $\pm$ 5,4	13,9 $\pm$ 12.5	p<0.02
Ratio T/Et	14.8 $\pm$ 29.8	13.2 $\pm$ 24.9	p>0.05
Androsterone [A]	1809 $\pm$ 1153	2358 $\pm$ 1160	p<0.009
Etiocholanolone [E]	1981 $\pm$ 1202	2350 $\pm$ 1227	p<0.003
Ratio A/E	1.14 $\pm$ 0.46	1.31 $\pm$ 0.45	p<0.04

\*statistical analyses after logarithmic transformation of date were performed

Table 3. Results of concentration of same parameters of steroids profile before and after exercise in 8 "negative" subjects (mean and  $\pm$ sd).

Parameter	Results before exercise	Results after exercise	p*
Density of urine	1.019	1.025	p<0.03
[H <sup>+</sup> ] of urine	0.00000144	0.0000054	p<0.03
pH of urine	6.63	5.69	p<0.02
19-norandrosterone [19-NA]	-	-	-
19-noretiocholanolone [19-NE]	-	-	-
Testosterone [T]	41.1 $\pm$ 30.5	42.5 $\pm$ 25.5	p>0.05
Epitestosterone [Et]	22.9 $\pm$ 16.0	20.9 $\pm$ 8.8	p>0.05
Ratio T/Et	2.2 $\pm$ 1.9	2.0 $\pm$ 1.3	p>0.05
Androsterone [A]	3114 $\pm$ 1506	3145 $\pm$ 1464	p>0.05
Etiocholanolone [E]	2118 $\pm$ 850	2125 $\pm$ 778	p>0.05
Ratio A/E	1.4 $\pm$ 0.4	1.5 $\pm$ 0.6	p>0.05

\*statistical analyses after logarithmic transformation of date were performed

Table 4. Correlation coefficients between exercise increased excretion of 19-norandrosterone and same other variables.

Parameter	r	p
Increase of concentration [H <sup>+</sup> ] in urine	0.855	p<0.01
VO <sub>2</sub> maxml	0.113	p>0.05
VO <sub>2</sub> max/kg	0.442	p>0.05
Increase of lactate	-0.236	p>0.05
Time of exhaustion [min] of exercise test	0.55	p>0.05
Twenty-four hours expulsion	0.3145	p>0.05
24 h urine excretion of 19-norandrosterone	-0.245	p>0.05

In 8 urine samples the presence of metabolites of nandrolone were discovered. The level of excretion of 19-norandrosterone during twenty-four hours (mean and  $\pm$ sd) 277.7  $\pm$ 347.7 mg/24h; with range of values from 7.5 up to 967 mg/24h was detected. The increase of excretion of 19-norandrosterone was observed in 6 cases. In two cases of the level of 19-norandrosterone under the influence of the physical effort was decreased.

In both cases, they declared AAS abuse for a long time – 11 and 10 years – and they actually used respectively in 30 and 39 cycle. The exercise test was performed in the 3<sup>rd</sup> and 4<sup>th</sup> weeks of cycle of using AAS (in top of abuse). Therefore the results of these two subjects were have discussed separately.

We have to stop test in a case of one person because of the increase of blood pressure above the level of 240/120 mm. Therefore we have analyzed the statistical assessment of the results of 6 subjects who carried out the exercise test in the full-time.

### Conclusion

- Among the people using preparations of nandrolone the physical exercise causes statistically significant increase of the excretion of metabolite of 19-norandrosterone, but we do not observe the increase of the of 19-noretiocholanolone.
- We observe statistically significant correlation coefficient ( $r=0.855$ ) between the increase of excretion of 19-norandrosterone and the increase of concentration of ions [H<sup>+</sup>] in urine after the exercise.
- Among the people using AAS the physical effort also causes increase of the excretion of metabolite of natural androgens, but at the same time T/Et ratio dose not change.
- The physical exercise among the people who don't use the preparations of AAS, does not cause any changes in steroids profile and value of T/Et ratio.

- Using huge doses of AAS (during cycle) cause the decrease of excretion of metabolite of 19-norandrosterone, as well as different kinds of metabolites of other AAS. This fact may indicate the injury of functions of kidneys by AAS (Table 5).
- We postulated that the increased of concentration of ions  $[H^+]$  in the renal tubule of nephrons enhanced the dissociation of metabolites of nandrolone from protein carriers (albumin) and facilitated the elimination them in urine.

Table 5. Changes of percentage of excretion of anabolic androgenic steroids metabolites (others than nandrolone) in urine of body builders before and after of exercise.

Volunteer	Anabolic steroid		Increase / Decrease [%]
V5_I	Metandienone	17 epimetendiol (17 $\beta$ -methyl-5 $\beta$ -androst-1-ene-3 $\alpha$ ,17 $\alpha$ -diol)	116,536
		18-Normetenolon (17,17-Dimethyl-18-nor-5 $\beta$ -androst-1,13-dien-3 $\alpha$ -ol)	124,895
		17 $\alpha$ -methyl-5 $\beta$ -androstane-3 $\alpha$ ,17 $\beta$ -diol	51,911
		6 $\beta$ -Hydroxymetandienone	141,331
		6 $\beta$ -Hydroxy-17-epimetandienone	33,221
		17-Epimetandienone	81,075
	Boldenone	5 $\beta$ -androst-1-en-3 $\alpha$ -ol-17-one	-13,882
		Boldenone (Androsta-1,4-dien-17 $\beta$ -ol-3-one)	21,550
	Stanozolol	3'-Hydroxystanozolol	-14,888
		16 $\beta$ -Hydroxystanozolol	10,469
	Clenbuterol	Clenbuterol (4-Amino- $\alpha$ -[t-butylaminomethyl]-3,5-dichlorobenzyl alcohol)	-42,450
	V5_II	Stanozolol	3'-Hydroxystanozolol
V4	Metenolone	1-Methylene-5 $\alpha$ -androstane-3 $\alpha$ -ol-17-one	-0,391
		Metenolone (1-Methyl-5 $\alpha$ -androst-1-en-17 $\beta$ -ol-3-one)	36,015
V3	Metandienone	17-Epimetendiol (17 $\beta$ -methyl-5 $\beta$ -androst-1-ene-3 $\alpha$ ,17 $\alpha$ -diol)	-52,504
		18-Normetenolon (17,17-Dimethyl-18-nor-5 $\beta$ -androst-1,13-dien-3 $\alpha$ -ol)	-29,813
		17 $\alpha$ -methyl-5 $\beta$ -androstane-3 $\alpha$ ,17 $\beta$ -diol	-55,306
		6 $\beta$ -Hydroxymetandienone	-53,200
		6 $\beta$ -Hydroxy-17-epimetandienone	-95,585
	Stanozolol	3'-Hydroxystanozolol	-15,112

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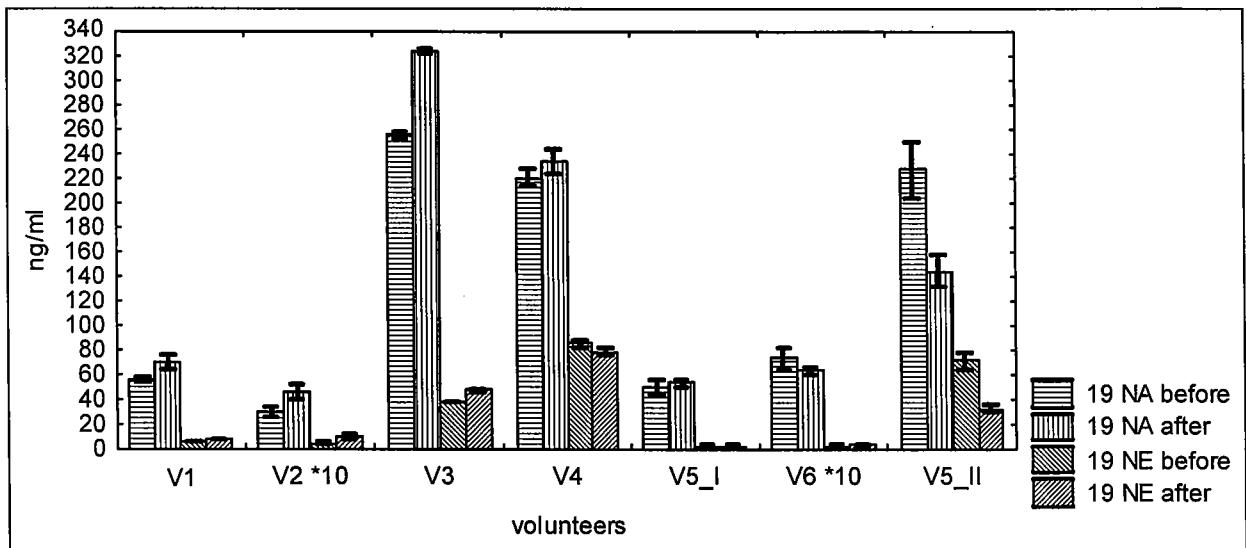


Fig.1. Individual changes of concentration of excretion of nandrolone metabolites in urine of bodybuilders before and after of exercise (mean and sd).

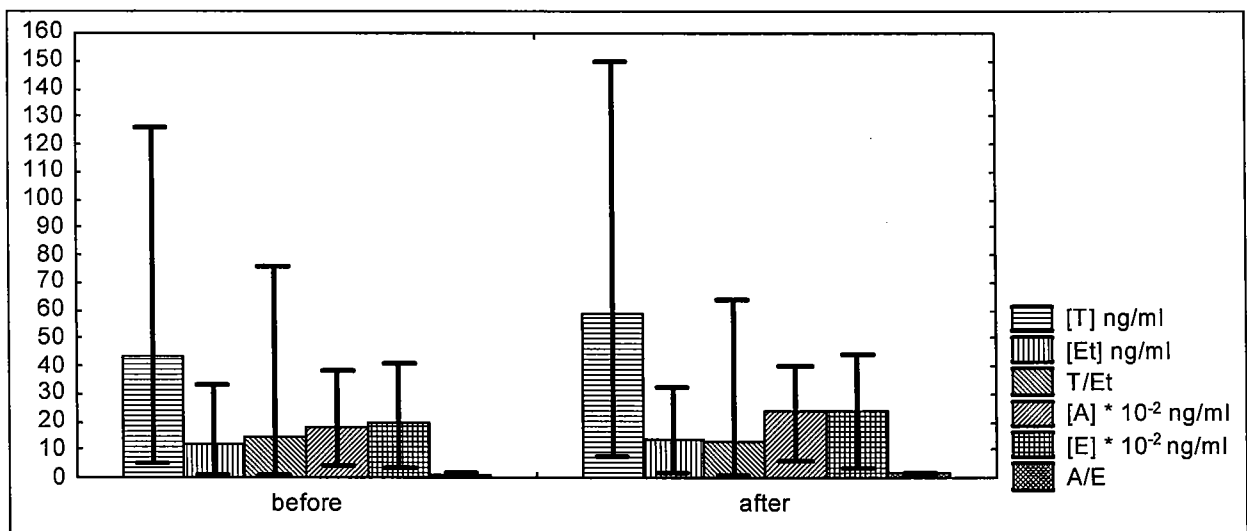


Fig. 2. Results of concentration of nandrolone metabolites (ng/ml) and same of parameters of steroids profile before and after exercise in 6 "positive" subjects (mean max and min).

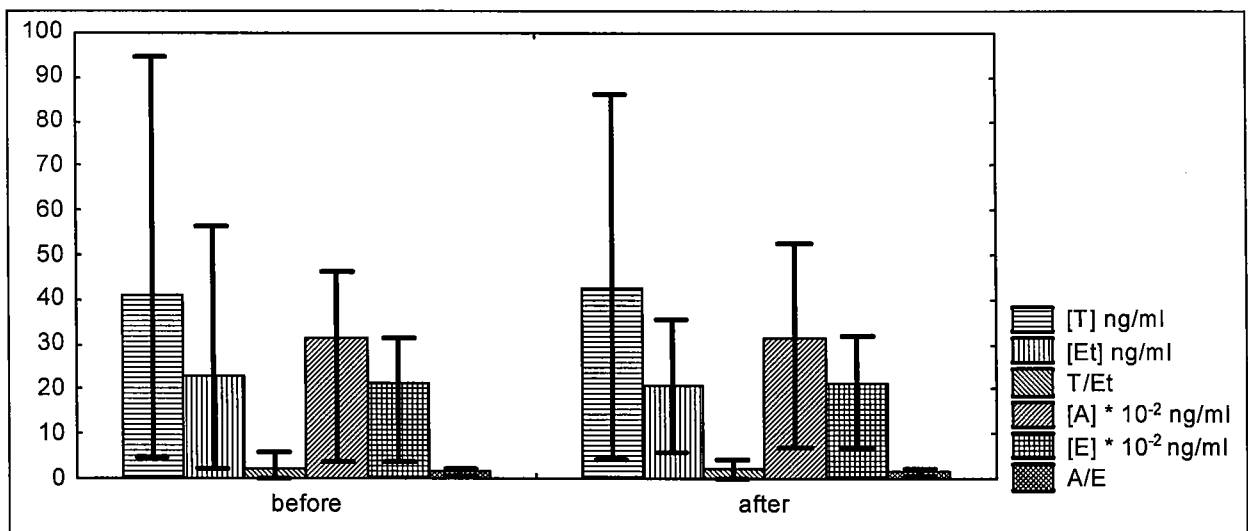


Fig. 3. Results of concentration of same parameters of steroids profile before and after exercise in 8 "negative" subjects (mean, max and min).