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RECENT ADVANCES IN DOPING ANALYSIS (4)

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Steroid Profile and Sports.
A cluster analysis of samples from Barcelona'92 Olympic Games.

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1. Introduction

Multiple factors can modify the excretion of steroids in urine: age, sex, exercise, diet, ethnical origin, some physiological or pathological conditions, drug consumption, etc.
Examples of drugs severely affecting the urinary steroid profile are probenecid, banned by the IOC as masking agent because it reduces the excretion of steroid glucuronides, and ketoconazole which inhibits the endogenous synthesis of steroids.

Alterations of steroid profiles (testosterone to epitestosterone ratio, T/E; androsterone to etiocholanolone ratio, A/Et;...) after anabolic androgenic steroid (AAS) abuse have been reported. As a consequence, the use of certain "normality limits" for some parameters defining that profile were used by the International Weightlifting Federation (IWF) to presume the use of anabolic steroids among its athletes (Donike M., 1993).

T/E and A/Et have a log-normal distribution with a median value around 1-1.5 respectively (Donike M., 1985; Vestergaard P., 1978). Those figures correspond to mainly Caucasian population and include sports of high and low risk of steroid use. The aim of this study is to analyse the steroid profiles obtained in the samples collected during the XXV Olympic Games of Barcelona 1992 through the analysis of the shapes of the distribution curves of those parameters without any previous discrimination.

2. Experimental

Samples used for this study were those obtained during the antidoping control at the Barcelona' 92 Olympic Games. They were subjected to the screening procedure for anabolic steroids (Segura J., 1993).

The parameters of the steroid profile studied were T/E and A/Et among male athletes (n=1300).
For the comparison of the distributions of the values among different sports, the distributions were divided in three segments according to the percentiles 15.85 % and 84.15% which would correspond to plus and minus one standard deviation of the mean in a normal distribution leaving 15.85% of the values on each of the two tails.
Those percentiles were calculated for the distribution of T/E and A/Et using the whole population studied. The values for T/E and A/Et corresponding to those percentiles were then applied to the distribution curves of each sport and the percentage of samples belonging to each of the defined segments were calculated.
A cluster analysis (SPSS for Windows version 6.1.3, 1995) was then applied to discriminate the possible groups and the differences they could present. Figure 1 shows the rational of the above described percentiles in a normally distributed curve and in the case of a T/E (no normal) distribution curve.

3. Results

Table 1 lists the calculated values for the T/E and A/Et ratio corresponding to the cited percentiles from all the samples studied ("population values").

Table 1. Ratios for T/E and A/Et corresponding to pre-established percentiles (full population)

	Percentiles	
	15.85 %	**84.15 %**
T/E	0.40	2.36
A/Et	1.10	2.65

The application of the values obtained to the distributions of the different sports gives the particular percentiles corresponding to each sport thus showing the differences from the population distribution. Table 2 summarises those values.

The analysis of A/Et distribution did not allow to obtain any significant difference between sports because of the wide range of values observed.

For T/E values, some sports show a shift on their distribution to high, low or both sides of the "population distribution".

Cluster analyses taking into account the values of the percentiles obtained for the highest part of the distribution (T/E > 2.36) and both highest and lowest parts (T/E < 0.4 and T/E > 2.36) are presented in the dendrograms of figures 2 and 3 respectively.

The cluster analysis highlights the existence of a group of sports having a very low number of samples above the value of 2.36. Among them some have most of the samples between 0.4 and 2.36, then in the central part of the distribution. Others (gymnastics, table tennis and badminton) have 30-50 % of the samples below the value of 0.4.

Contrarily, a second group of sports (fencing, weightlifting, canoeing and cycling) showed c.a. 25 % of the samples above 2.36, and in the case of fencing and weightlifting nearly the same percentage was below 0.4. Figure 4 shows the distributions corresponding to such groups of sports.

The combined cluster analysis with both T/E and A/Et ratios showed basically the same groups obtained with just the T/E values but less significant differences were found between them because of the "noise" added by the wide range of values showed by the A/Et distribution.

4. Discussion.

One important factor to establish steroid profiles is the ethnic origin of the population. It is well known that Orientals present a reduced excretion of testosterone compared to Caucasians, showing then lower T/E ratios.

One of the groups of sports highlighted by the cluster analysis show a T/E distribution that correspond to a shift towards lower values. That group is formed by badminton, gymnastics and table tennis. According to the final sporting results of the 1992 Olympic Games, we can see that most of the athletes (66.7 to 82.6 %) among the 6 best positions in the final score of these sports, were from oriental countries (table 3). It can easily be concluded that cluster analysis segregated, in this case, the sports with a main oriental ethnic origin of the athletes participating.

Among the sports with "abnormal" steroid profiles (e.g. shift towards higher T/E values) we found sports traditionally considered as high risk of steroid abuse (cycling and especially weightlifting). Canoeing was also present in the same group. However, fencing, a low risk sport was also included in the same group showing some weakness of the model.

5. Conclusions.

- Population based steroid profiles (T/E ratios) leads to differences that are the result of several factors:

  - Ethnical origin
  - Possible steroid consumption
  - Others...

- The addition of more endogenous substances (i.e. A/Et) to better define a steroid profile may not always be satisfactory and add noise to the analysis of data.

6.Acknowledgements.

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7.Rerferences.

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Figure 1. Parallelism between the analysis performed in normal and non normal distributions.

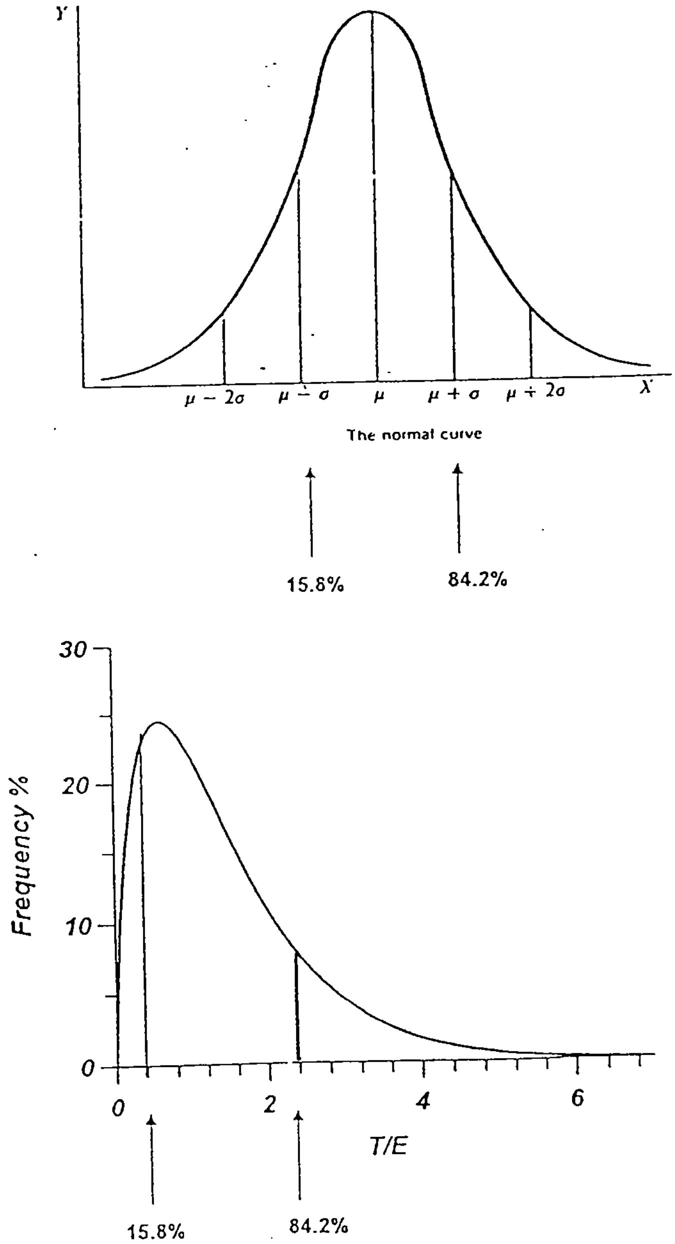

Table 2. Percentiles for T/E and A/Et corresponding to pre-established ratios (individual sports population).

T/E				A/Et		
<0,4	0,4-2,36	>2,36		<1.1	1,1-2,65	>2,65
11,5	69,1	19,4	ATHLETICS	22,3	61,9	15,8
,0	84,6	15,4	ARCHERY	15,4	38,5	46,2
24,1	65,5	10,3	BASEBALL	3,4	89,7	6,9
52,4	38,1	9,5	BADMINTON	9,5	81,0	9,5
12,7	67,3	20,0	BASKETBALL	10,9	83,6	5,5
23,1	63,1	13,8	BOXING	24,6	67,7	7,7
7,0	66,7	26,3	CANOEING	15,8	71,9	12,3
4,5	68,7	26,9	CYCLING	23,9	68,7	7,5
6,7	93,3	,0	EQUESTRIAN	26,7	60,0	13,3
20,0	56,7	23,3	FENCING	13,3	73,3	13,3
12,5	78,1	9,4	FOOTBALL	3,1	68,8	28,1
30,0	60,0	10,0	GYMNASTICS	10,0	60,0	30,0
18,1	72,3	9,6	HANDBALL	10,8	81,9	7,2
10,7	75,0	14,3	HOCKEY	20,7	69,0	10,3
18,9	78,4	2,7	JUDO	8,1	64,9	10,3
12,5	62,5	25,0	MODERN PENTATHLON	12,5	87,5	,0
16,7	66,7	16,7	PELOTA	11,1	67,7	22,2
12,0	72,0	16,0	ROLLER HOCKEY	12,0	56,0	32,0
11,6	67,4	20,9	ROWING	7,0	72,1	20,9
15,5	67,2	17,2	SHOOTING	15,5	65,5	19,0
9,7	73,6	16,7	SWIMMING	25,0	58,3	16,7
35,7	57,1	7,1	TABLE TENNIS	21,4	64,3	14,3
23,5	64,7	11,8	TAEKWONDO	11,8	41,2	47,1
15,4	73,1	11,5	TENNIS	15,4	50,0	34,6
20,0	66,3	13,7	VOLEYBALL	9,5	76,8	13,7
12,1	72,7	15,2	WATER POLO	18,2	57,6	24,2
23,3	51,7	25,0	WEIGHTLIFTING	28,3	55,0	16,7
18,8	75,0	6,3	WRESTLING	10,0	75,0	15,0
10,7	73,2	16,1	YACHTING	17,9	69,6	12,5
15.9	68.2	15.8	MEAN	16.1	68.3	15.7

Figure 2. Dendrogram showing the results of the cluster analysis based on the values of the percentiles of each sport corresponding to the value T/E = 2.36.

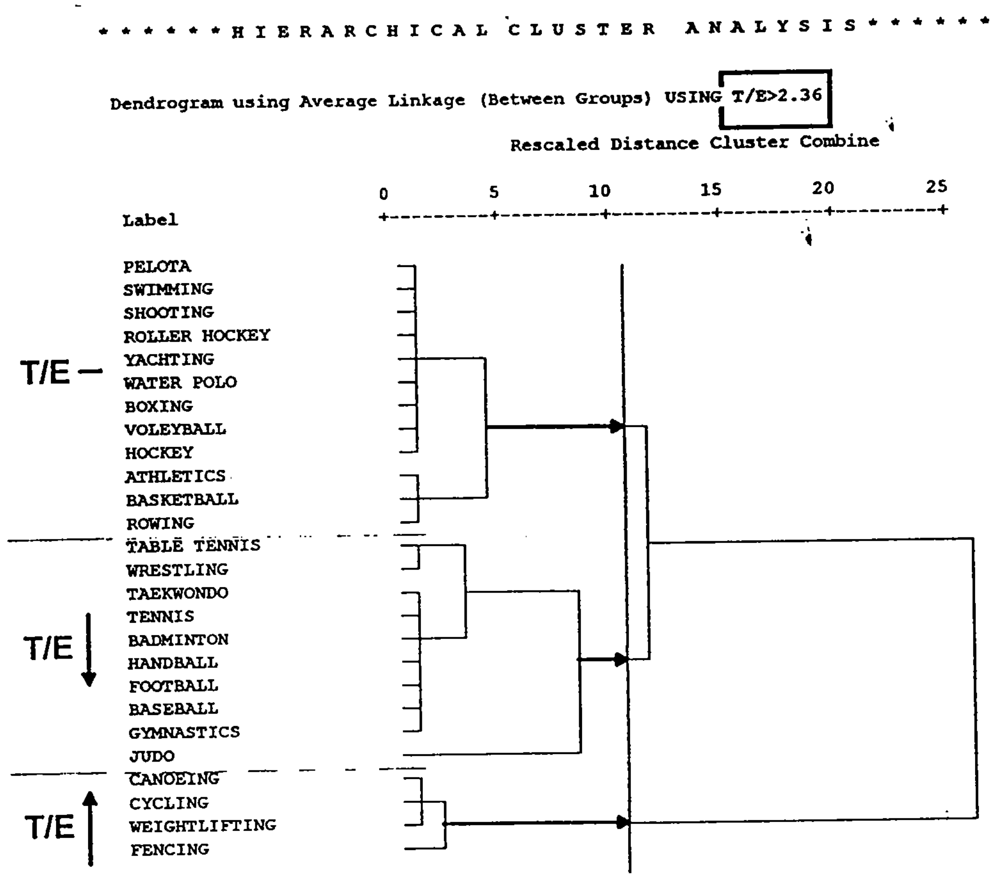

Figure 3. Dendrogram showing the results of the cluster analysis based on the values of the percentiles of each sport corresponding to the value T/E = 2.36 and T/E=0.4.

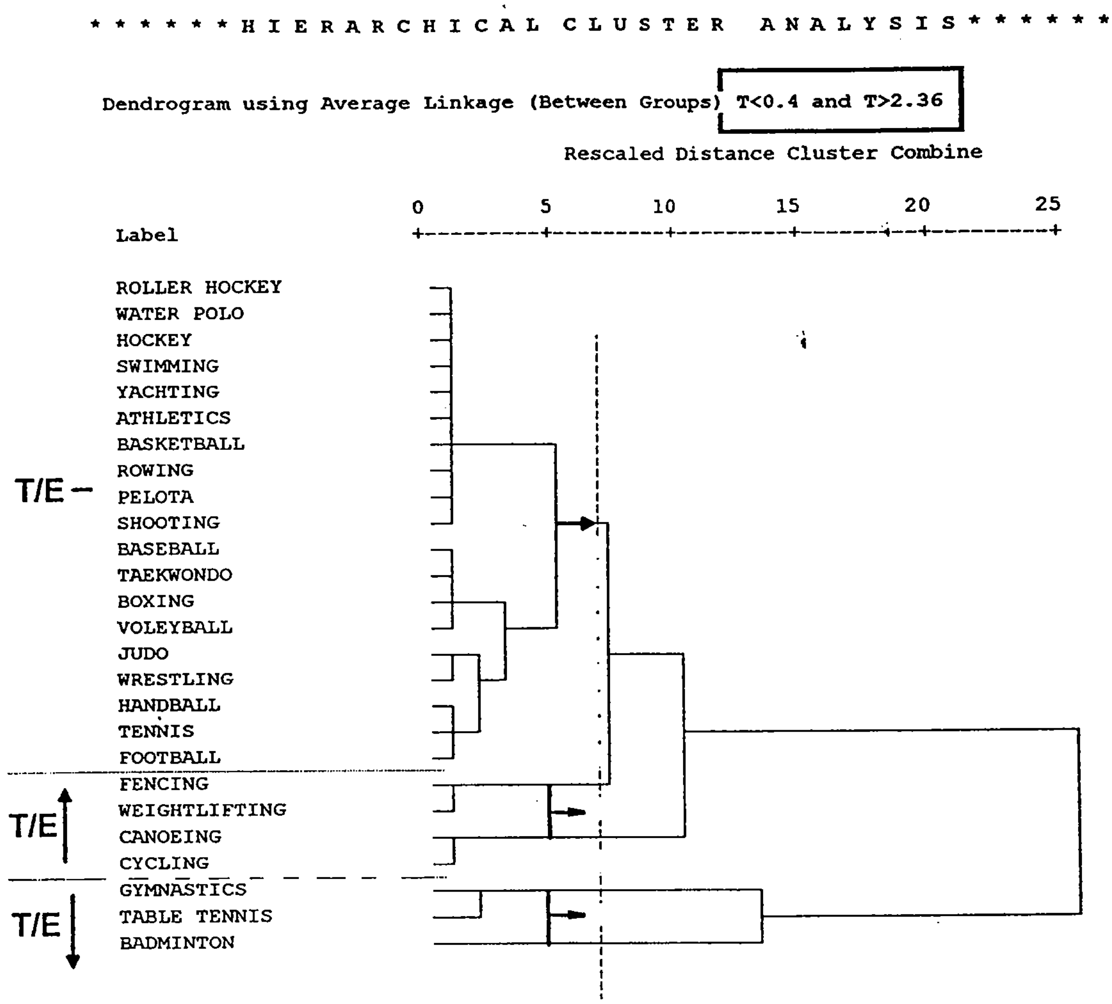

Figure 4. T/E frequency distributions of the values obtained from the groups resulting from the T/E cluster analysis (Reference group includes all the other sports not presented in the other distributions) .

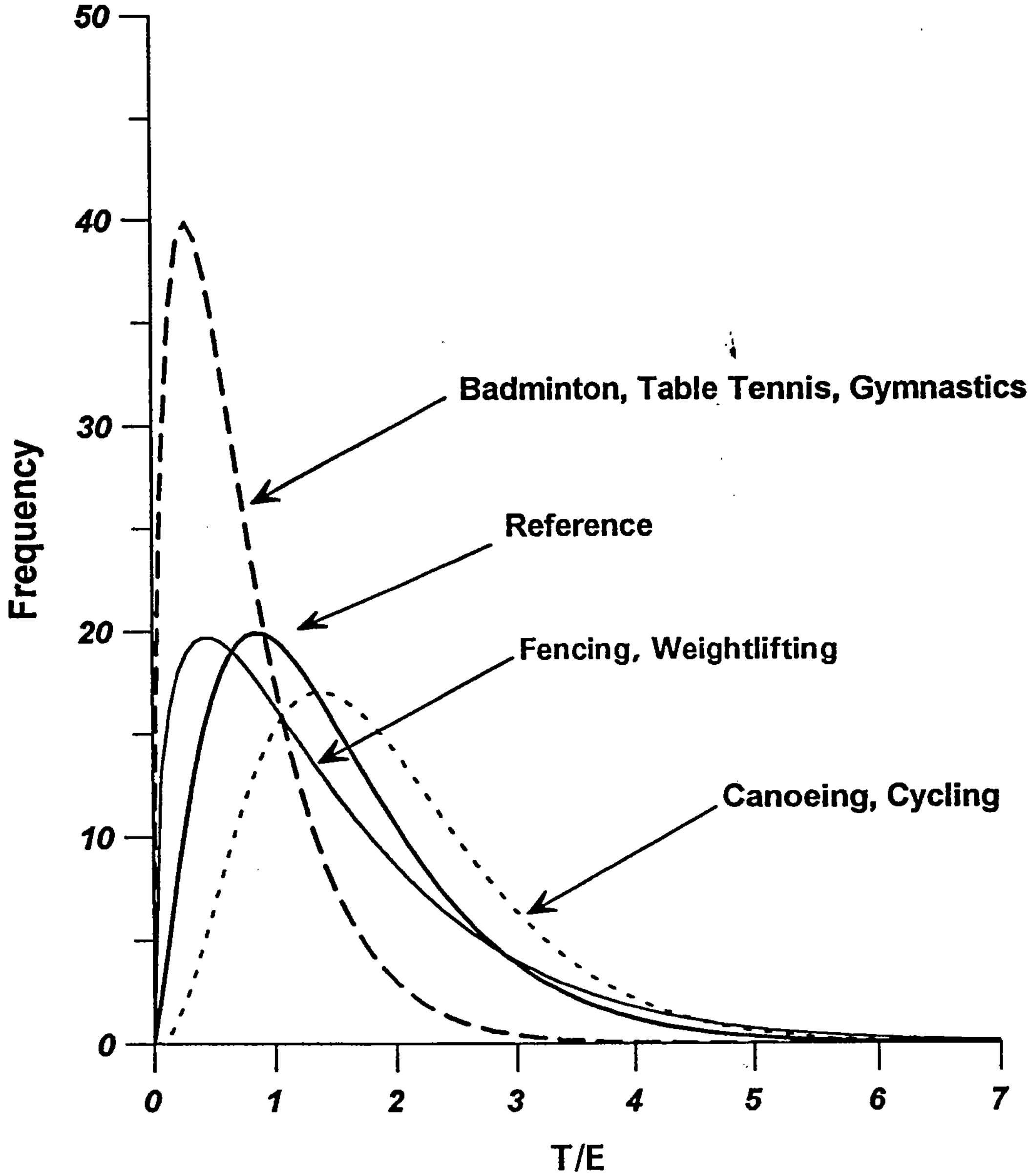

Table 3. Relationship between low T/E observed during the Barcelona Olympic Games 1992 and percentage of samples from oriental competitors (according to the final results).

Males

	Samples analyzed		Final classification					
Sport	**n**	**T/E<0.44 (%)**	**Gold**	**Silver**	**Bronze**	**4^{th} to 6^{th} place**	**total**	**orientals (%)**
Badminton	21	52.4	INA KOR (2)	INA(3)	DEN INA CHN(2) MAS(2)	CHN MAS DEN(3) KOR(3) INA(2) JPN(2)	23	82.61
Gymnastics	10	30	CHN EUN(4) USA PRK	CHN(2) EUN(2) JPN	CHN(2) GER(2) EUN JPN KOR	KOR JPN(4) EUN(3) HUN(2) USA(2) CHN(3) GER	35	77.14
Table tennis	28	35.7	SWE CHN(2)	FRA GER(2)	CHN KOR(5)	AUT* SWE GER CHN(3) IOP(2) EUN(2) FRA(2)	24	66.67