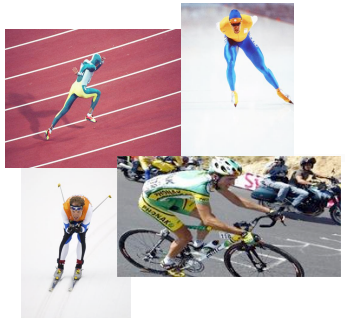


L'ALTITUDE….
DOPAGE NATUREL?

Martial Saugy

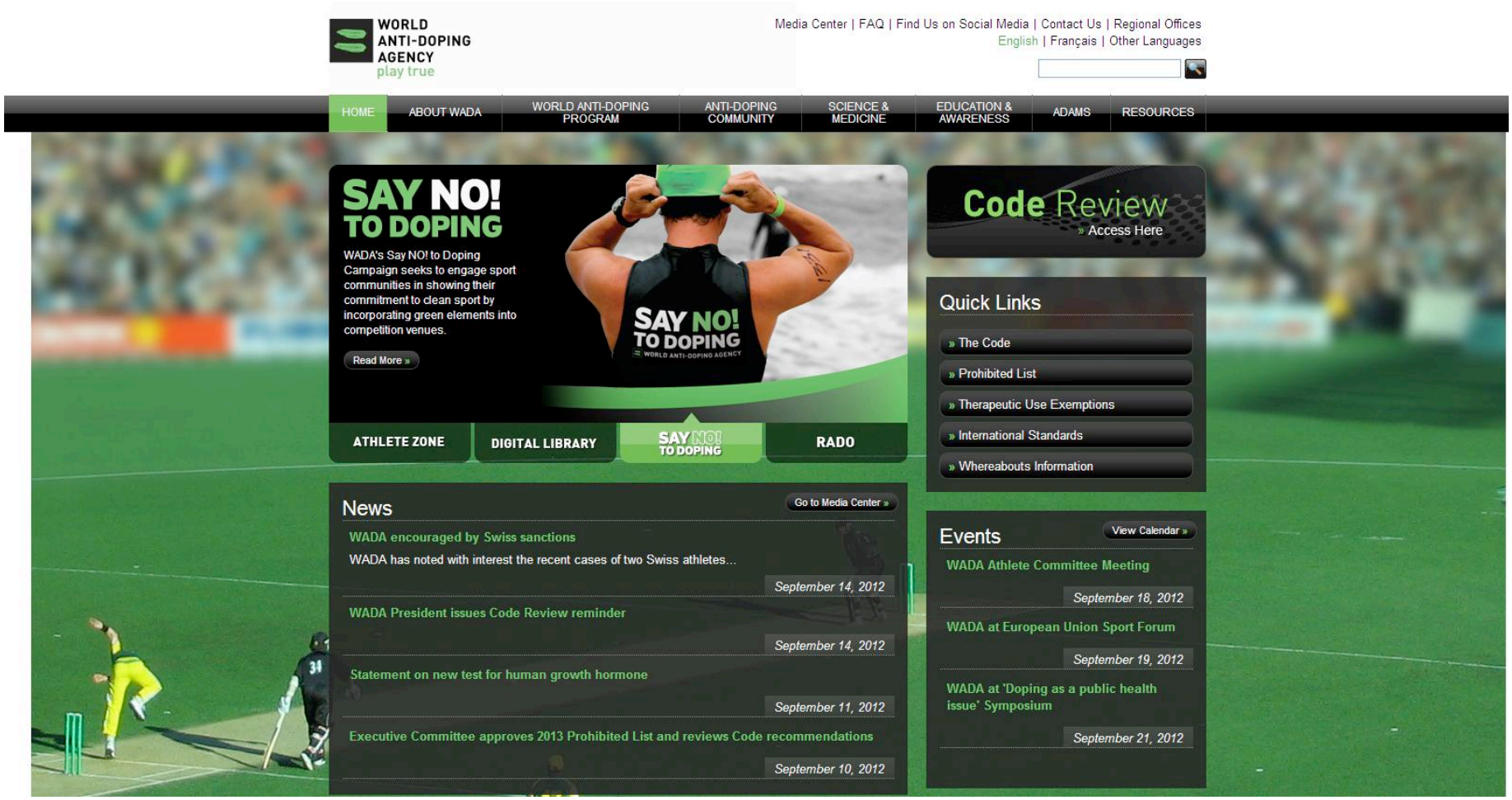
Swiss Laboratory for Doping Analyses

CHUV & UNIVERSITY of LAUSANNE

Switzerland

Altitude Training ....Doping?

What are the WADA rules



List of prohibited substances & methods

S2. PEPTIDE HORMONES, GROWTH FACTORS AND RELATED SUBSTANCES

The following substances and their releasing factors are prohibited:

1. **Erythropoiesis-Stimulating Agents** [e.g. **erythropoietin (EPO), darbepoetin (dEPO), hypoxia-inducible factor (HIF) stabilizers, methoxy polyethylene glycol-epoetin beta (CERA), peginesatide (Hematide)];**

M1. ENHANCEMENT OF OXYGEN TRANSFER

The following are prohibited:

1. Blood doping, including the use of autologous, homologous or heterologous blood or red blood cell products of any origin.

2. Artificially enhancing the uptake, transport or delivery of oxygen, including, but not limited to, perfluorochemicals, efaproxiral (RSR13) and modified haemoglobin products (e.g. haemoglobin-based blood substitutes, microencapsulated haemoglobin products), excluding supplemental oxygen.

IOC Consensus on …

BJSM Online First, published on July 27, 2012 as 10.1136/bjsports-2012-091296

Original article

International Olympic Committee consensus statement on thermoregulatory and altitude challenges for high-level athletes

Bergeron MF,[1,2] Bahr R,[3] Bärtsch P,[4] Bourdon L,[5] Calbet JAL,[6] Carlsen KH,[7-9] Castagna O,[5] González-Alonso J,[10] Lundby C,[11] Maughan RJ,[12] Millet G,[13] Mountjoy M,[14-16] Racinais S,[17] Rasmussen P,[11, 18] Singh DG,[19-21] Subudhi AW,[22] Young AJ,[23] Soligard T,[24] Engebretsen L[24]

IOC Consensus on …

International Olympic Committee consensus statement on thermoregulatory and altitude challenges for high-level athletes

Hypoxia for improvement of performance near sea level

Placebo-controlled double-blind studies show that passive exposure to hypoxia over several hours does not improve aerobic or anaerobic performance.[93–95] Whether training in hypoxia while living in normoxia is superior to training in normoxia for enhancing performance of elite athletes near sea level needs to be investigated in carefully controlled double-blind studies. Moreover, the purported performance gain by living at simulated moderate altitude and training at low altitude[91] has been challenged recently.[96]

Intermittent hypobaric hypoxia

First published August 9, 2007; doi:10.1152/japplphysiol.01320.2006.

Performance of runners and swimmers after four weeks of intermittent hypobaric hypoxic exposure plus sea level training

Ferran A. Rodríguez,[1,2] Martin J. Truijens,[1,5] Nathan E. Townsend,[3] James Stray-Gundersen,[1] Christopher J. Gore,[4,6] and Benjamin D. Levine[1]

–This double-blind, randomized, placebo-controlled trial examined the effects of 4 wk of resting exposure to intermittent hypobaric hypoxia (IHE, 3 h/day, 5 days/wk at 4,000–5,500 m) or normoxia combined with training at sea level on performance and maximal oxygen transport in athletes. Twenty-three trained swimmers and runners

We conclude that this "dose" of IHE was not sufficient to improve performance or oxygen transport in this heterogeneous group of athletes.

LHTL normobaric hypoxia

J Appl Physiol 112: 106–117, 2012.
First published October 27, 2011; doi:10.1152/japplphysiol.00388.2011.

"Live high–train low" using normobaric hypoxia: a double-blinded, placebo-controlled study

Christoph Siebenmann,[1] Paul Robach,[2] Robert A. Jacobs,[1,3] Peter Rasmussen,[1] Nikolai Nordsborg,[4] Victor Diaz,[1,3] Andreas Christ,[5] Niels Vidiendal Olsen,[6] Marco Maggiorini,[5] and Carsten Lundby[1]

Sixteen endurance cyclists trained for 8 wk at low altitude (<1,200 m). After a 2-wk lead-in period, athletes spent 16 h/day for the following 4 wk in rooms flushed with either normal air (placebo group, $n = 6$) or normobaric hypoxia, corresponding to an altitude of 3,000 m (LHTL group, $n = 10$).

In conclusion, 4 wk of LHTL, using 16 h/day of normobaric hypoxia, did not improve endurance performance or any of the measured, associated physiological variables.

WADA Statistics

2010 *Adverse Analytical Findings* and *Atypical Findings*
Reported by Accredited Laboratories

Overview of Results

Table A All Sports

Differentiation between Olympic and Non-Olympic Sports	**A *Samples* Analyzed**	**A *Samples* *Adverse Analytical* *Findings*** [1,3]	**(%)**	A *Samples* *Atypical* *Findings* [2,3]	(%)	A *Samples* Total *Findings* [3]	(%)
Olympic Sports	**180,584**	**1,624**	**(0.90%)**	1,593	(0.88%)	3,217	(1.78%)
Non-Olympic Sports	**77,683**	**1,166**	**(1.50%)**	435	(0.56%)	1,601	(2.06%)
TOTAL	**258,267**	**2,790**	**(1.08%)**	2,027	(0.78%)	4,817	(1.87%)

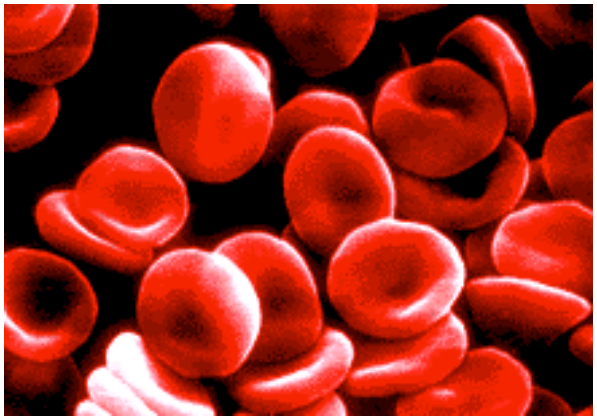
WADA Statistics

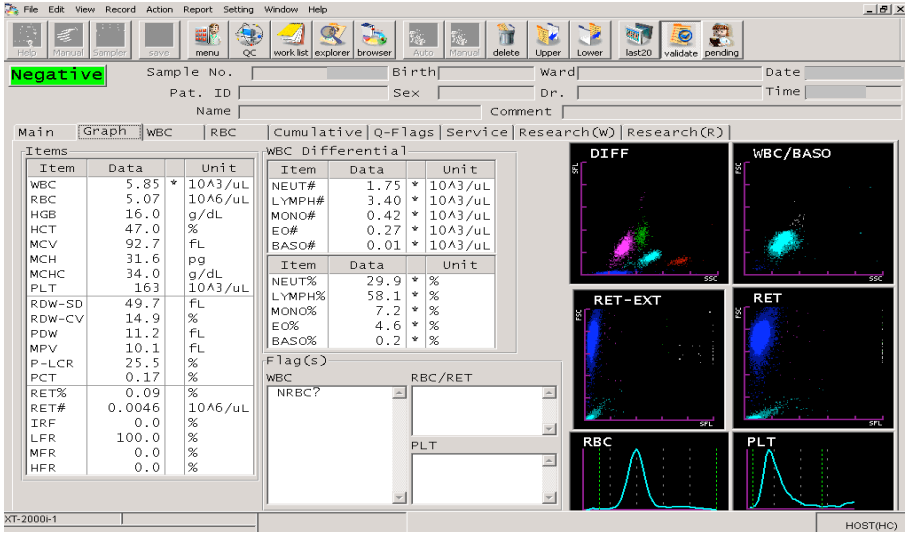
2010 *Adverse Analytical Findings and Atypical Findings*
Reported by Accredited Laboratories

Table E Number of Prohibited Substances Identified in Each Drug Class (All Sports)

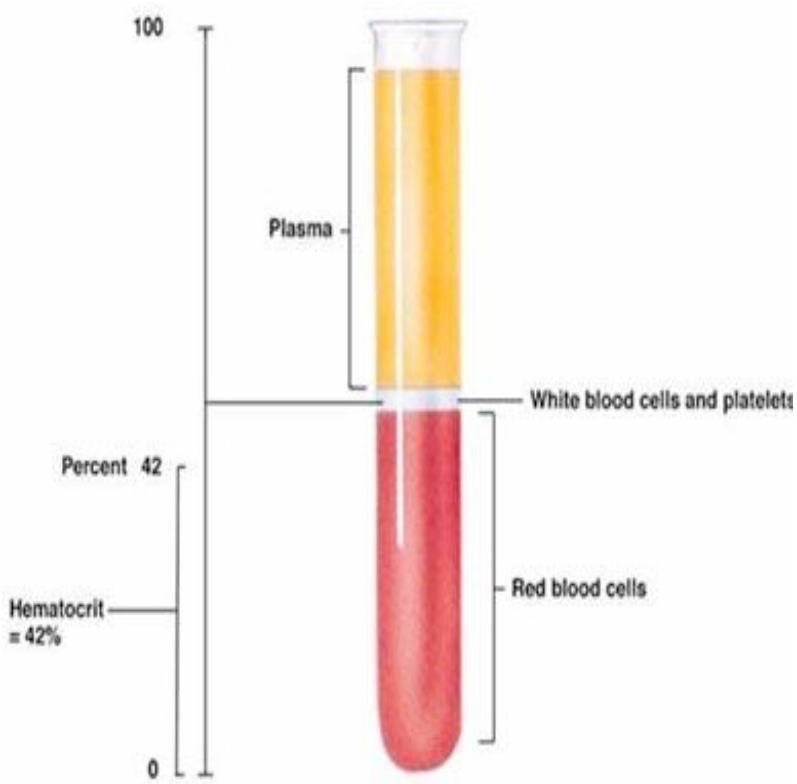
Substance Group	Number*	% of all reported findings*
S1. Anabolic Agents	3,374	60.8%
S6. Stimulants	574	10.3%
S8. Cannabinoids	533	9.6%
S5. Diuretics and Other Masking Agents	396	7.1%
S9. Glucocorticosteroids	234	4.2%
S3. Beta-2 Agonists	209	3.8%
S2. Hormones and Related Substances	86	1.6%
S4. Hormone Antagonists and Modulators	75	1.4%
P2. Beta-Blockers	30	0.5%
S7. Narcotics	20	0.4%
P1. Alcohol	9	0.2%
M2. Chemical and Physical Manipulation	6	0.1%
M1. Enhancement of Oxygen Transfer	-	0.0%
TOTAL	**5,546**	

Biological passport to solve the problem of blood doping ?





A bit of History
1997: No Start Rule



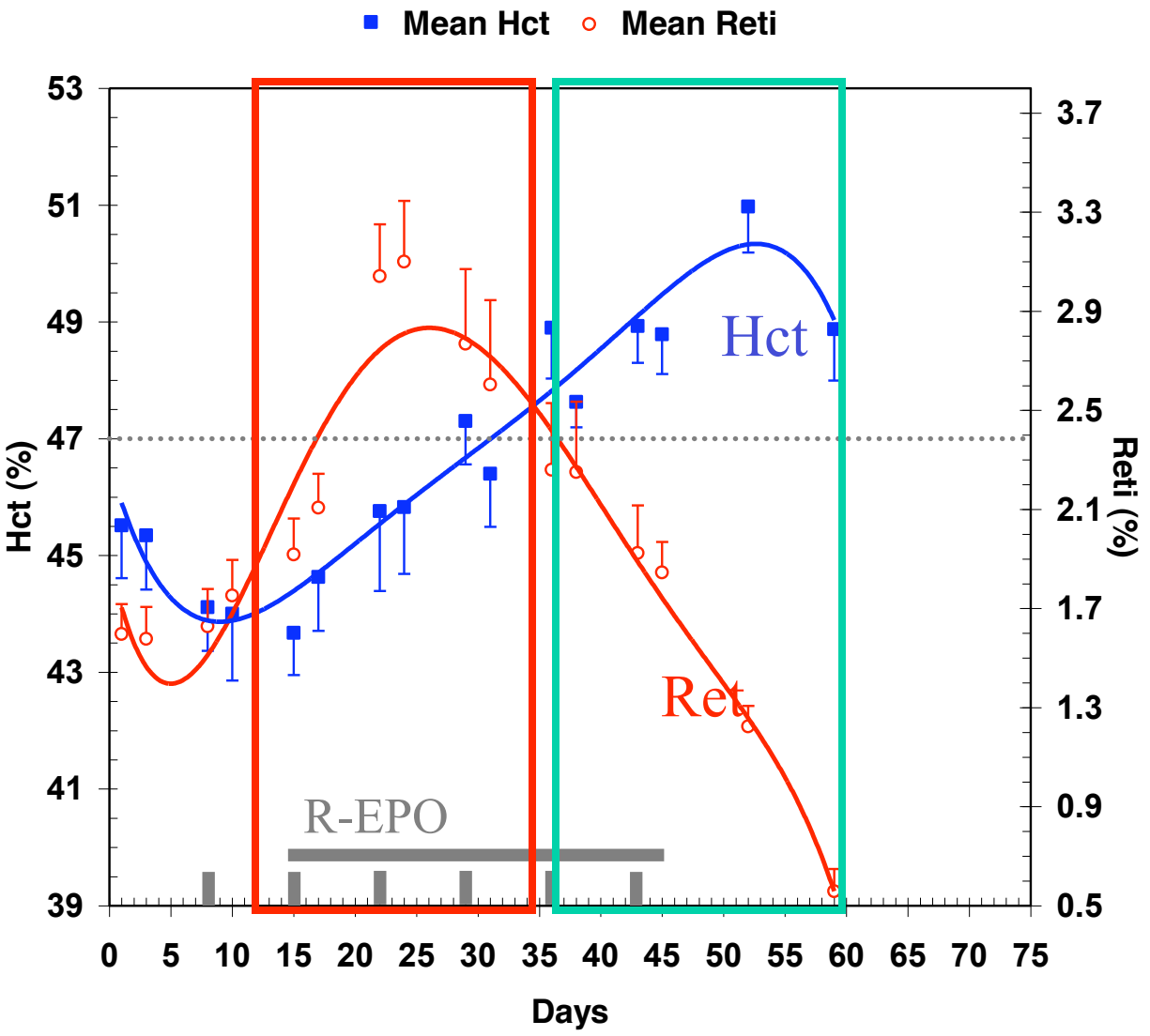
1997 in cycling:
NO START Rule: 50%

Later based on Hgb : 170 g/l

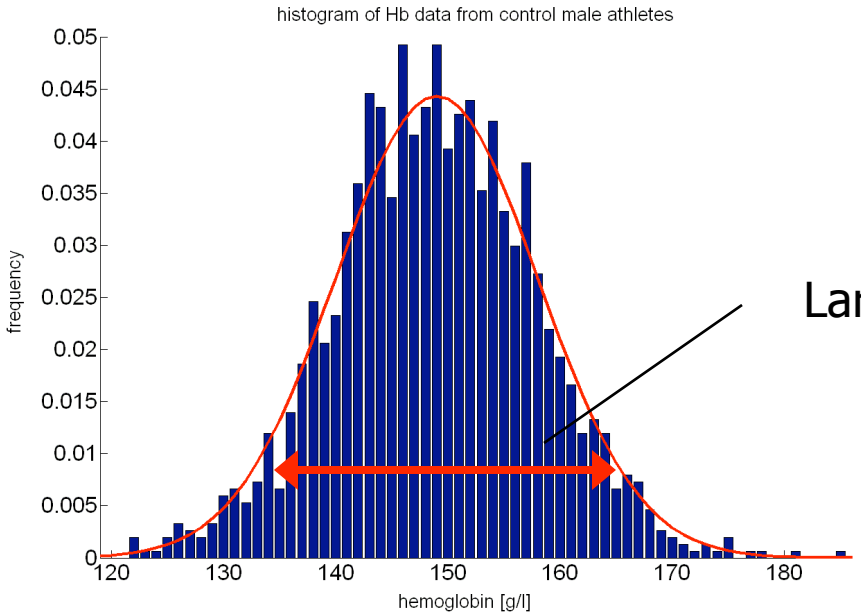
2001 ➡

Blood for targetting

On
&
Off



Hgb Distribution



Hgb

Large between-rider variance

Hgb

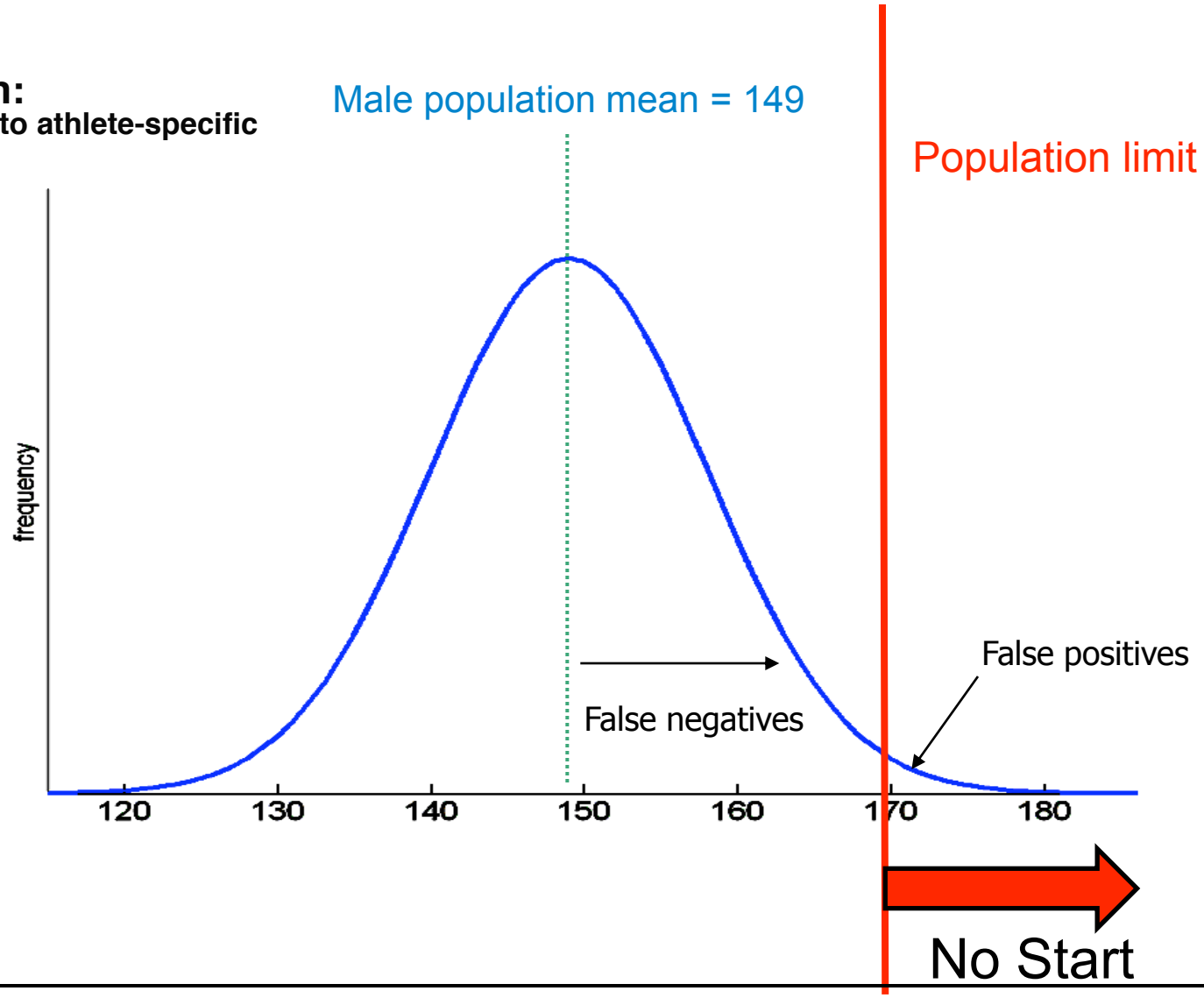
Population mean value is 149 g/L for males and 133 g/L for females

Between-rider variance = 57.2g/L

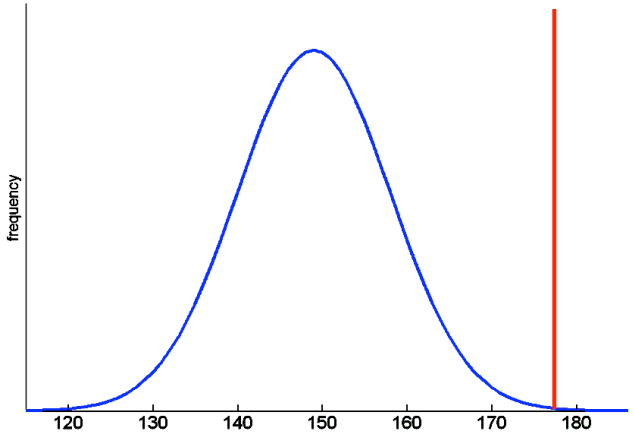
Within-rider variance = 28.2g/L

Hgb Distribution

Haemoglobin:
from population to athlete-specific values



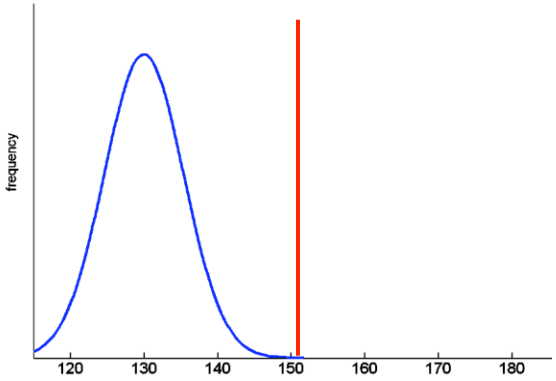
Hgb: from population to athlete-specific values



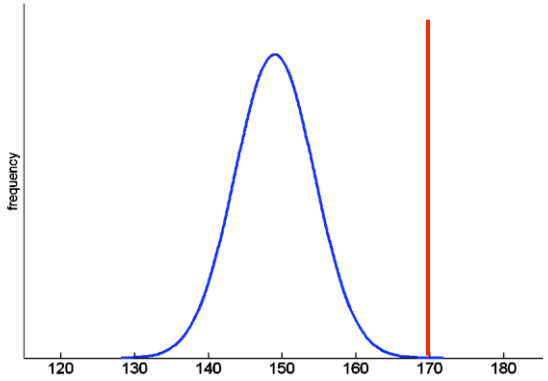
maximal value

expected values

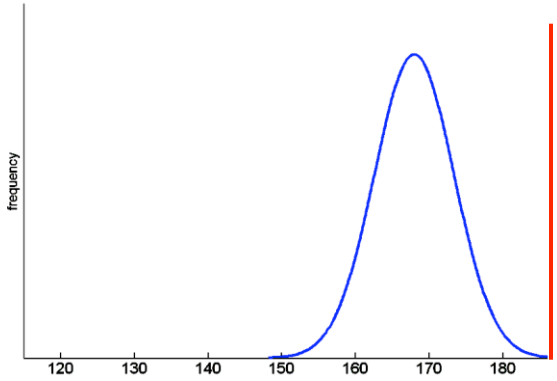
differentiation based on previous test history



athlete with naturally low hgb



athlete with medium hgb



athlete with naturally high hgb

Main principles of the athlete passport

- **1 : Individual**
- **2 : Longitudinal**

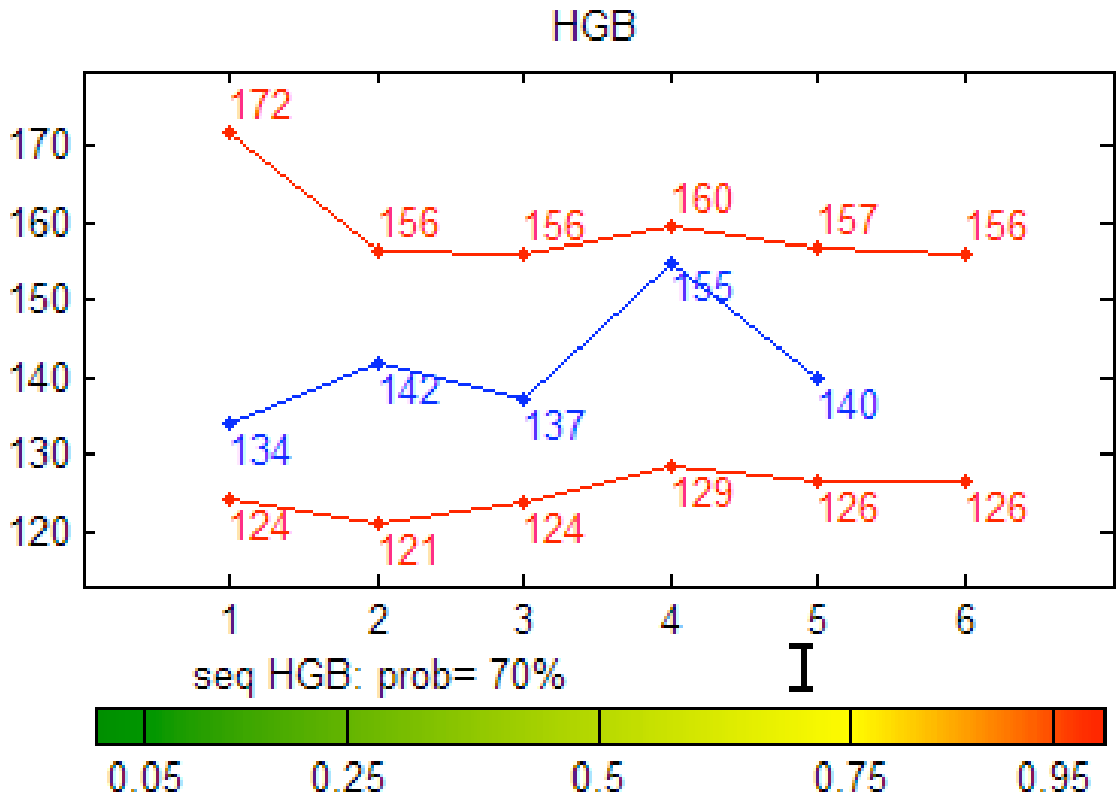
- **Based on an adaptive model**
- **Defines normal individual limits for biological parameters**

Principles of the blood passport

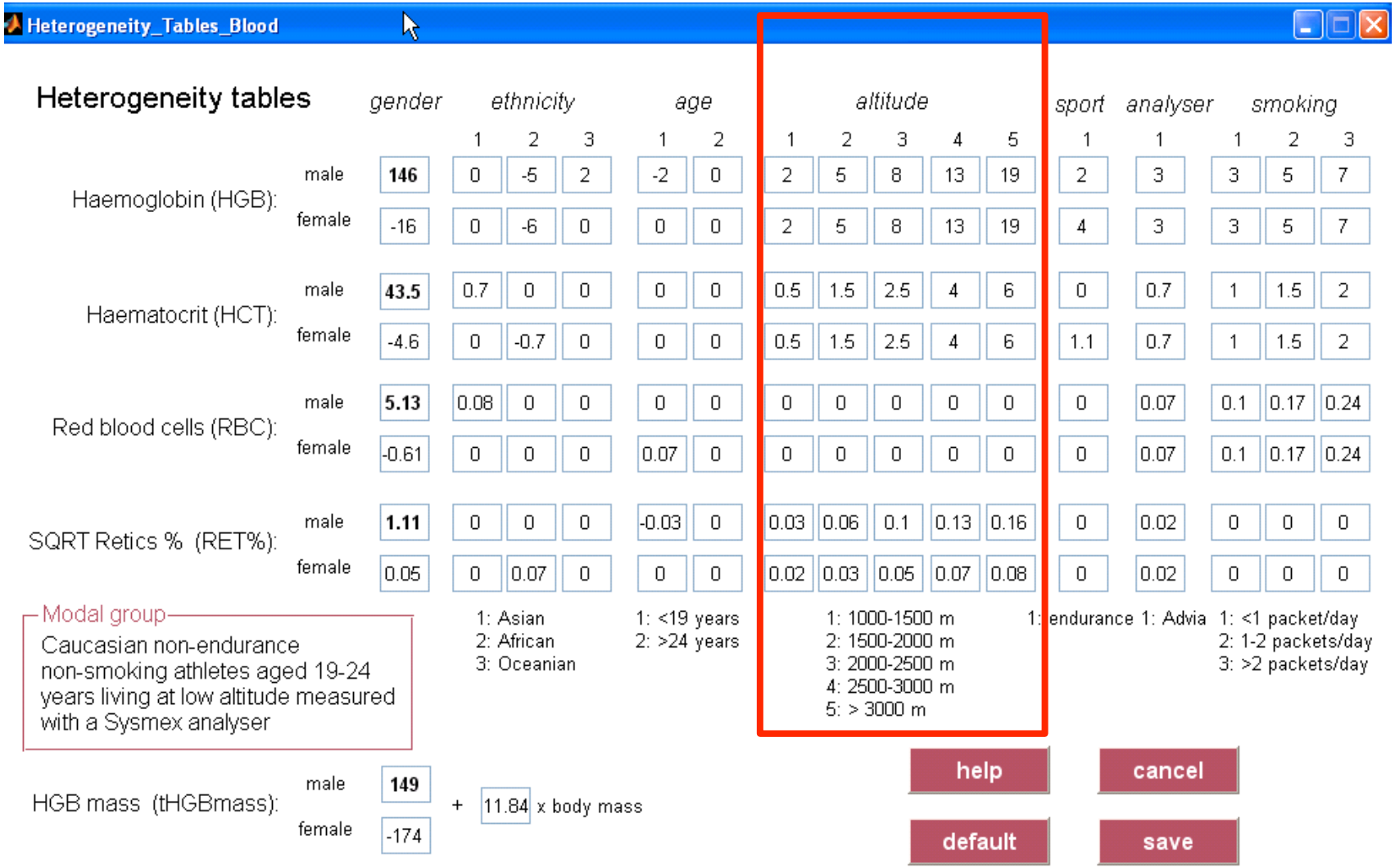
Heterogeneous/confounding factors for Hgb and OFFScore:

- **(1) gender (fixed factor)**
- (2) ethnic origin (fixed factor)
- (3) age (fixed factor)
- **(4) altitude (time-varying factor)**
- **(5) type of sport (fixed factor)**

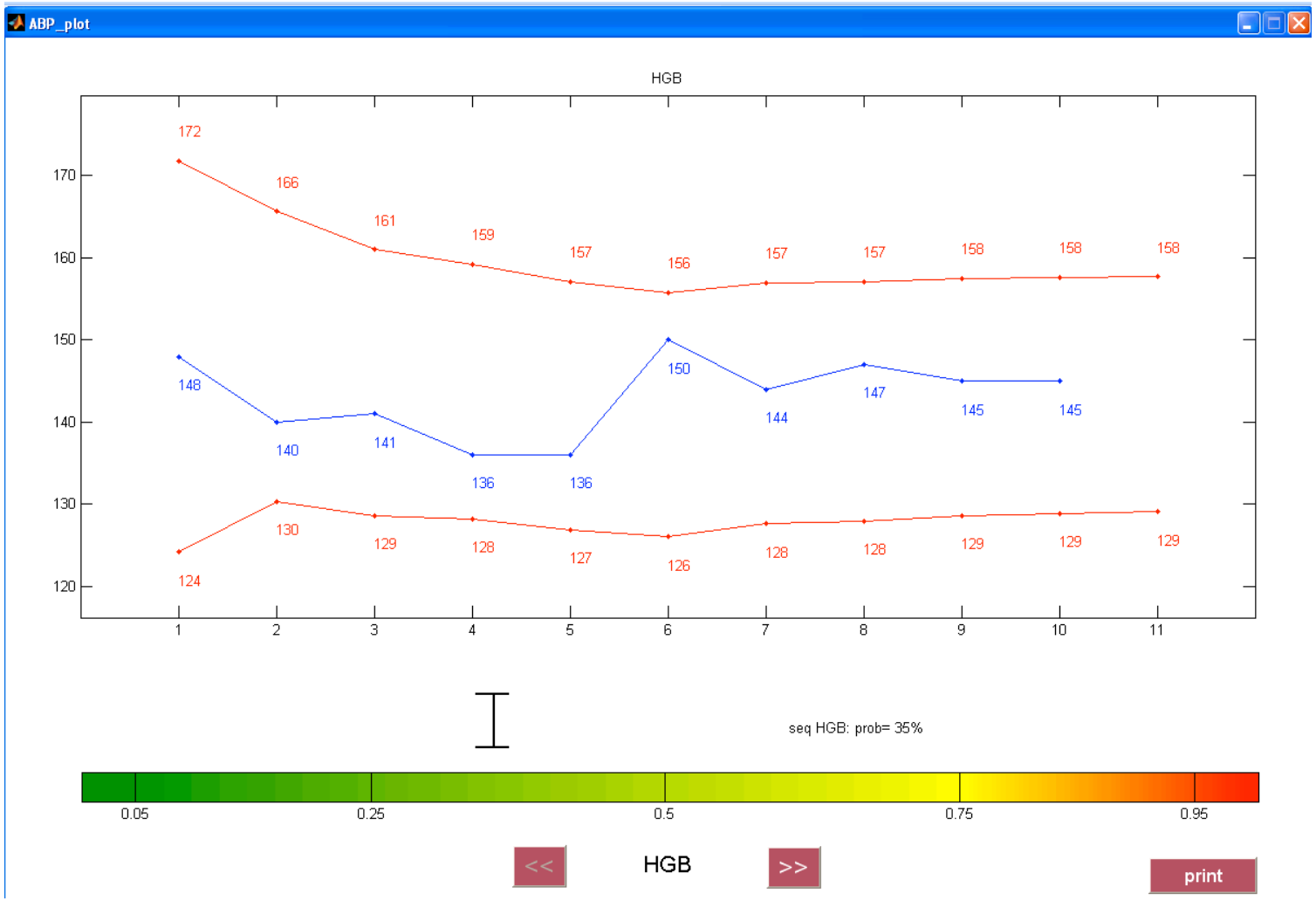
Normal hematological passport



Principles of the blood passport



At Sea level


ABP_plot
HGB
172
166
161
159
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158
148
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141
136
136
150
144
147
145
145
124
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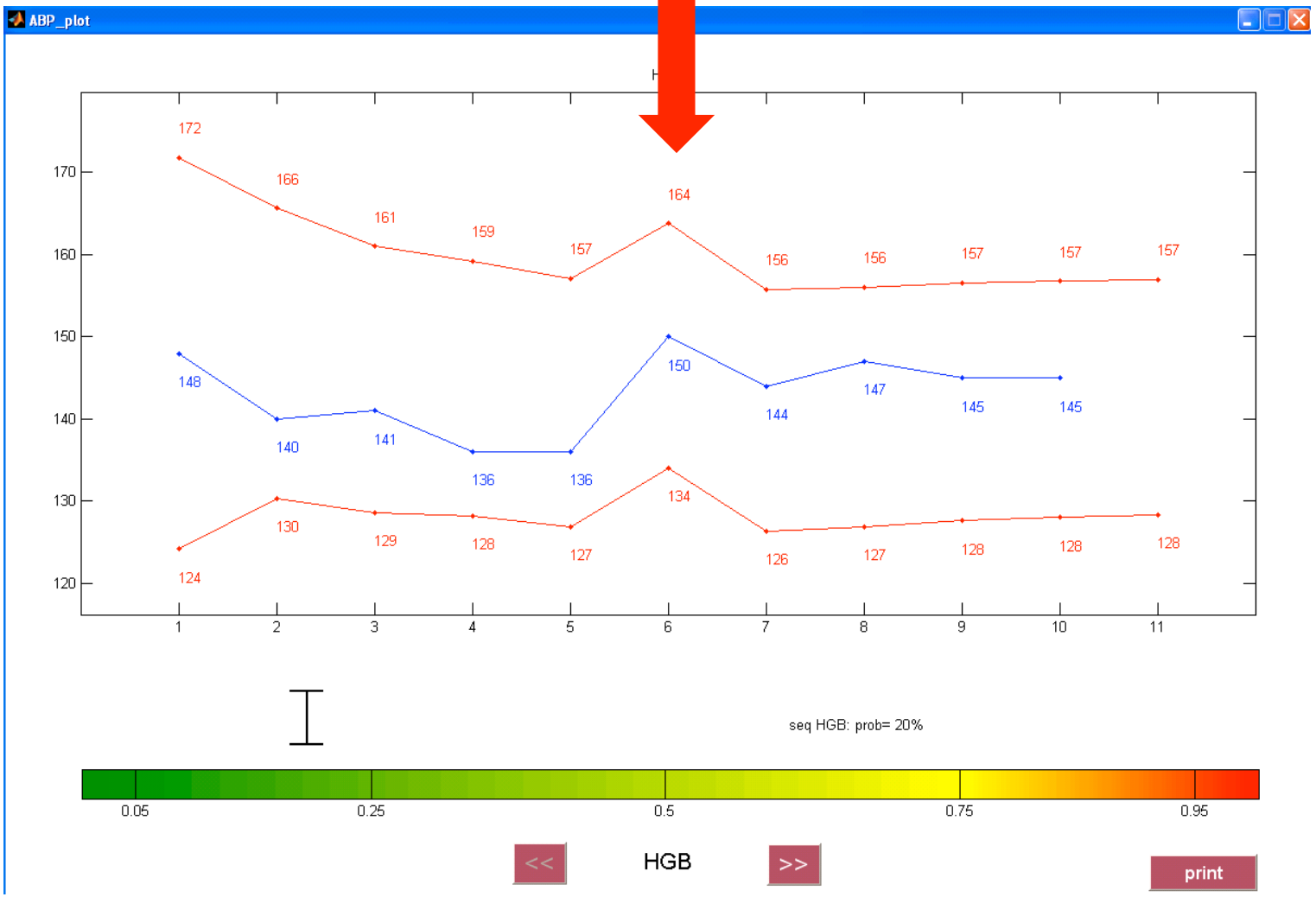
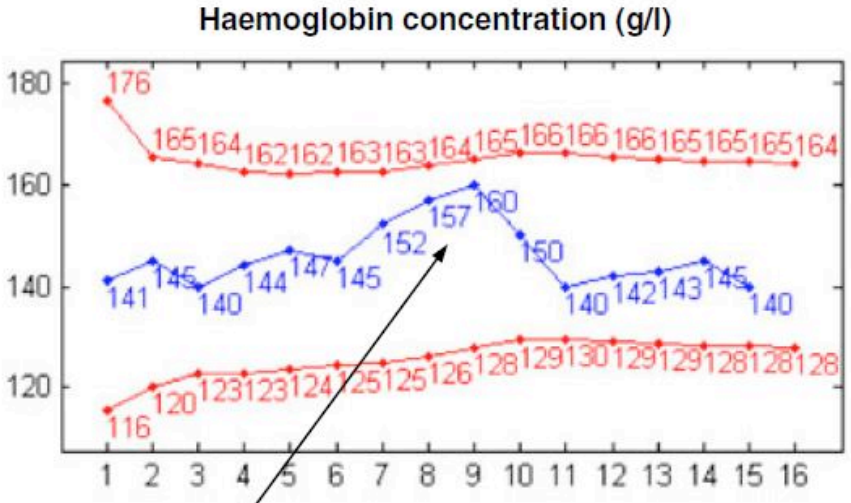
128
129
129
129
170
160
150
140
130
120
1
2
3
4
5
6
7
8
9
10
11
seq HGB: prob= 35%
0.05
0.25
0.5
0.75
0.95
<<
HGB
>>
print

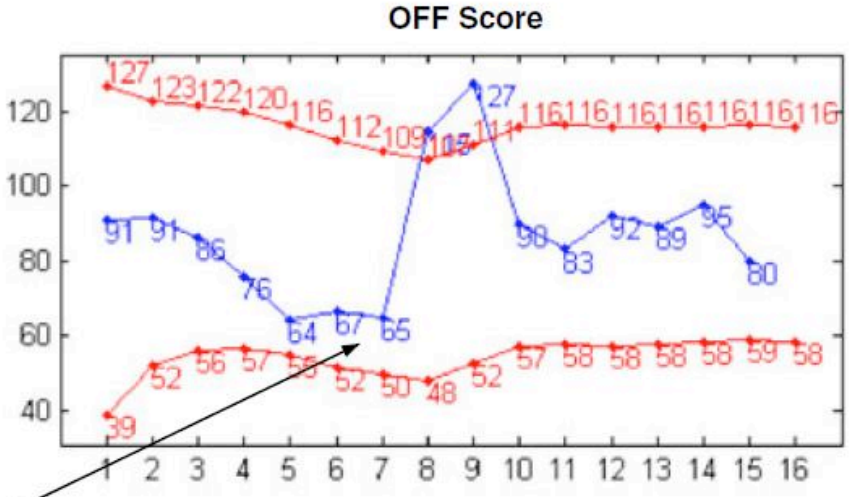
At 2200m altitude



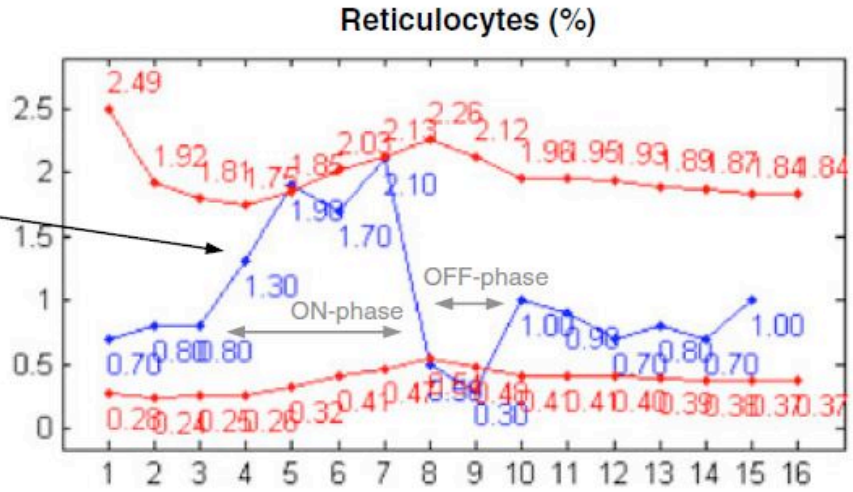
Examples of Blood passports



Continuous, slight increase in Haemoglobin concentration



The OFF score amplifies the changes observed in Haemoglobin and Reticulocytes.

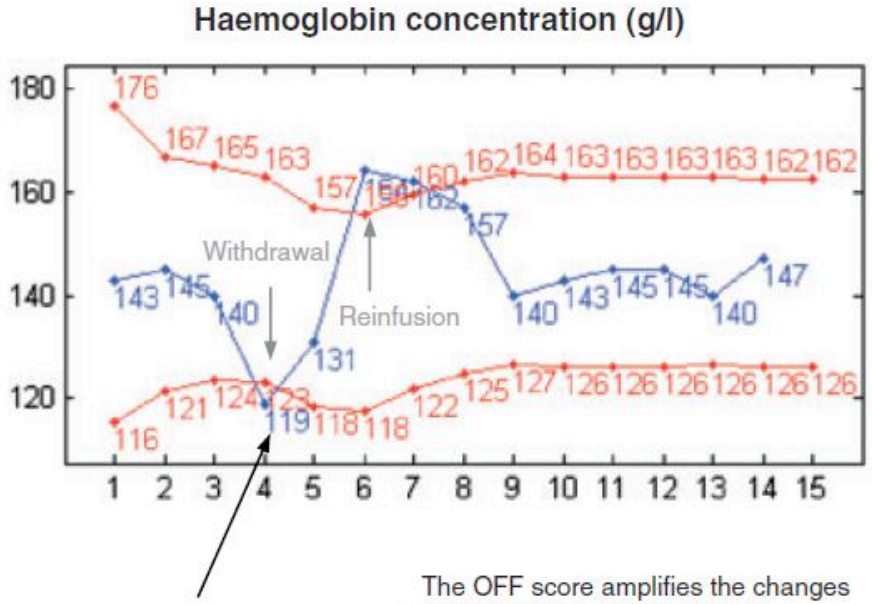


Abnormal increase in Reticulocytes (samples 3-7, „ON phase“) followed by marked drop when EPO is withdrawn and Erythropoiesis is suppressed (samples 8+9, „OFF phase“).

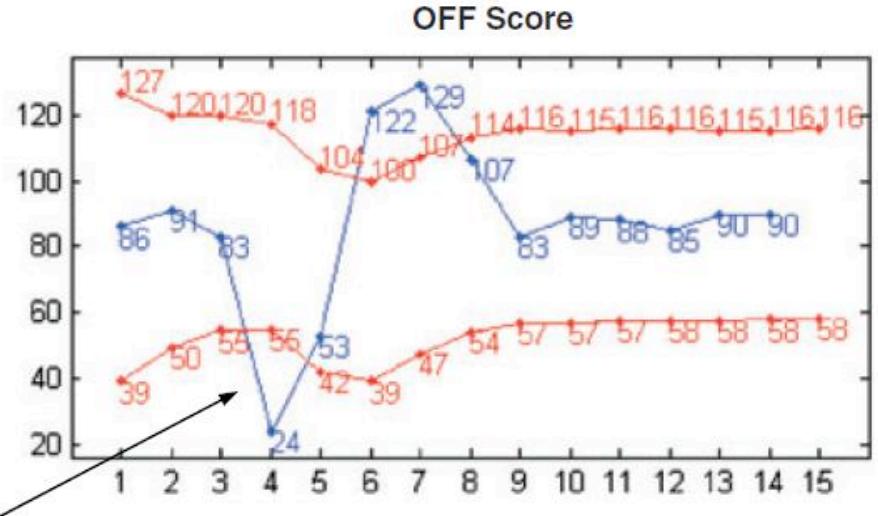
Biological passport: EPO/ ESA abuse

The samples 2-10 were taken on a regular base over a period of ~8 weeks.

Examples of Blood passports

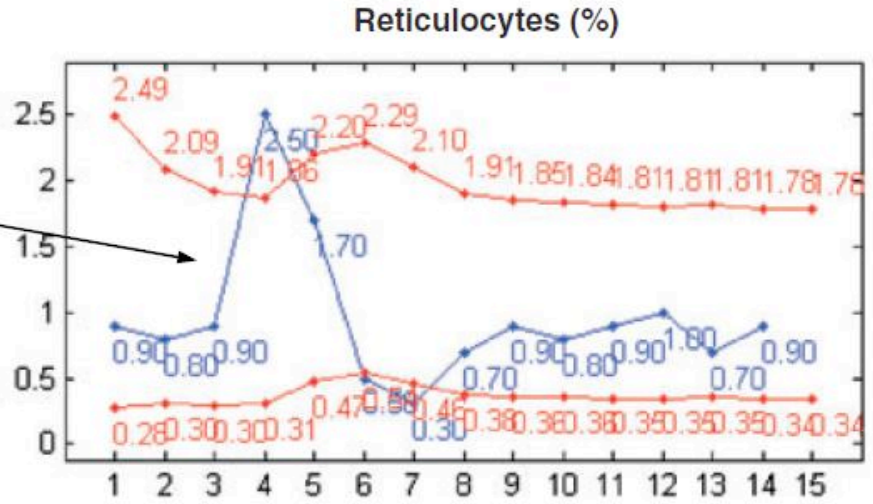


Large variation in Haemoglobin concentration after blood withdrawal and reinfusion.



The OFF score amplifies the changes observed in Haemoglobin and Reticulocytes.

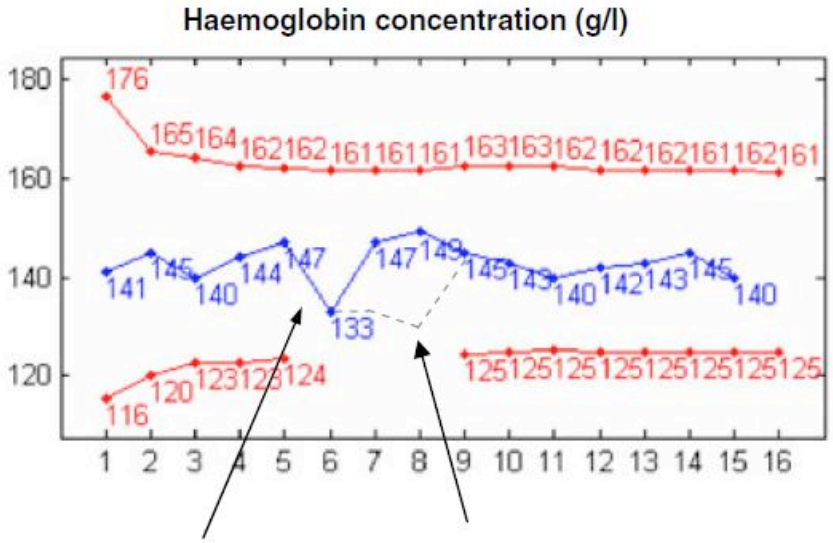
High Reticulocytes paired with low Haemoglobin concentration suggesting hyperproliferative condition after blood withdrawal (samples 4+5).
Low Reticulocytes with high Hb indicating supressed erythropoiesis after reinfusion of blood (samples 6+7).



Biological passport: Blood Transfusion

The samples 2-10 were taken on a regular base over a period of ~8 weeks.

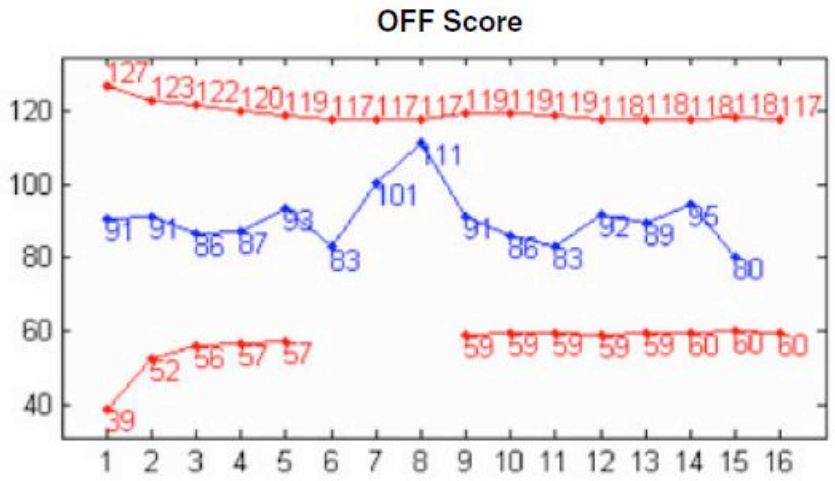
Examples of Blood passports

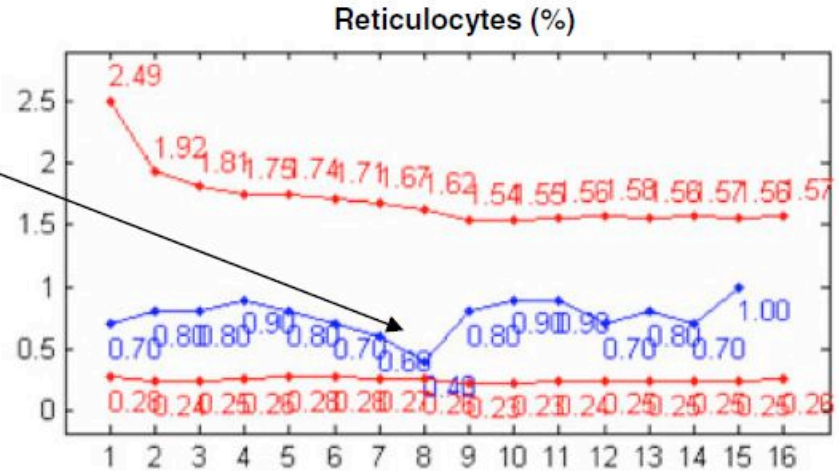


Normal drop (sample 6) from pre-competition test (sample 5) due to exercise-induced plasma volume expansion.

Abnormal increase in values despite ongoing exercise (samples 7,8). The decrease in Reticulocyte% suggests an increase in total Haemoglobin mass.

The grey dotted line illustrates the exspected physiologcal behaviour of the values).





Biological Passport:
Abnormal Haemoglobin pattern during a cycling stage race

Sample 5 was taken the day prior to the race, samples 6 and 7 after 1 week resp. 10 days of racing in a three week stage race. Sample 9 was taken 1 month after the race.

Limitations to ABP ?

Eur J Appl Physiol (2011) 111:2307–2314
DOI 10.1007/s00421-011-1867-6

ORIGINAL ARTICLE

Current markers of the Athlete Blood Passport do not flag microdose EPO doping

Michael Ashenden · Clare E. Gough ·
Andrew Garnham · Christopher J. Gore ·
Ken Sharpe

Blood doping Biomarkers:

Tool to measure the prevalence of blood doping

IAAF Blood tests: 2001 - 2009

	n[a]	Occurrence
Athletes	7289	Number: 2737
Sex	7289	Male: 55%
		Female: 45%
Competition	7287	Pre: 71%
		In: 6%
		Out: 23%
Age	6266	<19 years: 6%
		19–24 years: 28%
		>24 years: 66%
Nationality	6597	A: 9.8%
		B: 7.3%
		C: 6.1%
		D: 4.7%
		E: 4.0%
		F: 3.9%
		G: 3.8%
		Other: 140 <3.7%
Ethnicity	3487	White: 63%
		Asian: 9%
		African: 27%
		Oceanian: 1%
Sport	6328	Endurance: 79%
		Nonendurance: 21%

Distribution Functions

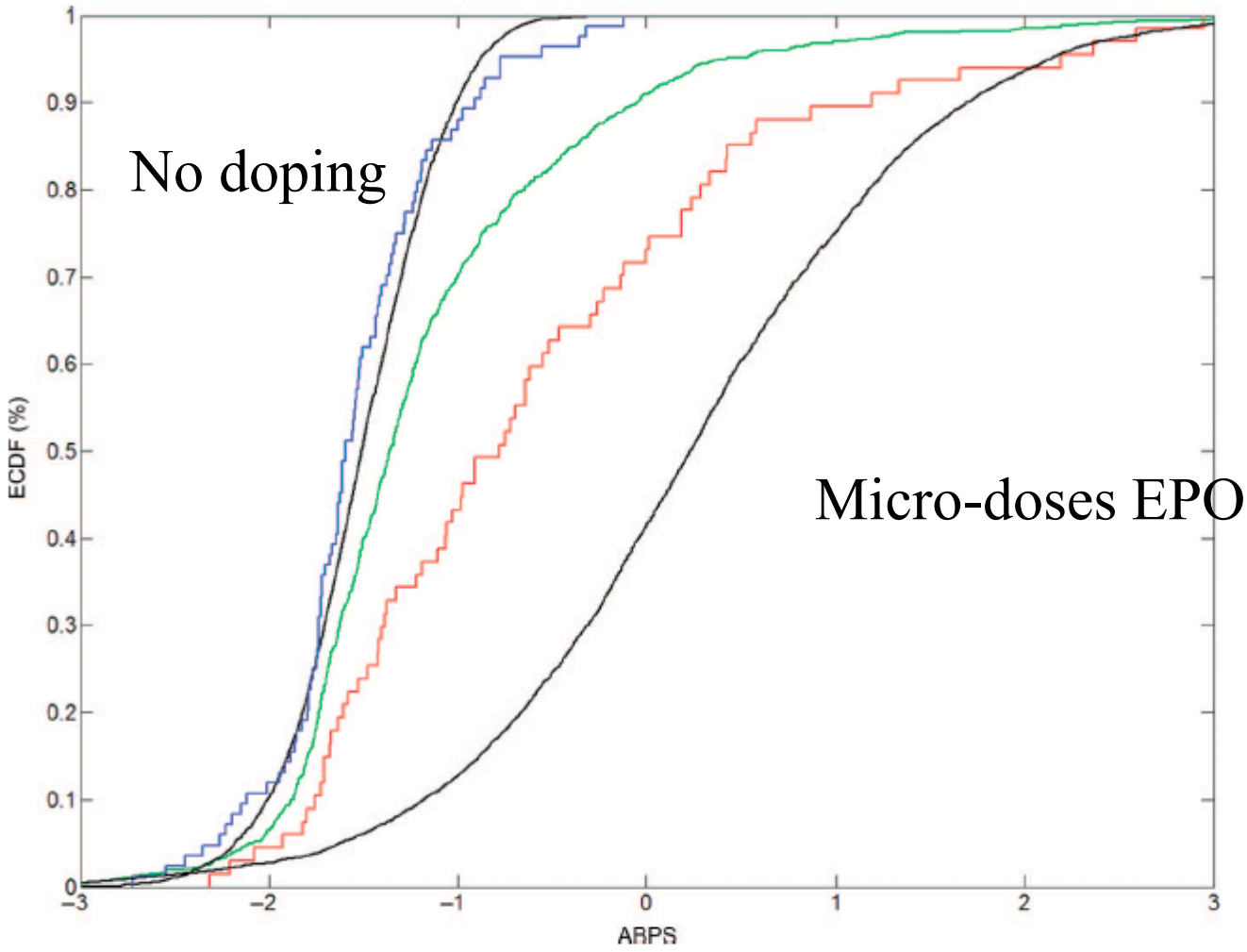
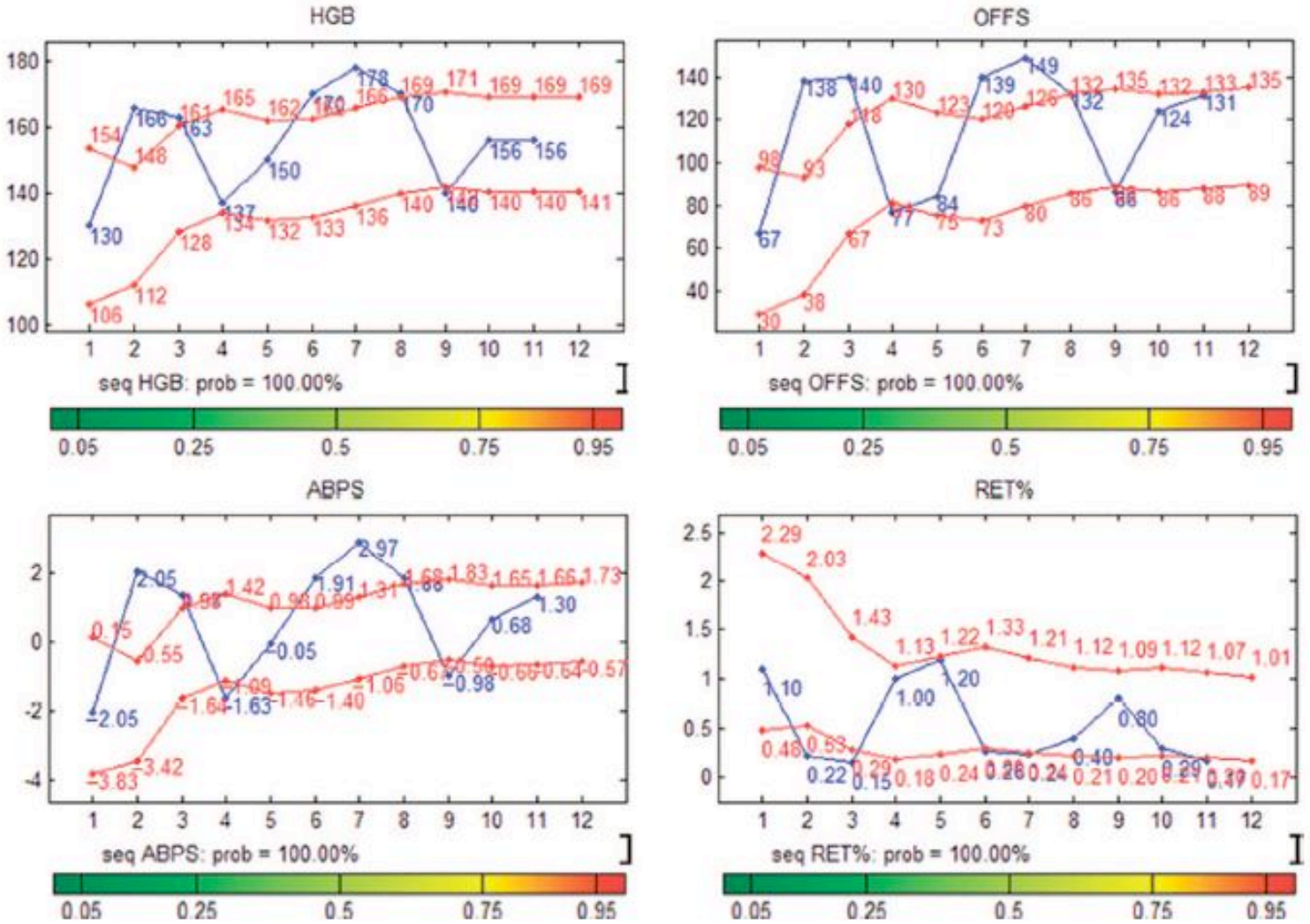


Fig. 1. Cumulative distribution functions of the multiparametric marker of blood doping ABPS based on the 7 blood variables: hemoglobin, hematocrit, red blood cell count, mean corpuscular volume, mean corpuscular hemoglobin, mean cell hemoglobin concentration, and reticulocyte percentage.

Caucasian Female Endurance Athlete 2005 - 2008



Prevalence of blood doping in Athletics

Table 2. Period prevalence estimates of abnormal blood profiles in elite track and field athletes.

	n[a]	Prevalence M1, %[b]	Prevalence M2, %
Males	4028	12 (10–15)	12 (10–15)
Country A	205	48 (35–63)	78 (54–99)
Country B	352	3 (1–11)	1 (0–2)
Country C	257	23 (15–30)	28 (17–36)
Country D	208	6 (3–19)	5 (0–17)
Country E	160	18 (11–30)	18 (7–28)
Country F	148	6 (1–25)	2 (0–22)
Country H	160	39 (20–54)	51 (21–87)
Females	3261	18 (15–21)	18 (15–21)
Country A	445	46 (35–58)	50 (35–68)
Country B	130	8 (4–34)	2 (0–11)
Country C	147	12 (4–20)	14 (1–28)
Country D	103	1 (0–11)	0 (0–3)
Country E	106	11 (7–20)	8 (1–14)
Country F	110	6 (3–19)	0 (0–13)
Country H	65	36 (13–62)	36 (5–66)

Blood tests 2001-2009

Mean: 12%
Country A: 78%
Country B: 1%

Prevalence M2:
Assumption of rhEPO microdoses

Sottas et al, 2011

Altitude Training: Natural Doping?

The Ethics of Altitude Simulation in Sport

Does altitude simulation technology impart an unfair advantage to the adopters of the technology?

Will the use of altitude simulation technology result in guaranteed increases in performance?

NO!

Does the use of altitude simulation technology result in supra-physiological performance enhancement?

Is the manipulation of the environment something that should be banned?

Thank you !