BOOK OF ABSTRACTS **Open Access**

Within-individual haemoglobin variation and the athlete biological passport: a longitudinal investigation of 13,887 haemoglobin concentration readings in elite athletes

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Abstract

The Athlete Biological Passport (ABP), introduced by the Union Cycliste Internationale (UCI) in 2008, has proven a critical tool for the reduction of doping cases. The ABP estimates individual reference ranges for haemoglobin concentration ([Hb]) and percentage reticulocytes from predetermined population mean, between- and within-individual variances. Here, we aim to verify the previously published estimate for within-individual variance of [Hb] (39.86 g2/L2) and determine whether sex-, sport- or season-specific values are required.

Our reference population contains 7,723 male (mean ± s, 22.3 ± 4.6 years of age) and 6,164 female (21.6 ± 4.3 years of age) athlete observations from 49 sports. [Hb] was calculated using one of three cytometers; Bayer-H3 (1997 – 1999, n = 4,554), ADVIA-120 (1999 – 2010, n = 8,636) and Sysmex XT-2000i (2010 – 2012, n = 697).

Linear mixed models were fitted with [Hb] as the response variable, analysis system (H3, ADVIA, Sysmex), sex (male, female), sport (power endurance, endurance, team, skill, disabled and non-athletes), season (summer, winter) the fixed effects and athlete the random effect. The final model contained an exponential correlation structure for the within-individual variance and allowed different within-individual variances for each sport.

Within-individual [Hb] variance was spatially correlated up to 36.5 days (95% CI 28.3 – 47.1) between measures. The proportion of within-individual variance that is analytical in origin was estimated as 0.54 (95% CI 0.50 - 0.60). Within-individual [Hb] variance did not differ between sexes (37.54 males, 37.79 females g2/L2) but was significantly less for power endurance, disabled and non-athletes than for endurance and team sports athletes and significantly higher during the hot months.

In conclusion, the current estimate of within-individual [Hb] variance is accurate and no new evidence was found to justify adjusting this value.

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