Letter to the Editor

Rafael Alis*, Fabian Sanchis-Gomar, Davide Ferioli, Antonio La Torre, Andrea Bosio, Jincheng Xu, Giovanni Lombardi, Marco Romagnoli and Ermanno Rampinini

Association between physical fitness and mean platelet volume in professional soccer players

DOI 10.1515/cclm-2014-1275
Received December 24, 2014; accepted January 8, 2015

Keywords: Platelet activation; sports performance; team sports.

To the Editor,

Platelets play an important role in the formation of blood clots and atheromatous plaques by adhering to damaged endothelium and releasing the content of their granules. Consequently, platelet hyper-aggregation and -activation are involved in the onset of atherosclerosis, and hence, in cardiovascular diseases (CVD), myocardial infarction and stroke [1]. It is now well known that hemostasis is directly implicated in the health benefits of regular exercise and physical activity. In fact, regular practice of exercise reduces platelet aggregability, decreases clotting factors and enhances fibrinolysis which altogether provoke hypocoagulability [2].

***Corresponding author: Rafael Alis,** Research Institute "Dr. Viña Giner", Molecular and Mitochondrial Medicine, Catholic University of Valencia San Vicente Mártir, C/ Quevedo 2, 46001 Valencia, Spain, Phone: + 34 963637412, Fax: +34 963944590, E-mail: rafael.alis@ucv.es; and School of Medicine, Catholic University of Valencia San Vicente Mártir, Valencia, Spain
Fabian Sanchis-Gomar: Research Institute of the Hospital 12 de Octubre ("i+12"), Madrid, Spain
Davide Ferioli and Antonio La Torre: Department of Biomedical Sciences for Health, Università degli Studi di Milano, Milan, Italy.
Andrea Bosio and Ermanno Rampinini: Human Performance Laboratory, MAPEI Sport Research Center, Olgiate Olona (VA), Italy
Jincheng Xu: Sport Rehabilitation Department, Beijing Sport University, Beijing, P.R. China
Giovanni Lombardi: Laboratory of Experimental Biochemistry & Molecular Biology, I.R.C.C.S. Istituto Ortopedico Galeazzi, Milan, Italy
Marco Romagnoli: Research Institute "Dr. Viña Giner", Molecular and Mitochondrial Medicine, Catholic University of Valencia San Vicente Mártir, Valencia, Spain; and Department of Physical Education and Sports, University of Valencia, Valencia, Spain

Interestingly, it has been recently shown that the baseline platelet size, conventionally expressed as mean platelet volume (MPV), may be negatively associated with the time to complete a half-marathon race, being a predictor of endurance performance [3].

MPV is routinely determined, along with others parameters, in automated hematological analyzers as a marker of platelet activation and/or reactivity. Accordingly, it could be used as an easy and inexpensive biomarker of physical performance in other exercise settings [4]. In this study, we aimed to prove whether MPV might be associated with physical fitness in professional soccer players throughout a competitive season.

To this aim, 15 male professional soccer players from an Italian Serie A team (age 27±5 years, weight 76.9±4.1 kg, height 1.82±0.05 m) were included in this study. Goalkeepers were excluded from the study because their total distance covered and running intensities during soccer matches highly differ from those experienced by the field players. The players were controlled two times during the end-part of the professional soccer season (at January and at March). The competitive season finished at the end of May. Thereafter, all players took vacation time and returned to the team discipline at the beginning of July, when the players included in the study were sampled again. The study, which complies with the World Medical Association Declaration of Helsinki regarding ethical conduct of research involving human subjects and/or animals, was approved by the Ethics Committee of University of Valencia and by the soccer club involved.

At all time-points, the samples were drawn at the same hour (between 7 and 8 a.m.) in fasting conditions, and carried to the laboratory within the same time-frame. Hematological parameters (RBC count, hemoglobin, hematocrit, WBC count, neutrophils count, MPV and platelet count) were determined in an automated hematological analyzer (XE-2100L, Sysmex, Kobe, Japan). Biochemical parameters [lactate dehydrogenase (LDH), creatine kinase (CK), cortisol and testosterone] were also determined.

Each athlete was evaluated using a continuous running test (Mognoni's test) and a high-intensity intermittent test. During the Mognoni's test [5], blood lactate (La^-) concentration was determined immediately after a single 6 min run at 13.5 km/h while the mean heart rate (HR) of the last minute of running was considered for the analysis. After 10 min of passive recovery, subjects completed, following an acoustic signal, a HIT protocol (total duration=5 min) consisting of 10×10 s shuttle running at 18 km/k over a 25+25 m course with 180° a direction change and 20 s of passive recovery between each bout [6]. Immediately after the HIT protocol, La^- concentration was determined and the mean HR of 5 min run was considered for the analysis. La^- accumulation was measured using a portable amperometric microvolume lactate analyzer (Lactate Plus, Nova Biomedical, Waltham, MA, USA) according to the manufacturer instructions. HR data were collected using Polar Team^2 Pro system (Kempele, Finland).

All data were analyzed for normality by Shapiro-Wilk test. The effect of exercise and recovery on the parameters tested were analyzed by one-way ANOVA for repeated measures (sampling time: January, March and July) with Bonferroni's post hoc comparisons. When the data were not normally distributed, Friedman's test and Wilcoxon-paired comparisons were used. The statistical analyses were performed using SPSS, version 21 (IBM Corporation, Armonk, NY, USA). The results were considered statistically significant when $p<0.05$. Data were expressed as mean±one standard deviation or as median (25th–75th percentile).

No effect of the detraining period was observed on the hematological and biochemical parameters determined a part from LDH and CK serum concentrations which were lower at July when compared with the in-season time points (Table 1). As the sampling at July was performed before the beginning of the preparation period, the reduction in LDH and CK activity in the in-season samples could be attributed to exercise-induced muscle damage, recovering after the resting period.

The mean HR after the Mognoni's and HIT tests were found to be higher after the detraining period (Figure 1). Blood lactate concentrations after both exercises were higher at July when compared with those of March (Figure 1). These data clearly describe the detraining status of players due to the vacation time. In this sense, total body weight was slightly higher at July when compared with earlier measurements (Table 1).

MPV was found to be affected by the detraining period [$F(2,28)=15.064$, $p<0.001$]. We found higher values of MPV during the competitive period (Figure 1). Conversely, no effect was found on platelet count [$F(2,28)=1.874$, $p=0.172$].

These data indicated that a lower MPV is associated with lower fitness levels in professional soccer players. Nevertheless, previous studies have explored the association of training status with platelet activation, mostly reporting that a high training status is related with lower platelet activation. For instance, moderate exercise training decreases platelet adhesiveness and aggregability, returning to pretraining states after deconditioning [7].

However, we observed lower MPV when the fitness markers worsened (Figure 1). This is in agreement with the study performed by Lippi et al., in which the authors reported that baseline MPV levels were negatively associated with the time to complete a half-marathon race [3]. Platelets might thus have a role in medium-/long-term exercise by promoting the gradual release of

Table 1 Players' hematological and biochemical parameters in January, March, and July (the beginning of the next pre-season).

	In-season January	In-season March	Pre-season July	ANOVA p-value
Weight, kg	76.8±4.4[a]	77.0±4.5[a]	78.3±5.3	0.007
RBC count, $\times 10^6/\mu L$	5.09±0.37	5.13±0.25	5.21±0.40	0.193
Hemoglobin, g/dL	15.06±0.70	15.29±0.63	15.30±1.01	0.465
Hematocrit, %	43.92±2.10	44.38±1.60	44.1±2.50	0.691
WBC count, $\times 10^3/\mu L$	5.09±0.84	5.31±1.38	5.38±1.22	0.395
Neutrophils, $\times 10^3/\mu L$	2.20±0.49	2.55±0.93	2.47±0.71	0.065
Lactate dehydrogenase, U/L	205 (188–215)[a]	190 (171–201)[a]	158 (152–187)	<0.001[c]
Creatine kinase, U/L	392 (341–813)[b]	382 (215–544)[a]	294 (152–362)	<0.001[c]
Cortisol, ng/mL	236.6±29.5	225.3±31.7	212.2±44.8	0.110
Testosterone, ng/mL	7.03±1.80	7.18±1.43	7.46±1.68	0.526

RBC, red blood cell; WBC, white blood cell. Data as mean±standard deviation but for lactate dehydrogenase and creatine kinase which are expressed as median (25th–75th percentile). [a]$p<0.05$; [b]$p<0.01$ vs. July; [c]Friedman's test.

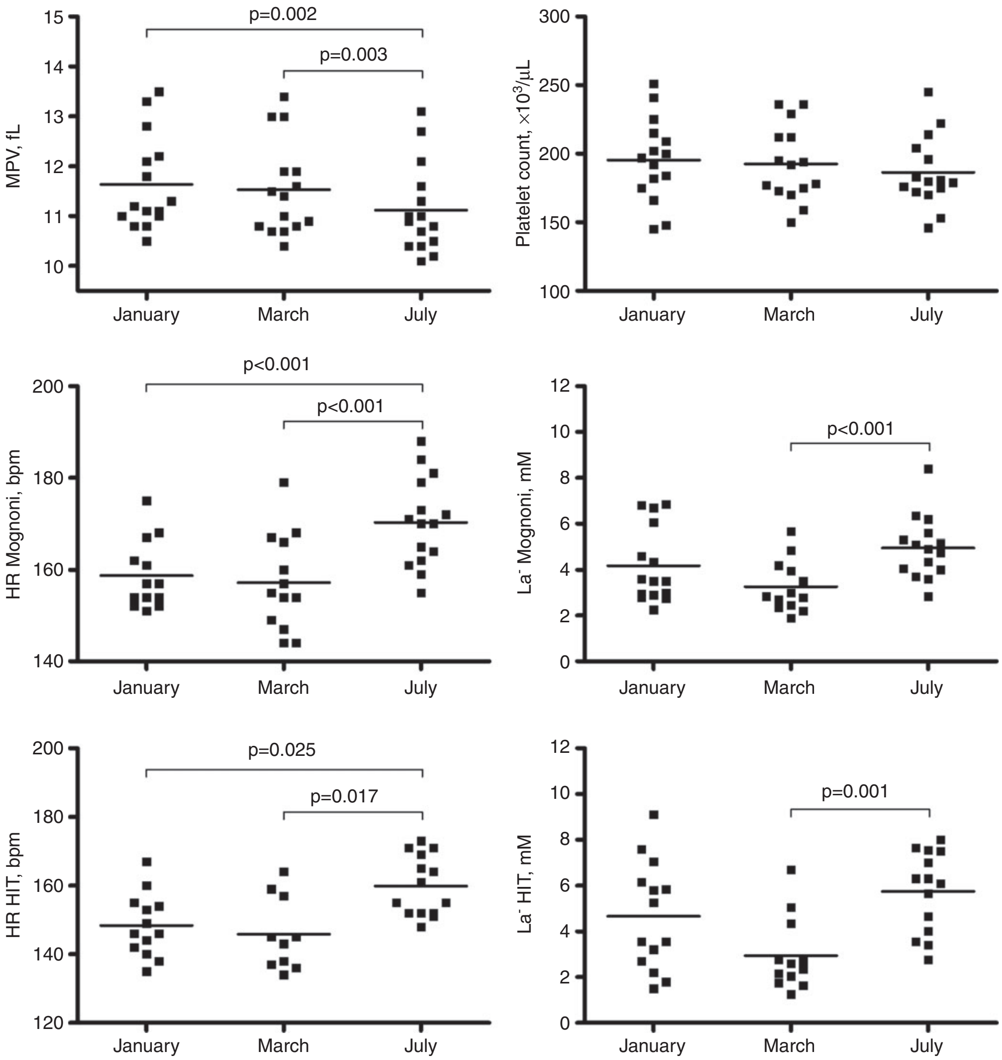

Figure 1 Mean platelet volume (MPV) and platelet count (up), heart rate (HR) and blood lactate (La^-) concentration in the Mognoni test (middle) and in the HIT test (down), in January, March and July (the beginning of the next season).
Significant Bonferroni's post hoc comparisons have been indicated. Horizontal lines indicate mean values.

performance-enhancing systemic growth factors and attenuating neuropathic pain and/or fatigue [3], which in turn, could explain the association between baseline MPV and endurance performance [3]. This mechanism could also play an important role in soccer players, who perform repetitive explosive actions during a prolonged time frame (90-min).

The relative MPV change after detraining in respect to the mean of January and March values was about 4%, which is slightly lower than the intrinsic subject biological variation reported for this parameter (i.e., 4.3%) [8]. Therefore, the MPV variation has low clinical relevance. As this study was performed during a large period of time (6 months), MPV could be affected by seasonal variations rather than training processes. However, MPV showed no seasonal variation in a large cohort of Italian blood donors [9]. Accordingly, seasonal variation does not seem to be related with the MPV decrease found after detraining.

Catecholamines also play a role on platelet activation through α_2-adrenergic receptors in thrombocytes [10]. Changes in circulating catecholamines levels driven by training could affect MPV. Nonetheless, this hypothesis should be empirically proved.

Our results indicate that MPV would be associated with fitness in professional soccer players. Therefore, this parameter could constitute an easy and inexpensive biomarker to monitor individual physical performance in team sports. Nevertheless, the association of MPV with physical fitness in soccer players should be tested throughout a whole season, as well as in other team sports.

Acknowledgments: This research has been supported by grant DEP2012-37494 from the Spanish Government and by grants 2013-168-002 and 2012-011-001 from Catholic University of Valencia.
Author contributions: All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission. RA is predoctoral fellow of Catholic University of Valencia.
Financial support: None declared.
Employment or leadership: None declared.
Honorarium: None declared.
Competing interests: The funding organization(s) played no role in the study design, in the collection, analysis, and interpretation of data, in the writing of the report, or in the decision to submit the report for publication.

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