

Acute Hematological Changes in Jiu Jitsu Athletes

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Abstract This study deals with acute changes in hematological parameters in athletes of the Brazilian fight Jiu Jitsu. The aim is to discuss the variations of these parameters in athletes who underwent some training in two different levels of intensity in order to identify the effects of this kind of sport, in what relates to effort intensity features in the organism, and also analyze the possibilities in what has to do with human health. Fourteen volunteers participated in this study, athletes with at least 2 years of practice in this type of fight and competitors. The athletes were monitored for over 2 months in their training routine. Blood samples were collected formerly and immediately after the training sessions in two specific moments, the first collection happened right next to one of the team target competitions and the second collection in post competition period. There was a statistically significant increase in total leukocytes and platelets (both months), neutrophils (month #1), lymphocytes and monocytes (month #2) and significant decrease in eosinophils (both months). The changes induced by exercising in a state of organic homeostasis don't seem to affect the red series, acutely. However, the white series is largely affected by physical effort, and its magnitude keeps depending on the intensity of effort and the modality of fight.

Keywords: *physical exercise, haematological parameters, immune system, injuries, competition*

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1. Introduction

Physical exercise has been considered an important variable in the study of human health, mostly by changes induced in several biomarkers. In physical training, adaptations of the body are quite specific for each kind of sport or type of effort. Intensity and duration of training have been indicated as relevant factors in the variability of several biomarkers, including hematological ones [1].

Tests results, done outside the conventional reference ranges in athletes, not only can reflect the presence of diseases, but can often reveal an adaptation to regular training or changes that have occurred during/after the exercise, and that must be clearly recognized to avoid misinterpretation of laboratory data. Thus, the values of some biomarkers in athletes or in physically active individuals should be interpreted with caution.

Jiu Jitsu is a sport which has gained prominence and has become popular. It is a full contact fight that takes place predominantly on the floor, where the fighters try to subdue the opponent using drops, locks, levers and rearm-naked. Among its main features is the similarity with grappling fights, such as Judo, Greco Roman and Wrestling, differing primarily in the rule set. The fight lasts about 8 minutes and the fact that it takes place predominately on the ground brings some of the own characteristics to the training, marked by intense isometric effort and the development of large aerobic capacity [2,3].

Throughout the whole year of training, athletes alternate periods of high intensity training, when the competitions are near, with periods of low intensity and even periods of some rest. The energy outlay is high and the maximal or submaximal effort often leads to muscle, joint and bone injuries. The athlete of fighting sports rarely trains without the presence of pain from injuries or micro lesions acquired in previous training sessions [4].

Our goal with this study is to discuss the changes in some hematological parameters in Brazilian Jiu Jitsu athletes who underwent training in two different levels of intensity in order to know the effects of this type of fight in what relates to its effort intensity features to the body, and also evaluate the possibilities in what has to do with human health.

There are many studies that address hematological parameters in athletes or physically active individuals, separated in studies of chronic effects checked by monitoring the changes in parameters over the training practice time, and studies of acute effects verified by comparison, in parameters values before and after the training section or sections. Studies on acute effects, even they taking into account the transient changes, search for, in these modifications, consequences related to health.

Among the most common effects reported are the decrease in the concentration of red blood cells [5,6], hemoglobin [5,6], hematocrit [6] and RDW [5,7]; and also an increase in the concentration of platelets [5,7]. Authors report that these alterations can last from 30 minutes to 20 hours from the end of the training section and some of

them suggest that this effect is related to the overtraining syndrome. By these results, authors state that reference values for blood counts could only be applied to individuals at rest, since almost all parameters tested during the practice, or soon after, experience variations. It's necessary to consider that trained individuals in general may experience an increase in the blood volume; and the transient hemoconcentration due the loss of water, commonly resulted from the exercise, can lead to results stemmed from altered tests, but which in fact would result from the simple decrease in plasma volume [1]. It has been found recently a relationship between elevated values of RDW and platelet after the exercise and the mortality of exercisers who practice moderate exercises for a long time [1]. This association has not been proven yet, but there is strong suspicion.

On the other hand, there are reports of increase in plasma volume as a result of intense exercise causing hemodilution and transient decrease in levels of red blood cells and hemoglobin, which can be mistaken for anemia [8]. In addition, iron metabolism is pointed as an important factor in gas transport mechanism, in maintenance of hemoglobin concentration and volume of red blood cells [8]. The increase in the generation of reactive oxygen species in muscle tissue, caused by intense effort, generates an oxidative stress condition that has the consequence of severe cellular damage [1]. Muscle and joint microlesions are results of this process that is said to be the cause of hemolysis of red blood cells and it can lead to a decrease in the concentration of these cells [8].

Regarding the white series, it has been demonstrated a difference between effects after post moderate exercise and post intense one, described so that the moderate effort tends to stimulate the increase in parameters related to the immune system, while intense effort will produce a decrease of these parameters [9]. Among the effects related to intense exercise, reports of leukocytosis occurring immediately after the exercise and involving an increase of neutrophils, monocytes and lymphocytes are usual [10,11,14]. The imbalance during the state of homeostasis caused by an intense effort leads to the increase of epinephrine and cortisol secretion, and also an increase in the concentration of "Natural killer" cells, considered the cause of variations in leukocytes [10,12]. However, there are reports also about the decrease in the concentration of lymphocytes and eosinophil after intense exercise, which lasts until 48 hours after the effort is ceased [10].

In studies involving athletes of fight sports, the results don't differ from athletes of other sports. Acute changes induced by Kung Fu training were: an increase of neutrophils, lymphocytes decrease, which ran into the 30%, and eosinophils, whose count was already low, got lower due to training [13]. In elite competitors of Brazilian Jiu Jitsu, the variations followed the same pattern: leukocytosis with increase in neutrophils and monocytes and decrease in lymphocytes and eosinophils after the end of the competition [15]. However, another study with Brazilian Jiu Jitsu athletes describes an increase in the concentration of lymphocytes as a result of intense training [16].

2. Materials and Methods

This study had the participation of 14 volunteers with a mean age of 27 ± 4.56 , athletes with at least 2 years of practice in this modality of fight and competitors from regional and national tournaments. The athletes were monitored for over 2 months in their training routine. Blood samples were collected before and immediately after each training session in two specific moments: the first collection happened close to one of the team target competitions. The athletes were in pre-competitive training period characterized by higher intensity of effort. The second collection was realized during post-competitive training season or recovery period, characterized by lower intensity. Despite the difference in training intensity between the two moments, the training phase and the weekly frequency did not change from one month to the other.

In total, 4 ml of blood was collected, using tubes BD Vacutainer™ with EDTA, in vacuum puncture needles BD Eclipse™ about 10 minutes before the beginning of each training section. The blood samples after the training sessions were collected similarly, about 10 minutes after the end of the sections. During practice, athletes were not deprived of drinking water, but they were not fed. The blood counts were performed on KX-21N Sysmex™ device and involved RBC count, hemoglobin, hematocrit, MCV, MCH, MCHC, RDW, platelet count, total leukocytes, neutrophils, lymphocytes count and the total monocytes, eosinophils and basophils. Smears were also made, which were stained by Quick Panoptic method for counting monocytes, basophils and eosinophils. Blood counts were performed in the laboratory of immunology III of the course of Biomedicine at UFG Regional Jataí.

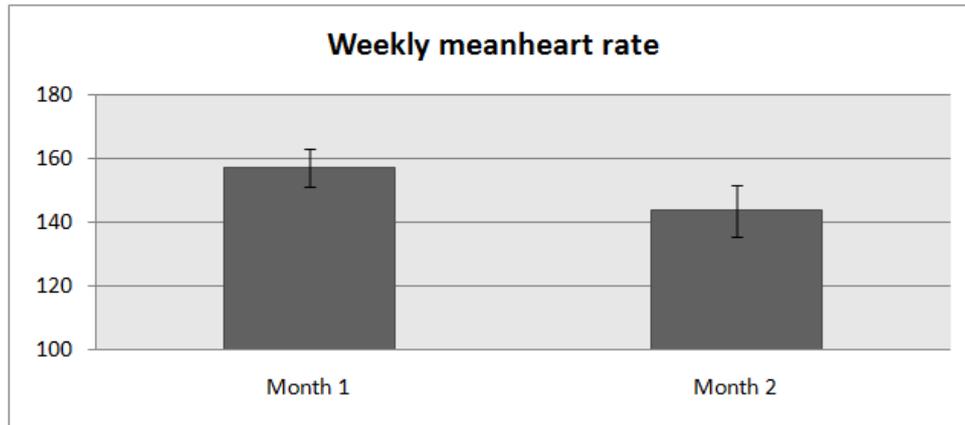
Athletes usually train about 8 hours a week on alternate days and the average heart rate was monitored during training in the weeks in which there were blood collections, using frequencymeter device Polar™, which provided the mean heart rate for training time. It was used 5 devices and volunteers were randomly selected from each training session, among the group, to use the device. The average weekly heart rate was obtained from the arithmetic mean of all the week's measurements.

Statistical calculations were done using the software R i386, version 3.2.1. Tests were realized as follow: Shapiro-Wilk test for normality samples and t-student test for paired samples, with significance level of $p < 0.05$. This study was submitted to the Ethics Committees in Research of the Federal University of Goiás and was approved by the opinion 692.581 on 05/29/2014. Volunteers signed a Free and Clarified Consent Term before the start of the study, ensuring the confidentiality, according to the ethical standards in research with human beings, established by the national and international documents.

3. Results and Discussion

During the monitoring of Brazilian Jiu Jitsu athletes, the average heart rate (Chart 1) reflected the change in intensity of training [17]. They have gone through periods of higher intensity, proper of the preparation for competitions, and of lower intensity ones, proper of the short-term periods between competitions.

Heart rate data were organized in weekly average for each time of blood collection.



Graph 1. Weekly meanheart rate

As observed, the two moments of sample collection had different training intensities. In the first collection, the average rate was higher due to an upcoming competition. In the second collection, the frequency was lower due to a less intense training proper of post competition period. In the week of the first collection the average heart rate was 157.1 bpm ± 6.05. (70%) In the week of the second collection, the average heart rate was 143.5 bpm ± 8.14. (60%)

During the follow-up of Brazilian Jiu Jitsu athletes, blood samples were collected before the training session in two occasions, and immediately after the training section too, in order to perform blood counts. We've opted for the same procedure twice in order to check for any acute changes induced by more intense and less intense training.

In the table below, data of the red series exposed as mean ± standard deviation:

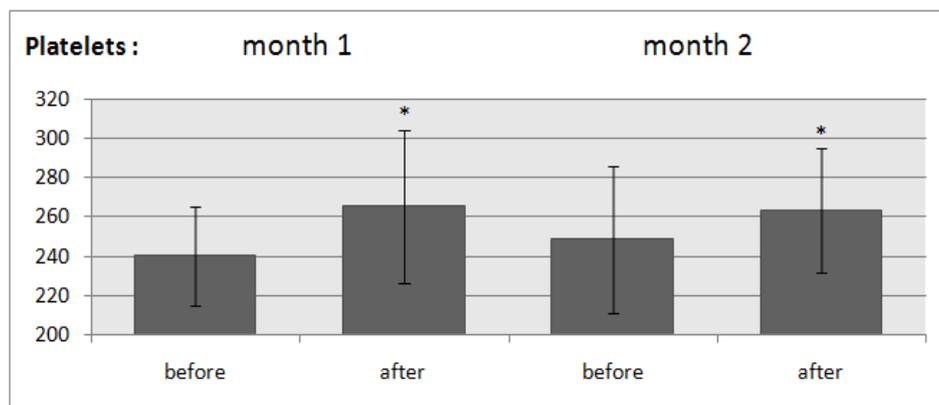
3.1. Results - Red Series

Table 1. Acute changes in red series

	Month 1		Month 2	
	Before	After	Before	After
Red blood cells (million/mm ³)	5,270 ± 0,463	5,255 ± 0,453	5,382 ± 0,446	5,362 ± 0,350
Hematocrit (%)	43,85 ± 2,32	43,57 ± 3,03	47,75 ± 3,73	47,54 ± 3,14
Hemoglobin (g/dl)	14,34 ± 1,19	14,48 ± 1,29	15,37 ± 1,49	15,34 ± 1,42
MCV (ft)	83,83 ± 8,37	83,41 ± 8,02	89,20 ± 9,39	89,09 ± 9,09
MCH (pg)	27,49 ± 3,71	27,76 ± 3,45	28,73 ± 3,78	28,74 ± 3,72
MCHC (g/dl)	32,69 ± 1,73	33,20 ± 1,34	32,10 ± 1,10	32,17 ± 1,12
RDW (%)	12,97 ± 1,54	12,75 ± 1,54	13,02 ± 0,81	13,07 ± 0,87

The statistics showed no significant difference in any of the parameters of the red series in the period before and after the training session. Data indicate that the parameters

of the red series were not affected acutely by physical training, even being the two measurement times characterized by different intensities of training.



Graph 2. Variation in platelets

Concerning the platelets, however, there was a significant increase in both, first and second collection. In the first measurement of acute training effects, P-value was 0.048, in the second measurement, P-value was 0.038.

3.2. Results - White Series

In white series, the results were different regarding the influence of physical training. White series parameters are shown below as mean ± standard deviation:

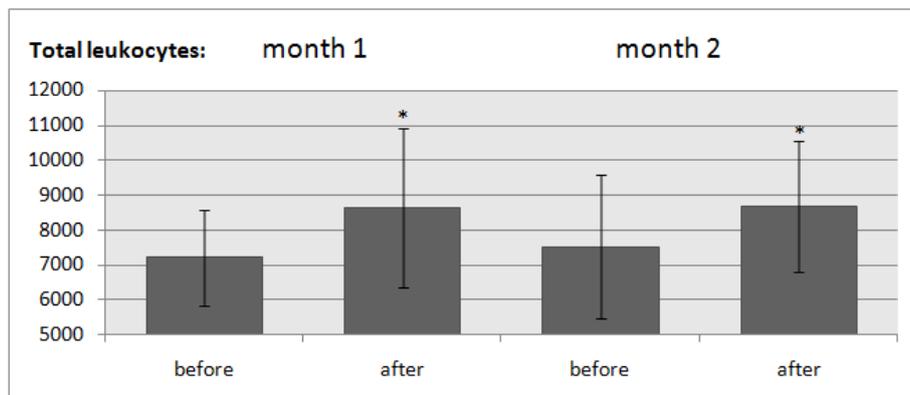
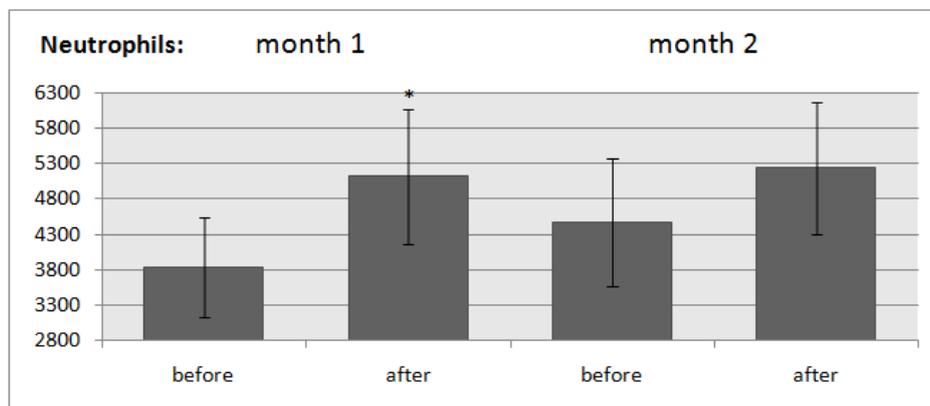
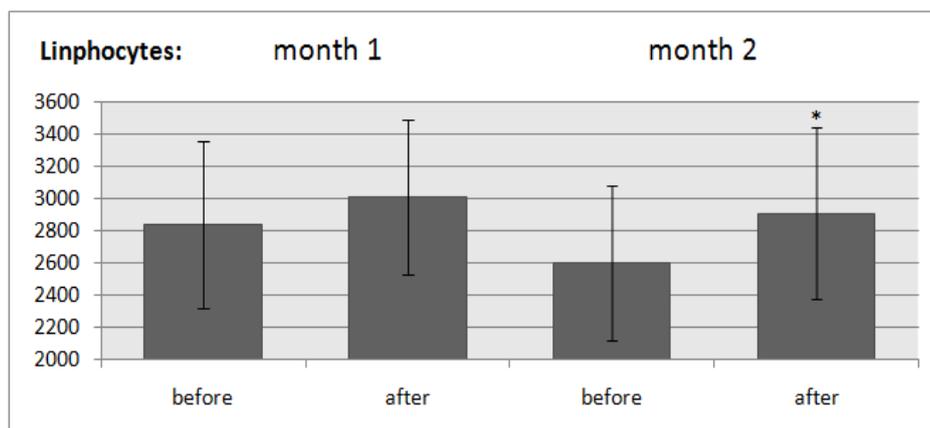
Table 2. Acute variations in white series (cells/mm³)

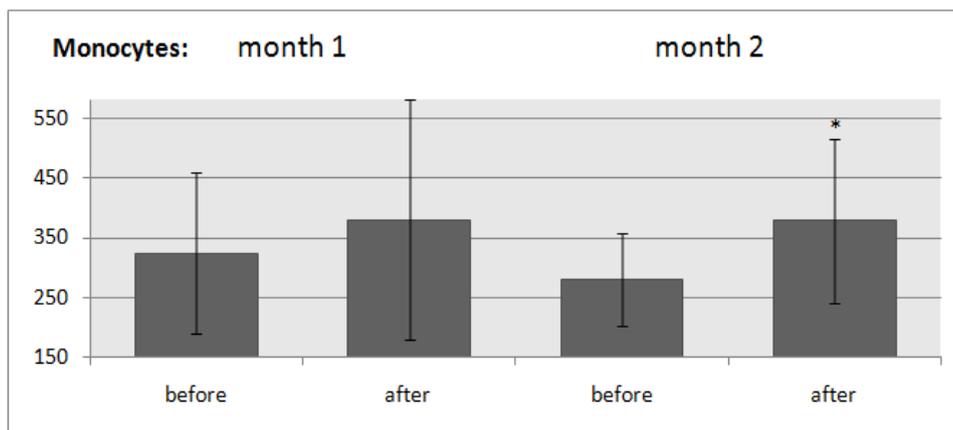
	Month 1		Month 2	
	Before	After	Before	After
Total leukocytes	7218,18 ± 1373,91	8641,66 ± 2274,94*	7518,18 ± 2059,52	8672,72 ± 1891,60*
Neutrophils	3842,72 ± 1410,18	5122,50 ± 1910,24*	4478,45 ± 1910,04	5238,27 ± 1854,74
Lymphocytes	2839,09 ± 519,16	3004,16 ± 481,10	2597,18 ± 515,44	2907,63 ± 535,97*
Monocytes	323,09 ± 135,38	380,41 ± 233,33	279,72 ± 78,46	378,63 ± 138,57*
Eosinophils	194,00 ± 85,37	115,25 ± 66,91*	162,81 ± 66,33	128,18 ± 52,61*

*significant difference compared to the prior with $p < 0.05$.

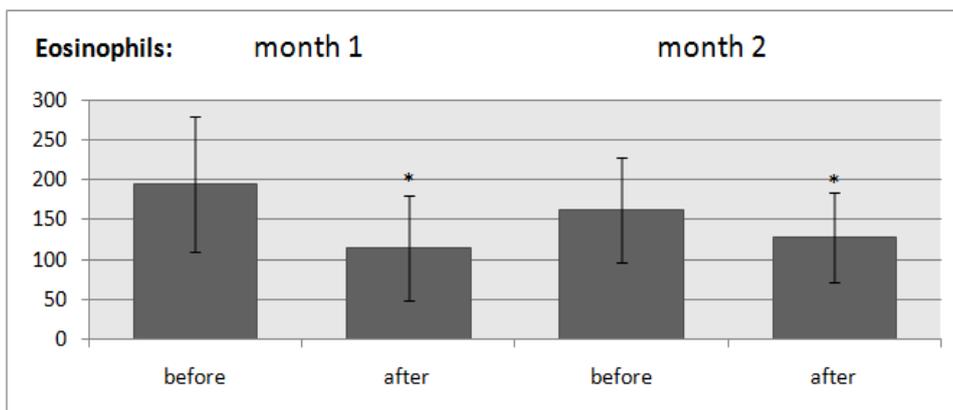
All parameters increased after the training session, except eosinophils that in both occasions decreased its value after the exercise. Total leukocytes showed a statistically significant increase in both occasions, with P-value=0.044 in month1 and P-value=0.038 in month 2. Neutrophils showed a statistically significant increase only in month 1, with P-value=0.009. In month 2 the increase

was not significant. Lymphocytes showed a statistically significant increase only in month 2, with P-value=0.002. In month 1 the increase was not significant. Monocytes showed a statistically significant increase only in the month 2, with P-value=0.027. The decrease of eosinophils was significantly detected in both tests. In month 1 the P-value was 0.014 and in month 2 was 0.048.

**Graph 3.** Total leukocyte variation**Graph 4.** Variation in neutrophils**Graph 5.** Variation in lymphocytes



Graph 6. Variation in monocytes



Graph 7. Variation in eosinophils

The intensity of training seems to interfere in the results in a specific way, since as neutrophils increased significantly in the month of higher intensity, lymphocytes and monocytes increased significantly in the month of lower intensity. Eosinophils proved to be susceptible to physical exertion by reducing its concentration significantly before the exercise. How long these variations may last could not be verified in this study, for logistical issues.

As observed, hematological parameters don't seem to vary according to a well-defined pattern associated with physical exercise. What can be perceived in most studies is that the exercise exerts some influence on these parameters, but this influence appears to vary according to the intensity and extent of the exercise, and especially according to the modality of training.

Changes in plasma volume after exercising, as a common effect in studies of this type, may partly explain the results in this study, since there was an acute increase of platelets and almost all white cells [1]. However, the decrease in plasma volume by loss of water caused by the exercise can increase the concentration of red blood cells firstly, what hasn't occurred in this case.

Another aspect to be considered in white cells variations is the high propensity to muscle and joint tissue injuries due to the type of training in Jiu Jitsu. Tissue lesions are associated with the release of chemical mediators of inflammation that generate changes in the function and concentration of white cells.

The use of exercise intensity calculation based on the mean heart rate reveals inconsistencies in relation to other

more accurate tests [18]. However, it may offer a relatively safe parameter, taking into consideration the training duration and measurement (about 2 hours). In the first month of monitoring, next to competition period, the activity can be considered intense, as it reaches nearly 75% of maximum intensity. In the second month, the intensity is classified as moderate, ranging nearly 60% of maximum intensity. The relevance of these data is the finding that principally the white cells vary according to the intensity of the effort.

The increase in leukocytes as an acute training effect comes from the recruitment of these cells, from structures and peripheral tissues to the bloodstream [14]. Increased heart rate produces a reaction of mobilization in the immune system causing the migration of part of the defense cells from lymphoid tissues and organs into the bloodstream. Neutrophils, which are mostly marginalized into lungs, liver and spleen, are mobilized by the higher heart rate; increasing their concentration in the bloodstream [10]. Their concentration shows a clear relationship with the intensity of the effort, since a significant increase was statistically observed in the month of higher effort. Physical exercise seems to recruit those neutrophils that migrated into the tissues, bringing them back to the bloodstream. Another factor to be considered is the largest nitric oxide production caused by the heart rate increase. Nitric oxide leads to reduction in platelet aggregation and in the adhesion of leukocytes in general and platelets, which may explain the increase in concentration of these cells after the exercise [22].

In studies focused on the ratio between exercise and the immune system, some authors suggest a higher incidence of upper respiratory tract infections after intense exercise in elite athletes, as the result of an immunity reduction reaction [12,21]. This reaction appears as an acute leukocytosis followed by a drastic reduction in the concentration of lymphocytes [11]. The gradual and continuous decrease in lymphocytes and eosinophils, unleashed after intense long-term exercise, lasts up to 4 hours after the end. This is reported as a cause of an increased susceptibility to respiratory infections in elite athletes. However, this reaction only occurs when exercising to the fullest intensity.

Physical exercise can produce changes in concentration, ratio and function of leukocytes, even affecting the Natural Killer cells, polymorphonuclear and immunoglobulin ones [19]. These changes are attributed to the state of stress generated by the effort and metabolites that are related to it, such as adrenaline, cortisol and catecholamines, which can generate an immunosuppressive effect [10,14]. The intensification of this chain of reactions is characteristic of overtraining, which is precisely the limit of what may or may not be healthy in physical exercise. Lymphocytes are susceptible to cortisol which tends to decrease their concentration in intense effort. In our experiment there was an increase of lymphocytes in the two measurements, to a lesser extent in the month of higher intensity. It is possible that if the training intensity was elevated up to the maximum effort, it would then be observed the suppressive effect of lymphocytes. This predisposition can be confirmed in studies that report decreased lymphocyte only before a very high stress [7,16]. The concentration of lymphocyte population in an inverse proportion to the intensity of training can be explained by the increasing percentage of apoptosis of these cells induced by high catecholamine concentrations and oxidative stress proper from the intense effort [20].

Regarding eosinophils, as it all points, it seems that the higher the training intensity is, the lower these cells concentration is into the bloodstream. The relation between training intensity, or of the fight itself, and lesions or inflammation seems to be direct [7], which may explain the decrease in the concentration of eosinophils, in the rate that the more intense the fight and training are, the larger the amount of micro-lesions and inflammatory areas and the higher the quantity of eosinophils moved from the bloodstream to these regions.

Intense exercise can lead to oxidative stress manifested in some alteration of endocrine, hematologic and immunologic profile. Although the changes in the immune system caused by oxidative stress are transient and of reversible character, they may explain, in part, the leukocytosis observed as acute effect from the training [6]. In addition, the exhaustive exercise causes an increase in the generation of reactive oxygen species, expanding the oxidative stress sign in cells, resulting in cellular damage [1]. Frequent microlesions, common in fight trainings, especially in muscle tissues, causing up to severe damage due to the volume and intensity, seem to stimulate the mobilization of white blood cells, which start helping in inflammatory areas that are formed since then.

4. Conclusion

Changes originated from the physical exercise during organic homeostasis state do not seem to affect the red series, acutely. However, the white series is largely affected by physical exertion, getting its magnitude depending on the intensity of effort and on the modality too. Fight modalities characterized by causing lots of injuries tend to produce different effects in hematological parameters. Even so, it is reinforced the theory that the very intense physical effort can produce a disorder in the immune response, to the outbreak of infectious diseases. Despite being a high intensity effort fight, Brazilian Jiu Jitsu demonstrates, in its training, a potential for health maintenance. Even generating muscle and joint strain injuries, which is common in this sport modality, hematological parameters showed no alarming data. Despite the variations in these parameters, all remained within internationally accepted normal values.

Statement of Competing Interests

The authors have no competing interests.

References

- [1] Sanchis-Gomar F, Lippi G. Physical activity - an important preanalytical variable. *Biochemia Medica* 2014; 24(1):68-79.
- [2] Andreato L V, Franchini E, Moraes S M F, Pastório J J, Silva D F, Esteves J V D C, et al. Physiological and Technical-tactical Analysis in Brazilian Jiu-jitsu Competition. *Asian Journal of Sports Medicine*, Vol. 4 (Number 2), June 2013, Pages: 137-143.
- [3] Del Vecchio F B, Bianchi S, Hirata S M, Chacon-Mikahil M P T. Análise Morfo-funcional de praticantes de Brazilian Jiu Jitsu e estudo da temporalidade e da quantificação das ações motoras na modalidade. *Movimento & Percepção*, Espírito Santo do Pinhal, SP, v.7, n.10, jan./jun. 2007.
- [4] Bledsoe G H, Hsu E B, Grabowski J G, Brill J D, Li G. Incidence of injury in professional Mixed Martial Arts competitions. *Journal of Sports Science and Medicine* (2006) CSSI, 136-142.
- [5] Lippi G, Salvagno G L, Danese E, Tarperi C, Guidi G C, Schena F. Variation of Red Blood Cell Distribution Width and Mean Platelet Volume after Moderate Endurance Exercise. *Advances in Hematology*, Volume 2014, Article ID 192173, 4 pages.
- [6] Reis L C, Oliveira S F, Oliveira C S E S, Campos L A S, Neto O B. Exercício resistido agudo altera perfil hematológico em atletas praticantes de levantamento de peso. *Coleção Pesquisa em Educação Física - Vol.8, n° 3-2009*.
- [7] Bradão F, Fernandes H M, Alves J V, Fonseca S, Reis V M. Hematological and biochemical markers after a Brazilian Jiu-Jitsu tournament in world-class athletes. *Revista Brasileira de Cineantropometria e Desempenho Humano*.
- [8] Latunde-Dada G O. Iron metabolism in athletes – achieving a gold standard. *European Journal of Haematology* 90 (10–15). October 2012.
- [9] Ott J N, De Oliveira K R. Análise hematológica de jogadores de futebol profissional antes e após esforço físico intenso. Relatório técnico científico: XVIII Jornada de Pesquisa – Salão do Conhecimento, Ciência, Saúde, Esporte. UNIJUI, Ijuí – RS, 2013.
- [10] Bachur J A, Quemelo P R, Bachur C A K, Domenciano J C, Martins C H G, Stoppa M A, et al. Evaluation of the effect of hypothermia by cold water immersion on blood neutrophils and lymphocytes of rats submitted to acute exercise. *Rev. Bras. Hematol. Hemoter.* 2008; 30(6):470-474.
- [11] Gabriel H, Kindermann W. The Acute Immune Response to Exercise: What Does It Mean? *International Journal of Sports Medicine*, vol. 18 n. 1, p. 28-45, 1997.
- [12] Nieman D C. Immune response to heavy exertion. *Journal Applied of Physiology*, vol. 82 n. 5, p. 1385-1394, 1997.

- [13] Cordeiro E M, Gomes A L M, Guimarães M, Silva S G, Dantas E H M. Alterações hematológicas e bioquímicas oriundas do treinamento de combate em atletas de Kung Fu Olímpico. Rio de Janeiro: Fitness & Performance. v 6, n 4, 255-261, jul / ago 2007.
- [14] Costa Rosa L F P B, Vaisberg M W. Influências do exercício na resposta imune. Rev Bras Med Esporte 2002; 8(4):167-72.
- [15] Brandão F, Fernandes H M, Alves J V, Reis V M. Hematological and biochemical markers after a Brazilian Jiu-Jitsu tournament in world-class athletes. Rev Bras Cineantropom Desempenho Hum 2014, 16(2):144-151.
- [16] Gonçalves L C, Bessa A, Freitas-Dias R, Werneck-de-Castro J P S, Bassini A, Cameron L C A. sportomics strategy to analyze the ability of arginine to modulate both ammonia and lymphocyte levels in blood after high-intensity exercise. Journal of the International Society of Sports Nutrition 2012, 9:30.
- [17] Henríquez O C, Báez S M E, Von Oetinger A, Cañas J R, Ramírez C R. Autonomic control of heart rate after exercise in trained wrestlers. Biology of Sport, Vol. 30 No2, 2013.
- [18] Rondon M U P B, Forjaz C L M, Nunes N, Amaral S L, Barretto A C P, Negrão C E. Comparison Between Exercise Intensity Prescription Based on a Standard Exercise Test and Cardiopulmonary Exercise Test. Arq Bras Cardiol, volume 70 (nº 3), 159-166, 1998.
- [19] Oliveira C A M, Rogatto G P, Luciano E. Effects of high intensity physical training on the leukocytes of diabetic rats. Rev Bras Med Esporte _ Vol. 8, Nº 6 – Nov/Dez, 2002.
- [20] Terra R, Silva S A G, Pinto V S, Dutra P M L. Effect of exercise on immune system: response, adaptation and cell signaling. Rev Bras Med Esporte – Vol. 18, No 3 – Mai/Jun, 2012.
- [21] Peters E M. Exercise, Immunology and Upper Respiratory Tract Infections. International Journal Sports of Medicine, vol. 18 n. 11, p. S69-S77, 1997.
- [22] Barreto R de L & Correia C R D. Óxido nítrico: propriedades e potenciais usos terapêuticos. *Quim. Nova*, Vol. 28, No. 6, 1046-1054, 2005.