

# Chronic Haematological Profile Study in Brazilian Jiu Jitsu Athletes

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**Abstract** This paper will treat about hematological parameters in Brazilian Jiu Jitsu athletes, linking their training with some variations of these parameters. The aim of this study was to evaluate the potentialities of this sport modality in what it has to do with promotion and maintenance of human health. Fourteen athletes have participated in this study that consisted in accompanying them during their training for six months, when monthly blood samples were collected and weekly monitoring of heart rate training were done. Variations in hematological parameters have been compared with the intensity of the training performed all this long. Statistical analyzes performed were Student t test for paired samples when data showed a normal distribution, and Wilcoxon test for paired samples, when data didn't show a normal distribution. Results show that erythrocytes and lymphocytes varied in a very similar way to the intensity of training. Hemoglobin, hematocrit, total leukocytes, neutrophils and platelets varied oppositely to training intensity. RDW, monocytes and eosinophils varied randomly, with no relation to the intensity of training. The training stimulates an increase in the production of red blood cells and hemoglobin, however, the kind of intense training and full contact, with frequent injuries, might cause hemolysis, maintaining low concentrations of these parameters. Jiu Jitsu promotes specific effects both in the red data series as in white ones; and it can be recommended for health maintenance, since, despite the detected variations, all parameters remained under the reference values.

**Keywords:** Brazilian Jiu Jitsu, haematological parameters, health

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## 1. Introduction

Hematological parameters of human health have some factors that can interfere with the interpretation of results, such as altitude, stress, diet, level of physical fitness and exercise. These variables show up as relevant fields of research. In terms of physical training, body adaptations are quite specific to each type or kind of effort. Some authors propose the establishment of reference values of normality for trained people, slightly different from the general parameters [1].

The intensity and duration of training have been indicated as important factors in the variability of several analytes. The nature of the exercise or the sport practice in their volume and intensity can produce various effects demonstrated on several biomarkers, including hematological ones [2]. In this context, test results that come apart from the conventional reference ranges, in athletes, not only can reflect the presence of a particular disease, but can often

reveal an adaptation to regular training or changes that occurred during/after the exercise; and it must be clearly recognized to avoid misinterpretation of laboratory data. Thus, the values of some biomarkers in athletes or physically active individuals should be interpreted with some attention.

Brazilian Jiu Jitsu is a fight of intense contact, which takes place predominantly on the ground, in which the fighters try to subdue the opponent using drops, armbars, levers and bottlenecks. The fact of the fight to be developed predominantly on the ground brings some peculiar characteristics to the training itself, marked by intense isometric effort and aerobics [3]. The fight lasts around 8 minutes and requires great endurance in addition to strength, flexibility and motor coordination. During the fight, the athlete is often taken to maximum effort and in order to support five, six or seven fights, as it is common in those kinds of championships, the athlete must hold an excellent cardiorespiratory fitness. The recovery time in a competition between bouts is, mostly, 10 times lower than

the total time of the fights added up, revealing the need of a physical condition that's actually ascertained [4].

Although that effort is predominantly of an anaerobic lactic character, the need for recovery and discarding of lactate requires the athlete a great aerobic capacity [4]. Throughout the year of training, athletes alternate periods of high intensity of training when the competitions are near, with periods of low intensity and even a period of rest at the end of the scheduled competitions. The energy expenditure is high and this maximum or submaximal effort often leads to muscle, joint and bone injuries. A Jiu Jitsu athlete rarely practices with any pain from injuries or microlesions acquired in previous training sessions.

There are several studies on hematological parameters in athletes or people who work out regularly. These are divided primarily on studies of chronic effects, checked by monitoring the changes in parameters during training practice time, and the severe effects, checked by comparison, in the values of the parameters, before and after the section or sections of training. Studies of chronic effects in general seek modifications of a long-lasting character and that can point direct correlations with human health.

Among most of standard results found in chronic effects studies, the decrease stands out in hemoglobin concentration during the training period [5,6,8,9]. Apparently, the continuing training enhances the gas transport capacity of erythrocytes and consequently reduces the need for hemoglobin, which in its turn, reduces its concentration. However, this effect is obtained in elite athletes that undergo systematic training that aims competitions, and not in moderately trained people. The isolated training, done sporadically, does not change the hemoglobin parameters in people who work out in various practices, compared to baseline [7]. The decreases in concentration of erythrocytes, in hematocrit values and in the concentration of mean corpuscular hemoglobin (MCHC) are also mentioned as a result of intense and regular training [6,8,9]. However, these observed changes do not refer to a morphological change in the cells, but an improvement in the entire system of capitation and transport of gases as one effect of *endurance* training. On the other side, some studies have not observed any decrease in the concentration of any red blood parameter, and there are also studies that observed the opposite effect, an increase in hemoglobin concentration after the training period [10,11].

Concerning the white series parameters, the most common result found in similar studies is leukocytosis [11,12,13]. Authors attribute this increase of leukocytes to a white blood cell demargination which, due the increase in blood flow, falls into the bloodstream, enlisted as a possible inflammatory response caused by microlesions in the tissues. In addition to the increased leukocyte, there are reports of an increase in neutrophils and monocytes concentration, and a decrease in the concentration of eosinophils [11,12,13] and lymphocytes [14]. Neutrophilia is also attributed to the mobilization of bone marrow cells, and lymphopenia is associated with high concentrations of cortisol, typically originated from an intense effort. Reports of decrease in concentrations of lymphocytes and eosinophils are also associated with the migration of these cells to those inflammatory sites caused by microlesions due muscular effort.

Thus, this paper aims to discuss the results of hematological parameters in Brazilian Jiu Jitsu athletes

checked over six months compared with heart rate training data, characteristic in intense physical effort, in order to recognize this modality in its particularities related to intensity and physical effort and its effects on the body; and also to consider its potential in relation to human health.

## 2. Materials and Methods

This study involved 14 volunteers with a mean age of 27 ( $\pm$  4.56) years, Jiu Jitsu athletes with at least 2 years of practice in this modality and competitors in regional and national tournaments. The athletes were monitored for six months in their training routine (2014), when monthly blood samples collection were done before each training session.

4 ml of whole blood was collected using BD Vacutainer™ tubes containing EDTA K2, in vacuum puncture needle BD Eclipse™ about 10 minutes before starting each training session. CBCs were performed on the KX-21N Sysmex™ device and included erythrocytes, hemoglobin, hematocrit, MCV (Mean Corpuscular Volume), MCH (Mean Corpuscular Hemoglobin), MCHC (Mean Corpuscular Hemoglobin Concentration), RDW (Red Cell Distribution Width), platelets count, total leukocytes, neutrophils, lymphocytes, and the sum of monocytes, eosinophils and basophils. Smears were also made, which were stained by quick panoptic method for obtaining differential counting of monocytes, basophils and eosinophils. The blood counts were performed at the Laboratory of Biomedical Sciences II of the course of Biomedicine in UFG Regional Jataí.

Heart rate was weekly monitored, during the trainings, by a frequency counter. The heart rate monitoring meant to compare the variations in blood counts with the intensity of training, and for this, the mean heart rate was calculated for each month of training. All statistical analysis was performed using the software R i386 version 3.1.1. Tables and graphs were constructed using the software Office Excel 2007. Statistical tests performed in this study were Test t-student for paired samples, when data showed a normal distribution, and the Wilcoxon test for paired samples, when data did not show a normal distribution.

That study was submitted to the Ethics Committees in Research of the Federal University of Goiás and was approved by the opinion 692.581 on 05/16/2014. 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. This study was conducted in accordance with Resolution 466/2012 of the National Health Council and with Resolution 196/1996 from the same council and the Declaration of Helsinki.

## 3. Results

### 3.1. Evaluation of Cardiac Frequency

During these six months follow-up of Brazilian Jiu Jitsu athletes, results of the mean heart rate (Figure 1) reflected the variation of the intensity used in trainings [15].

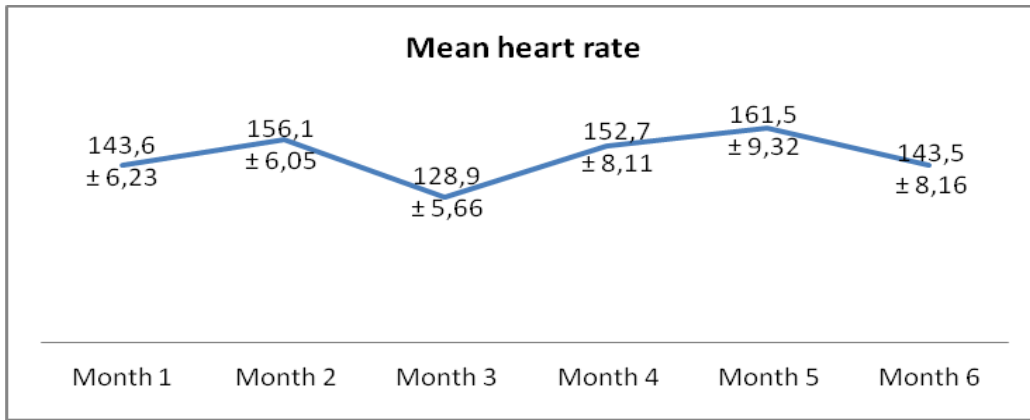


Figure 1. Monthly mean heart rate

As shown in Figure 1, the monitored training period had two peaks of greater intensity over 6 months: the first peak happened circa the second month and the other near the fifth month of training. This occurred due competitions in which the athletes have participated, thus the training sessions were carried out with more intensity. Periods of lower mean heart rate were periods of preparation and recovery, characterized by lower intensity.

### 3.2. Red Series

Erythrocytes data (million/mm<sup>3</sup>), hematocrit (%), hemoglobin (g/dl), MCV (ft), MCH (pg), MCHC (g/dl), RDW (%) and platelets (mil/mm<sup>3</sup>), are expressed in Table 1 as mean ± standard deviation.

Table 1. Data of red series

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Red blood cells (million/mm <sup>3</sup> )	5,25 ± 0,424	5,27 ± 0,463	4,93 ± 0,402*	5,14 ± 0,342*	5,17 ± 0,422	5,38 ± 0,446
Hematocrit (%)	44,00 ± 3,24	43,85 ± 2,32	44,60 ± 3,06	43,90 ± 2,83	44,74 ± 3,17	47,75 ± 3,73*
Hemoglobin (g/dl)	14,16 ± 1,21	14,34 ± 1,19	15,32 ± 1,14**	14,36 ± 1,17	14,99 ± 1,39	15,37 ± 1,49*
MCV (ft)	84,35 ± 9,71	83,83 ± 8,37	91,04 ± 10,45**	85,77 ± 8,44	87,02 ± 9,39	89,20 ± 9,09**
MCH (pg)	27,28 ± 3,63	27,49 ± 3,71	31,28 ± 3,96**	28,06 ± 3,24	29,16 ± 3,84**	28,73 ± 3,78
MCHC (g/dl)	32,27 ± 0,74	32,69 ± 1,73	33,96 ± 0,83*	32,65 ± 0,83	33,42 ± 1,04**	32,10 ± 1,10
RDW (%)	13,74 ± 0,72	12,97 ± 1,54	13,07 ± 0,95**	14,02 ± 0,96**	13,12 ± 1,03	13,02 ± 0,81**
Platelets (mil/mm <sup>3</sup> )	225,0 ± 50,31	240,3 ± 55,18*	264,6 ± 67,64*	213,6 ± 56,35	182,1 ± 60,29	248,5 ± 61,59*

\* significant difference from month # 1, with p<0,05 (Student t-test for paired samples).

\*\* significant difference from month # 1, with p<0,05 (Wilcoxon test for paired samples)

The behavior of the red series parameters can be compared with data from heart rate or from intensity of training. For red blood cell values (Figure 2) it was showed a significant decrease between the first month and the third month, with P-value = 0.0004 and also between the first and the fourth month, with P-value = 0.025. The

measurement of erythrocytes concentration showed a normal distribution by the Shapiro-wilk test over the 6 months of follow-up. Red blood cells ranged from a very similar way to the heart rate itself; markedly differing only in the sixth month of follow-up.

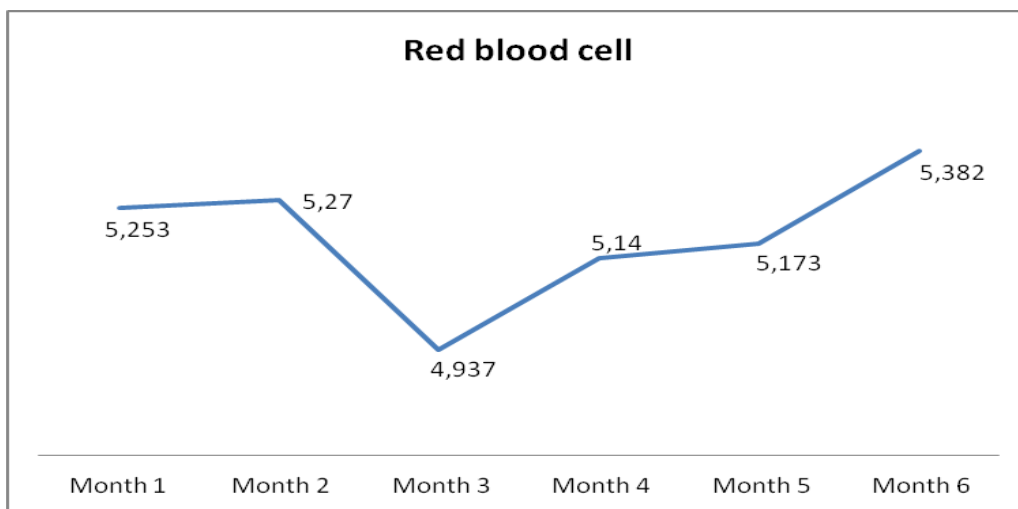


Figure 2. Variation of red blood cells

In hematocrit data a significant difference was only detected in the sixth month of study (P-value = 0.002), compared to the values of the first month. The distribution

of hematocrit presented normality in five out of the six months of tests and it may vary in a less intense way.

Hemoglobin (Figure 3) presented significant increase in the third month (P-value = 0.014) and in the six month (P-value = 0.01). As for the distribution of hemoglobin levels it didn't show normal distribution to four of the six months tested. The hemoglobin values varied differently

from the intensity of training, by having higher peaks in the values during the months that came after higher intense training. Months of higher mean hemoglobin are the months of lower intensity of training (Figure 3).

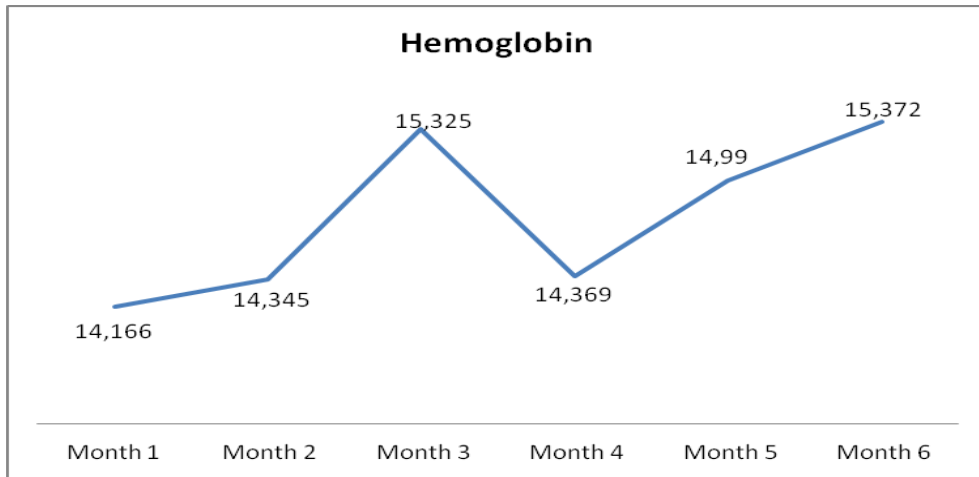


Figure 3. Hemoglobin variation

RDW values varied randomly with no reference to the intensity of those training data. However, there was significant statistical difference between the first and third month (P-value = 0.023), between the first and the fourth month (P-value = 0.024) and between the first and sixth month (P-value = 0.021).

compared to the first month. As for MCH and MCHC values, there was a significant difference in the third and fifth month, if compared to the first month.

MCV, MCH and MCHC data rarely presented normal distribution, thus they were tested by paired Wilcoxon test. MCV showed significant difference in third month (P-value = 0.015) and sixth month (P-value = 0.015)

### 3.3. White Series

Total leukocytes, neutrophils, lymphocytes, monocytes and eosinophils data (all measured in cells/mm<sup>3</sup> of blood) are shown in Table 2 as mean ± standard deviation:

Table 2. White series data

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Total leukocytes	6966,6 ± 1305,7	7218,1 ± 1373,9	7966,6 ± 1527,5*	7292,3 ± 1694,3	7340,0 ± 1119,7	7518,1 ± 2059,5
Neutrophils	3792,3 ± 1028,0	3842,7 ± 1410,1	4576,6 ± 1348,2*	4047,2 ± 1756,9	4117,5 ± 947,7*	4478,4 ± 1810,0
Lymphocytes	2852,5 ± 716,5	2839,0 ± 519,1	2760,0 ± 441,7	2767,3 ± 730,9	2777,6 ± 507,3	2597,1 ± 515,4
Monocytes	234,8 ± 58,5	323,0 ± 135,3	401,5 ± 120,2*	314,8 ± 81,7*	304,4 ± 110,3	279,7 ± 78,4
Eosinophils	86,8 ± 41,7	194,0 ± 85,3*	177,0 ± 71,7*	162,8 ± 67,6*	139,7 ± 60,8*	162,8 ± 66,3*

\* significant difference from month # 1, with p<0,05 (Student t-test for paired samples).

All white series parameters showed normal distribution (Shapiro-Wilk test), except for eosinophils in months 1 and 4.

Basophils statistically could not be tested because they are cells that were rarely observed throughout the study period.

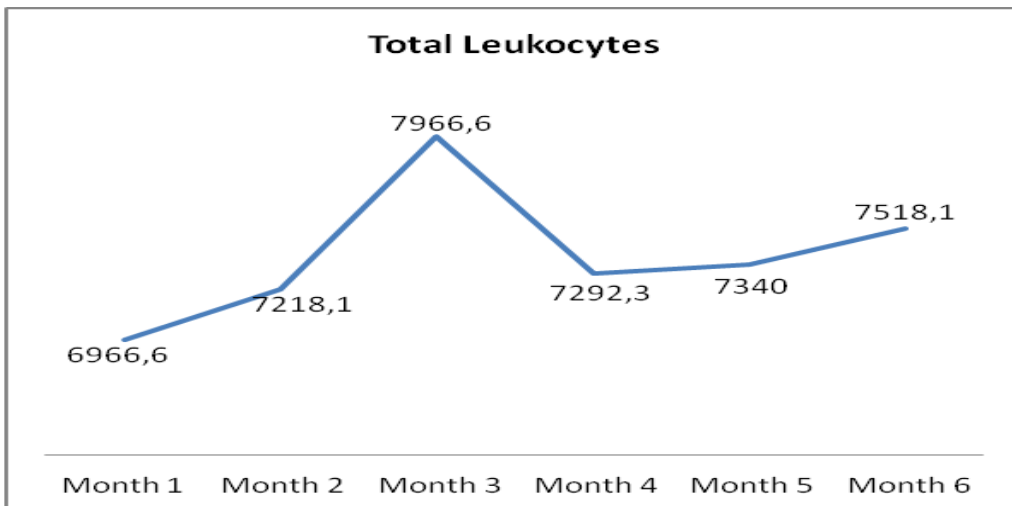


Figure 4. Variation of total leukocytes

Among the total leukocytes values, there is a significant difference only in month # 3 when compared to month # 1, with P-value = 0.004 (Figure 4). Month # 6, compared with # 1, did not show significant difference due to a high standard deviation. The mean values of total leukocytes presented subsequent peaks to those two of training

intensity ones, indicating an increase in months 3 and 6 when compared to month # 1, coinciding with those peaks of high hemoglobin values. Neutrophils values follow the same increasing tendency in months succeeding months of higher intensity in the training (months 3 and 6), following also the hemoglobin peaks (Figure 5).

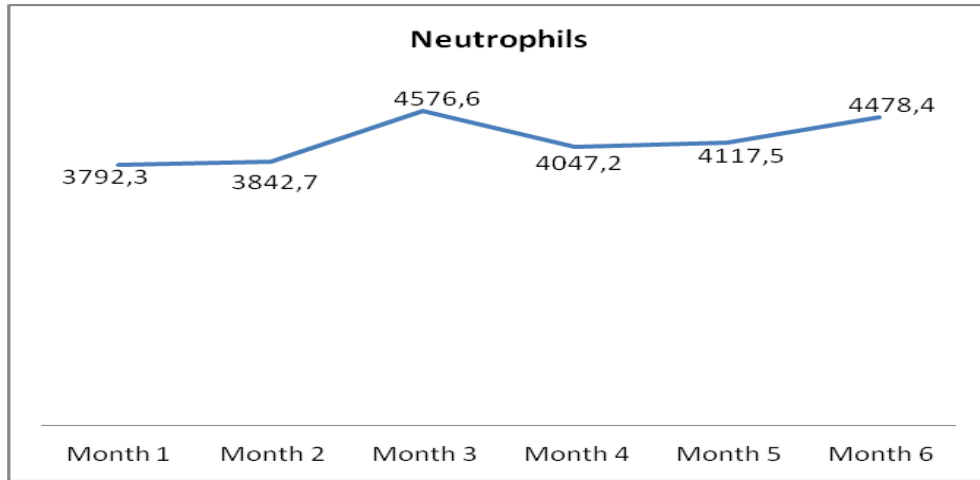


Figure 5. Variation of neutrophils

For neutrophils values, month # 3 shows significant difference from month # 1 (P-value = 0.002). Although the sixth month shows an increase compared to the first

month, this increase was not statistically significant. However, month # 5 shows significant difference from month # 1 (P-value = 0.032).

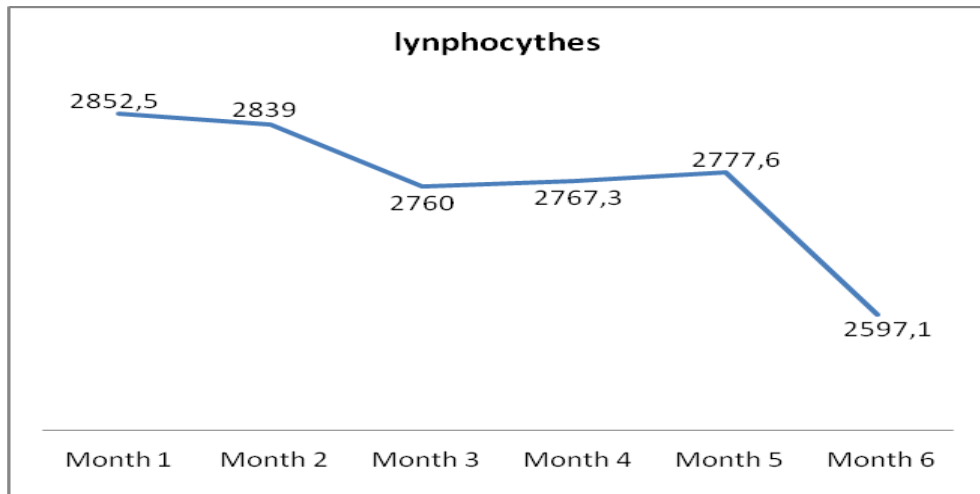


Figure 6. Variation of lymphocytes

Lymphocytes have a continuous decline over the study period, but there was no statistically significant variation in any month when compared to month # 1. Lymphocyte values may vary subtly, but inversely to the values of total leukocytes and neutrophils, with the lowest values found exactly in months # 3 and # 6. This variation, however, was not significant from a statistical point of view. Lymphocytes behave in an inverse way to red blood cells, hematocrit, hemoglobin, total leukocytes and neutrophils, revealing an almost steady decline over the 6 months (Figure 6).

Monocytes vary randomly and do not appear to follow the patterns of the other cell types. A significant variation was observed in third month (P-value = 0.003) and in fourth month (P-value = 0.033), relative to the first month. Eosinophils also vary out of the established patterns checked in neutrophils and lymphocytes, with significant variation over all months compared to month # 1.

Platelet parameters showed statistically significant changes in months 2 (P-value = 0.044), 3 (P-value = 0.002) and 6 (P-value = 0.006) compared to month 1. The variation in mean platelet in athletes draws a graph similar to neutrophils one, signifying a possible relationship between these two variables. The striking difference between the two graphs is observed only in the fifth month, which in neutrophil graph shows an increase if compared to the fourth month, and in the platelet graph shows a decrease when compared to the fourth month.

#### 4. Discussion

Hematologic parameters seem to show no variation according to a well-defined pattern associated with body exercise. What can be perceived in most of those cited studies is that physical exercise influences these

parameters, but it seems to vary according to the intensity and exercise's duration, and especially according to the type of training. The findings are not unanimous much less conclusive and require new and deeper studies. There is no single concept that can discourse and explain the variability between different sports practices or how they may be compared to each other. The level of physical effort or the volume/intensity of work can't characterize the difference between the different categories. Data from blood counts collected in this study and in other similar ones demonstrate this. Athletic modalities with similarities in training intensity present hematological parameters that vary differently, which requires, therefore, other classifications or concepts that can find justification for the phenomenon.

Erythrocytes values may vary similarly to the values obtained for heart rate. Hemoglobin values vary in a reverse way from the heart rate, showing higher values in months of lower intensity. This tends to confirm the explanation in which the most intense training enhances the gas transport system, reducing the need for hemoglobin [6,16]. Thus, in months of lower intensity, the body starts producing hemoglobin again in greater quantity, as seen in months 3 and 6, because the improvement is only checked in really intense training periods.

However, this result may have another explanation. In months of higher intensity of training, low concentrations of hemoglobin has been observed. This might suggest that the stress due intense training after the preparation for competitions has led to a loss of erythrocytes. Oxidative stress, cause of cellular damages in muscle tissue, leads to micro lesions originated from high tension and effort, causing hemolysis and maintaining low concentrations of erythrocytes, even before an intense stimulus of production of those cells [2,17]. Thus, in months of post competition characterized by a lower intensity of effort, the micro lesions would be less frequent, and the hemolysis in decrease, revealing higher concentration of erythrocytes. Reports of decrease in hemoglobin concentrations, including values below the international standard of normality, due to the high physical effort, are related to the stress in muscle and joint structures underwent to high stress [18,19]. Combat sports, and specifically the Brazilian jiu jitsu, are propitious to these lesions [19,20,21].

Regarding the white series, the leukocyte count varied very similarly to hemoglobin one, i.e., in months after a stronger intensity there is an increase in leukocyte concentration. This graph says much more in what relates to neutrophils, as long as the lymphocytes vary inversely. The specialized literature reports an increase in the concentration of neutrophils and a decreased in lymphocytes induced by exercise [23,24]. However, this reaction occurs only under maximum or submaximal effort [25,26]. In this study the same effect can be observed mainly in months of lower intensity of training.

## 5. Conclusion

Brazilian Jiu Jitsu fight has as characteristic a very intense contact between athletes, which may facilitate the dissemination of viral or bacterial infections within the

group, like in school environments, and it may affect the average values of some of these parameters, mainly in white series. In addition, the Jiu Jitsu exposes the athlete to high physical effort, demanding a lot from joints and tendons, which ends up turning to a very common inflammation in these structures, changing parameters of blood cells associated with the immune system.

However, it can't be stated that the training has no influence in those parameters, and therefore the hypothesis that the blood count parameters are affected by physical effort is sustained. The maintenance of lower hemoglobin concentrations in high-intensity training periods is evidence that the athlete suffers frequent injuries, which would be responsible for hemolysis of those cells. The body would have stimulated an increase in the production of red blood cells in intense training; however, the oxidative stress generated by that same intense training would lead to a decrease in concentrations of red blood cells and especially hemoglobin. Notwithstanding, this reaction doesn't confirm itself in white series, demonstrating an immune response mobilization, with an increase of neutrophils and lower lymphocyte, precisely in the subsequent months to the greater intensity.

This type of fight shows to be indicated for the maintenance of human health parameters, since all parameters verified during the study were within the reference standards accepted worldwide. It should be highlighted, however, the fact that several studies have come to affirm that parameters of normality must be reviewed when it's about trained athletes, with consequences that can reach issues related to doping in sports [2,6,16,18,22]. Further studies, with different designs, are necessary to confirm some of the hypotheses raised here for more accurate conclusions.

## Statement of Competing Interests

The authors have no competing interests

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