



The Effect of 6-weeks Military Training on Blood Hematological Parameters in Untrained Recruits in a Military University

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Abstract

Freshmen officer cadets in a military university participating in 6 weeks of induction undergo strenuous physical training. Vigorous physical training has been shown to affect red and white blood cell and platelet parameters. Effects have been related to the mode of exercise involved. Since the induction training encompassed various modes of exercise, we studied the effect of physical training on basic anthropometric and hematologic parameters. Twenty-seven healthy freshmen officer cadets (13 male and 14 female) joined the study. A blood sample and basic anthropometric measures were collected before and 6 weeks into the induction program. An automated complete blood count was done. Both male and female subjects experienced significant reduction in weight, while only female candidates had lower waist circumference and body mass index (BMI). Red cell count and hemoglobin reduced and mean cell volume (MCV) and mean cell hemoglobin (MCH) increased in the males subjects. Females had lower red cell counts and hemoglobin which was not significantly different, however, their MCV and red cell distribution width (RDW) increased. We conclude that the subjects showed evidence of sports anemia, runners macrocytosis and platelet activation. Raised RDW seen among female participants might indicate poor tolerance in that group.

Keywords: Physical activity, exercise, sports physiology, hematological parameters, platelet activation

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Introduction

Freshmen joining the National Defence University of Malaysia officer cadets undergo a military induction program of 6 weeks duration. The program prepares them for their new roles by inculcating discipline, loyalty and diligence, providing basic military knowledge and building physical agility, all desirable attributes of a young military officer. Thus the physical training element of the induction program is vital to its success and it is demanding in order to meet the preset goals and targets.

Hematologic parameters have been shown to be affected detrimentally by vigorous physical training [1,2]. Twelve weeks of strenuous physical activity resulted in a decrease in hemoglobin concentration as well as increase in platelet count [3], increase in platelet aggregation as well as leukocytosis [4,5]. Although the influence of various types of exercise on hematological indices has been studied, data studying that of military training are scarce. Military training not only encompasses physical fitness and endurance training, it also involves performing specialized activities such handling of weapons and route-marching. A study of the long-term effects (2 years) of Special Forces training on hematological indices describe a significant decrease in hematocrit and red blood cell count when compared with submariners over a similar period. The authors concluded that these hematological changes were due to effect of endurance training [6]. A high platelet count prior to 12 weeks of strenuous physical military training and the subsequent development of low hemoglobin have also been shown [3]. Thus the present study which is the first of its kind in Malaysia; was undertaken to study the effect of 6 weeks of military training on the hematological profile of untrained military university students.

Materials and Methods

Subjects: Twenty seven healthy subjects (14 male and 13 female) aged 17-21 years were recruited for the study. The students were untrained and newly recruited to the university and participated in the 6-week long induction program conducted by the military training unit of the university. The subjects were healthy, non-smokers and without any previous history of illness, especially hematological disease.

Experimental Protocol

Approval for this study was obtained from the institutional ethical review committee. Before the study began, the selected subjects were informed about the experimental protocol and an informed consent was obtained from each of them. Baseline anthropometry and body mass index measurements were carried out. Blood samples were collected from the subjects for the measurement of hematological parameters. The subjects then joined the induction program. This military training program conducted by the military training unit of the university is a regimental course and is of 6-weeks duration. It includes basic military training such as intense physical workout, weapons handling, survival training, route-marching along with several other sports activities. Table 1 and 2 give a brief description. During the training program all cadet officers ate a common dining facility and from a common menu. All subjects were required to adhere to this common menu. In order to eliminate the possible impact of dehydration on hematological parameters, the subjects were instructed to drink sufficient water and also to refrain from strenuous exercise during 24 hours prior to collection of blood samples. At the end of the 6-weeks of training, anthropometry, body composition measurements as wells as blood samples for hematological parameters were collected.

Table 1. Description of a typical day

Activity	Duration	Description
Physical training	2 hours	Moderate intensity aerobic exercise
Marching Drill	4 hours	Marching activities including run and stop, stand and responding to orders
Swimming	1 hour	-----
Sports	3 hours	Play sport of choice
Lectures and instruction	1 hour	-----
Meal, prayer, roll call and free time	7 hours	-----
Sleep	6 hours	-----

Table 2. Other training

Activity	Duration	Description
Basic Jungle training	1 week	Basic jungle training activities run through the day for 6 days and include: basic combat skills, leadership training, survival training, navigation (compass marching), rope handling, abseiling, route-marching and river crossing training.
Basic weapons training	1 week	Basic weapon training includes marksmanship and weapon handling in total 6 hours a day in addition to the physical training, sports and marching drills

Blood sampling and laboratory analysis

Venous blood samples (5ml) were collected in test tubes containing K₃EDTA (anticoagulant), and hematological parameters including red blood cell count (RBC), hemoglobin (Hb), hematocrit (Hct), mean red cell volume (MCV), mean red cell hemoglobin (MCH), mean red cell hemoglobin concentration (MCHC), red cell distribution width (RDW), white blood cell (WBC), blood platelets (PLT), mean platelet volume (MPV), platelet distribution width (PDW) and platelet- large cell ratio (p-LCR) were analyzed using a automated cell counter (Sysmex, USA). The data were expressed as mean and standard deviation. In order to determine the effect of 6-weeks of induction training on the hematological parameters before and after the training, Wilcoxon's signed-rank test was used for differences within groups, with p values < 0.05 considered significant. Data were analyzed on SPSS software version 16.1.

Results

Male officer cadets experienced a 2.2% reduction in the body weight which was significant. Waist circumference and BMI also reduced, though the changes did not approach statistical significance (Table 3 and 4). Among female officer cadets, body weight, waist circumference and BMI reduced, though these changes were not statistically significant.

While total RBC count and hemoglobin concentration reduced significantly, MCV and MCH increased significantly ($p < 0.05$) in male officer cadets (Figure 1, d, e). No significant changes were observed in hematocrit, MCHC and RDW (Figure 1, c.f.g). The MCV and RDW increased significantly among female officer cadets ($p < 0.05$), while there was a significant

decrease in MCHC (Figure 1, c.f.g). . There was also a 52.2% and 52.4% decrease in the total WBC count in male and female subjects respectively (Figure 2 a). There was a significant increase in MPV, PDW and p-LCR for both male and female subjects; total platelet count decreased; though not statistically significant (Figure 2 b, c, d).

Table 3. Anthropometric indices before and after 6-weeks of training in males

Anthropometry indices	Pre – training period	Post – training period	p
Body wt (Kg)	62.59 ± 9.67	61.48 ± 8.28	*
Waist circumference (cm)	76.14 ± 8.43	74.11 ± 5.20	NS
BMI (Kg/m ²)	22.07 ± 3.22	21.81 ± 2.58	0.054

* : p < 0.05

Table 4. Anthropometric indices before and after 6-weeks of training in females

Anthropometry indices	Pre – training period	Post – training period	p
Body wt (Kg)	54.60 ± 7.19	54.30 ± 6.04	NS
Waist circumference (cm)	72.31 ± 5.63	70.83 ± 3.78	NS
BMI (Kg/m ²)	21.63 ± 2.67	21.61 ± 2.20	NS

* : p < 0.05

Discussion

This study was conducted to determine the effect of 6-weeks of military induction training on hematological parameters in fresh untrained officer cadets. The training involved intense physical workout combined with training for route-marching and weapons handling. Hematological parameters altered by exercise training depend on the intensity of exercise as well as physiological adaptations to training. Sub-maximal exercise significantly increased RBC, WBC and platelet indices [7] while no change in RBC indices were found after acute exercise [8]. Endurance trained athletes had a decrease in Hb, hematocrit and RBC count when compared with normal population [9]. These changes could clearly be associated with both the intensity as well as type of exercise.

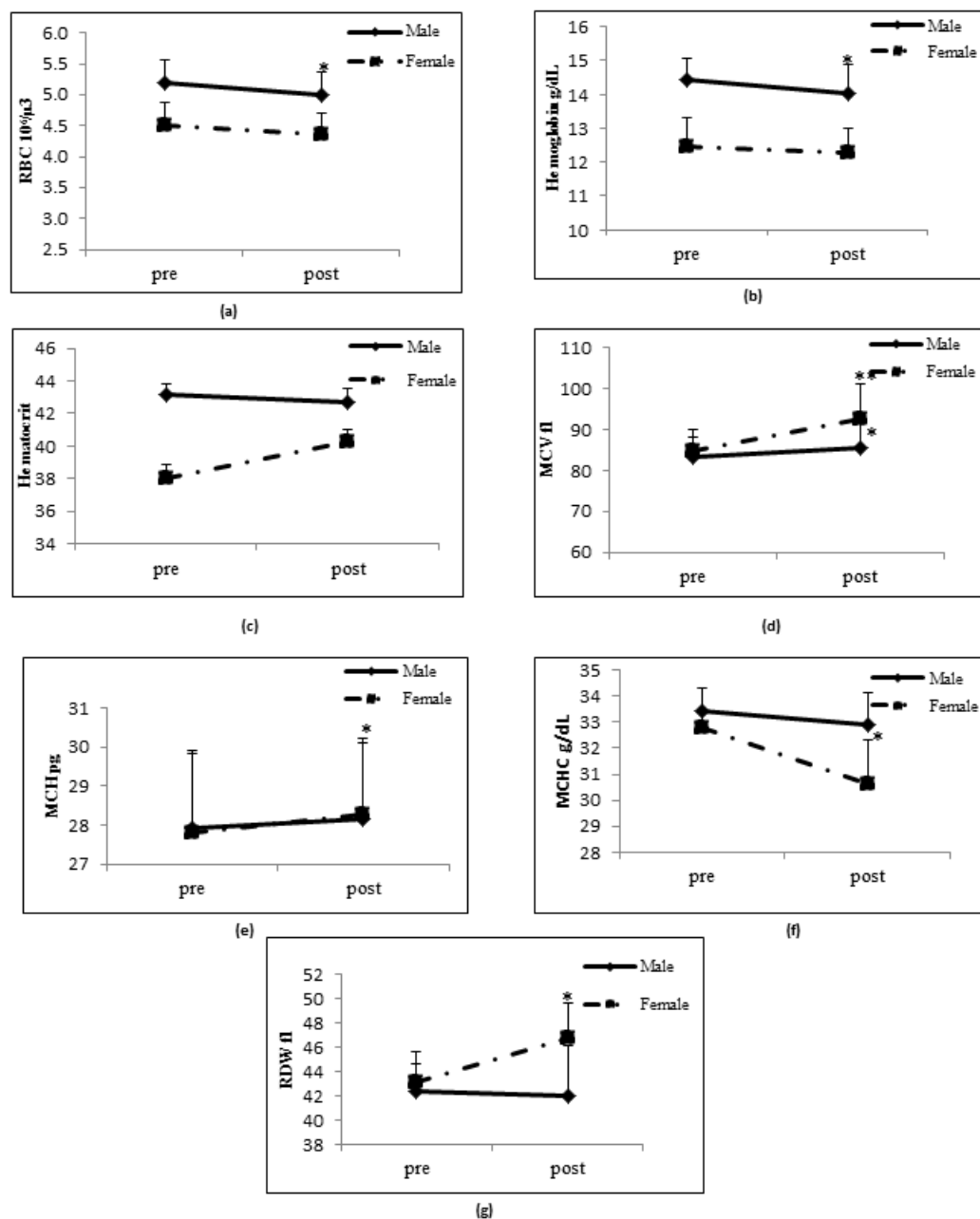


Figure 1. Red cell parameters of cadet officers before and after completion of induction training. Among male cadet officers, red cell count (a) hemoglobin fell significantly (b), while MCV (d) and MCH (e) increased. Among females, MCV (d), MCHC (f) and RDW (g) increased significantly. (*, ** p<0.05, paired t-test, all values presented and mean $\pm$ SD)

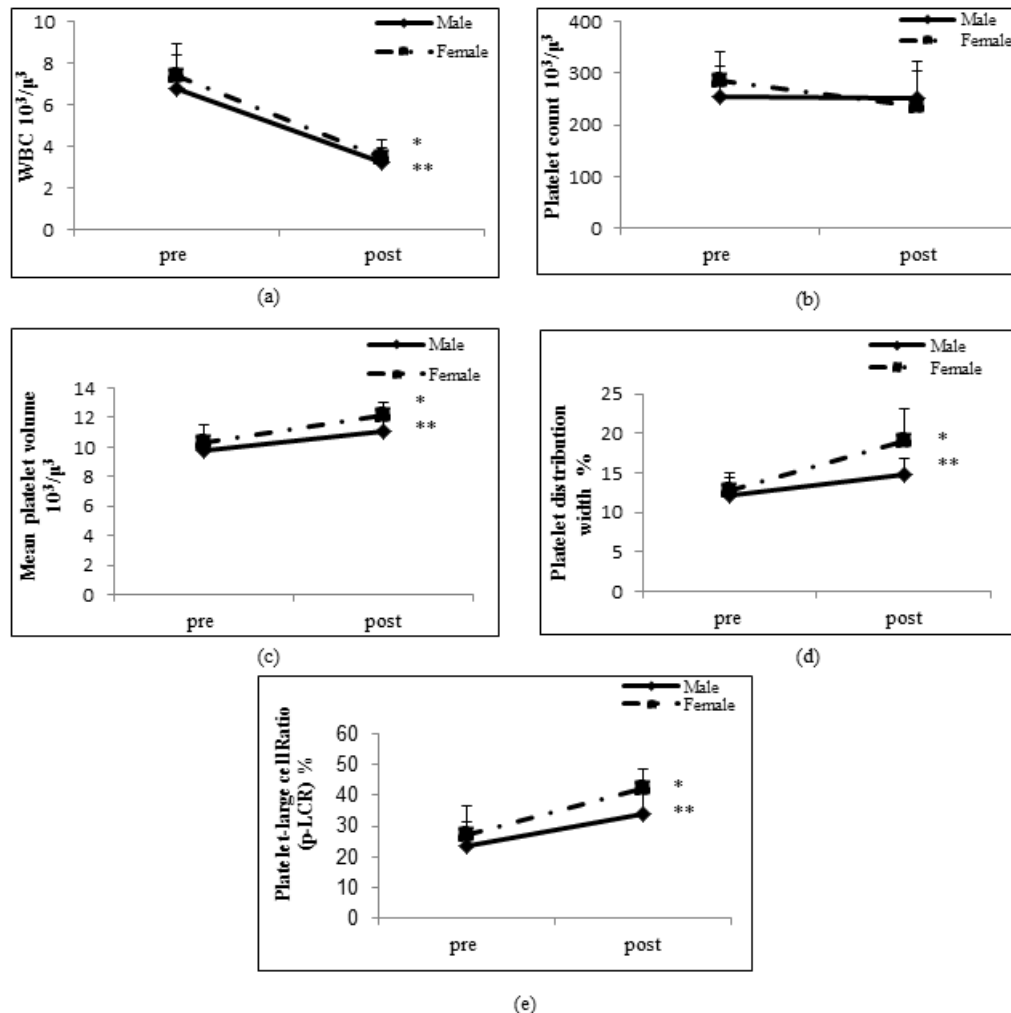


Figure 2. White blood cell count and platelet parameters of cadet officers before and after completion of induction training. White blood cell counts reduced significantly for both male and female cadet officers (a), while mean platelet volume (c), distribution width (d) and large cell ratio (e) increased significantly. (*, ** $p < 0.05$, paired t-test, all values presented and mean $\pm$ SD)

Though the major component of military training involved exercise, the type of activity differed throughout the program. A typical military training would involve both acute exercise protocols to improve agility and speed as well as endurance and resistance training protocols. These would be achieved by different modalities of training involving running, swimming, cycling, kayaking among others. In the university, the military training program involved running, swimming, resistance training, as well as certain sports such as handball, football and rugby. Each of these activities has been shown to have different effects on hematological

parameters. Training for swimming for 8 weeks among young females demonstrated a significant increase in WBC, RBC, Hb and hematocrit [10]. Hemaglobin and red cell deformability increased and lymphocytes decreased in elite kayakers following training [11]. An effect similar to that seen among the kayakers was also seen after progressive resistance exercise training [12]. Thus each type of military training would be expected to have different hematological effects depending on the content within the military training program.

Findings from this study show that male subjects have a significant decrease in Hb concentration and RBC count. The hematocrit decreased but not statistically significantly. Plasma volume expansion during prolonged exercise might explain the decrease in hemoglobin while fall in RBC count could be attributed to either intravascular hemolysis from mechanical trauma [13], osmotic/oxidative damage to erythrocytes [14] or gastrointestinal bleeding [15]. This phenomenon - “sports anemia”, is commonly encountered in endurance trained athletes due to the existence of a chronic dilutional state [16]. Male subjects also showed a significant increase in MCV which could be attributed to “runners macrocytosis” [17]. Strenuous exercise causes structural changes / damages to the RBC membrane resulting in the preferential hemolysis of older RBCs. The proportionately greater number of young and more deformable RBC’s in the circulation may be reflected as increased MCV. However, RDW which is an indicator of RBC membrane deformability was not significantly increased in these male subjects.

Among female subjects, however, there was a slightly different effect when compared with the male subjects. There was a decrease in hemoglobin, HCT and RBC count after the training; though not statistically significant. There was a significant increase in MCV, reflecting the “runners’ macrocytosis” which was similar to male subjects. A significant decrease in MCHC was also observed. An increased MCV along with a decreased MCHC might indicate the presence of more young erythrocytes in circulation. In addition, increased MCV and decreased MCHC predispose membrane deformability of RBCs [18], which is consistent with a significant increase in RDW, a measure of variability in red blood cell size. Oxidative stress has been proposed to cause membrane-damaging effect [19]. Red cell membrane deformity seen post (strenuous) exercise might be due to oxidative stress leading to hemolysis – thus increasing hemopoiesis (more young erythrocytes in the circulation) to meet the demand for oxygen transport. Interestingly, RDW has emerged as a marker of impaired

exercise tolerance in patients with chronic heart failure [20]. Thus we feel that the RDW in our female subjects may reflect a lower tolerance level to the 6-weeks of induction training when compared to the male subjects. A recent study of the effect of menstrual cycle phases shows that there is no significant effect on hematological parameters of hemoglobin, RBC count total and differential leucocyte and platelet count in 92 healthy females aged 18 to 23 years [21]. Studies on hemoglobin, reticulocytes, serum ferritin levels and RDW in women aged 23 to 30 years showed that a single sample was sufficient to report hematological data among women, irrespective of the phase of the menstrual cycle [22]. Thus we conclude that the changes observed in our study are unlikely to be affected by the effect of the menstrual cycles among our subjects.

Studies on WBC count after exercise showed a significant increase in WBC after four weeks of a regimen of chronic submaximal exercise [5]. Increases in WBC count have also been observed in athletes after a marathon run [23]. These increases were attributed to the leukocytosis caused by demargination of WBCs induced by increased blood flow as seen during an inflammatory response to tissue injury [24]. However, effects of exercise on WBC indices may vary. No change was observed WBC count after twelve weeks of exercise [25]. Others have shown a decrease in WBC count among rugby players after the summer training camp [26]. In our study, we observed a significant decrease in WBC count in both male and female subjects. This decrease was however within the reference range. This decrease could be due to the adaptation of the subjects to the exercise regimen. C-reactive protein, an established marker of inflammation has been shown to decrease after a standard exercise regimen. Decrease in CRP has also been correlated with decrease in WBC count as well as decrease in body weight and BMI [27]. Since our subjects also had decrease in body weight (significant among male subjects), decrease in waist circumference and BMI, the decrease in WBC count reflects a better immunological adaptation of subjects to the 6-weeks military training.

An increase in the platelet count has been observed during endurance exercise such as during ultra-marathon races [28]. This is probably due to the release of fresh platelets from the spleen, bone marrow and lungs. In our study we observed no difference in platelet count in both male and female subjects after the training. Similar findings have been observed among professional cyclists during races and during maximal isometric exercise [29, 30]. However,

our study showed a significant increase in MPV, PDW and p-LCR in all the subjects. The actual mechanism for the increase in these parameters is not known, but it may be attributed to increased platelet activation after strenuous exercise as measured by in-vitro platelet aggregation studies and by the measurement of plasma factors released by activated platelets [31]. Since strenuous exercise has been known to trigger acute myocardial infarction, there is a possibility that platelet activation might be a marker.

We do acknowledge limitations to this study. The water and food intake was not measured in our subjects during the training period. However, our results showed no change in hematocrit before and after the training period, thus eliminating the possibility of the effect of dehydration on the blood parameters. Since all the subjects had to dine in a common dining area with a fixed and common menu, the loss of body weight (especially in male subjects) may be attributed to the training. The other limitation of this study is that a detailed recording of the type, intensity and duration of the exercise regimen was not performed, however all subjects performed identical tasks throughout the program. Details regarding menstrual cycle/phase were also not obtained from the female candidates.

In conclusion, results of this study suggest that durations as short as 6 weeks are sufficient to induce changes in the hematologic profile of the participants. Overall, the effect of “sports anemia” was evident from red blood cell parameters. Platelet parameters showed signs of platelet activation which may be attributed to strenuous exercise. On the other hand, the decreased WBC count could be attributed to adaptation to long term exercise regimen. Further, we suggest that the increased RDW seen in the female participants might point to low exercise tolerance, to confirm this more studies are indicated. It might suggest that a period of adjustment to the induction program may be required so as to improve exercise tolerance. In addition, the impact of these changes on functional outcomes needs to be evaluated.

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