Original Article

Responses of Red Blood Cells Indices In Trained Female Athletes in Dhaka City

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Abstract

Background:. *Trained athletes have a decreased hematocrit, which is sometimes called "sports anemia." This is not anemia in a clinical sense, because athletes have in fact an increased total mass of red blood cells and hemoglobin in circulation relative to sedentary individuals.*

Objectives: To assess the basic red blood cell variables in trained female athletes and to compare the results with those for a control untrained groups.

Methods: *This was a cross sectional study was conducted in the Department of Physiology, Dhaka Medical College, Dhaka during the period of July 2015 to June 2016, on sixty apparently healthy female subjects aged 16 to20 years. Thirty highly trained athletes as experimental group were recruited from Sultana Kamal Women Complex, whereas thirty non-athletes as control group were collected from different halls of Dhaka university. Venous blood samples were drawn from the cubital vein, and the red blood cell count, packed cell volume, hemoglobin concentration, were measured. The mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, were determined by equations. Statistical indices were computed for each group and for each variables. Statistical analysis was done by unpaired Student's 't' test.*

Results: *The experimental group was found to have lower red blood cell count, packed cell volume, and hemoglobin ($p<0.05$) than that the control group. No significant differences were found in the mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration.*

Conclusions: *Continuous high intensity sports training over more than one year decreases basic red blood cell (RBC) variables in female athletes, this being more pronounced for submaximal sports.*

Key words: *Female athletes, Exercise, RBC, PCV, MCV, MCH, MCHC.*

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Introduction:

Physical activity can be looked upon as nourishment for the body, mind soul, just as food can be. Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objectives[1].The adaptation following muscular activity is associated with changes in whole blood volume and can make changes in the number of blood cells and their specialized distribution in different cells. In many of these cases the changes are necessary for improving physical function[2]. Recent physiological and hematological changes due to different physical activities have received much attention from researchers and specialists. Since some exercise sessions have higher intensity, especially at in-season tournaments, the circulatory system and hematological variables may undergo changes that in the long run considerably influence performance and the result of the competition[2]

Increased physical exercise generally results in no or only a small decrease in hemoglobin concentration, and RBC count has been found

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to be lower in physically well trained female athletes than in their sedentary counterparts[3]. Most interestingly, for more than ten years there have been many reports on anemia occurring in top-athletes of both sexes, even among the Olympic teams, performing in various endurance disciplines. This kind of anemia has been termed as sports anemia, athlete's anemia, post exercise anemia, runner's anemia, or swimmer's anemia[4]. Endurance training can lead to 'sports anaemia' although under normal conditions RBCs have a life span of about 120 days, the rate of ageing may increase during intensive training[4]. The prevention of anemia requires the rate of replacement of RBC to keep pace with that of destruction. Intensive physical training causes survival of RBCs for only 74 days in individual running up to 130Km/week compared to 114 days in untrained subjects.[5,6]. Exercise-induced hemolysis has been reported for more than fifty years. In particular, distance running has been associated with significantly destruction of red blood cells with RBC turnover being substantially higher in runners compared with untrained controls[6]. Intense exercise program (5 weeks training) causes decreases in hematocrit volume in athletes[7].The acute effects of different types of exercise causes decrease in red blood cell count, hemoglobin concentration, packed cell volume, mean corpuscular volume and mean hemoglobin concentration[8, 9,10,11]. Intensive physical exercise as well as training often leads to decreased in RBC count, hemoglobin (Hb), packed cell volume, mean corpuscular volume and mean corpuscular hemoglobin concentration[12,13]. Decreased in hematological parameters of erythrocyte system below pre-exercise level was observed one hour after a single prolonged intensive physical effort, even though they could be elevated immediately following it[4]. Maximum decreased of the above parameters were noted between the 24th and 72nd hours following exercise ("post-exercise over hydration" or "overshoot rehydration") was pointed out as the main cause of changes[4]. The changes in hematological parameters depend on the type of exercise, the intensity and duration. In Bangladesh, there are few studies on female athletes Therefore, this study was undertaken to assess the effects of exercise on red blood cell variables. It can be concluded that the training program positively effects red blood cell variables. This study will help to build awareness about sports anaemia which is now arousing topic of sports physiology.

Methods:

This was a cross sectional comparative study, carried out in the Department of Physiology, Dhaka Medical College, Dhaka between July 2015 to June 2016. The protocol of this study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka. Sixty apparently healthy female aged 16-20 years were included in this study, where 30 were considered as experimental group (athletes) and 30 were considered as control group (non-athletes). Athletes were recruited from Sultana Kamal Women Complex and non-athletes were recruited from different halls of Dhaka university. All the control subjects were regarded as apparently healthy persons who had never done exercise and were non-smoking women. While the experimental subjects were considered as one who had exercise at least two hours daily, five days a week, for one year or more. Subjects suffering from any cardiopulmonary disease and mild infection or fever within one month before enrollment were excluded from the study. Both the experimental group and control group were subdivided according to age. All the subjects were explained about the aims and objects of the study and the test procedures were briefed. Written consent was taken from the persons concerned in a prescribed form. A detailed history of each subject was obtained by using a pre-tested questionnaire. All subjects completed a questionnaire concerning their dietary habit, family history, athletic status including training intensity and duration. Heights, weight, were measured by standard weighing machine fitted with a height measuring rod. and BMI was calculated. Blood pressure were measured were carried out before and after exercise. The venous blood was collected and used for all hematological investigations. The sample of blood was

Table-I

Physical characteristics of different groups (n=60)

Parameters	Control (n=30)	Experimental (n=30)
Age (years)	18.17±1.09 (16.00 20.00)	17.90±1.16 (16.00 20.00)^{ns}
BMI (kg/m^2)	19.63±2.22 (15.24 23.06)	19.29±2.31 (15.06 23.24)^{ns}

Data expressed as mean±SD. Figures in parentheses indicate ranges. BMI = Body mass index. Unpaired student's 't' test was performed to compare between athletes and non-athletes ns=p>0.05

Table-II

The basic red blood cell (RBC) variables in control and experimental groups. (n=60)

Parameters	Control (n=30)	Experimental (n=30)
Hb (g/dl)	12.30±1.47	11.55±1.22*
	(7.10 14.70)	(8.20 13.10)
RBC (m/ul)	4.42±0.68	4.03±0.50*
	(3.26 6.23)	(3.02 4.91)
PCV Hct (%)	38.90±4.87	36.17±3.67*
	(30.00 46.00)	(26.00 43.00)
MCV (fl)	82.96±12.93	82.83±9.03^{ns}
	(56.20 96.20)	(67.00 96.00)
MCH (pg)	29.30±2.30	28.35±2.02^{ns}
	(20.00 32.10)	(24.00 32.00)
MCHC (g/dl)	31.92±1.68	31.35±1.41^{ns}
	(29.00 34.00)	(29.00 34.00)

Data expressed as mean±SD. Figures in parentheses indicate ranges. Hb = Haemoglobin, RBC = Red blood cell, PCV Hct = Packed cell volume Haematocrit, MCV = Mean corpuscular volume, MCH = Mean cell haemoglobin, MCHC = Mean cell haemoglobin concentration. ns=p>0.05, *=p<0.05,

collected under aseptic conditions. Hemoglobin (Hb), RBC count, Packed cell volume (PCV) were measured by fully automatic hematology analyzer. The mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) were determined by equations. Analysis of the data was performed using SPSS statistical package program. Statistical significance of difference between groups were evaluated by using students unpaired 't' test. Statistically significant level was set at p<0.05 and p<0.01.

Results:

The mean age BMI of the subjects were 18.17±1.09 years and 19.63±2.22 respectively. (Table I). The mean (±SD) of red blood cell count, packed cell volume, hemoglobin concentration were significantly lower in experimental groups than the control group (*=p<0.05,) (table-II), There were no significant difference in mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were found between the trained and untrained females (ns=p>0.05).

Discussion:

The present study has been carried out to find out the effects of exercise and training on red blood cell variables in female athletes and non-athletes. The trained athletes had significant lower values of red blood cell counts, PCV, Hb concentration than their control counterparts ; the difference was significant at p<0.05 (table-II). In athletes groups, the mean value for red blood cell count was 4.03±0.50*, whereas mean value of Hb and PCV were 11.55±1.22* and 36.17±3.67* respectively. However, no significant difference was found in MCV, MCH and MCHC when compared with sedentary group (table-II). These findings were consistent with the findings of others[4,5, 14,15,16]. The lowest PCV was found in swimmers: on average, lower by 10.10% (p<0.001) than that of control group but no difference in MCV were found in between trained and untrained girls[16].

A study, reported that there were considerable amount of decrease hematocrit for men and 8 women judoka after 5 weeks training[7] and the result was similar to our study. It was widely believed in the 1920's and 30's that physical exercise leads to increased RBC 25%. At first, this changes was justified by mobilization of blood stores, since stored blood has many cells and little plasma in comparison to circulating blood. That is, 20% more RBC are released into blood[17]. There was significant difference of Hb between and after training program, results showed that the higher PCV related to increase in Hb production and the RBC values also increased[17,18]. However, the results were inconsistent with the our study. A study suggested that there were no significant differences in RBC count after 12 week regular exercise of 14 men and 23 women participants[7]. It was shown that there were insignificant differences between MCV, MCH, and MCHC value which was compose of erythrocyte index. All the parameter were in average range[19]. The result was similar to our study.

Decreased RBC count in athletes was due to shortening of the mean life of RBCs by 30-40%[6,14]. RBC deformity was higher in a group of world-class endurance (road) cyclists compared when with that in a group of untrained controls[5,6]. Exercise training accelerated the destruction of the smaller aging red blood cell and replacement by younger larger erythrocytes [14]. The precise mechanism for this changes include squeezing and rupture of the erythrocytes by treading on the foot sole, rupture of blood cells in blood capillaries during muscle contraction, hemolysis due to increased blood flow and blood pressure[14]. In individuals who practice frequent aerobic sport activity there may be co-existing events such as haematuria, gastrointestinal blood loss, as well as an increased in the intravascular haemolysis[14].Increased intravascular haemolysis occurred in activities including weight lifting, swimming, long distance running, and .cycling. It was observed that there were mechanical damage of RBC in the feet vessels (foot strike haemolysis) especially when running on a hard surface which promote destruction[6,15,20]. Hemolysis in exercise could result not only from running long distance where erythrocyte were stroke, but also from other mechanism such as the oxidative stress in which the free radicals were over the systemic mechanisms of the anti-oxidant defense and making them susceptible to present injury in their enzymatic systems as well as in lipids and membrane receptors. Moderate intensity exercise and high intensity exercise cause post-exercise hemodilution at 24 hours and 48 hours and did not have a significant effect on hemoglobin concentration[21]. Athletes performing marathons and ultra-marathons in higher altitudes over several years, may have stability in hemoglobin level as an index of general health status and exogenous stimulation of bone marrow[22]. Severity of this sports anemia correlate with the amount of training, Intravascular hemolysis occurred during all the races; the fastest swimmers in the longest races had the greatest decrease in haemoglobin[6].

Conclusion:

From the analysis of these results in the context of various existing reports, we may conclude that the intense exercise and training have effects on red blood cell variables which can lead to sports anaemia or athletes anaemia. Since this study was done with small number of subjects with limited facilities, further work may be done with large number of subjects to draw a definite conclusion.

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