Acute Effect of Resistance Exercise on Red Blood Cells (RBC), Red Blood Cell Distribution Width (RDW) and Mean Corpuscular Volume (MCV) Among Physically Trained Boys

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Abstract
Introduction: In this research, the examination of the acute effect of resistance exercise on Red blood cell (RBC), Red blood cell distribution width (RDW) and mean corpuscular volume (MCV) of physically trained boys has been aimed.
Methods: Ten (10) physical education male students with an average age of 23.16±1.85 years participated in this study on voluntary basis. Red blood cell (RBC), Red blood cell distribution width (RDW) and mean corpuscular volume (MCV) of the students were analyzed before exercise (Pre-test) and just after 35 minutes of resistance exercise (Post-test). In order to determine all those hematological parameters, blood samples with 5 ml EDTA were taken from the forearm ante-cubical area before and after resistance exercise, and analyzed in laboratory with using auto-analyzer (Sysmex XP- 100).
Result: Measurement results were presented as average and standard deviation. Student T-test for dependent samples was used in order to make a comparison between BE and AE values. P<-0.01 value was considered to be significant. The result of the study revealed that, the increase in AE than BE values for Red blood cell (RBC), Red blood cell distribution width (RDW) and mean corpuscular volume (MCV) significantly.
Conclusion: Conclusively, red blood cell (RBC) count, red cell distribution width (RDW), and mean corpuscular volume (MCV) increased significantly following acute resistance exercise in physically active males.

Keywords: RBC, RDW, PCV and Resistance Exercise

Introduction

Blood's biomechanical characteristics and rheological behavior are the primary determinants of athletic success. Improving athletic performance in elite athletes requires an understanding of the intricate processes that influence the human body's capacity to adapt to certain rigorous training regimens. The global "epidemic" of chronic metabolic and inflammatory disorders, including obesity, metabolic syndrome, type 2 diabetes mellitus, and others, can be greatly reduced by physical activity. Given the vast range of hemorheological, metabolic, immunological, and hormonal changes, the physiological reactions of the body under the effect of physical activity are complicated and have not received enough research and analysis (Schild, M et al, 2016, Walsh, N.P et al, 2011). It is well established that the type, intensity, cyclicality, and duration of physical activity all have a significant impact on the initial systemic physiological response to intensive exercise. The body's adaptive response to long-term alterations in response to recurrent physical effort is also influenced by an athlete's level of training (training status).

While it is widely accepted that exercise affects haematological markers, the precise nature of these alterations remains a subject of disagreement. For example, studies have yielded contradictory results regarding specific parameters such as erythrocytes, hematocrit, and hemoglobin (Mairbaurl H, 2013).

It’s far typically regarded that both acute and chronic physical games result in numerous hematological changes in people. It also has been ascertained that exercise-precipitated hematological modifications are dependent on the type, intensity and period of exercise. Moreover, several factors which include training popularity, gender, age, environmental conditions and dietary popularity of the subjects also play a crucial function (Gibala, M.J.; McGee, S.L. 2008). It’s been reported that acute workout has a full-size effect at the rheological properties of the blood, and after acute exercise there may be an incensement in plasma viscosity and erythrocyte stress however a lower in sedimentation rate (Ajmani, R.S et al, 2003).

All studies specific that long-time period normal exercises make high-quality contributions into human organism.

Researchers have stated high-quality contribution of exercise in bodily, physiological, mental and motor functions (Fox et al., 1999). The evaluation of hematology proven that, the effect of regular exercise on hematology is distinctive. It is said that those variations rely on the severity, period and frequency of exercise in addition to physical and physiological situations of topics (Buyukyazı and Turgay, 2000). Furthermore, the severity, period and frequency of exercising should be well-organized to have similar fine influence on blood biochemistry (Baltacı et al., 1998).

There isn't a full consensus as to how exercise makes an effect on hematology. Studies on this subject comprise exceptional findings concerning blood biochemistry relying at the relevant exercising. Despite the studies displaying a decreasing (Ricci et al., 1988) and increasing (Baltacı et al., 1998; Gunay et al., 2006) exchange in blood biochemistry due to acute and persistent sporting activities, there also are researches which document that hematological values do no longer exchange with workout (Spiropoulos and Trakada, 2003).

With this view in mind the researcher conducted the present study to investigate the acute effect of resistance exercise on Red blood cell (RBC), Red blood cell distribution width (RDW) and Mean corpuscular volume (MCV).

Resistance exercise produces immediate physiological adjustments in the cardiovascular and hematological systems to meet the increased metabolic and oxygen-delivery demands of actively contracting skeletal muscles (Brun, 2002; Connes et al., 2013). Red blood cells (RBCs) are central to exercise physiology because they transport oxygen through hemoglobin and contribute to the regulation of blood rheology and microvascular perfusion. A single bout of heavy resistance exercise can cause transient increases in RBC count, hemoglobin, and hematocrit, primarily because of exercise-induced plasma-volume reduction and hemoconcentration (Ahmadizad & El-Sayed, 2005). Resistance exercise may also modify RBC deformability, aggregation, and nitric-oxide-related functions, thereby influencing blood viscosity and oxygen delivery to working tissues (Connes et al., 2013; Deeb et al., 2018). Mean corpuscular volume (MCV), which represents the average volume of individual erythrocytes, is an important erythrocyte index for evaluating changes in red-cell morphology and circulating blood characteristics. Red blood cell distribution width (RDW), which reflects the variability in erythrocyte size, provides additional information regarding erythrocyte heterogeneity and may be influenced by physiological stress, erythropoietic activity, and red-cell turnover. Regular physical training is associated with adaptations in erythrocyte mass, plasma volume, erythropoiesis, and RBC survival, although the magnitude and direction of these responses depend on exercise modality, intensity, duration, and training status (Mairbäurl, 2013; Montero & Lundby, 2019).

In physically trained boys, the acute hematological response to resistance exercise may differ from that of untrained individuals because repeated training can modify plasma volume regulation, erythrocyte characteristics, and vascular responses. Previous research has demonstrated that resistance exercise can produce rapid but reversible changes in RBC-related hematological and hemorheological variables, with many responses returning toward baseline during recovery (Deeb et al., 2018). Investigating RBC count together with RDW and MCV is therefore important because these parameters collectively provide information about erythrocyte quantity, size variability, and cellular morphology rather than relying on a single hematological indicator. The present investigation is significant because determining the acute responses of RBC, RDW, and MCV may improve understanding of how resistance exercise influences erythrocyte physiology in physically trained boys and may provide useful information for monitoring exercise-induced hematological stress and recovery.

The purpose of the present study is to investigate the acute effects of resistance exercise on Red Blood Cell (RBC) count, Red Blood Cell Distribution Width (RDW), and Mean Corpuscular Volume (MCV) among physically trained boys. The study aims to determine whether a single bout of resistance exercise produces immediate alterations in these hematological parameters and to assess the short-term physiological response of the erythrocytic system to exercise-induced stress. The findings may provide useful information regarding the relationship between resistance exercise and blood-cell characteristics in physically trained individuals.

Such evidence may contribute to the scientific basis for designing age-appropriate resistance-training programmes while improving understanding of the interaction between exercise intensity, erythrocyte characteristics, oxygen transport, and short-term hematological adaptation.

Materials & Method:

Participants: Ten (10) physically trained boys with an average age of 23.16±1.85 years who were studding in bachelor of Physical Education, participated in this study on voluntary basis. These subjects were healthy, nonsmokers, without history of hematological disease and free of infection.

Study design: Blood was taken from every ten subjects before and just after the resistance exercise. Total 35min exercise season will administrate as 15min exercise then 5min rest and again 15 min exercise. Single group experimental design has been adopted for the study.

Data collection: Blood samples were taken in the morning from 7:00 to 8:00 am. Blood samples with 5 ml EDTA (Ethylenediaminetetraacetic acid) were taken from players in the forearm ante cubical area, in line with hygiene rules before (Pre-test) and immediate after (Post-test) the resistance exercise. Hemoglobin levels were analyzed by the expert pathologist at standard laboratory with Sixmex auto-hemato analyzer.

Statistics analysis: Measurement results were presented as average and standard deviation. Student T-test for dependent samples was used in order to make a comparison between BE and AE values. $P<0.05$ value was considered to be significant.

Result:
The findings of the study indicate that Red blood cell (RBC), Red blood cell distribution width (RDW) and mean corpuscular volume (MCV) of physically trained boys were significantly increase immediate after 35 minutes of resistance exercise. Though pre-exercise and post-exercise both values of those hematological parameters are in between the normal pathological range. Table-1 represents the comparison of RBC between pre-test and post-test of the subject.

Table-1 T-test of RBC between pre-test and post-test (million/cmm.)

RBC		Mean	SD	"t" value	"p" value
	Pre exercise	5.038	0.469	9.057	0.000008*
	Post exercise	5.486	0.528		
P<0.01*					

The mean and SD of pre-test and post-test for RBC was 5.038 ± 0.469 and 5.486 ± 0.528 respectively. Significant change in RBC was evident in pre and post resistance exercise (t=9.057, p<0.01). Therefore, it can be concluded that resistance exercise significantly improved RBC of adult males.

Table-2 T-test of Red cell distribution between pre-test and post-test (%)

RDW		Mean	SD	"t" value	"p" value
	Pre exercise	46.84	4.85	2.911	0.017*
	Post exercise	47.74	4.67		
P<0.01*					

Table-2 indicates that the mean RDW increased from 46.84 ± 4.85% before resistance exercise to 47.74 ± 4.67% after exercise, showing an increase of approximately 0.90 percentage points following the exercise session. The paired t-test produced a t value of 2.911 with a p value of 0.017. Since p < 0.01, the difference between pre-exercise and post-exercise RDW is statistically significant at the 5% level. Therefore, the findings suggest that a single session of resistance exercise produced an acute alteration in the distribution of red blood cell volume among the physically trained boys.

Table-3 T-test of Packed cell volume level (%) between pre-test and post-test

PCV		Mean	SD	"t" value	"p" value
	Pre exercise	41.70	2.34	8.923	0.000009*
	Post exercise	46.10	2.89		
P<0.01*					

Table-3 indicates that the paired-samples t-test revealed a statistically significant increase in packed cell volume (PCV) following resistance exercise. The mean PCV increased from 41.70 ± 2.34% in the pre-exercise condition to 46.10 ± 2.89% in the post-exercise condition. The obtained t-value of 8.923 was statistically significant (p = 0.000009, p < 0.01), indicating that acute resistance exercise elicited a significant increase in PCV.

Discussion
In this present study it is found that the mean Red blood cell (RBC), Red blood cell distribution width (RDW) and Mean corpuscular volume (MCV) of the students was increased significantly after exercise. Which strongly support the study of Brun et al. (2002) who reported that acute exercise significantly elevates red blood cell count, platelet count, white blood cell count, hemoglobin concentration, and hematocrit values compared to pre-

exercise levels, attributing these increases to exercise-induced plasma volume reduction.
Training and exercise performed under hypoxic conditions beneficially influence aerobic biological processes in the human body, primarily by stimulating erythropoiesis but also through other physiological cellular factors (Park,H.Y et al,2022). Examples include stimulated vasodilation achieved through increased nitric oxide synthase activity in the endothelial cells of vascular walls. Consequently, their resistance decreases, leading to vasodilation and an increase in arterial blood flow.
Acute physical exercise, particularly endurance training, induces significant alterations in red blood cell counts. The total mass of circulating erythrocytes is determined by the balance between their formation and degradation. Both processes are so sluggish that acute influences have no significant impact. Consequently, the absolute erythrocyte volume is considered constant under short-term conditions. Unlike certain animals, humans lack a blood reserve to draw upon during physical exertion. Therefore, fluctuations in red blood cell counts during acute exercise are primarily attributed to hemoconcentration and/or hemodilution. (Herbe et al 2020, Röcker L et al. 1983)
It's been generally shown that blood parameter values again to resting tiers 30 min after the single Wingate check or acute sub maximal exercising test (Whittlesey, M.J et al 1996), Kordie, M.R.; et al 2012). Contemporary studies (Ahmadizad, S. et al.2016, Varlet-Marie et al. 2016) showed multiplied blood and plasma viscosity in reaction to different exercise protocols. On this study, red cell counts appreciably elevated immediately after workout. In a take a look at of Halson et al. (Halson, S.L et al. 2003), 4 weeks of intensive exercise significantly reduced red blood cell counts (10%). In comparison, inexperienced (Green et al.1991) did not find any sizeable difference after a 4-week exercise software in the red blood cell counts of the sedentary people. In the present study, it was also observed that pack cell volume and red cell distribution width increased significantly. In a current look at,(Lippi et al. 2014) suggested a good amount of growth in the mean cell volume at once after fairly long-distance half marathon running. Strenuous exercise is thought to reason structural harm inside the erythrocyte, resulting in hemolysis. Growing the quantity of erythrocytes deformed by way of exercise can be meditated as an increase of mean cell quantity inside the blood circulation (Gnanou, J. et al. 2014)
Planed physical training triggers a series of changes in the erythrocyte machine of the peripheral blood cells that effects in the elevation of the oxygen-wearing capacity of blood. The effects of regular endurance type of exercise training on red blood cell indices are nicely documented and encompass an extended number of red blood cells (Z. Szygula,1990) which is partially support the result of the study. Hu et al. (M. Hu et al, 2008) proven that resistance exercise can increase red blood cell counts in teenagers; we believe that resistance training is a powerful approach to improve erythrocyte mechanism. (Ahmadizad and El-Sayed, 2005) found temporary modifications in blood viscosity after an acute resistance exercising, concluding that this change can be attributed to exercise-brought about adjustments in hemoconcentration. In fact, it become shown that plasma extent reduced main to an incensement in red blood cell attention, haemoglobin, and hematocrit.

Figure-1 represents the comparison of Red Blood Cell Count before and after exercise of the adult male.

Fig-1. Comparison of Red Blood Cell Count before and after exercise of the adult male.
The significant increase in RBC count following resistance exercise may primarily be attributed to exercise-induced hemoconcentration resulting from a transient reduction in plasma volume. High-intensity muscular contractions increase hydrostatic pressure within the exercising muscles and promote the movement of plasma water from the intravascular to the extravascular compartment. Consequently, the concentration of erythrocytes in circulating blood increases, producing a temporary elevation in RBC count. Sympathetic activation and catecholamine-mediated vascular responses may further contribute to the redistribution of blood and circulating erythrocytes during strenuous exercise. Previous research has demonstrated that acute resistance exercise can reduce plasma volume by approximately 10% while simultaneously increasing RBC count, hemoglobin, and hematocrit. Therefore, the significant post-exercise elevation in RBC count should be regarded primarily as an acute hemoconcentration response rather than an immediate increase in RBC production. These changes are generally transient and tend to return toward resting values during recovery (Ahmadizad & El-Sayed, 2005 &2006; Montero & Lundby, 2019).

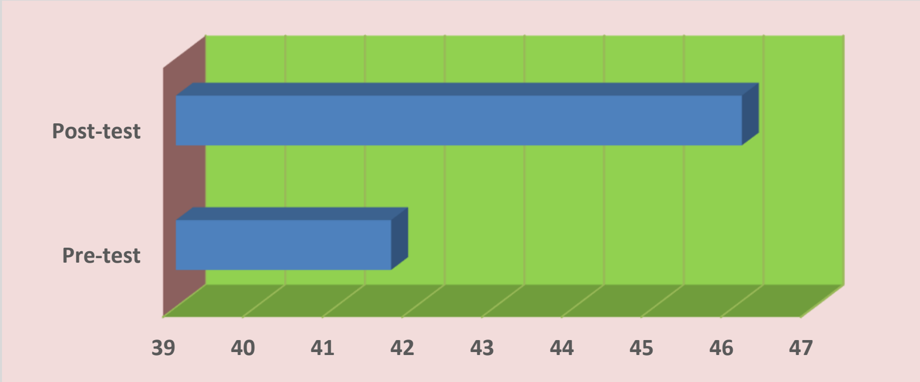

Figure-2, represents the comparison of red blood cell distribution of the subjects of the study.

Figure-2. Comparison of Red Blood Cell Distribution before and after exercise
The study demonstrates a significant decrease in RDW following resistance exercise, the finding can therefore be interpreted as indicating a temporary reduction in variability in erythrocyte size. Such a response could reflect acute redistribution of circulating erythrocytes, changes in plasma volume, altered erythrocyte deformability, or exercise-related changes in erythrocyte turnover. Conversely, if your study demonstrates a significant increase in RDW, it may indicate greater heterogeneity of erythrocyte size, potentially associated with the appearance of younger erythrocytes or transient erythrocyte stress. The interpretation should therefore consider the timing of blood collection, exercise intensity, duration, hydration status, nutritional status, and baseline hematological characteristics.
Importantly, the distinction between acute resistance exercise and long-term resistance training is essential. Acute exercise produces transient hemodynamic and plasma-volume changes, whereas repeated training may induce longer-term adaptations in blood volume, erythrocyte turnover, and oxygen-transport capacity. The literature indicates that exercise training can modify erythrocyte volume and turnover, although the most pronounced expansion of red-cell volume has generally been demonstrated with endurance training rather than resistance training (Montero D, Lundby C,2018). Therefore, RDW responses observed immediately after resistance exercise should not be interpreted as evidence of long-term erythropoietic adaptation.
Overall, available evidence suggests that resistance exercise does not consistently increase RDW. Instead, habitual muscle-strengthening activity has been associated with lower odds of elevated RDW, while studies of trained individuals have found no significant elevation in RDW despite changes in other erythrocyte indices (Loprinzi, P. D., Loenneke, J. P., & Abe, T. 2015). Consequently, if your experimental results show a significant post-exercise alteration in RDW, the most scientifically appropriate explanation is that resistance exercise temporarily modifies erythrocyte and plasma-volume dynamics rather than directly producing a large change in erythrocyte morphology.

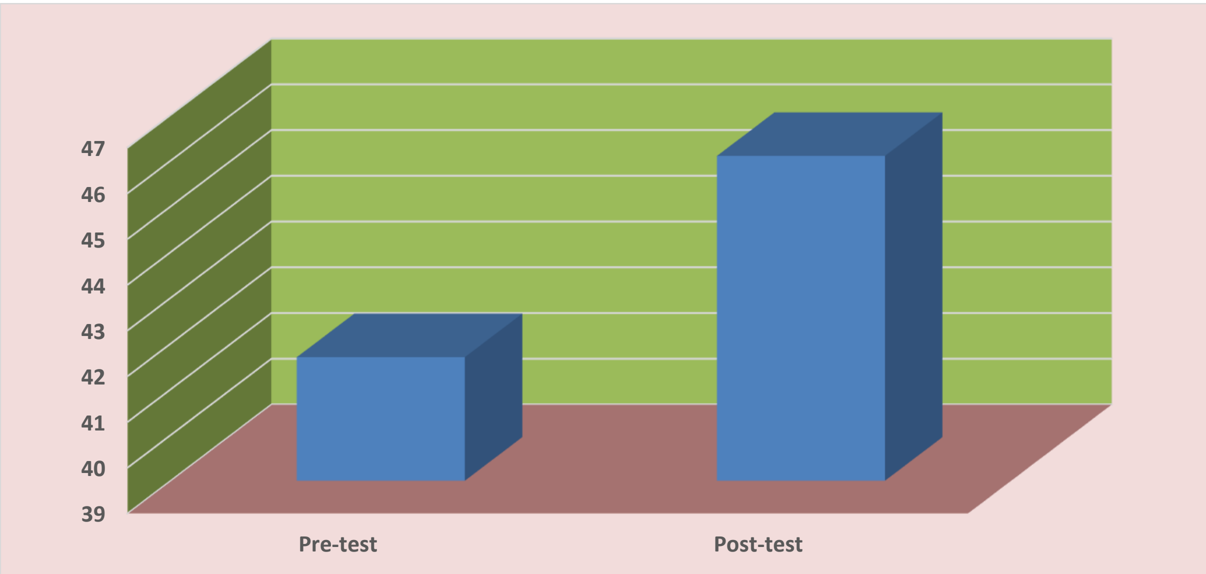

Figure-3. Represents the comparison of Packed cell volume level before and after registance exercise of the subjects.

Figure-3. Comparison of Packed cell volume level before and after resistance exercise of the subjects
From Figure-3, it is observed that Packed cell volume of the active individual was increased following resistance

exercise. Therefore, the significant increase in PCV after resistance exercise in the present study is physiologically plausible and can primarily be attributed to transient hemoconcentration resulting from a reduction in plasma volume. The response may reflect the combined effects of exercise intensity, muscular contraction, redistribution of body fluids, sweating, sympathetic activation, and the hydration status of the participants. The finding is consistent with experimental evidence showing increased hematocrit following acute resistance exercise (Freitas et.al. 2020). Nevertheless, the magnitude of the increase should be interpreted cautiously because factors such as posture, ambient temperature, pre-exercise hydration, duration and intensity of exercise, and the exact timing of post-exercise blood collection can substantially influence PCV (Craig and coworkers, 2018 and Sanchis-Gomar & Lippi, 2014) .

Conclusions:

In conclusion, acute resistance exercise produced significant increases in red blood cell (RBC) count among physically active males. The elevation in RBC count may reflect transient hemoconcentration and mobilization of erythrocytes from the splenic and vascular reservoirs during exercise. Red blood cell distribution width (RDW) also increased significantly, indicating a temporary alteration in the distribution of circulating erythrocyte volumes following exercise. The significant increase in mean corpuscular volume (MCV) suggests an acute shift in erythrocyte volume, potentially associated with changes in plasma volume, cellular hydration, and erythrocyte dynamics. Collectively, these hematological responses demonstrate that resistance exercise can induce measurable short-term changes in red blood cell characteristics. Such alterations may represent normal physiological adaptations that facilitate oxygen transport and meet the increased metabolic demands imposed by exercise. Therefore, acute resistance exercise appears to exert a significant immediate influence on RBC count, RDW, and MCV in physically active males.

Some photos of data collection:

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