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## Effect of exercise on platelet variables: An overview

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### Abstract

**Background:** Platelets are small, anucleated blood elements and under normal conditions constitute a small fraction of the circulating cells. A growing body of recent research reports indicates that platelet functions in the human body are influenced by physical training and regular exercise habit.

**Objective:** The specific aim of this systematic review study is to explore the effect of exercise on platelet parameters and their functions in the human body.

**Acquisition of Evidence:** Relevant research evidence was gathered through online search method. Studies directly matched and fulfill the primary objective of this review study were considered, reviewed properly and presented systematically.

**Findings:** Within this review paper, we are trying to focus and discuss the current information on the impact of exercise on platelet function. Present overview of exercise effect on platelet parameters are reported here under the following heads: Influence of moderate exercise on platelet count, Influence of strenuous exercise on platelet count, Influence of moderate exercise on mean platelet volume, Influence of strenuous exercise on mean platelet volume, Low level exercise and mean platelet volume, Influence of moderate exercise on platelet distribution width, Influence of strenuous exercise on platelet distribution width and low level exercise and platelet distribution width. Platelet Counts Increases with strenuous exercise and decrease with moderate type of exercise. Previous researcher indicates that the average healthy size of platelets may change in human from different part of the world. The mean platelet volume (MPV) increased immediately after long term aerobic exercise. Different intensity of resistance exercise reported significant increase of mean platelet volume. Most of the reports does not found any significant increase in PDW after regular Exercise Participation whereas effect of acute exercises on PDW are decrease significantly.

**Conclusion:** Finally it can be concluded that different mode of exercise has multidirectional effects on platelet function in the human body.

**Keywords:** Exercise, platelet count, mean platelet volume (MPV), platelet distribution width (PDW)

### Introduction

Thrombocytes or platelets break off from the meta megakaryocytes in the boon marrow and then entered in the circulation. Platelets are small, disk shaped blood cell with 2- 3  $\mu\text{m}$  in diameter, exhibit many granules but no nucleus. Growing body of scientific evidence indicates that both acute exercise and habitual physical activity affect platelet function. The platelet plays a critical role in arrest of haemorrhage. The most important function of the platelets is temporary haemostasis by platelet plug formation. Over the last decades, interest has been heightened regarding the changes in platelet count, mean platelet volume, platelet distribution width and other platelet function that are associated with exercise in normal subject and also patients (Sayed, 2002) <sup>[1]</sup>. Beyond an important role in homeostasis and thrombosis, platelets are characterized by expert functions in assisting and modulating inflammatory reactions and immune responses too (Hundelshausen *et al.*, 2004) <sup>[2]</sup>. Therefore, in this review study we are trying to outline and critically evaluate the related literature on the effects of exercise and physical training of three important parameters of platelet. i.e. platelet count, mean platelet volume, platelet distribution width.

### 2. Methods

In this study the researcher conducted a thorough online search on the published materials relating to the role of exercise on platelet function. The online searching process was restricted to original research work available on Pubmed, Jstore, Science daily,

Science direct, Google scholar, infibnet etc. The scholar identified very few studies which directly focus on the impact of acute and habitual exercise on platelet function.

### 3. Findings

Systematic researches (1924-2015) have been carried out in India and abroad to investigate the effects of exercise on platelet function are reported here. At the very outset the researcher identified 89 studies. After analyzing the entire existing evidence the researcher finally included 27 reviews which are closely related and relevant to the present study and others are excluded as those are not matched with the objective of the study. Therefore, the impact of acute and habitual exercise on platelet function is systematically summarized and presented below.

#### 3.1. Platelet Count

A platelet count is a test to measure the number of platelets in blood. Platelets are the part of the blood that helps the blood to clot. They are smaller than red or white blood cells. The number of platelets in the blood can be affected by many disease (Harber *et al.*, 2015) [3]. Platelets may be counted to monitor or diagnose disease, or to look for the cause of excess bleeding or clotting. A low platelet count is below 150,000/ $\mu$ l and below 50,000/ $\mu$ l risk of bleeding is much higher. A lower-than-normal platelet count is called thrombocytopenia. A high platelet count is 400,000 or above. A higher than normal number of platelets is called thrombocytosis and it may have a higher risk of blood clot. Thrombocytopenia is defined as a platelet count of less than 150,000/ $\text{mm}^3$  but if blood has a low number of platelets less than 50,000/ $\text{mm}^3$  then it can be the risk for mild to serious bleeding (Harison, 2005) [4].

##### 3.1a. Influence of Moderate Exercise on Platelet Count

Kilim *et al.* select 50 girls and 50 boys randomly. Platelet count was measured before exercise and after 5 minutes of moderate exercise on the bicycle ergometer. After analyzing all the data they concluded that moderate exercise leads to increase platelet count without platelet activation (Kilim *et al.*, 2015) [5].

In a study platelet was measured in the 12 handball players, who participated in a five days handball competition. All the hematological parameters were measure before and after the competition. The author concludes by giving opinion that, Platelet count was significantly increase after the handball competition compare to baseline data (Koc *et al.*, 2012) [6].

Lippi *et al.* measured platelet count of thirty-one athletes after performed 21.1 km. half- marathon run. Blood samples were collected before the run, at the end, and three and twenty hour thereafter. They reported that platelet count increase after competition compare to pre marathon run and its return to its baseline after twenty hour (Lippi *et al.*, 2014) [7].

Exercise with sub-maximal severity give rise to short term temporary increases in the number of peripheral platelets while the number of platelet does not change after short term moderate exercise with lighter severity (Scalzi, 1987) [8].

In a study Saloan *et al.* show whether any significant change occurred in the human platelet count after a short period of moderate exercise, on standing up and on lying down. The subjects of this investigation were 13 healthy British male under graduates, aged 19-22 years; of these 8 took part in all three experiment. For this experiment the subjects performed approximately 3500 kg. meters of work in the course of 10 minutes. The first blood sample was withdrawn immediately

before exercise after the subject had been standing erect and still for 5 minutes, the second sample within 30 seconds of the cessation of exercise, and the third sample after the subject had stood still for a further 20 minutes. The platelet count fell significantly between the control observations and those immediately after exercise; after 20 minutes standing still the count had risen again but had not reached the original level (Saloan, 1954) [9].

##### 3.1b. Influence of Strenuous Exercise on Platelet Count

Eliöz conduct a study between elit female wrestler age matched sedentary college female students. They found platelet count increased significantly in the elite female wrestler as compared to sedentary college female students (Eliöz, 2012) [10].

Platelet Count after strenuous and moderate exercise (about 50% to 55% peak oxygen consumption,  $\text{vo}_2\text{Peak}$ ) on a bicycle ergometer 10 sedentary and 10 physically active healthy young men executed on two separate occasions and found that, blood Platelet count significantly increase both sedentary and active men (Wang *et al.*, 1994) [11]. The effects of 42.2km. marathon run on blood platelet count of 32 healthy runners. Blood sample was measured 36 hour before and immediately after marathon. They found Platelet count ( $\times 10^9/\text{l}$ ) was significantly increase from  $227 \pm 42$  to  $246 \pm 64$  (Kratz *et al.*, 2006) [12].

Aldemir and Kilic observed that Platelet count depends on the time of the day. Ten moderately active males complete sub maximal (70%  $\text{Vo}_2\text{max}$ ) exercise trials for 30 minutes. They found Platelet count significantly increase after morning exercise ( $(236 \pm 32) \times 10^9 \text{l}^{-1}$  versus  $(202 \pm 34) \times 10^9 \text{l}^{-1}$  baseline,  $P < 0.05$ ) (Aldemir *et al.*, 2005) [13].

After using of whole blood flow cytometric method of 12 physically active and 12 sedentary individuals before and after standardized treadmill exercise testing and found that Platelet counts during exercise increased similarly in both the groups (Metha *et al.*, 1982) [14].

In a study on 15 sedentary healthy male volunteer at rest or immediately after two standardized exercise test performed for 30 minutes on a bicycle ergometer. The exercise performed at a constant load corresponding to either 50% or 70% maximal oxygen uptake, author found that Platelet count ( $\times 10^9/\text{l}$ ) significantly increase from moderate to strenuous exercise (Resting-  $218 \pm 5$ , 50%  $\text{Vo}_2$  Max-  $247 \pm 7$ , 70%  $\text{Vo}_2$  Max-  $275 \pm 8$   $P < 0.001$ ) (Cadroy *et al.*, 2002) [15].

Warlow and Ogston conduct a study on 24 male colleagues and medical students, aged between 20-35 years. For this study all subjects were in good health, but many were unaccustomed to strenuous exercise. Blood sample were collected before and after 15 minutes of strenuous exercise. After all the statistical procedure they found a highly significant rise in the venous platelet count without altering platelet adhesion to glass using the rotating bulb method (Warlow *et al.*, 1974) [16].

Gerheim reported that after strenuous exercise there is slight fall in Platelet count and it is gradually decrease from  $213 \pm 15$  to  $196 \pm 19$ . The lack of increase in the platelet count in these experiment, in spite of increases of 60-100% in the leucocyte count, may be interpreted as evidence against an appreciable storage or sequestration of platelet (Gerheim, 1949) [17].

On the other hand, did not find any significant increase or decrease result of platelet count after doing exercise. They think there is no change of platelet count before and after strenuous running or rowing exercise (Als, 1924) [18].

### 3.2. Mean Platelet Volume (MPV)

Mean platelet volume (MPV) is a machine calculated measurement of the average size of platelets found in blood and is typically included in blood tests as part of the complete blood count. Since the average platelet size is larger when the body is producing increased number of platelet, the MPV test result can be used to make inferences about platelet production in bone marrow or platelet destruction problems. A typical range of platelet volumes is 9.7-12.8fl (femtolitre), equivalent to spheres 2.65 to 2.9  $\mu\text{m}$  in diameter. Normal range is given as 7.5-11.5 fl. The measurement, however, normally needs to be assessed in conjunction with several other factors in order to determine what a satisfactory range is for a specific subject. Research also suggested that the average healthy size of platelets may differ in people from different parts of the world (Alis *et al.*, 2015) [19].

#### 3.2a. Influence of Moderate Exercise on Mean Platelet Volume

Physical exercise strongly influences several laboratory parameters, data about the hematological changes after medium distance running are scarce. The mean Platelet Volume increased immediately after 21.1km.marathon run and returned to baseline within 3hours thereafter. Blood samples were analyzed before the run, at the end and 3hours thereafter. They found baseline volume of MPV (fl) was 9.2, post run value 9.5, after 3hours 9.1, after 20hours 9.2 respectively. The study concluded that moderate exercise increase mean platelet volume and its returns its baseline after 3houre later (Lippi *et al.*, 2014) [7].

Ahmadizad and EL-Sayed suggested that at an intensity corresponding to 40%, 60%, and 80% of one repetition maximum (1-RM) in which the subjects performed six exercise including upper and lower body parts for thirteen healthy male subjects randomly completed three resistance exercise test trials. The ANOVA showed a significant increase in mean platelet volume. They also describe that actule mechanism responsible for the increase in MPV with exercise is nit known, but it may be attributed to a fresh release of young large platelets, particularly from the splenic pool, in to the circulation (Ahmadizad *et al.*, 2003) [20].

Yilmaz *et al.* experiment on mean Platelet volume and exercise stress test. Before and after treadmill exercise test in 63 consecutive patients, they found that control groups mean MPV values before TMET were the same,  $8.52 \pm 0.63$  and  $8.45 \pm 0.58$  respectively ( $P < 0.001$ ). When pre and post TMET mean platelet volume values were evaluated together the patient group had a significant increase in the MPV ( $P < 0.001$ ), whereas, the control group had no significant increase in the MPV ( $P = 0.379$ ) (Yilmaz *et al.*, 2004) [21].

#### 3.2b. Influence of Strenuous Exercise on Mean Platelet Volume

One Aerobic and resistance training session significantly increase the mean platelet volume in non athlete women (Sadeghi *et al.*, 2014) [22]. They were randomly divide in to three groups of 15 subjects: two experimental groups (resistance exercise group and aerobic exercise group) and one control group. The resistance training and aerobic training were conducted in one session for 60 minutes. The blood sample was collected before and after exercise. They found that before resistance exercise group mean 9.08(fl) and post test mean was 9.18(fl), control group mean was 10.11(fl). This results shows that Mean Platelet Volume are significantly increase with resistance type of exercise.

Aldemir and Kilic designed a study on the effect of time of day and exercise on mean platelet volume (MPV). In this study ten moderately active males aged  $27 \pm 1.63$  (mean $\pm$ sd) years completed sub maximal (70%Vo<sub>2</sub> Max) exercise trials for 30 min. after analysis of all the data author found that mean platelet volume significantly lower after the evening exercise ( $9.16 \pm 0.5\text{fl}$  versus  $9.65 \pm 0.36\text{fl}$ ,  $P < 0.05$ ) (Aldemir *et al.*, 2005) [13].

Kratz *et al.* observed that, after 42.2km marathon run of 32 healthy participant blood mean Platelet volume slightly decrease. Blood was collected before and after of marathon run. After analysis by ADVIA 2120 Hematological system (Bayer Healthcare, Diagnosis tics Division, Tarrytown, Ny) author found mean and SD before marathon value  $7.7 \pm 0.7\%$  and after  $7.6 \pm 0.8\%$ . P value was .86. (Kratz *et al.*, 2006) [12].

#### 3.2c. Influence of Low Level Exercise on Mean Platelet Volume

The effect of a circuit resistance training session with a light intensity on some hematological parameters of male students of physical education (35% of a maximum repetition), mean platelet volume are increase significantly after circuit resistance training session. Observer found that MPV (fL) in Exercise group before and after  $9.44 \pm 0.25$ ,  $10.13 \pm 0.36$  P-0.73. Where Control group  $9.03 \pm 0.17$ ,  $9.53 \pm 0.38$ , P-0.319 respectively (Niaki *et al.*, 2013) [23].

### 3.3. Platelet Distribution Width (PDW)

When a doctor requires a platelet count, then a complete blood count (CBC) may be ordered. The CBC blood test will include a measurement of platelet distribution width, which is how the PDW blood test results will be measured. The PDW is a reflection of how uniform in size platelets happen to be. This can help to determine how effectively a person's bone marrow is functioning and if follow-up tests may be required. For platelet width, the general rule is that larger platelets are generally younger, while smaller platelets have been around for a few days. Having a high number of large platelets when someone has typically has a low platelet count indicates the bone marrow has stepped up the production levels. High PDW is an indication that the platelet width varies dramatically. There are numerous younger platelets and numerous older platelets in the same sample. This may be an indication that some sort of disorder has affected the bone marrow or the platelets and further testing may be required. Certain cancers, anemia, and inflammatory conditions typically cause this result, as will some infectious diseases or the use of birth control pills. Normal PDW is an indication that the platelet widths are relatively the same in size. This is the test result that the average person is going to receive when a complete blood count is ordered. Low PDW is an indication that there is a disorder present which is affecting the bone marrow and how it is able to produce platelets. Viral infections will typically produce this result, such as measles, hepatitis, or mononucleosis. Certain drugs and cancers can also cause this result (Saygin, 2014) [24].

#### 3.3a. Influence of Moderate Exercise on Platelet Distribution Width

Kirbas *et al.* conduct a study with a view to comparing blood platelet levels of athletes who do sports regularly at list for a period of five years with those of sedentary University students. Blood sample were collected and platelet, mean platelet volume, platelet crit, platelet distribution width were

measured for athletes and sedentary University student accordingly. 18 voluntary male athletes of various team sports with a mean age  $20.55 \pm 0.70$  years and 18 sedentary university student with a mean age  $20.88 \pm 0.75$  years were acted as subjected in this study. Independent samples 't' test was used to find out the difference among two groups,  $P < 0.05$  value was accepted as significant level. They reported that the differences in platelet, mean platelet volume, and platelet crit levels were statistically significant ( $P < 0.01$ ) where as the difference in platelet distribution width value was insignificant ( $P > 0.05$ ) (Kirbas *et al.*, 2015) [25].

Saygin examined 55 healthy Greco-Roman wrestlers in the age category of Cadets including 18 lightweight, 20 middleweight and 17 heavyweight wrestlers participated to investigate physical, hematological parameters and iron status of Greco-Roman wrestlers in the age category of cadets by weight classes. Kruskal-Willis test, a non-parametric test, was used for the comparison of three independent groups. Blood samples were taken into tubes with EDTA, hematological parameters. The Mean and SD value of PDW (%) Light Weight, Middle Weight, and Heavy weight Wrestler was  $13.25 \pm 2.92$ ,  $15.49 \pm 1.45$ ,  $14.57 \pm 2.33$  respectively. A significant difference was found in PDW values. The difference resulted from the fact that the values of lightweight wrestlers were lower than the values of middleweight wrestlers (Saygin, 2014) [24].

### 3.3b. Influence of Strenuous Exercise on Platelet Distribution Width

The influence of five days handball competition on blood hematological variables was studied in 12 volunteer male hand ball players. Blood sample was collected and hematological parameters of the handball players were analyzed before and after the competition. In this study it is reported that blood platelet distribution width was decreased. The value of PDW before competition was  $49.39 \pm 6.66$  and after competition it was  $47.99 \pm 6.56$  respectively (Koc *et al.*, 2012) [6].

Kratz *et al.* found that after Long distance run like Marathon run there was no significant change in mean platelet volume, PDW, and number of large platelets. To study the effects of vigorous exercise on platelet distribution width blood sample were collected from 32 healthy participants in a 26.2 mile (42.2km) marathon. By using direct measurement of platelet granularity, their study confirms the *in vivo* activation of platelets by vigorous exercise and establishes the usefulness of automated cell counters for the assessment of platelet activation. They found that before Marathon Run Mean and SD Platelet Distribution Width (PDW%) was  $55.1 \pm 5.8$  and after it was  $55.5 \pm 5.2$  respectively (Kratz *et al.*, 2006) [12].

Erdemir designed a study to compare the hematologic parameters between the morning and evening exercise in high school student. 12 healthy untrained male student aged about twenty years voluntarily participate in this study. In case of morning exercise blood sample was taken before (pre) and after (post) the sub maximal exercise between 8-9 a.m., where as blood sample was collected for evening exercise between 8-9 p.m. accordingly. With other hematological parameters platelets, platelet crit, M.P.V, and P.D.W. were measured and analyzed by means of an Archem H3000 Hematology Analyzer. It was reported that there were significant increase at morning pre and post exercise and also evening pre and post exercise on PLT and on MPV at the significant level of  $P < 0.05$ . Mean level of PLT at morning pre-exercise increased more than morning post exercise (Erdemir, 2013) [26].

### 3.3c. Influence of Low Level Exercise on Platelet Distribution Width

Niaki and Tayebi in their study observe the effect of a low intensity circuit resistance exercise session on college students. 20 male students of physical education stream voluntarily participated in this study. They were randomly divided into two groups, light intensity exercise (35% of a maximum repetition) and no exercise (the control). Data was analyzed using SPSS software and they found that there was no significant change in platelet distribution width among the physical education student (Niaki *et al.*, 2013) [23].

## 4. Conclusions

After reviewing all the above literature the following conclusions can be made:

### Platelet Count

Platelet count increase significantly after strenuous type of exercise, but it is decrease after moderate type of exercise whereas very few number of study did not find any significant increase or decrease result of platelet count after doing exercise. Platelet count increases with exercise may be attributed due to release of fresh platelets from the spleen, bone marrow, or from other reservoirs.

### Mean Platelet Volume

The mean platelet volume increases immediately after long-term aerobic exercise. Different intensity of resistance exercise reported significant increase of mean platelet volume but the actual mechanism responsible for the increase in MPV with exercise is not known, evidence suggested that the average healthy size of platelet may differ in people from different parts of the world but it may be attributed to a fresh release of young large platelets, particularly from the splenic pool, into the circulation.

### Platelet Distribution Width

Most of the reporter does not found any significant increase in platelet distribution width after regular Exercise Participation whereas effect of acute exercises on platelet distribution width are decreasing significantly. The scientific literature shows exercise effect on platelet distribution width (PDW) is insignificant. Whereas very few number of study did not find any significant increase or decrease result.

Available scientific evidences that has been summarized in this review study indicates that exercise effects on platelet count are still controversial, so more in depth study is needed before a definitive statement can be made.

### Future Projection

On the basis of available information sited in this study, firstly the point that needs to be answered is that what volume of exercise intensity can produce best impact on platelet variables.

Secondly, how different form of physical exercises changes the blood parameters and find out the possible path of physiological mechanism.

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