Effect of exercise on pseudo dilution anemia in healthy male subjects.
A comparative study.

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Abstract
Regular exercise is largely done to have maintained body shape and fitness. It exerts influence on almost all physiological and psychological parameters. One of these is dilutional anemia or sports anemia that is the initial adaptation of body to exercise. The aim of present study was to evaluate the extent of dilutional anemia in healthy males who have been exercising for past three years at least. Randomly selected 40 male subjects from gyms of Karachi were recruited in the study. Peripheral blood was collected pre and post exercise, and tested for hematocrit, hemoglobin concentration and red blood cell count. Increased hemoglobin concentration was observed which is directly related to increased red blood cell count which is inversely proportional to blood plasma level. So, decreased plasma level is the possible cause that pseudo dilution anemia was not observed in males who have been regularly exercising for past three years.

Key words
sports anemia, exercising males, hemoglobin level, hematocrit, pseudo-dilution anemia

Introduction
Plasma volume is increased by 20-30 percent due to regular physical exercise which leads to a slight decrease in hemoglobin concentration than normal values while low serum ferritin level of athletes is caused by pseudo dilution anemia, also known as pseudo-anemia (Bartsch P. et al, 1998). Pseudo-dilution anemia is the first adaptation of the body due to regular exercise indicating less hemoglobin with normal red blood cell mass (Bruckheim A. et al, 1990). Although adaptive response occurs to the reduction in plasma volume in early exercise but the three main factors that contributes to decreased plasma volume or decreased hemoglobin concentration are:
1) Increased compression on venules due to muscles and elevated mean arterial blood pressure contributes to increased hydrostatic pressure of capillary.
2) Lactic acid and different other tissue metabolites are generated that contributes to increased tissue osmotic pressure.
3) Fluid loss results due to the production of sweat (Safran et al. 1998).

Body responses to pseudo-dilution anemia
Body releases renin, aldosterone and vasopressin to conserve water and salt. To increase plasma volume, albumin is also added to blood (Nagashima et al., 2000). As hemoglobin deliver oxygen to muscles, endurance capability can be reduced by anemia but as an adaptive response pseudo-dilution anemia is present as a paradox (Fink et al. 2006). As increased plasma volume cause rise in cardiac stroke volume rises, hemoglobin compensated for any loss and more and thus, more oxygen is delivered to
muscles (Gillen, 1991). The reduction in plasma Hemoglobin levels can vary from 5% to 20% in individuals doing exercise (Safran et al. 1998). One common cause of Pseudo dilution anemia in athletes is the lack of iron in their diet because heavy exercise elevates the need of iron up to 1-2 mg per day. This is caused by multiple factors like:


Loss of blood in urine or from gastrointestinal tract
Breakdown of red blood cells due to heavy foot striking (Smith, J.A. et al, 1999). During sternous exercise, blood loss/day increases up to 4-6 ml significantly whereas iron excretion in urine was found to be negligible, indicating gastrointestinal blood loss as the main reason for iron loss (Nachtigall, D. et al, 1996). Oral iron as a performance enhancer
Iron supplements can cause ferritin levels in serum to rise, but this increase in serum ferritin levels, solitary increases hemoglobin concentration only but not the endurance performance (Kimberly Harmon 2004). The degree of dilution anemia is proportional to exercise intensity and lies approximately 10-20% below hemoglobin concentration (Hinton, P.S. et al, 2000). Sternous exercise causes hemoglobin to decrease 0.5 to 1 gram below normal range (E R Eichner, 2001).

Methodology
The study was conducted on 40 samples i.e. 20 male subjects, in the age group of 19-32, bearing weight in the range of 60 kg to 120 kg and height in the range of 5ft to 6ft 3 inches. They were all the resident of Karachi, Pakistan and were not suffering from any pathological disease at the time of sampling. Sampling was done from Murtaza Gym (Hyderi), Head quarter Gym (Board Office) and Eid-Gah Gym (Gol Market). The subjects were divided into two groups:
Standard Group
It comprises of 20 samples. The individuals of this group were used as a control. Blood sampling in this group was done before performing exercise.
Experimental Group
It again comprises of 20 samples. The individuals of this group were used as a test. Blood sampling in this group was done after performing exercise.

2ml collected blood is transferred to lavender top test tube having KEDTA anticoagulant which is used in blood CP. Gently shake the tube to mix anticoagulant with blood so that blood do not clot. Blood parameters are measured using Hematology analyzer.

Result
Hematocrit (Hct) value
65% (44.384 ± 3.15) individuals show increased hematocrit value after exercise. 10% (39.5 ± 4.949) of individuals show decreased hematocrit value while 25% (41.4 ± 3.361) of individuals did not show any change in hematocrit value compared before and after exercise.

Hemoglobin concentration
65% (15.123 ± 1.154) individuals show increased hemoglobin concentration after work out. 20% (14.375 ± 2.976) of athletes showed decreased hemoglobin concentration after exercise while 15% (14.566 ± 0.986) of exercising males did not show any change in their hemoglobin concentration when compared before and after exercise.

Red Blood Cells (RBCs) per cubic millimeter (cmm)
65% (5.307 ± 0.347) of exercising male subjects show increased red blood cell
concentration per cubic millimeter of blood after exercise. 25% (5.1 ± 0.244) of athletes showed decreased red blood cell concentration per cubic millimeter of blood after exercise while 10% (4.9 ± 0.282) individuals did not show any change in their red blood cells concentration per cubic millimeter of blood when compared before and after performing exercise.

Table 1: Comparison of blood parameters pre and post exercise.

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<thead>
<tr>
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<th>Pre-Exercise</th>
<th>Post-Exercise</th>
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<tbody>
<tr>
<td>Hematocrit (PCV) (%)</td>
<td>42.6 ± 2.692</td>
<td>43.15 ± 3.631</td>
</tr>
<tr>
<td>Hemoglobin (%)</td>
<td>14.93 ± 1.288</td>
<td>14.94 ± 1.479</td>
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<tr>
<td>Red blood cells (M/cmm)</td>
<td>5.07 ± 0.265</td>
<td>5.215 ± 0.336</td>
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Discussion

Hematocrit value increases after exercise, it is also confirmed by the p value which is found to be above 0.05, and so, the results are non-significant indicating that pseudo dilution anemia was not observed after exercise. The possible reason is iron or protein supplements intake which causes red blood cells to increase after exercise.
ultimately not causing pseudo dilution anemia in individuals performing exercise because one common cause of Pseudo dilution anemia in athletes is the lack of iron in their diet because heavy exercise elevates the need of iron up to 1-2 mg per day (Carol L. Otis, 2000).

Increased Hemoglobin concentration is directly related to increased red blood cell count which is inversely proportional to blood plasma level. So, decreased plasma level is the possible cause that pseudo dilution anemia was not observed. The pseudo dilution-anemia during exercise is only concerned when the hemoglobin levels are alone compared with the state when the individual is not training (E Watts - 1989). And lies in the range of approximately 10-20% below the hemoglobin concentration. With moderate and heavy exercise, the hemoglobin concentration may decrease 0.5 grams to 1 gram lower than the normal range of an athlete's. But such decrease in hemoglobin concentration is not observed in our study after performing exercise that is the reason pseudo dilution anemia is not observed in exercising males.

All above results supporting that pseudo dilution anemia was not observed are confirmed by Reb blood cell count concentration that increases after exercise decreasing the plasma levels in exercising individuals. With initiation of exercise training, there is rapid increase in blood volume during the first few weeks, but then eventually decreases. This preliminary increase is mostly due to an increase in blood plasma, resulting in a decreased hematocrit value which is called pseudo dilution anemia, but it is the normal physiological response to endurance exercise, rather than true pathological anemia. But after sometimes of training, red blood cell count also begin to increase to in contest with the increase in volume of plasma and the possible reason for this is the growth hormones released during exercise (Sharon A., 2011).

**Conclusion**

Comparative evaluation of the recruited subjects confirm that pseudo dilution anemia was not observed as these males were exercising for years, thus, there red blood cell count have already have increased their mass to equal the plasma volume. This increase in RBC count is a long-term adaptation for exercise. But further studies could be done to compare and observe pseudo dilution anemia between individuals who have recently started workout and individuals who have been working out from years to better understand the phenomenon of sports anemia.

**Competing Interests**

No competing Interests found.

**Acknowledgment**

The authors would like to acknowledge the authorities of Murtaza Gym, Rangers Head quarter Gym and Eid-Gah Gym for their valuable participation and the efforts of Ramsha Alam of Department of Physiology, University of Karachi, for her valuable input in collecting samples.

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Physiology-Health-Fitness-Performance/dp/0781779766


