

Original Article

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 gymnasiums 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 iron in sweat (Waller, M. F. et al, 1996).

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 strenuous 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). Strenuous 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 anti-coagulant which is used in blood CP. Gently shake the tube to mix anti-coagulant 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.

	Pre-Exercise	Post-Exercise
Hematocrit (PCV) (%)	42.6 ± 2.692	43.15 ± 3.631
Hemoglobin (%)	14.93 ± 1.288	14.94 ± 1.479
Red blood cells (M/cmm)	5.07 ± 0.265	5.215 ± 0.336

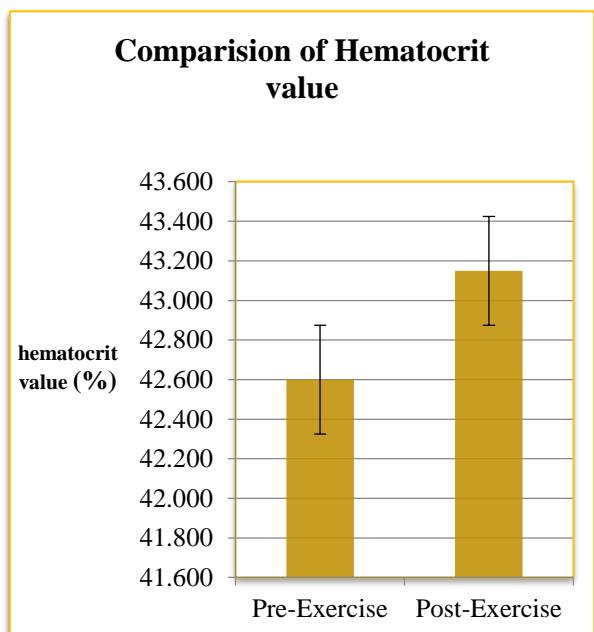


Fig. 1. Comparison of Hematocrit value

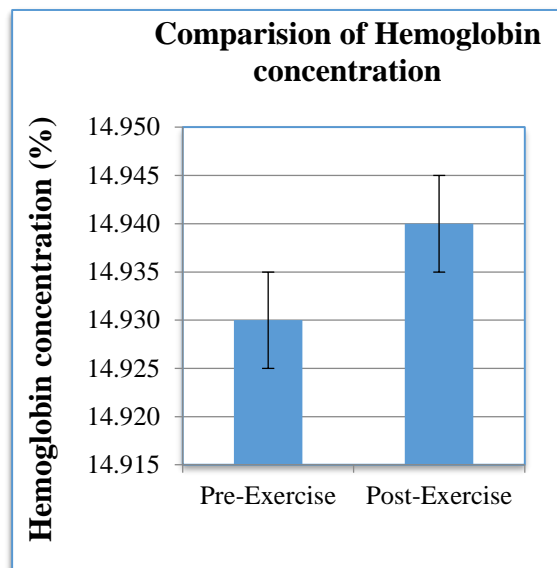


Fig. 2. Comparison of Hemoglobin concentration

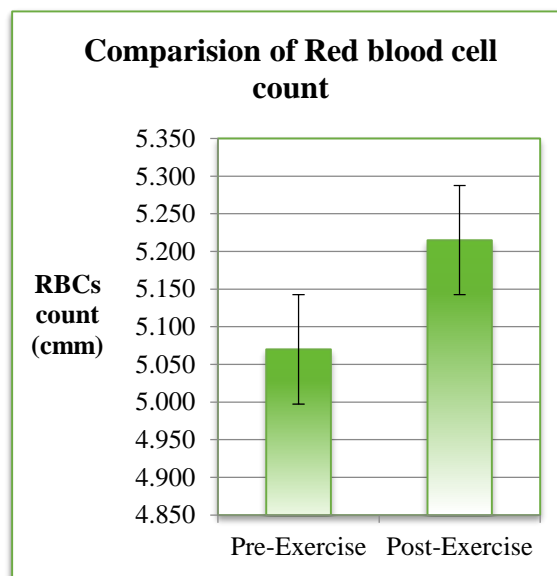


Fig. 3. Comparison of Red blood cell count

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 Red 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, their 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

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References

- E Watts - 1989 Michael Darmady Laboratory, Queen Alexandra Hospital, Cosham, Portsmouth, P065 3LY, Athletes' anaemia A review of possible causes and guidelines on investigation.
- Sharon A. Plowman and Denise L. Smith; 2011. "Exercise Physiology for Health, Fitness and Performance"; ISBN-13: 978-0781779760; ISBN-10: 0781779766. <http://www.amazon.com/Exercise->

Physiology-Health-Fitness-
Performance/dp/0781779766

- Gillen, C.M., R. Lee, G.W. Mack, C.M. Tomaselli, T. Nishiyasu, and E.R. Nadel (1991). Plasma volume expansion in humans after a single intense exercise protocol. *J. Appl. Physiol.* 71: 1914-1920.
- Dr. Allan Bruckheim. August 15, 1990. Pseudo-anemia Helps Athletes` Performance. http://articles.chicagotribune.com/1990-08-15/features/9003080317_1_red-cells-hemoglobin-footstrike
- Smith, J.A., D.T. Martin, R.D. Telford, and S.K. Ballas (1999). Greater erythrocyte deformability in world class endurance athletes. *Am. J. Physiol.* 45:H2188-2193.
- Hinton, P.S., C. Giordano, T. Brownlie, and J.D. Hass (2000). Iron supplementation improves endurance after training in iron depleted, nonanemic women. *J. Appl. Physiol.* 88: 1103-1111.
- Nachtigall, d., p. Nielsen, R. Fischer, R. Engelhardt, and E.E. Gabbe (1996). Iron deficiency in distance runners: a reinvestigation in distance runners: a reinvestigation using ⁵⁹Fe-labelling and non-invasive liver iron quantification. *Int. J. Sports Med.* 17:473-479.
- Safran, Marc R., Douglas McKeag, and Camp Steven P. Van. *Manual of Sports Medicine*. Philadelphia, PA: Lippincott-Raven, 1998.
- Waller, M.F., and E.M. Haymes (1996). The effects of heat and exercise on sweat iron loss. *Med. Sci. Sports Exerc.* 28: 197-203.
- Kimberly Harmon, 2004, Anemia (including iron metabolism), <http://www.cptips.com/blood.htm>
- Fink, Heather Hedrick., Lisa A. Burgoon, and Alan E. Mikesky. *Practical Applications in Sports Nutrition*. Sudbury, MA: Jones and Bartlett, 2006.
- E. Randy Eichner, M.D. (2001). Anemia and blood boosting, sports science exchange 81 volume 14-number2. <http://www.gssiweb.org/Article/sse-81-anemia-and-blood-boosting>
- Nagashima, K., G.W. Cline, G.W. Mack, G.I. Shulman, and E.R. Nadel (2000). Intense exercise stimulates albumin synthesis in the upright posture. *J. Appl. Physiol.* 88: 41-46.
- Bärtsch P, Mairböurl H, Friedmann B. Apr 1998. Pseudo-anemia caused by sports. *Ther Umsch.* ; 55(4):251-5.