

A regional study on the effects of altitude on hematological parameters in Van city of Turkey

ERCAN M.¹, TUNCER I.², AKDENİZ H.³, ÖZTÖRK G.³, ÇİFTÇİ LH.¹

Departments of Physiology¹ and Physical Therapy and Rehabilitation² and Clinical Bacteriology & Infectious Disease³

School of Medicine Yüzüncü Yıl University, Van

Objective In this study, we aimed to determine hematological values of people living at altitude of 1717 m above the sea level in Van city of Turkey. Almost all blood samples assessed in the study have been taken from population living at places of the mentioned altitude or even above that.

Methods In the study, a total of 583 blood samples of 188 men and 347 women (20-45 years old), and 48 children (5-12 years) admitted to hospital either to obtain a health state report or for a check-up and lacking any sickness or complaint in physical examinations, were assessed in respect of RBC, Hb, Hct, MCV, MCH, MCHC, RDW, Platelet and MPV values.

Results In all three groups, mean RBC values were found higher than the international standard values given by International Hematology Standardization Committee.

Mean Hb and Hct values were lower than the standards in men, but higher in women and children. MCV, MCH, MCHC and Plt values were found under the standards in all three groups.

Conclusion In this study aiming to investigate the effects of altitude on blood parameters by determining hematological values of people in Van region, we found generally increases in RBC, Hb and Hct values and decreases in MCV, MCH, MCHC and Platelet values, when compared with the standards. But unfortunately, we were not able to obtain similar data pertaining to other regions of Turkey to make a comparison.

Key words Altitude, blood parameters, RBC, Hb, Hct,

Introduction

This study was realized mainly to assist the physicians working in this area or at alike altitudes in the course of assessing blood parameters of their patients and to contribute to the studies related to determining blood norms in Turkish population.

Material and Method

The study was performed in Hematology Laboratory of Yüzüncü Yıl University, Medical Faculty between January and May 1995. In the study, a total of 583 blood samples of 188 men and 347 women (20-45 years old), and 48 children (5-12 years old), who were admitted to the hospital to obtain health state report or for a check-up and lacking any sickness or complaint in physical examination, were assessed.

Blood samples were drawn from the antecubital vein of subjects in 2 ml and transferred into special tubes (LP-ITALIANA SPA VIA) containing EDTA-3K within without waiting. Subsequently they were mixed in a mixer (Coulter LU 33 RH) for 10 minutes. For measurements of whole blood parameters, automatic blood counting apparatus was used (Coulter Max-M).

In this study, red blood cell (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration

(MCHC), red cell distribution width (RDW), platelets (Plt) and mean platelet volume (MPV) values belonging to the region population applying to the Medical Faculty of Yüzüncü Yıl University, were investigated. In statistical analyses done, (simple paired two-tail) student-t test was used. P values "0.05" and less, were statistically accepted significant.

Results

In the study, total of 583 blood samples, 188 of which belonging to men, 347 to women and 48 to children were assessed.

Mean and standard deviations of RBC, Hb, Hct, MCV, MCH, MCHC RDW, Plt and MPV values obtained with the study were separately calculated for men, women and children.

The values belonging to men, women and children (mean \pm SD) are shown in Table 1.

Blood values belonging to men (Mean and SD)

In calculations done for blood parameters belonging to men, the values were as follows: RBC 5.30 ± 0.42 ; Hgb 15.31 ± 1.45 ; Hct 45.31 ± 4.09 ; MCV 85.44 ± 4.09 ; MCH 28.87 ± 1.56 ; MCHC 33.75 ± 0.76 ; RDW 12.49 ± 0.77 ; Plt 259.83 ± 63.15 and MPV 8.32 ± 0.72 .

Blood values belonging to women (Mean and SD)

In calculations done for blood parameters belonging to women, the values were as follows: RBC 5.04 ± 0.39 ; Hb 14.37 ± 1.28 ; Hct 42.72 ± 3.57 ; MCV 84.76 ± 3.88 ; MCH 28.50 ± 1.61 ; MCHC 33.59 ± 1.11 ; RDW 12.67 ± 1.19 ; Plt 265.49 ± 58.98 and MPV 8.46 ± 0.75 .

Table 1. Blood values (means \pm SD) of children, women and men.

	RBC	HGB	HCT	MCV	MCH	MCHC	RDW	Plt	MPV
Child blood values (n=48)									
Mean	5.06	14.00	41.57	81.70	27.55	33.74	12.68	284.96	8.17
Standard Deviation	0.32	0.90	2.66	2.99	1.08	0.59	1.10	68.65	0.70
Male blood values (n=188)									
Mean	5.30	15.31	45.27	85.44	28.87	33.75	12.49	259.83	8.32
Standard Deviation	0.42	1.45	4.06	4.09	1.56	0.76	0.77	63.15	0.72
Female blood values (n=347)									
Mean	4.93	14.04	41.81	84.76	28.50	33.59	12.67	265.49	8.46
Standard Deviation	0.36	1.04	2.99	3.88	1.61	1.11	1.19	58.98	0.75

Blood values belonging to children (Mean and SD)

In calculations done for blood parameters belonging to children, the values were as follows: RBC 5.06 ± 0.36 ; Hgb 14.00 ± 0.90 ; Hct 41.57 ± 2.66 ; MCV 81.70 ± 2.99 ; MCH 27.55 ± 1.08 ; MCHC 33.74 ± 0.59 ; RDW 12.68 ± 1.10 ; Plt 284.96 ± 68.65 and MPV 8.17 ± 0.70

Discussion

In this study, RBC, Hb, Hct, MCV, MCH, MCHC, RDW, Plt and MPV values belonging to the local population, applying to the Medical Faculty of Yüzüncü Yil University, were investigated. Blood samples used for the study were belonging to healthy people applying to the hospital to obtain a health state report or for a check-up and lacking any sickness or complaint in their physical examination.

Van Lake Region is at an altitude of 1727 m. above the sea level. Consequently, almost all blood samples assessed in the study had been taken from population living at places of the mentioned altitude or even above than.

Since 1890, the effects of altitude on blood parameters have become subject to many investigations which had been done until today and have still been investigated [1,2]. It has been demonstrated in investigations that the altitude was effective on most of blood parameters. In more recent reports, however, investigators suggest that the marked erythrocytosis at high altitude reported in early studies (25 to 30 % higher Hb concentration, Hct, and red cell mass values in Andean natives than in subjects at sea level) may in large part reflect selection of subjects with pulmonary diseases mostly from mining communities, because an agrarian population from the same area exhibited only a 10 to 12 % increase above values obtained at sea levels [3,4]. But some investigators reported not being any significant Hb and Hct changes at altitude and attributed the encountered changes to a variety of

factors, including nutritional habits, exercise and occupational characteristics [3,4,5]. According to our knowledge, in addition to altitude, the factors mentioned above are also effective on blood parameters. However, the reports proved increases in blood values are in majority [6,7,8]. In an interesting study performed on 45 children radically treated for cancer demonstrating disorders of hemopoiesis, the effect of rehabilitative treatment given at a medium altitude mountain resort was shown to improve blood parameters. In 42 of 45 patients with anemia, thrombocytopenia, leukopenia and lymphopenia, the indexes returned to normal [9].

Consequently, we could not come to a clear conclusion about the changes in peripheral blood values caused by high altitude. According to the results, it is essential to know blood parameter norms for the region, in order to assess blood parameters of patients by the physicians working in this area. In searching the literature, we have not found any investigation in this matter relating Van Lake environment or its neighborhood in Turkey. With this study, we aimed to assist the physicians working in this region or at alike altitudes in the course of assessing blood parameters of their patients and to contribute to the studies related to determining blood values norms in Turkish population.

According to the criteria determined by International Hematology Standardization Committee, mean RBC count for men is 5.21, for women 4.60 and for children 4.60 million/dl; mean Hb value for men 15.7, for women 13.8 and for children 13.5 g/dl; mean Hct value for men 46 %, for women 40 % and for children 40 %. From other parameters mean MCV value is 88, being 86 for children and 90 fl for adults. Mean MCH and MCHC values being equally in adults and children, MCH is 30.4 pg, MCHC is 34.4 g/dl. RDW is 13.1%, mean thrombocyte count is about 311.000 /dl., MPV is 7.1 fl. (2.10).

The blood values found in this study are summarized in Table 1. As shown in the table, there are some differences between all blood parameters. However, in subjects living at high altitude alike Van, it is an expected conclusion to encounter to a normocytic, normochromic increase in erythrocytes (2,4-7).

The events associated with acclimatization at high altitude are not understood completely, but probably include an increase in erythrocyte 2,3 diphosphoglycerate levels and a shift to the right in the O_2 -Hb dissociation curve, thus allowing better tissue delivery of oxygen in spite of decreased oxygen saturation, an increase in plasma and urinary erythropoietin levels with subsequent increase in plasma iron turnover, reticulocytosis, and increase in red cell mass and blood volume (11,12,13). In addition, the pathogenesis may involve hypoxia and subsequent excessive secretion of ADH and adrenal steroids with resulting fluid retention and increased blood volume (14,15,16). MCV is normal or slightly increased. MCHC is normal, reticulocyte count may be increased, but being generally normal. Trombocyte count is generally normal or may be increased (9,11). In ascending to high altitude, despite the normal serum iron concentration, transferrin-iron concentration is decreased and iron absorption is increased (13,17,18). According to these data, the criteria determined by International Hematology Standardization Committee, if compared with the blood values found in this study, it is obvious that mean RBC count is higher than the international values for all 3 groups, mean Hb and Hct value is below the standards in men, whereas above the standards in women and children; MCV, MCH, MCHC and platelet values are below the standards. Decreases in MCV, MCH and MCHC values are in large part related to iron metabolism, but also another factors may play a role in this change. We have not got too sufficient data, at present, to compare these values with those of another region in Turkey. If altitude is excluded, it is possible to attribute these values to another characteristic of this region and nutritional habits etc. However, it is a known fact that there is no study systematically performed with certain standards, to compare these values with those of another region in Turkey or with general Turkish population values.

References

1. Allen JE, Williams JW. Hematology, Fourth Edition. New York: McGraw-Hill publishing Company Press 1991.
2. Richard LG. Wintrobe's clinical hematology. Ninth edition. Philadelphia: Lea & Febiger Press. 1993.
3. Schmidt W, Dahners HW, Corcos R, Ramirez R, Rojas J, Boring D: Blood gas transport properties in endurance-trained athletes living at different altitudes. *Int J Sports Med* 11: 15-21, 1990.
4. Garruto RM, Dutt JS: Lack of prominent compensatory polycythemia in traditional native Andean living at 4,200 meters. *Am J Phys Anthropol* 61: 355-358, 1983.
5. Frisano AR: Functional adaptation to high altitude hypoxia. *Science Clin Sci* 67: 453-457, 1984.
6. Boutellier U, Desisz O, di-Pompero PE, Genetelli P: Aerobic performance at altitude: effects of acclimatization and hematocrit with reference to training. *Int J Sports Med* 11: 21-26, 1990.
7. Ferretti G, Boutellier U, Pendergast DR, Moia C, Minelli AE, Howald H, di-Pompero PE: Oxygen transport system before and after exposure to chronic hypoxia. *Int J Sports-Med* 11: 15-20, 1990.
8. Inger F, Mylne K: Physiological effects of altitude training on elite male cross-country skiers. *J-Sports-Sci* 10: 37-47, 1992.
9. Kamek ZP, Mašumbeiov EK: The effect of a stay under central highlands conditions on the dynamic indices of the peripheral blood in children receiving treatment for cancer. *Vopr Onkol* 38: 352-357, 1992.
10. Philip L: Manual Pediatric Hematology and Oncology. Second edition. New York: Churchill Livingstone Inc. Press. 1995.
11. Klausen T, Mohr T, Ghisler U, Nielsen OJ: Maximal oxygen uptake and erythropoietic responses after training at moderate altitude. *Eur J Appl Physiol* 62: 376-379, 1991.
12. Oo LC, Chen J, Fione E, Letter JC, Brinck JT, Berhard GP, Clemens G, Smith RP: Ventilatory and hemosteporic responses to chronic hypoxia in two rat strains. *J-Apppl-Physiol* 72: 2354-2363, 1992.
13. Richalet JP, Souberbielle JC, Antezana AM, Dechaux M, Le-Trong JL, Biervenu A, Daniel F, Bianchet C, Zitoun J: Control of erythropoiesis in humans during prolonged exposure to the altitude of 6,542 m. *Am J Physiol* 266: 756-764, 1994.
14. Levine BD: Dexamethasone in the treatment of acute mountain sickness. *N Eng J Med* 321: 1707-1709, 1989.
15. Milledge JS, Dotley DM: Angiotensin converting enzyme response to hypoxia in man: Its role in altitude acclimatization. *Clin Sci* 67: 453, 1984.
16. Perez PR, Sales J, Carrillo G, Seiman M, Chapela R: Prevalence of high hemostocis in patients with interstitial lung disease in Mexico City. *Chest* 101: 1691-1693, 1992.
17. Martin DT, Watts PB, Newbury VS: The effect of Alpine mountaineering on acute erythrocyte hemolysis. *Int J Sports Med* 13: 31-35, 1992.
18. West JB: Human physiology at extreme altitudes on Mount Everest. *Science* 10: 223: 784, 1984.

Correspondence to:

Yrd.Doç.Dr. Muhterem Ercan
Yüzüncü Yıl Üniversitesi Tıp Fakültesi
Fizyoloji Anabilim Dalı Van
Fax: (432) 216 75 19