



### The Effects of Altitude Training on Erythropoietic Response and Hematological Variables in elite endurance athletes

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**Objective** To increase the capacity of blood oxygen-carrying of the endurance performance in athletes is the goal of altitude training. The key factor in the achievement of enhanced hematological variables is the stimulation in the hypoxia condition. Reticulocyte cells is the earliest red blood cells released to the bloods, it to be matured about 4 days in the marrow. There are lots of research in the clinic tested reticulocyte can be monitor the change of the bone marrow hematopoietic system. The purpose of this study was to find out the effect of altitude training on reticulocyte indices of elite endurance athletes, further to analyze the kinetics of erythropoiesis and hematological variables during and after altitude training.

**Methods** The main content of high altitude training are as following: 1~2 weeks before the plateau, the main content of training was special aerobic endurance training and special strength endurance training; 1~5 days after plateau, the main content of training was Low intensity, relaxation of the adaptive training; 5~15 day after plateau, the main content of training was Intensive training phase, the main content of training was aerobic endurance and greater intensity of the special training; 16~20 days after the plateau, adjustment training 21~25 days after the plateau, the main content of training was same to the training plan of 5~15 day after plateau; 2~3 days after return to the sea level, adjustment training; 1~2 days after return to the sea level, the mainly training content was rhythm and strength training; 2 weeks after return to the sea level, the mainly content of training was normal training, the intensity of training was greater than the intensity in the sea level.

At this stage, we tested the changes of the reticulocyte indices before \after half past three weeks altitude (2366m, DuoBa, QingHai) training, to provided the basis for the develop research the influence of the bone marrow hematopoietic system. Blood parameters were collected two days before altitude training \ two days after off altitude \ two weeks after altitude. All the data measured from venous blood samples (1.5~2ml) collected via venipuncture from athletes in a supine position. All the samples were tested using ADVIA120. Data were analyzed by spss17.0 software.

**Results** MCVr/RDW were significantly increased after altitude training,  $P < 0.05$ ; CHCMr and RDWr significantly decreased after altitude training,  $P < 0.05$ ; CHCMr were changed more significantly between before and after,  $P < 0.01$ ; the reason why retici# was decreased were analyzed that when the athletes training in the hypoxia condition, lack of oxygen and the mechanical injury of friction resulting in a new generation of reticulocyte number was less than the number of destruction. Hb \ #RETIC \ RDW were changed significantly,  $P < 0.05$ ; but there was no significant changed find in RBC/HCT. After two weeks off altitude, MCVr、CHCMr、#RETIC、%RETIC all had significantly changed,  $P < 0.05$ ; and #RETIC,  $P < 0.01$ ; Hb is significantly increased controlled to the indices which tested before the athletes went to the altitude. It indicated altitude training can stimulated the bone marrow hematopoietic system to released more reticulocyte cells. RBC and HCT were decreased in our study, but they were not showed any significantly changed, to analyzed that we found it was relatively large individual differences, which mean the athletes had the different reaction when they training in the plateau and after they back to the sea level; RDW was increased, but it was not showed the significantly changes too. IRF was increased, but #RETIC \ %RETIC \ RBC were decreased after back to the sea level, it showed that the #reticulocyte was not increased, it means that the consumption of the RBC was faster than the number of the erythropoiesis. The indices (CHr、MCVr、

CHC<sub>Mr</sub>) which correlated with the Hb contents was increased significantly, it indicated the stimulate of the hypoxia condition can enhance the synthetic of hemoglobin content, but the effect was not occur immediately, it will occurred after 2~3weeks after the athletes back to the sea level.

**Conclusions** Because the test groups were top-level middle-long distance race athletes, they were adapt the training stimulate, so it can not make the reticulocyte indices changed solely, but in the plateau where lack of the oxygen, it will be result the bone marrow hematopoietic system to released more reticulocyte cells to satisfied the needs of the oxygen; the indices which be mutually related with Hb and #reticulocyte both showed the good effece, it indicated that there had certain effect of altitude training on erythropoiesis, but these changes did not showed immediately, it needs 2~3 weeks to occur after returning to sea level.