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ABSTRACT

This study investigated the effects of chronic and acute exercise upon selected blood measures and indices. Nine male cross-country runners were studied. Red blood count, hemoglobin, and hematocrit were measured using standard laboratory techniques; mean corpuscular volume (MCV), mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentrations were calculated using standard formulas. Samples were taken during the preseason, at two times during training, once after the season was completed, and after two weeks of de-training. Analysis of chronic effects show that all measures except MCV increased during the season. The analysis of acute effects shows consistent hemoconcentration after both types of conditioning session (intermittent and continuous). The increases were similar for each type of session, showing little difference due to form of exercise. (Three tables of data are presented.) (JB)

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THE CHRONIC AND ACUTE EFFECTS OF EXERCISE UPON SELECTED BLOOD MEASURES

Introduction

The oxygen carrying capacity of trained subjects has been widely and extensively studied. The changes seen have been quite significant in most area of transport and usage. However, the minute changes occuring in highly trained athletes within whom gross adjustments to training have already occurred, have been investigated rather sparingly. This study was undertaken to investigate some of these changes in oxygen transport capacity.

Sample

Nine volunteers from the University of Northern Colorado Cross Country team were used for this investigation. All subjects were from 18 to 22 years of age and were full-time students. They were from 66 to 73 inches in height and 136 to 154 pounds in weight.

Variables

The subjects were studied under chronic exercise conditions, that is, throughout the eight-week season, and under acute exercise conditions, i.e. an interval-type training session and a long distance, continuous running training session of 10.5 miles. The time for all subjects in the distance was under 60 minutes. It should be noted here that all subjects were in a rather advanced state of training at the time of the pre-season sample. They had been running 6 to 10 miles per day for approximately 4 months prior to this sample and previously to that had been in training for the track team for 6 months. Theoretically these runners are in year round training.

Blood measures used were RBC count, Hct, Hb, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration. RBC was measured using a Coulter counter; Hct was measured using the standard centrifuge method and Hb was measured as cyanomethemoglobin. The indices were calculated with standard formulas utilizing RBC count, Hct, or Hb as required. The inaccuracy in determining the various indices in this manner has been shown not to exceed 2%. (Wintrobe)

Results

Chronic Effects:

The effects of chronic training showed classical changes although not as significant as gains shown previously (See Table One). Hb increased significantly from pre-season to post-season ($p < .01$). The changes in Hct and RBC count, although positive, were not significant; Hb was the only measure to increase steadily throughout the training season. The values of both RBC and Hct showed a consistent decrease through the fourth week of the season and then an increase to the end of the eight week period.

The indices showed two significant changes. Mean corpuscular hemoglobin (MCH) increased from 30.13 to 31.78 $\gamma\gamma$ ($p < .02$). Mean corpuscular hemoglobin concentation (MCHC) increased from

33.75% to 35.56% ($p < 001$). Mean corpuscular volume (MCV) seemed to be quite variable during the season, however, the values were contained within quite a small range, therefore the size of the cells seemed to show little change. MCH and MCHC showed an inverse relationship to the chronic changes seen in Hct and RBC count. Both indices increased consistently to the fourth week of the season; subsequently, each declined until the eighth week. The 8 week values, however, were significantly higher than the pre-season values.

Acute Effects:

The interval training session studied for acute effects showed definite signs of hemo-concentration with RBC, Hct, and Hb showing some insignificant increases. MCV, however, showed a decrease ($p < .10$) as did MCH (NS). No change in MCHC was shown.

The long distance training session showed fewer changes than the interval session. None of the changes seen was significant although MCV showed negative changes in this session which are consistent with those seen in the interval session.

In a comparison between the two types of training session, significant differences can be seen in Hb, MCV, and MCHC. These differences are misleading, however, because the values showed the same differences before the training session was undertaken. It may be concluded, therefore, that mode of training had little relationship to the changes in acute exercise conditions.

The period of detraining following the competitive season lasted for two weeks. In this time the subjects participated in no regular physical activity. RBC, Hct, and Hb all increased over the values shown for the post-season sample; however, none of the differences was statistically significant (See Table Two). Two of the indices showed significant changes. MCV increased from 89.53μ^3 to 92.13μ^3 . MCHC decreased from a post-season value of 35.56% to 34.58%. Both are significant at the .01 level. MCH showed no significant change, although the value did decrease from 31.78$\gamma\gamma$ in the post season to 31.38$\gamma\gamma$ in the period of detraining.

It may be interesting here to look at some comparisons to a control group of subjects taken from the same geographical area. This group consisted of 20 adult males ranging in age from 32 to 66 years. None were in ill health and all lived sedentary lives. These data show the trained runners all to be lower in Hb, Hct, MCV, and MCH in the preseason sample. The difference between control and pre-season MCV and MCH were both statistically significant.

The post-season data show the experimental group approaching the control group in various measures. Hb had surpassed control levels, Hct was approaching those levels, and the RBC difference was widening. At this time, MCHC had become significantly higher than the control group level. MCV was still significantly lower than the control values. At the time of the detraining sample, no differences existed between the two groups. However, all measures, with the exception of MCV and MCH, had surpassed the control group values.

Discussion

As was previously stated these data concur with the classical blood studies presented. I have seen little information previously on cell size, Hb concentration, and the associated changes that were studied here. I have, however, extrapolated the data of Knehr (1942) and Halicka (1969). These data do not concur with those of Knehr, who found little if no consistent changes in either size or the hemoglobin content of red cells. Halicka showed no significant changes in MCHC, but did see large differences in both MCH and MCV between control and exercise groups. The trained group was higher in each case. He did, however, show an increase in the MCHC of the females in his study that was not seen in the male population. Some of the women also exhibited what can be classified as macrocytic cells (Wintrobe).

Neither of these investigaters presents MCHC values as great as those seen in this study. The values for MCHC presented here approach the maximum given for MCHC (Wintrobe). One possible reason for this is that this large increase may be the cell's effort to carry as much Hb as possible in order to increase oxygen transport capacity of that individual.

Perhaps one conclusion to be drawn from these data concerns the trained individual's adaptation to the stress of chronic conditioning. It would appear to be cellular in nature; that is, in this study, the trained runners concentrated more Hb per RBC. This type of cellular adaptation may be necessary because, as was previously stated, the gross changes accompanying training had already occurred. This would perhaps indicate that the cellular changes occurring in training not only precede the gross adaptations, but that they accompany those changes as training state progresses. This may be the systems method of producing maximal changes necessary for the advanced training state of these athletes.

Table One

Chronic Effects

Pre-Season vs. Post-Season

Measure	Pre	Post	Sig. Level
RBC ($x\ 10^6/mm^3$)	5.11	5.19	NS
Hct (%)	45.88	46.22	NS
Hb (g%)	15.40	16.34	$p < .01$
MCV (μ^3)	89.88	89.33	NS
MCH ($\gamma\gamma$)	30.13	31.78	$p < .02$
MCHC (%)	33.75	35.56	$p < .001$

Table Two

Chronic Effects

Post-Season vs. Detraining

Measure	Post	Detraining	Sig. Level
RBC (x $10^6/mm^3$)	5.19	5.28	NS
Hct (%)	46.22	48.25	NS
Hb (g%)	16.34	16.61	NS
MCV (μ^3)	89.33	92.13	$p < .01$
MCH ($\gamma\gamma$)	31.78	31.38	NS
MCHC (%)	35.56	34.38	$p < .01$

Table Three

Chronic Effects

Control vs. Trained

Measure	Control	Pre-Season	Post-Season	Detraining
RBC (x $10^6/mm^3$)	5.02	5.11	5.19	28
Hct (%)	47.80	45.88	46.22	8.25
Hb (g%)	16.10	15.40	16.34	16.61
MCV (μ^3)	95.5	89.88*	89.33*	92.13
MCH ($\gamma\gamma$)	32.0	30.13#	31.78	31.38
MCHC (%)	33.6	33.75	35.56*	34.38

#-$p < .05$

*-$p < .01$

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