Letters To The Editor

Exercise training in normobaric hypoxia: is carbonic anhydrase III the best marker of hypoxia?

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To the Editor: We read with great interest a series of three articles (1, 4, 5) published in the April 2006 issue of the Journal of Applied Physiology examining the effect of exercise training in normobaric hypoxia on aerobic performance capacity, muscular adjustments of selected gene transcripts, and skeletal muscle mitochondrial properties in endurance runners. The authors found an improvement in $V_{O_2max}$, an increase in time to exhaustion ($T_{lim}$) at the velocity at $V_{O_2max}$, simultaneous mitochondrial adaptations, and increases in transcriptional factors implicated in skeletal muscle adaptation. These findings have substantial implications for athletes undergoing endurance training programs in hypoxia. However, as we critically reviewed the papers, we found several points that require clarification. First, although we agree that carbonic anhydrase (CA) was significantly upregulated after training in hypoxia, there is a lack of rationalization for the use of the CA3 gene as a marker of hypoxia. Other isoenzymes of CA (CA4 and -14) have been shown to be upregulated in response to chronic hypoxia (2) but it is questionable whether or not this is true for CA3. Juel et al. (2) found no significant changes in CA3 in response to hypoxia. In addition, a murine study by Kim et al. (3) investigated the significance of this gene and found that it was not affected by changes in environmental oxygen alterations. Could the authors discuss their logic for choosing CA3 instead of a more established isoenzyme of CA that marks hypoxia? Second, inconsistent sample size across manuscripts, without adequate justification, was observed. Third, in all three articles (1, 4, 5), the authors used a two-way ANOVA with one repeated factor, which is the appropriate model for their statistical analysis. However, in the results, they do not report the group by time interaction although this interaction is necessary to justify a statistically different response to endurance training between groups. Fourth, Fig. 2 of the third article (5) illustrates the correlation between mRNA levels and $T_{lim}$ combining pre- and post-training values. It is assumed that data were presented in absolute terms, however, the range of values for $T_{lim}$ (0–20 s) do not make sense as presented.

REFERENCES


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