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Effect of intermittent hypoxia in rest on endurance performances

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Introduction:
Examinations of intermittent hypoxia (IH) of humans are still seldom. Russian scientists developed a model in which hypoxia and normoxia change every 5 minutes. O_2-concentration is reduced to 9-10%. This method successfully improved neurological diseases (Novikov et al. 1998). Cardiac diseases and high tension are treated with IH as well.
In New Zealand and Australia athletes use this technique to enhance their endurance performance. Most of the results were obtained under non-controlled conditions.

Methods:
In our study the athletes (relative performance: from 3,07 Watt/kg to 6 Watt/kg) were assigned into four groups (group 1: change between inspiratory hypoxia (9%) and normoxia for 1 hour; group 2: change between inspiratory hypoxia (9%) and normoxia for 1.5 hours; group 3: change inspiratory hypoxia (9%) and hyperoxia (50-60%) for 1.5 hour; group 4: served as control (normoxia)). For 14 days (ten workdays in a row) healthy male athletes came once a day to breathe the mentioned gas mixtures. Before and after the 14 days the athletes were examined in a handgrip endurance test until exhaustion with 90 % of their maximal power from the incremental test. After one hour an endurance test followed on a cycle ergometer until exhaustion with 80% of maximal power from the respective incremental test.

Results:
The results of the first group (n=5) show a distinct improvement in the exercise duration of forearm muscles, but no significant difference in cycling time. This forced us to increase the inspiration time to 1.5 hours. The following results refer to group 2-4. Group two and three consisted of 9 subjects and group four of 8. The results show an improvement of endurance performance. In both hypoxia groups the average cycling time increased more than 20 percent ($p < 0.02$) (Fig. 1). After 14 days IH there was on the one hand side a significant increase in reticulocytes but on the other hand no increase in total-haemoglobin and hematocrit. Also the O_2-consumption and lactate concentrations were not different.
In simultaneous studies of endurance performance of the forearm muscles the working time was almost doubled ($p<0.004$) (Fig. 2).

Discussion:
The larger improvement in endurance performance in forearm exercise compared to cycling exercise with no differences in blood volume leads to the conclusion, that muscular adaptations cause the improvement.

Figure 1

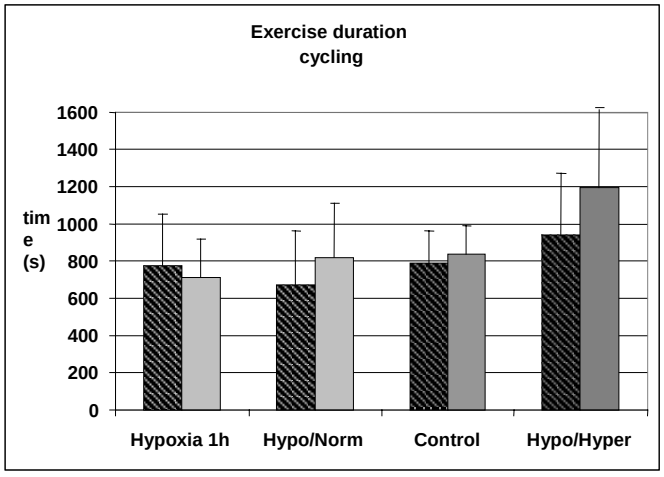
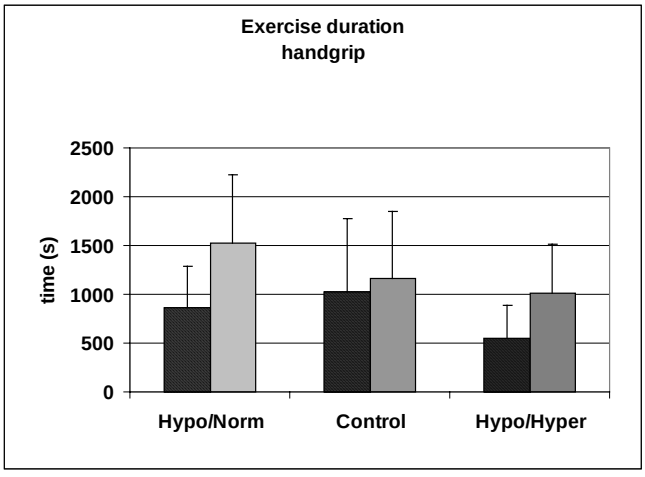


Figure 2



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