Tibetan and Han Chinese oxygen transport at 2200 m and simulated 4200 m during peak exercise

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Despite lower Hb concentration, Tibetans resident at 4200m exhibit greater exercise capacity than do Han Chinese also resident at 4200m. Whether these adaptations are maintained at intermediate altitude and/or acute hypobaric hypoxia are unknown.

Thirty-seven healthy, non-smoking subjects, all resident for at least six months at ~2200 m, of Tibetan (N_{male} = 10; N_{female} = 9) or Han Chinese (N_{male} = 8; N_{female} = 10) ancestries were studied at 2200 m and then during acutely simulated altitude (4200 m in a hypobaric chamber). Subjects performed an incremental cycle test to exhaustion. At peak exercise, oxygen consumption (VO_{2MAX}), cardiac output (QT_{MAX}), ventilation (VE), hemoglobin ([Hb]), blood oxygen saturation (S_aO_2), and arterial blood gases were measured and diffusing capacity in lung (DL) and muscle (DM) were calculated.

At peak exercise at 2200 m, Tibetan males had 1.23 g/dL less [Hb] compared to their Han Chinese male counterparts (p = 0.03). Tibetan females had 1.05 g/dL less [Hb] then Han Chinese females, but the result is not statistically significant (p = 0.064)

Compared to Han Chinese, Tibetan females tended to have 4.85 and 2.72 $mLmin^{-1}Kg^{-1}$ higher VO_{2MAX} at 2200 m and 4200 m (both p = 0.03). For males, Tibetans tended to have 6.90 and 2.78 $mLmin^{-1}Kg^{-1}$ higher VO_{2MAX} than Han Chinese. However, the difference in VO_{2MAX} was not significant in males at 2200 m or 4200 m (p = 0.095, p = 0.306, respectively).

Tibetan males, but not females, had a significantly higher lung O_2 diffusing capacity (DL) compared to Han Chinese (p = 0.028 for males; p = 0.192 for females). Tibetans also tended to have increased muscle O_2 diffusing capacity (DM), but the difference was not statistically significant.

Tibetan compared to Han Chinese females exhibited higher VE during maximal exercise at both 2200 m and 4200 m ($p < 0.03$, $p < 0.02$, respectively). The differences were not significant in males ($p > 0.54$ for 2200 m, $p > 0.20$ for 4200 m).

In addition, Tibetans had 0.53 g/dL higher carboxyhemoglobin compared to Han Chinese at 2200 m (p = 0.005) independent of sex. Considering Tibetans had lower [Hb] than Han Chinese, higher CO content might suggest increased red blood cell destruction in Tibetans.

In summary, among Tibetans, who exhibit significantly lower [Hb] and elevated COHb, females exhibit increased exercise capacity and ventilation compared to Han Chinese females at 2200m, and similar trends were exhibited in males acutely exposed to simulated 4200 m. Male Tibetans exhibited greater DL than Han Chinese counterparts. Trends were further noted for greater QT and DM in Tibetans, which is consistent with our previous studies of Tibetans residents at 4200 m. Therefore, it is evident that unique traits of high-altitude adaptation of Tibetans are retained at intermediate altitude. Such differences between hypoxic-exercise responses of Tibetans and Han Chinese are likely innate and may be attributed to genetics.