

Tibetans and Han Chinese residents at intermediate altitude respond differently to chronic and simulated altitude-induced hypoxia

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It has previously been shown that Tibetans residents at high altitude (> 4000m), have higher resting ventilation, lower heart rate, and higher blood-oxygen saturation compared to Han Chinese residents at the same altitude. However, the extent to which these findings are due to differences in acclimatization versus innate variation between populations is unclear.

Thirty-seven healthy, non-smoking subjects, all resident at intermediate altitude (2200m) were studied. The subjects were of Tibetan ($N_{male} = 10$; $N_{female} = 9$) and Han Chinese ($N_{male} = 8$; $N_{female} = 10$) ancestries between ages of twenty to twenty-five. The study was carried out under ambient conditions at 2200m and during acutely simulated altitude at 4200m in a hypobaric chamber. For each subject at rest, oxygen consumption ($\dot{V}O_2$), heart rate (HR), ventilation (VE), hemoglobin concentration ([Hb]), blood oxygen saturation (S_aO_2), and arterial blood gases were measured at both altitudes.

Tibetans males, compared to Han Chinese, tend to have 1.2 g/dl lower [Hb] at 4200 m and 0.89 g/dl lower [Hb] at 2200 m. However, the difference is only significant at 2200 m ($p = 0.036$), and no difference in [Hb] is found in females.

At 2200 m, Tibetan males have significantly lower resting heart rate compared to Han Chinese males ($p = 0.0062$). At 4200 m, this difference persists: both Tibetan males and females have lower resting heart rates than their Han Chinese counterparts ($p = 0.042$, $p = 0.043$).

At both 2200 m and 4200 m, Tibetan females tend to have significantly higher $\dot{V}O_2$ (both $p = 0.043$), higher $\dot{V}CO_2$ ($p = 0.027$, $p = 0.033$) and higher VE ($p = 0.018$, $p = 0.019$) compared to Han Chinese females, suggesting increased ventilation. In males, no differences in $\dot{V}O_2$ or $\dot{V}CO_2$ were observed at 2200 m and 4200 m, and Tibetan males tend to have higher VE only at 4200 m, though the result is not statistically significant ($p = 0.12$).

At 2200 m, there is no difference of S_aO_2 between Tibetans and Han Chinese; all groups have S_aO_2 well above ninety percent. However, the difference of S_aO_2 is more pronounced at 4200 m. Both Tibetan males and females have higher S_aO_2 compared to Han Chinese, although the result is only significant in the males ($p = 0.045$) and exhibits a trend in females ($p = 0.15$).

In conclusion, Tibetans, whose ancestors lived at ~4200m, retain certain physiological traits when resident at 2200m. These include lower resting [Hb], higher $\dot{V}O_2$, $\dot{V}CO_2$ and VE. When acutely exposed to altitude-induced hypoxia, Tibetans tend to maintain higher resting S_aO_2 and $\dot{V}O_2$. Therefore, the differences we found between Tibetans and Han Chinese are likely due more to innate differences, such as genetic and epigenetic programs.