PURPOSE: To determine whether total hemoglobin (tHb) mass and total blood volume (BV) are influenced by training, by chronic altitude exposure, and possibly by the combination of both conditions. METHODS: Four groups (N = 12, each) either from locations at sea level or at moderate altitude (2600 m) were investigated: 1) sea-level control group (UT-0 m), 2) altitude control group (UT-2600 m), 3) professional cyclists from sea level (C-0 m), and 4) professional cyclists from altitude (C-2600 m). All subjects from altitude were born at about 2600 m and lived all their lives (except during competitions at lower levels) at this altitude. tHb and BV were determined by the CO-rebreathing method. RESULTS: VO2max (mL x kg(-1) x min(-1)) was significantly higher in UT-0 m (45.3 +/- 3.2) than in UT-2600 m (39.6 +/- 4.0) but did not differ between C-0 m (68.2 +/- 2.7) and C-2600 m (69.9 +/- 4.4). tHb (g x kg(-1)) was affected by training (UT-0 m: 11.0 +/- 1.1, C-0 m: 15.4 +/- 1.3) and by altitude (UT-2600 m: 13.4 +/- 0.9) and showed both effects in C-2600 m (17.1 +/- 1.4). Because red cell volume showed a behavior similar to tHb and because plasma volume was not affected by altitude but by training, BV (mL x kg(-1)) was increased in C-0 m (UT-0 m: 78.3 +/- 7.9; C-0 m: 107.0 +/- 6.2) and in UT-2600 m (88.2 +/- 4.8), showing highest values in the C-2600 m group (116.5 +/- 11.4). CONCLUSION: In endurance athletes who are native to
moderate altitude, tHb and BV were synergistically influenced by training and by altitude exposure, which is probably one important reason for their high performance.