Ambulatory Blood Pressure, Sleep Quality, and Acute Mountain Sickness in the Setting of Acute High Altitude Exposure
The Colorado High Altitude Monitoring Pressure Study (CHAMPS)

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Abstract

Objective

Acute high altitude exposure may increase 24-hour ambulatory blood pressure (ABP), but change in blood pressure with acclimatization is poorly understood. Additionally, high altitude may negatively affect sleep quality, but the association between poor sleep and acute mountain sickness (AMS) is controversial. BP measured at the time of altitude-related symptoms has no association with AMS, but nocturnal BP might. Thus, we compared 24-hour ABP at low altitude versus the first 24 hours at high altitude and after 72 hours as well as sleep quality and 24-hour ABP in high altitude travelers with and without AMS.

Methods

This is a prospective observational cohort study of 28 lowlanders visiting 2500-2800m during their first 24 hours at high altitude, and at 72 hours. BP was monitored every 30 minutes while awake and every hour overnight using Welch-Allyn6100 ABP monitors. Sleep quality with the Groningen Sleep Quality Scale (GSQ), AMS by the 2019 Lake Louise Score Questionnaire (LLS). High altitude data was collected during the first and third days at high altitude. Data collection for these participants was done between 2019-2022.

Results

We enrolled 28 participants (mean age 58, range 32-77, m=18, f= 10). In preliminary data for 8 of these participants (f=5, m=3), we found an increase in average 24-hour SBP between low and high altitude (121 [91-150] mmHg vs 132 [96-169] mmHg, respectively), with a mean SBP increase of 12 [-16-40] mmHg, p=0.049. Diurnal SBP was greater at high altitude (123 [94-151] vs 136 [100-172], p=0.02), but nocturnal SBP did not differ (112 [72-151] vs 121[79-163], p=NS). Results were similar for DBP. Comparing the first 24 hours versus 72 hours at high altitude, we found no differences

in average 24-hour SBP (132 [96-169] mmHg vs 132 [92-172] mmHg, p=NS), diurnal SBP (136 [100-172]) mmHg vs 136 [95-177] mmHg, p=NS) or nocturnal SBP (121 [79-163] mmHg vs 113 [84-142] mmHg, p=NS). For the entire cohort, there were 3 participants with AMS and 23 without AMS (missing data, n=2). Baseline GSQ did not differ in AMS+ vs AMS- (p=NS), however, AMS+ had higher 24-hour GSQ scores, (ie, worse sleep quality) vs AMS- (mean GSQ AMS+= 10.7 [95%CI:8.88-12.4] vs AMS-= 5.5 [95%CI:3.89-7.16], p=0.04). In a subset (n=8), baseline GSQ did not differ versus 24-hour GSQs or 72-hour scores (p=NS); however, sleep quality was worse on the first night vs the third (GSQ 6.9 vs 1.9, p=0.02). Mean 24-hour SBP (129 mmHg vs 140 mmHg) and mean daytime SBP (136 mmHg vs 150 mmHg) did not differ by AMS status (p=NS), however, AMS+ had lower mean nocturnal SBP versus AMS- (96 mmHg vs 127 mmHg, p=0.01).

Conclusion

In our cohort, BP was elevated at high altitude compared to low altitude due to increases in diurnal BP and remained so after 72-hours of acclimatization. The clinical importance and the long-term effects of elevated BP during high altitude sojourns remain to be determined. Those with AMS had worse sleep quality, supporting the inclusion of a sleep quality question in the LLS. Sleep quality improved after time at high altitude. Surprisingly, mean nocturnal SBP was lower in those who develop AMS. We need more participants to validate this finding.