Change in Basic Pulmonary Function in Response to Altitude Change

Holly Radke, Mitchell Rush, Andrea Pham, Hannah Berhow, Emily Schwartz,, Jaden Arnold, Mindy Cook, Bivash Neupane, Rebekah Hans, Hunter Stutz, Nicole Lashiker, David Sant PhD, Erika Noonan MD

Background

Altitude sickness is a well-known phenomenon among those who frequently participate in mountain-based outdoor activities. It is caused by the sudden decrease in available atmospheric oxygen and is usually experienced within 6-24 hours after reaching an elevation of 2500m (8200 ft) above sea level (NHS).

Symptoms of altitude sickness typically include:

- Headache
- Nausea
- Fatigue
- Dizziness
- Loss of appetite
- Shortness of breath

High altitude activities, such as mountaineering, often involve preparation to prevent altitude sickness. While this is a common practice, preparing for the elevation change when moving from San Diego, California to Provo, Utah is not often discussed.

This study aimed to determine the effects of moving from a location of low elevation to a location of high elevation on lung function, as measured by spirometry.

Methods

Our study tracked changes in pulmonary function over time after moving from a region of low elevation (1,000 feet above sea level or lower) to one of high elevation (4,500 feet above sea level in Provo, Utah). Subjects were recruited from incoming students at Noorda College of Osteopathic Medicine that hailed from places of elevation lower than 1,000 feet.

Participants underwent spirometry testing to index their forced vital capacity, forced expiratory volume, and peak expiratory flow rate. Initial testing on subjects was completed at day three after arriving in Provo, UT. Repeat testing occurred at 1 week and 1 month after arrival, and monthly over the subsequent 4 months. Changes in the above markers were graphed over time. Data analysis was as follows: Baseline comparisons were performed using paired t-tests.
All p-values were corrected to false discovery rates (FDR) using Benjamini-Hochberg correction.

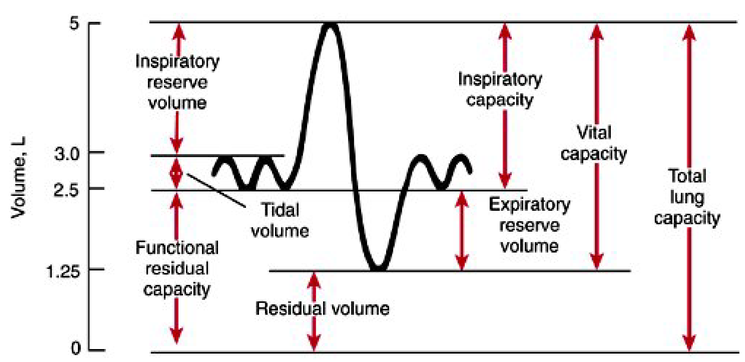
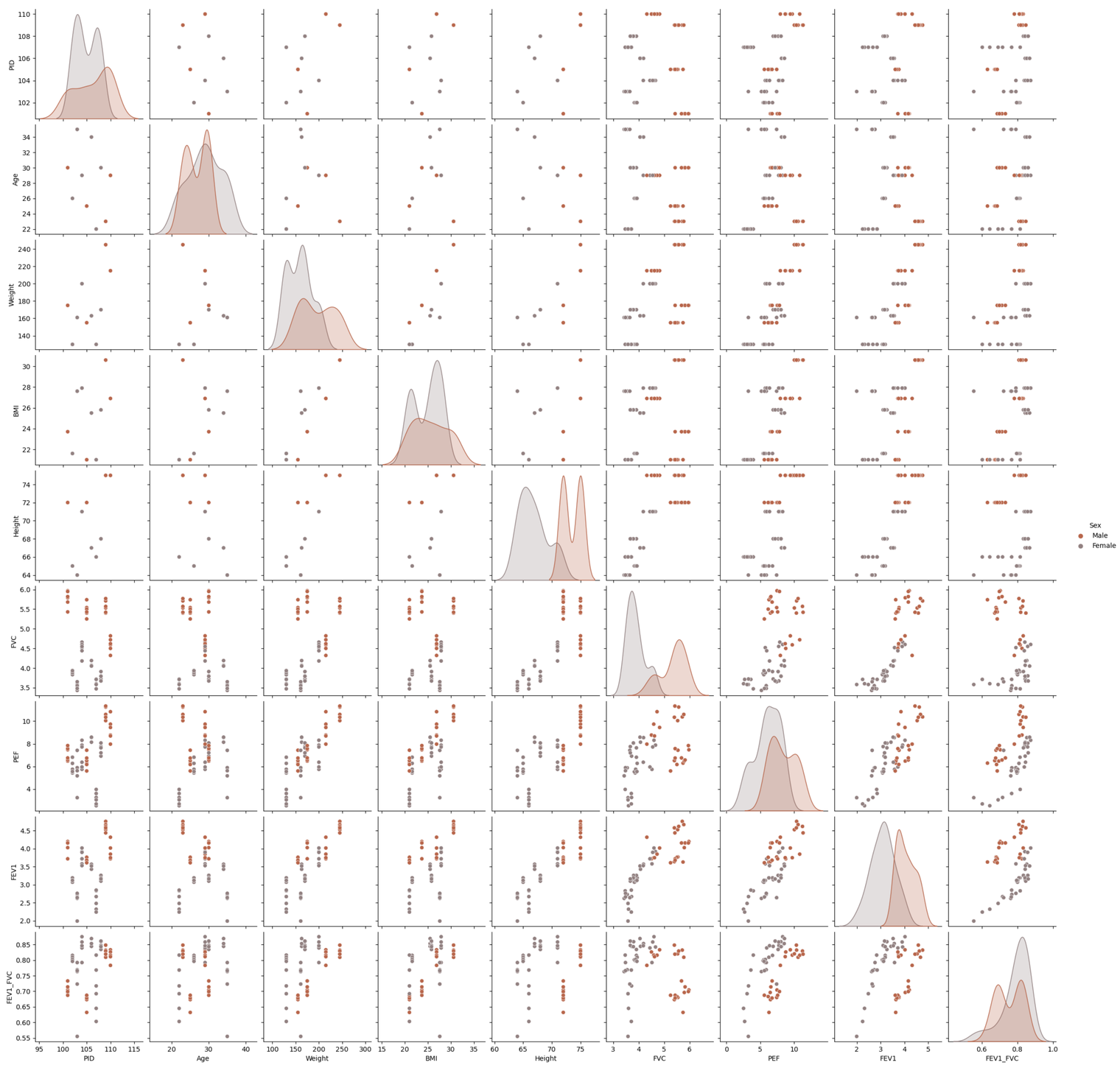


Figure 1. Depicts the various lung volumes and capacities that can be assessed. Image obtained from EmergencyPedia.

Results

We hypothesized that when an individual initially arrives at a location of higher elevation, lung function will be decreased due to the lower availability of oxygen. We expected a period of adjustment, where it will take time for lung function to return to normal levels following a move to higher altitude.

	Average (StdErr)						Within Group Comparison				
Measure	Intake	Week 1	Month 1	Month 2	Month 3	Month 4	Week 1	Month 1	Month 2	Month 3	Month 4
Forced Vital Capacity (FVC)	4.59 (0.32)	4.56 (0.30)	4.56 (0.27)	4.53 (0.28)	4.44 (0.25)	4.48 (0.27)	0.621	0.583	0.308	0.116	0.172
Peak Expiratory Flow (PEF)	6.86 (0.75)	7.01 (0.75)	6.88 (0.58)	7.07 (0.81)	6.87 (0.68)	7.08 (0.71)	0.699	0.959	0.548	0.978	0.578
Forced Expiratory Volume in 1 second (FEV1)	3.49 (0.24)	3.50 (0.25)	3.53 (0.19)	3.54 (0.20)	3.39 (0.21)	3.54 (0.23)	0.94	0.63	0.39	0.16	0.58
FEV1/FVC Ratio	0.76 (0.03)	0.77 (0.03)	0.78 (0.02)	0.79 (0.02)	0.76 (0.03)	0.77 (0.02)	0.887	0.373	0.041	0.913	0.678



As seen in the table, there is no significance (FDR ≤ 0.0025) seen in FVC, PEF, PEV1, or FEV1/FVC ratio. The pairplot also shows no correlation between any variables. A slight positive correlation can be seen between FEV1 vs FVC and FEV1 vs PEF over time, however, these values are still not significant.

Conclusion

The observed results from the pulmonary function testing show no statistical significance. These findings suggest that there is no effect in lung function when an individual moves from an area of low elevation to an area of high elevation. We expect this data to be valuable to those moving from areas of low to high elevation, in reassuring them that there is no significant changes in forced vital capacity or peak expiratory flow rate.