The Effects of Altitude on Resting Metabolic Rate at 3,048m and 0m

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INTRODUCTION

There is debate on whether resting metabolic rate (RMR) is increased or decreased at altitude. RMR is energy expended by the body at rest to maintain basic function and gives insight into an individual's energy availability. The purpose of this study was to determine the effects of RMR at 3,048m and 0m. It was expected that RMR would increase at 3,048m.

METHODS

Four, college aged female subjects who met ACSM guidelines for physical activity were asked to perform two RMR tests at 3,048m and 0m in the Darwin Environmental Chamber. RMR was measured using a Parvo Medics TrueOne 2400 metabolic cart. The metabolic cart was placed inside the chamber and was calibrated before testing. Measurements were made in a randomized cross over fashion where each RMR test was done at the same time, on the same day, one week apart. Each subjects VO_2 and respiratory exchange ratio (RER) were measured in each condition for 30 minutes, which was simulated in an environmental chamber where O_2 levels were either increased or decreased for 3,048 and 0m respectively. Subjects were asked to fast for 8-10 hours, abstain from physical activity for 24 hours, and abstain from alcohol, nicotine, or tobacco.

RESULTS AND DISCUSSION

We concluded that two subjects had a significantly higher VO_2 and RER at 0m, however one subject had a significantly higher VO_2 and RER at 3,048m ($p<0.05$). Group analysis demonstrated that only one subject had a higher mean VO_2 at 0m ($p<0.05$), whereas two subjects had a lower mean VO_2 at 0m ($p<0.05$). Two subjects had a higher mean RER at 0m, however, another had a lower mean RER at 0m ($p<0.05$). We hypothesized that RMR would be higher at 3,048m than at 0m due to the body requiring more energy to run metabolic processes with less oxygen. These differences were determined measuring VO_2 and RER in the Darwin Environmental Chamber, which simulates different elevations by changing O_2. The results from this study demonstrated that RMR was significantly higher at 0m than at 3,048m. T Using simulated altitudes versus terrestrial altitudes could explain these results. The chamber decreases O_2 levels as altitude increases, therefore causing RMR to be higher at 0m. RMR at 0m was likely higher because there was more oxygen available in the chamber.

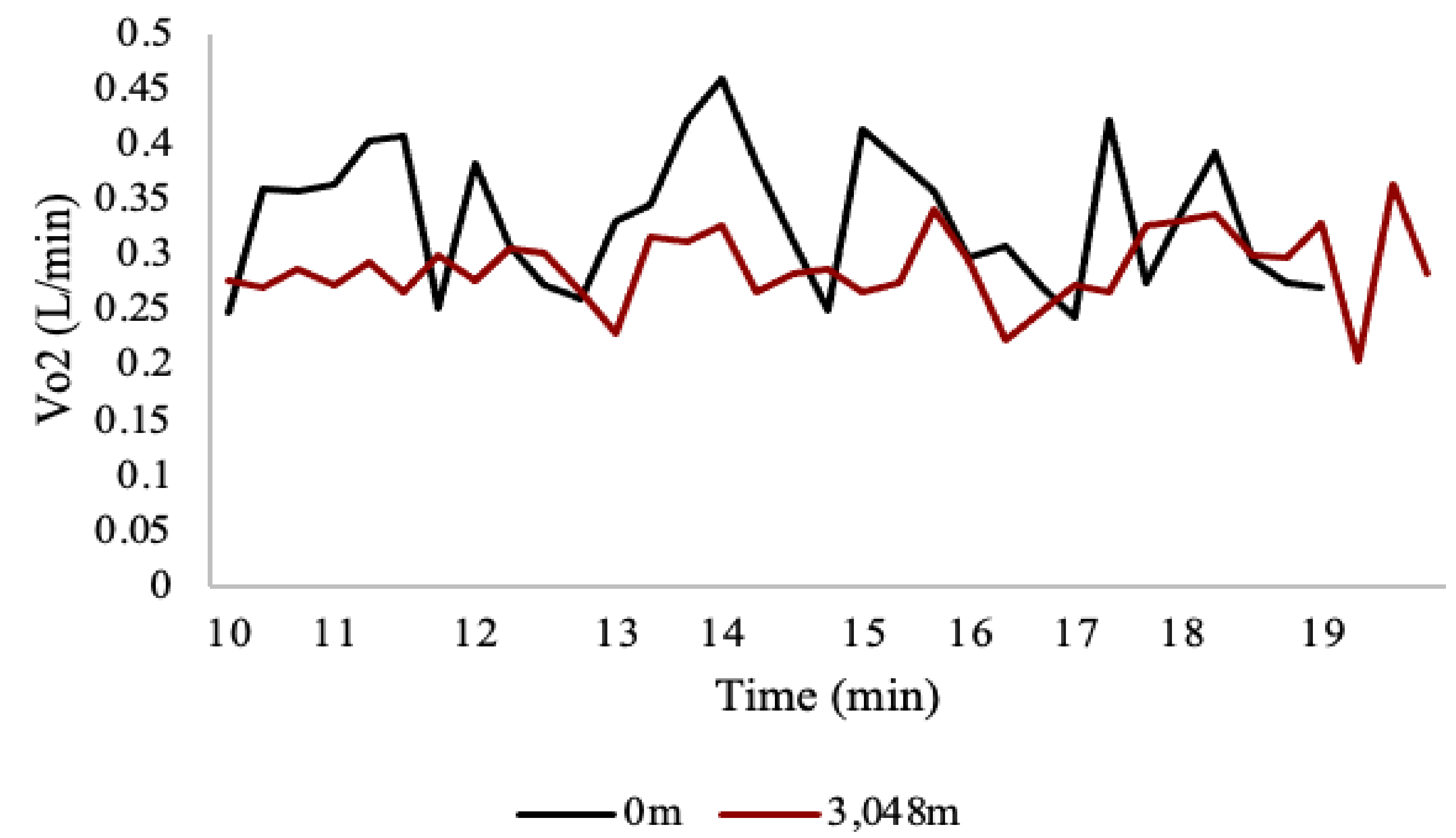

Figure 1. VO_2 differences at 3,048m (altitude) and 0m (sea level) during the selected time. Note that the VO_2 at sea level was consistently higher during the time selected for this subject meaning more oxygen was required to at rest at sea level than at altitude. Outliers with a SD of ± 1.5 were removed.

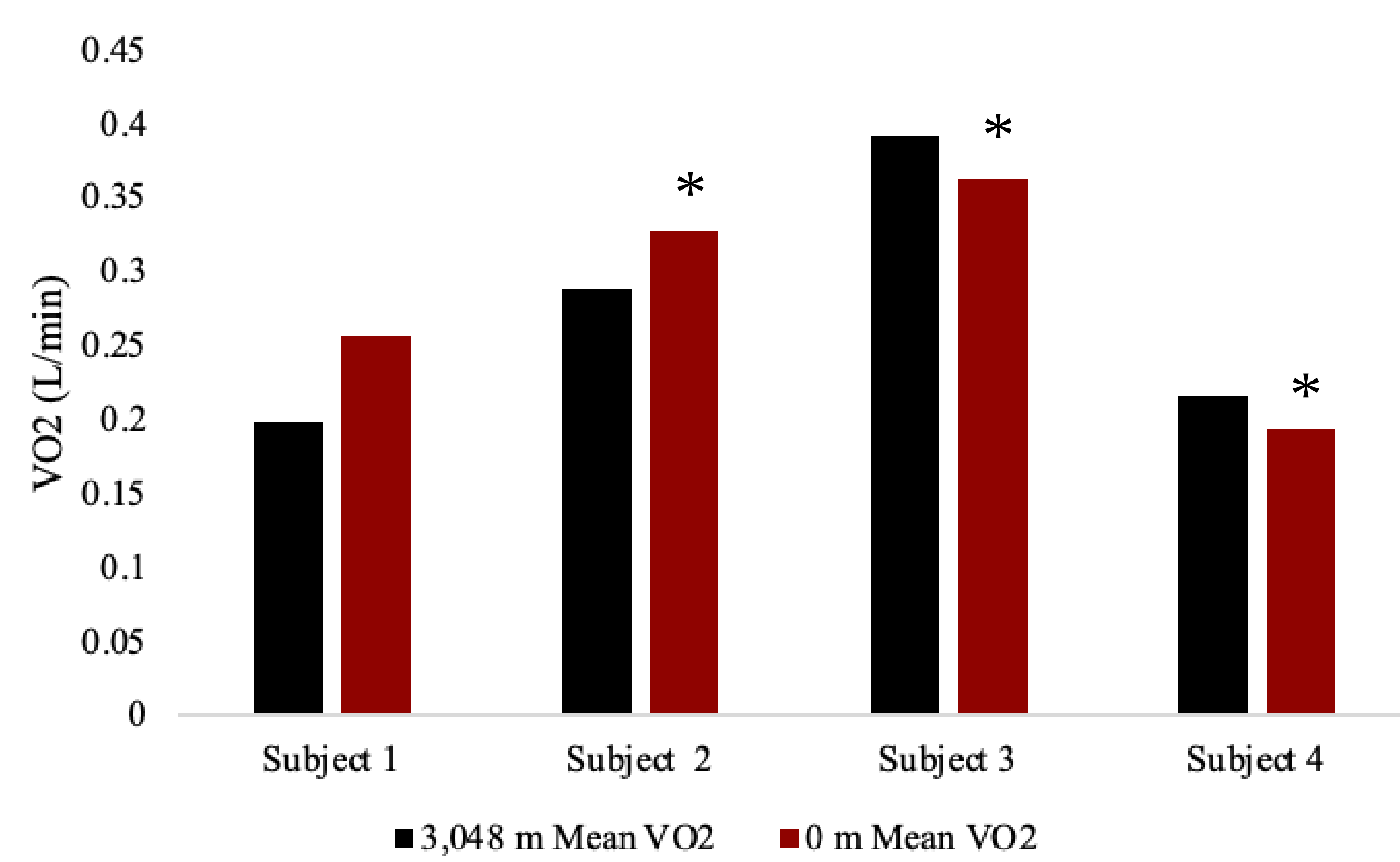

Figure 2. The mean VO_2 for each subject at 3,048m and 0m. The asterisk represents a $p<0.05$. Some subjects were significantly higher at sea level, and some subjects were significantly lower at sea level.

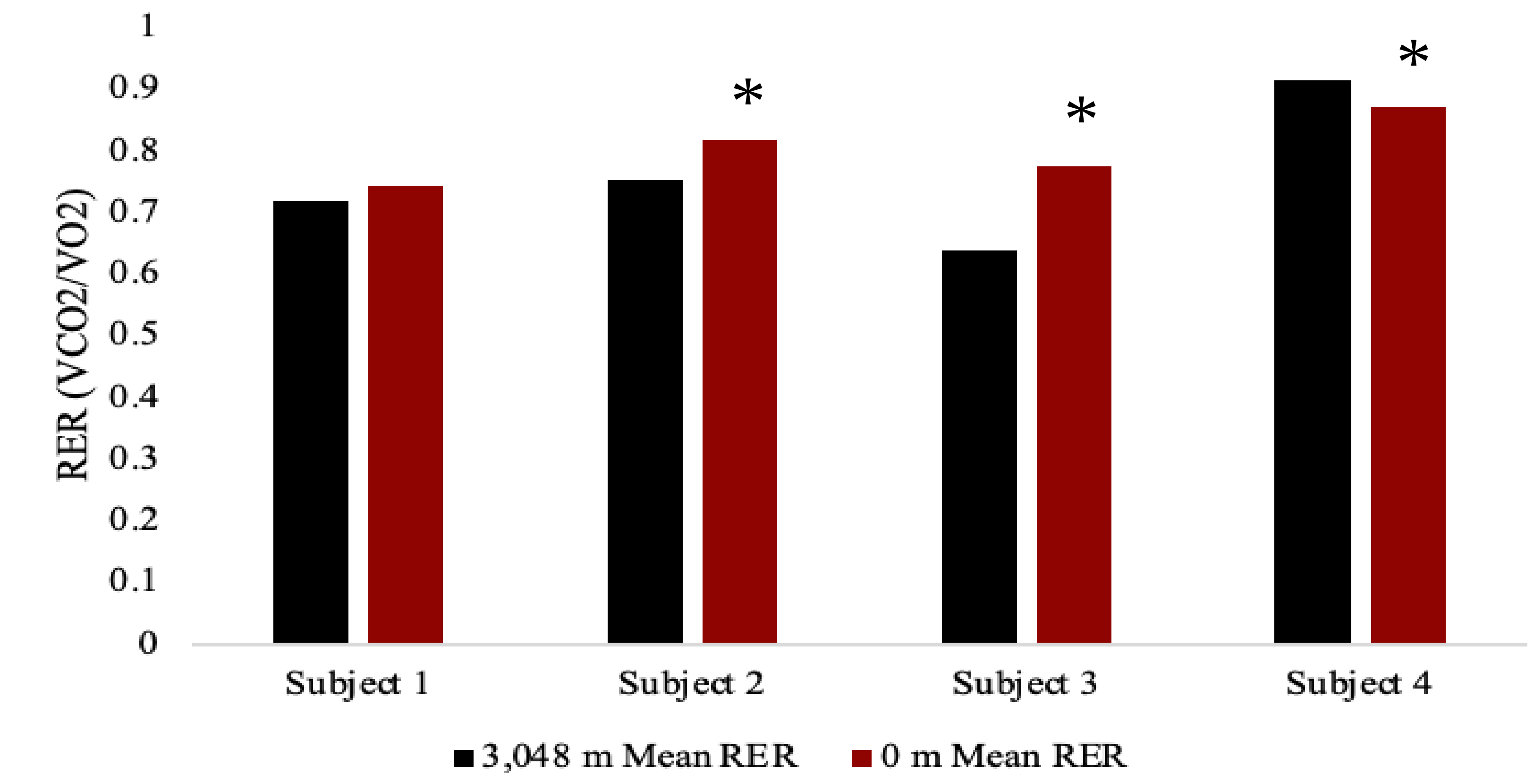

Figure 3. The mean respiratory exchange ratio (RER) for each subject at 0 meters and 3,048 meters. The asterisk represents a $p<0.05$. Some subjects had a significantly higher RER at sea level and other subjects have a significantly lower RER at sea level.

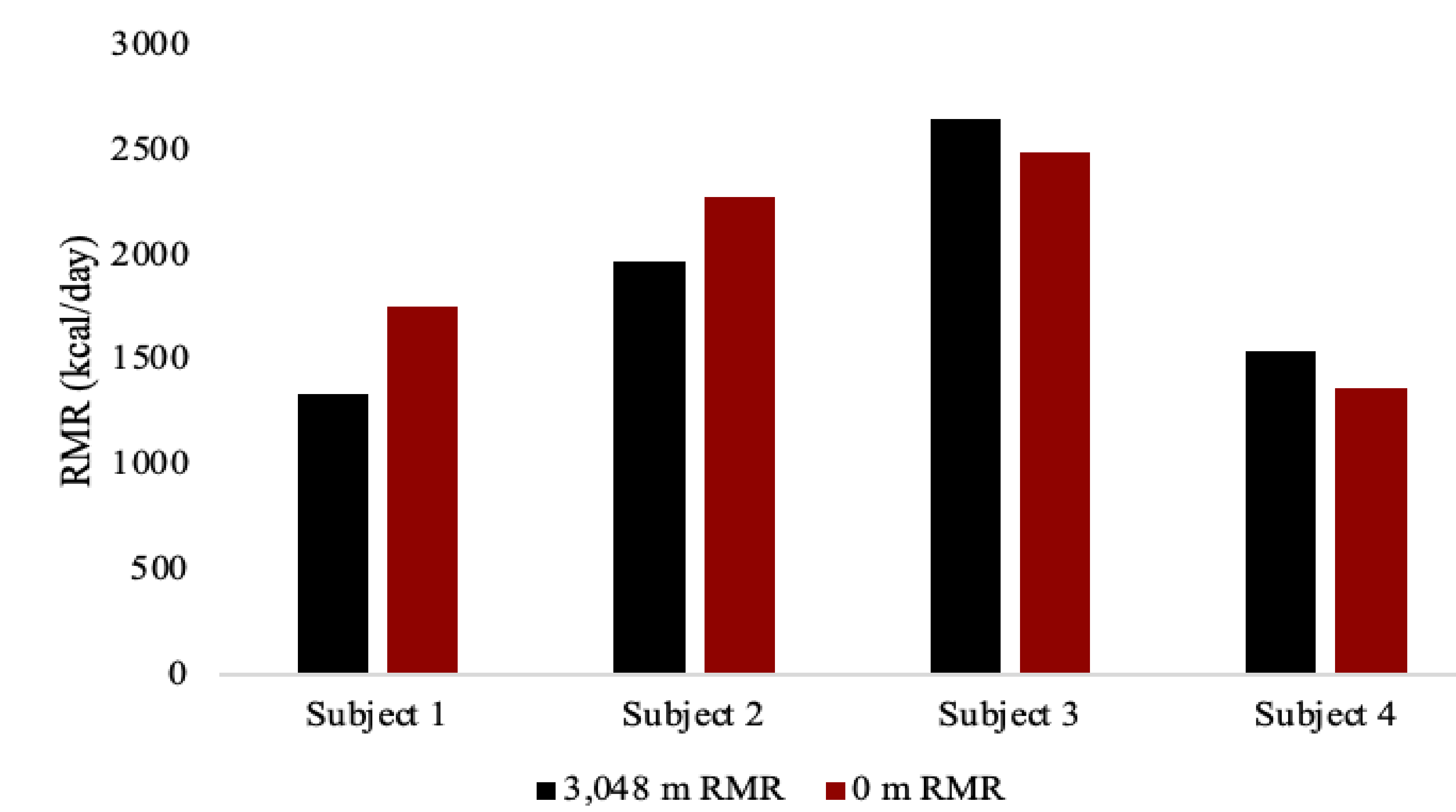

Figure 4. The differences in resting metabolic rate for each subject at 3,048 meters and 0 meters.

CONCLUSIONS

Differences in resting metabolic rate varied between subjects. We found that RMR was higher at 0m than at 3,048m, unlike what we hypothesized. When simulating various altitudes using changes in O_2 levels, it is important to calibrate to the appropriate O_2% in addition to closely monitoring changes throughout the testing. Future research should consider these complications or perform measurements at terrestrial elevation where O_2 levels do not change based on altitude.