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The Comparison of Physiological Demands in Experienced Climbers When Climbing Top Rope Versus Lead Rope

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Physiological Demands of Experienced Climbers When Climbing Top Rope Compared to Lead Rope

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Abstract

Rock climbing is a sport that has experienced rapid growth while gaining global engagement as it was recently added to the Summer Olympics. There are different variations of rock climbing and this study focused on the comparison between lead rope and top rope. Previous research has compared the physiological demands while climbing routes at different inclines. Additionally, many studies have observed changes in heart rate while climbing, but few have studied breathing rate and caloric expenditure. Therefore, the purpose of this study was to compare the physiological responses (heart rate, breathing rate and caloric expenditure) and rate of perceived exertion of experienced rock climbers when climbing top rope vs. lead rope. Ten experienced climbers were recruited from Scrapyard Climbing Collective LLC. A preliminary testing session was held at DeVos Fieldhouse where the participants were fitted for a Hexoskin smart shirt and had bodily measurements taken. The Hexoskin Smart Shirt has been validated to measure physiological changes during exercise (Smith, 2019). Participants then met at the Scrapyard Climbing Collective LLC and completed a climbing sequence using two different routes while wearing the Hexoskin shirt. The order of climbing was as follows: Route 1: top rope, lead rope, Route 2: top rope, lead rope. Participants rested for eight minutes between each climb. It was hypothesized that the lead rope courses would elicit a higher heart rate, breathing rate, caloric expenditure, and rate of perceived exertion than the top rope climbs. Results will allow experienced climbers to have a better understanding of the demands that are required with lead rope and top rope climbs which can benefit their training and climbing technique.

Introduction

- Rock climbing is a sport that has increased in popularity over the past few years, both in the realm of recreational sport, competitive sport, and research as it has recently been added to the Summer Olympics.
- Rock climbing is unique in that climbers perform an acrobatic exercise that engages in isometric muscle contractions as they climb the wall (Sheel, 2004).
- Research on advanced climbers has found significantly higher heart rate (HR) on the lead rope protocol (Fryer, 2013; Zarattini, 2018) with no differences in climbing anxiety (Fryer, 2013) and no significant differences in VO2 (Fryer, 2013; Zarattini, 2018) when comparing climbing styles or difficulties.
- Research on intermediate climbers has found significant (Mermier, 1997) and nonsignificant (Draper, 2008) differences in HR and VO2, as well as significant differences in energy expenditure (Mermier, 1997) and anxiety for lead rope climbing (Draper, 2008).
- Overall, current research exhibits mixed results for the physiological (HR, VO2, energy expenditure) and psychological (anxiety) responses of intermediate and advanced rock climbers during lead rope and top rope protocols.
- The Hexoskin smart garment is a validated biometric shirt worn directly against the skin that provides and non-invasive and non-restrictive method in which to measure variables such as heart rate, respiratory rate, minute ventilation, caloric expenditure, and g-force (Smith, 2019).

Purpose

The purpose of this study was to compare the physiological responses (HR, breathing rate (BR), caloric expenditure) and rate of perceived exertion (RPE) of experienced rock climbers when climbing top rope versus lead rope.

Special Thanks

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Methods

Participants: 10 participants were recruited for this study (9 male, 1 female). Participants were 18 years or older and experienced climbers, climbing for at least 1 year and were lead rope certified.

Study Design: participants were required to complete two sessions. Following baseline measurements, assessments, and Hexoskin shirt fitting at DeVos Fieldhouse, participants attended a climbing session at Scrapyard Climbing Collective where each climber completed two routes of lead rope climbing and two routes of top rope climbing with an 8-minute rest between each climb. Pre-climbing data and during climb data were collected via the Hexoskin shirt. Data were compared individually between top rope climbing and lead rope climbing.

Figure 1. Study Design.

Results

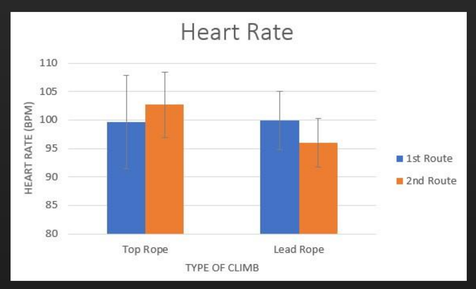

Figure 1. The average heart rate for two different top rope climbs compared to two different routes of lead rope climbs.

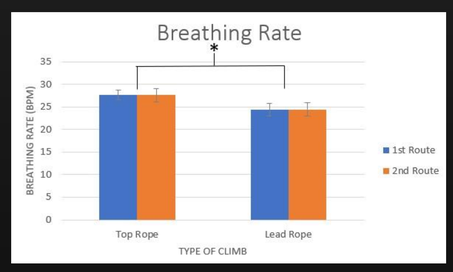

Figure 2. The average breathing rate for two different top rope climbs compared to two different routes of lead rope climbs. * *p-value <0.05.*

Figure 3. The average caloric expenditure during two different routes of top rope compared to two different routes of lead rope climbs.
Note: The significance of caloric expenditure may vary due to the total duration that the Hexoskin device was collecting data compared to the time it took to complete the climb.

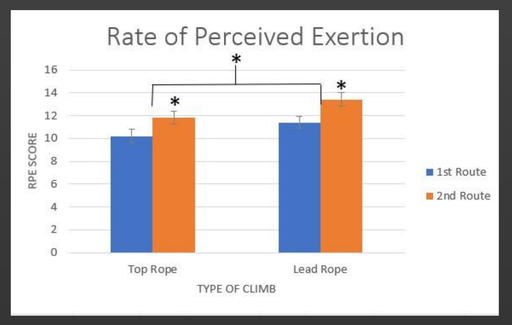

Figure 4. The average RPE for two different routes of top rope climbs compared to two different types of lead rope climbs. * *p-value<0.05*

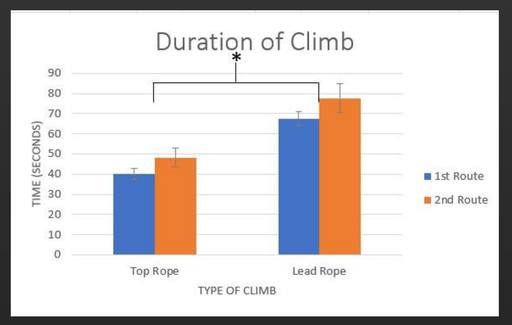

Figure 5. The average time it takes to reach the top of the wall on two different top rope climbs and two different lead rope climbs. * *p-value<0.05*

Conclusions

- There were no significant differences in heart rate when comparing climbing style (p=0.668) or routes (p=0.900).
- There was a significant difference in breathing rate between climbing styles (p=0.021) but not between routes 1 and 2 (p=0.986).
- Caloric expenditure was significantly different between climbing styles (p=0.004) but not significantly different between route 1 and 2 (p=0.760).
- There was a significant difference for the duration of climb between climbing styles (p=0.000) and there was a trend toward a difference between routes (p=0.052).
- RPE was significantly different between climbing styles (p=0.001) and routes (p=0.005).

Limitations

- Lack of subject availability may have prevented the development of a large, more representative pool of subjects.
- Relatively small female participant pool disrupts the ability to make inferences about disparities between genders.
- Tight-fitting Hexoskin shirt may have the potential to infringe on normal breathing rate by constricting natural breathing movements.
- The order in which the climbers completed the climbing sequence was not randomized, which may have impacted participant anticipatory physiological response prior to climbing.

Implications

Hexoskin devices could provide a unique opportunity to measure responses that contribute toward the developing sport of rock climbing and therefore impact the way climbers train.