Differences in Blood Flow Patterns and Wall Shear Stress at the Carotid Artery Using Different Exercise Modalities and Intensities.

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# Abstract

# Introduction

Endothelial function relies on shear stress (SS) which is frictional force produced by blood flow and endothelial cells, which can help to determine the efficiency of blood flow. Purpose: To observe the differences of the carotid endothelial shear stress during various intensities during the back squat and running on a treadmill.

The purpose of this study was to determine the differences in blood flow patterns across exercise modalities at three different intensities. Therefore, it was hypothesized that Anterograde velocity of the Carotid artery would increase linearly as intensity increases regardless of the exercise modality. In addition, it was also hypothesized that the treadmill at a high intensity would result in greater anterograde velocity and wall shear stress of the carotid artery compared to the other exercise modalities.

# Methods

## Experimental Design

20 participants were recruited for a repeated measures study design. 6 participants were unable to continue due to the COVID-19 lockdown. Hence, only 14 participants were able to complete the study. The study involved 4 sessions for maximal testing, and 2 sessions of ultrasonography testing. A priori power analysis was conducted in Rstudio using R statistical programing language and the “pwr” library; a total of 14 subjects with stratification by sex (7 per group) at an alpha level (α) of 0.05 with an large effect size (f) of 0.4, was determined to be enough to obtain a power (β) of 0.94 All studies protocols were in accordance the Declaration of Helsinki and were approved by the Institution Review Board at the University of Texas at El Paso (Reference number: 1250657-5).

*Study Protocol*

On the initial visit, participants signed a consent form. Following, participants completed a demographics and initial screening questionnaires to determine eligibility. Height and Mass were taken using a calibrated scale and a detecto stadiometer. Thereafter, blood pressure was obtained, and for every visit, hematocrit and resting lactate levels were obtained form the lower end of the earlobe. Then, for visit 1, subjects completed 3 maximal strength tests (Squat, Bench Press, and Biceps curls), then subjects rested for approximately 30 minutes and performed a VO2max treadmill test. On visit 2, participants performed a VO2max Bike followed by 30 minutes of VO2max on the Arm Crank.

Maximal O2 consumption (VO2max) testing were conducted in Bike, Arm Crank, and Treadmill conditions using a metabolic cart (Parvo Medics, TrueOne 2400). An graded exercise test protocol was utilized with speed increased every 2-minutes (Beltz et al., 2016). At 30-20 seconds before the end of each stage, lactate was drawn from the participants, heart rate was recoded, and rate of perceived exertion was reported. A successful trial was considered if the following criteria were met: 1) Lactate > 4.0 mmol/L, respiratory exchange ratio (RER) > 1.10, heart rate was within 10 bmp of estimated maximal heart rate (220 – age), and RPE < 17 (Beltz et al., 2016). For the subsequent visits, intensities for the VO2 max modalities (treadmill, bike, and arm crnak) were be selected as: low = 0-1 mmol/L, moderate = 2-4 mmol/L, and high > 4.0 mmol/L (Rascon et al., 2020).

The 1-RM testing consisted in

(Montalvo et al., 2021)

For the 1-RM back squat three intensities will be selected as: low = 45% of 1RM, moderate = 65% 1RM, high = 85% 1RM and the intensities

*Data Analysis*

All data was exported and compiled into a comprehensive Excel Sheet (Microsoft, 2021). Data was then improted into Rstudio IDE (RStudio: Integrated Development for R. RStudio, PBC, Boston, MA) and analyzed using a custom-build script with R statistical programming language. Data visualization was conducted using “ggpurb” and “ggplot2” libraries. Data distribution was assessed using the Shapiro-Wilk test (“rstatix” library). Data was analyzed using a repeated-measures linear mixed effects models (“lme4”), with a Tukey post-hoc analysis to determine pairwise differences (“emmens”). Statistical significance was defined piori at critical alpha value of 0.05. Data analysis script is available within the supplemental materials of this manuscript.

# Results

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# Discussion

# Conclusion

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