

# Relationship between performance in a simulated firefighting work circuit, work economy and muscle oxygenation

Gendron P., Freiburger E., Laurencelle L., Trudeau F., Lajoie C.\*  
 Département des sciences de l'activité physique de l'UQTR



## Introduction

Firefighting is a hazardous task requiring heavy workload that may be limited by air cylinder reserve. It is likely that increased fitness can lead to a better air economy and duration at a given heavy work intensity.

## Objectives

1. The main purpose of this study was to measure if the fastest firefighters during a simulated work circuit (SWC) were those who consumed less air at a given intensity.
2. Secondly, this study aimed to measure if the fastest firefighters during a SWC were the most performant at a graded walking test (GWT).
3. Thirdly, the aim was to determine if there were any central and peripheral physiological parameters correlated with performance at a SWC.

## Materials & Methods

Thirteen males firefighters (28.4 ± 5.1 years; 175.5 ± 4.5 cm; 84.4 ± 9.0 kg;  $VO_{2peak}$ : 47.8 ± 5.1  $mlO_2 \cdot min^{-1} \cdot kg^{-1}$ ) performed a graded walking test (GWT), a 10 METS treadmill test (T10) and a simulated work circuit (SWC) similar to the test described by Deakin et al. (1996). The intensity of 10 METS represents the average  $VO_2$  of work associated with completion of the fire fit test work simulation described by Deakin et al. (1996) at a specified performance standard of 8 minutes (Dreger and Petersen 2007).

Oxygen consumption ( $VO_2$ ), ventilation ( $V_E$ ), respiratory equivalent for oxygen ( $V_E/VO_2$ ) and respiratory exchange ratio (RER) were measured during GWT using gas analyzer cart. Heart rate (HR) was measured during every test. Difference of concentration of hemoglobin (HbDiff) and tissue saturation index (TSI%) were measured by near-infrared spectroscopy (NIRS) during each test.

## Results

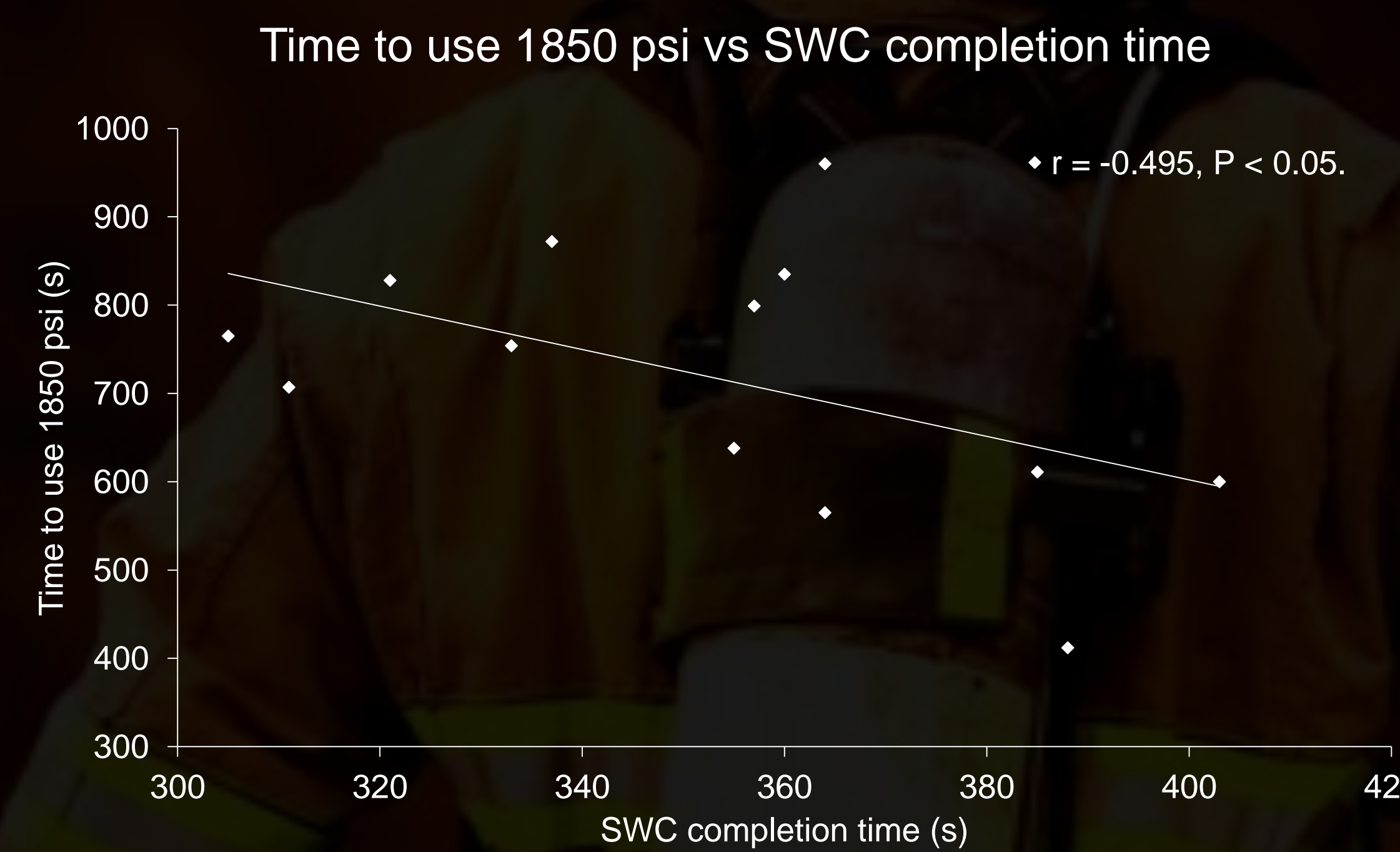


Table 1 : Pearson and Kendall's  $\tau$  correlations matrix.

|   | SWC completion time |        |        |         |         |         | Global $\tau$ |
|---|---------------------|--------|--------|---------|---------|---------|---------------|
|   | PSI 500             | 1000   | 1500   | 2000    | 2500    | 3000    |               |
| N | 13                  | 13     | 13     | 11      | 11      | 9       |               |
| r | -0.339              | -0.397 | -0.454 | -0.512* | -0.571* | -0.630* | 1.000**       |

PSI, psi consumed.  
 \*Significant at  $P < 0.05$ . \*\*Significant at  $P < 0.01$ .

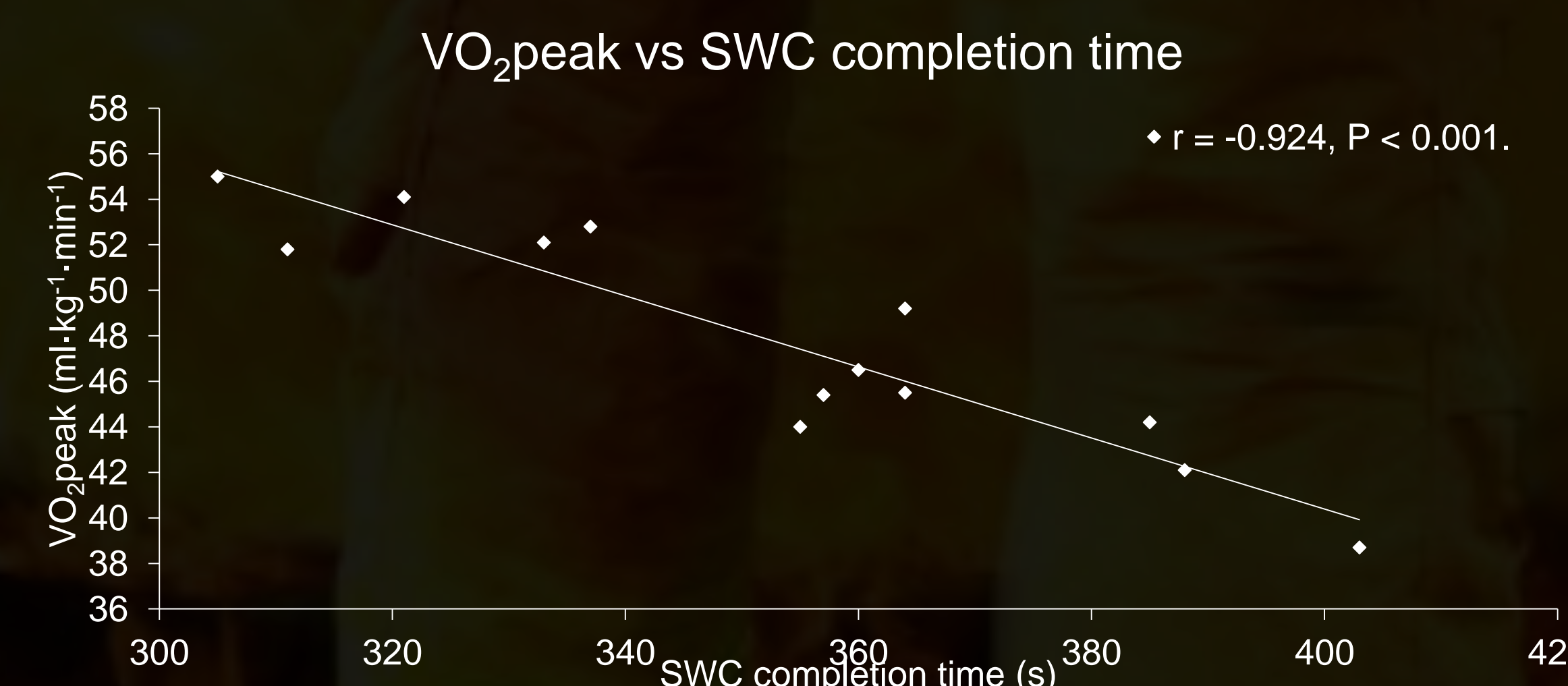
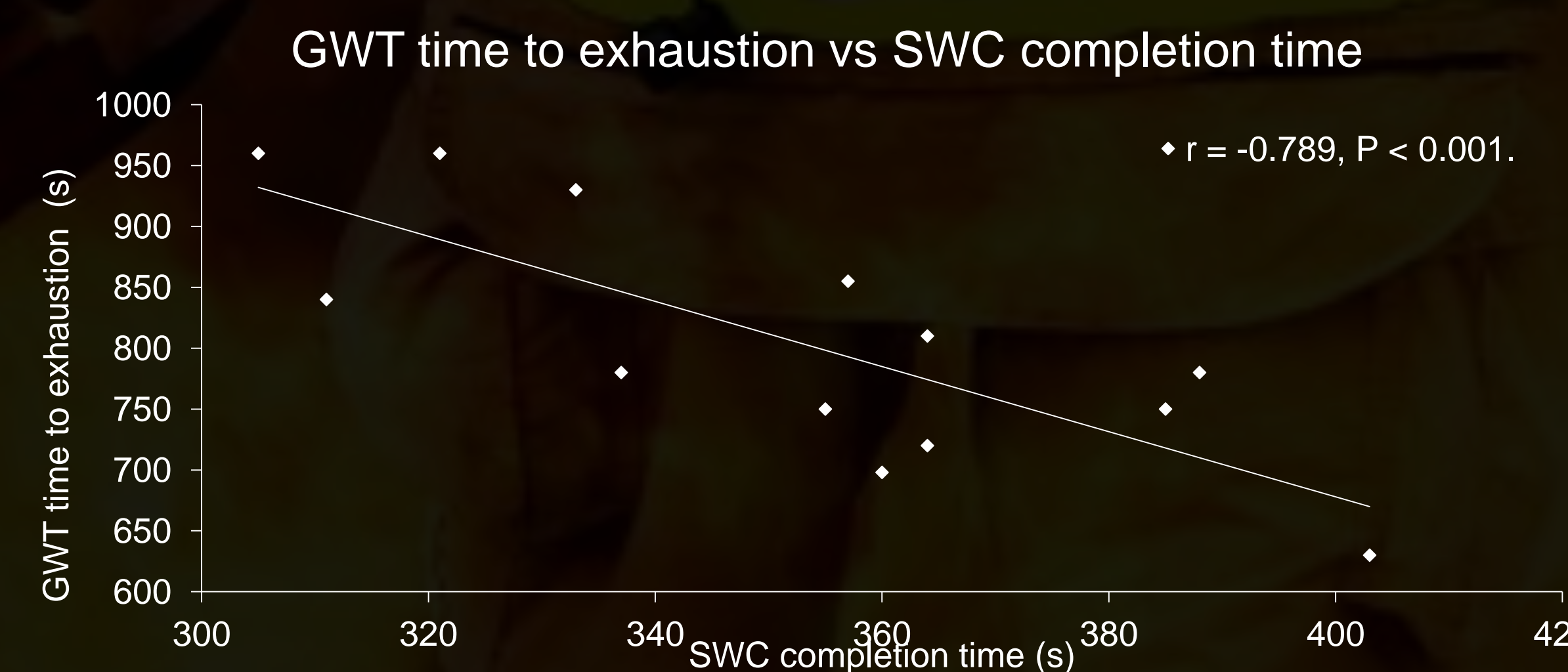
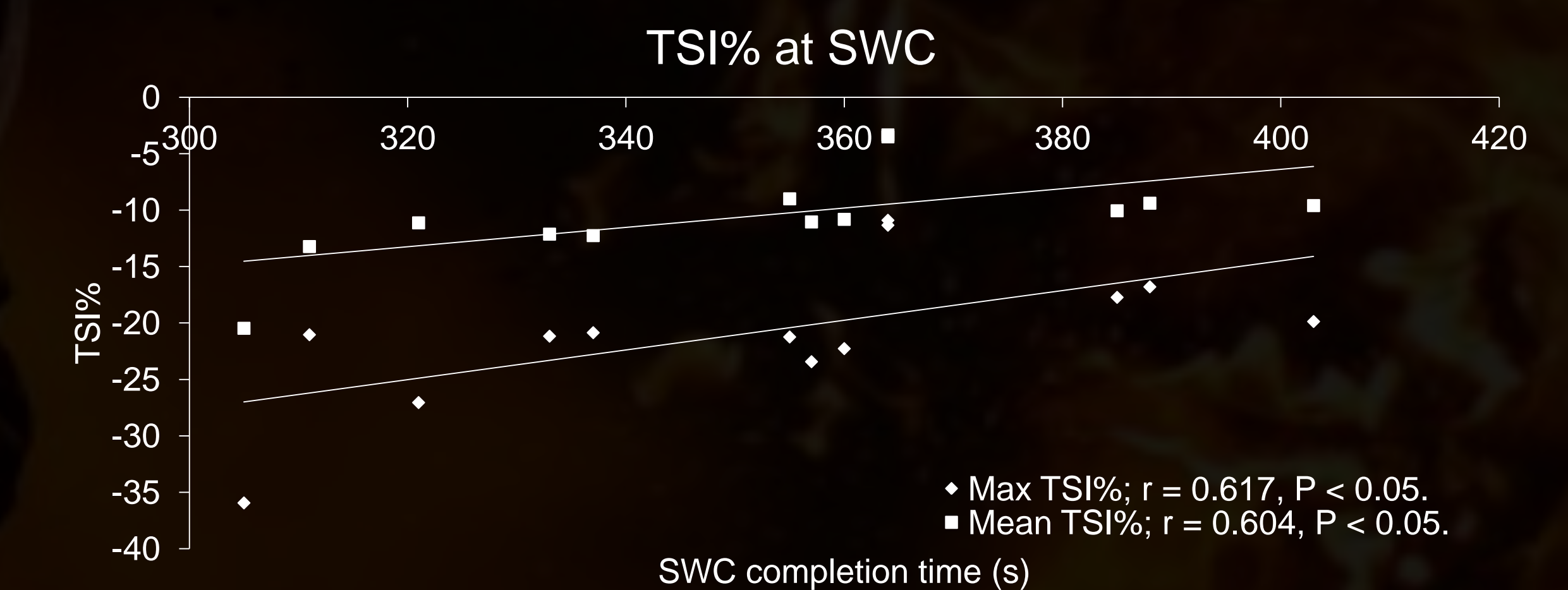
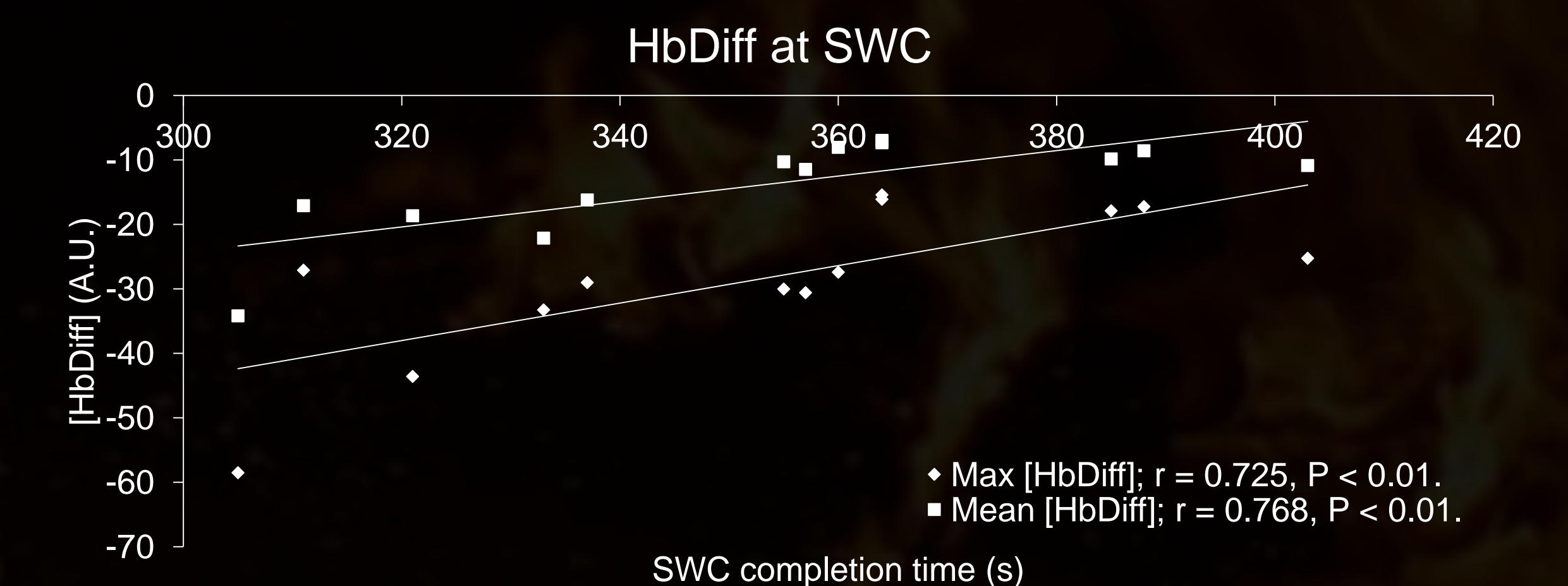


Table 2 : Pearson and Kendall's  $\tau$  correlations matrix.

|                    | SWC completion time |       |        |         |         |         | Global $\tau$ |
|--------------------|---------------------|-------|--------|---------|---------|---------|---------------|
|                    | Grade (%)           |       |        |         |         |         |               |
|                    | 2                   | 4     | 6      | 8       | 10      | 12      |               |
| RER                | 0.341               | 0.406 | 0.599* | 0.613*  | 0.717** | 0.653*  | 0.867*        |
| $V_E/VO_2$         | 0.258               | 0.237 | 0.312  | 0.442   | 0.657** | 0.734** | 0.867*        |
| $V_E$              | 0.117               | 0.157 | 0.232  | 0.392   | 0.484*  | 0.440   | 0.867*        |
| %HR <sub>max</sub> | 0.259               | 0.429 | 0.508* | 0.758** | 0.761** | 0.692** | 0.733*        |

RER, respiratory exchange ratio;  $V_E/VO_2$ , ventilatory equivalent ratio for oxygen;  $V_E$ , ventilation; HR, heart rate.  
 \*Significant at  $P < 0.05$ . \*\*Significant at  $P < 0.01$ .



## Conclusions

1. These results demonstrated that the fastest firefighters at SWC had a lower pulmonary air ventilation at a given work intensity. The observed increased work economy could allow firefighters in better physical condition to perform a heavy workload task in the heat longer.
2. Furthermore, the fastest firefighters at the SWC were the most performant at the GWT.
3. Finally, a better  $VO_{2peak}$  and a better oxygen extraction rate of skeletal muscle were correlated with better performance at the SWC.