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INTRODUCTION

- Traditional sport-athlete training load models have been utilized to quantify the objective work, or external load, and intrinsic responses to work, or internal load, to minimize risk of over-exertional injury (2).
- Similarly, firefighters (FFs) are at risk for injury, with cardiac injury heightened following fireground operations (3), especially in FFs with lower cardiovascular fitness (4).
- To date, FF workload is generally defined as the number of calls responded to across a 24-hour shift (1,5).
- However, call volume measures do not quantify the objective work completed at a single emergency response, nor identify how intrinsic responses to fire tone calls may vary across individual fitness levels, which may support risk identification and injury prevention in FFs.

PURPOSE

- The **purpose** of this study was to identify relationships between cardiovascular fitness and the external and internal load demands of fire tone call responses in active-duty FFs

METHODS

Participants

- 33 (29 male, 4 female) FFs (36.46 ± 9.13 yrs, 179.92 ± 7.02 cm, 91.43 ± 12.75 kg) volunteered to participate in this study.

Procedures

- All participants completed a laboratory session and on-duty data collection.

Lab Session

- Participants completed a maximal treadmill test to quantify cardiovascular fitness as peak aerobic capacity (VO_{2PEAK}).



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METHODS

Procedures Cont.

On-Duty Data Collection

- Participants donned a remote physiological strap (Zephyr™ Bioharness and BioModule™ device, Medtronic, Annapolis, MD) that continuously measured acceleration and heart rate (HR) for 4-6 shifts.



Retrieved from: <https://www.zephyranywhere.com/system/components>.

- Time-stamped call logs were utilized to post-hoc quantify the external load of each fire tone call response as impulse load (IMPULSE), the squared sum of triaxial acceleration scaled to gravity (N*s).
- The physiological internal load for each call was quantified as Edward's Training Impulse (ETRIMP), a metric derived from time spent in 5 HR-based intensity zones (AU).
- Following call completion, participants provided a rating of perceived exertion from Borg's CR-10 scale to quantify Foster's Session Rating of Perceived Exertion (SRPE) and reflect perceived internal load (AU).

Statistical Analyses

- The external and internal loads for all calls were averaged for a single IMPULSE, ETRIMP, and SRPE observation per participant.
- Bivariate Pearson correlations examined for relationships between VO_{2PEAK} and IMPULSE, ETRIMP, and SRPE. An alpha of $p < 0.05$ determined statistical significance.

RESULTS

Table 1. Mean ± SD Fire Emergency Workloads

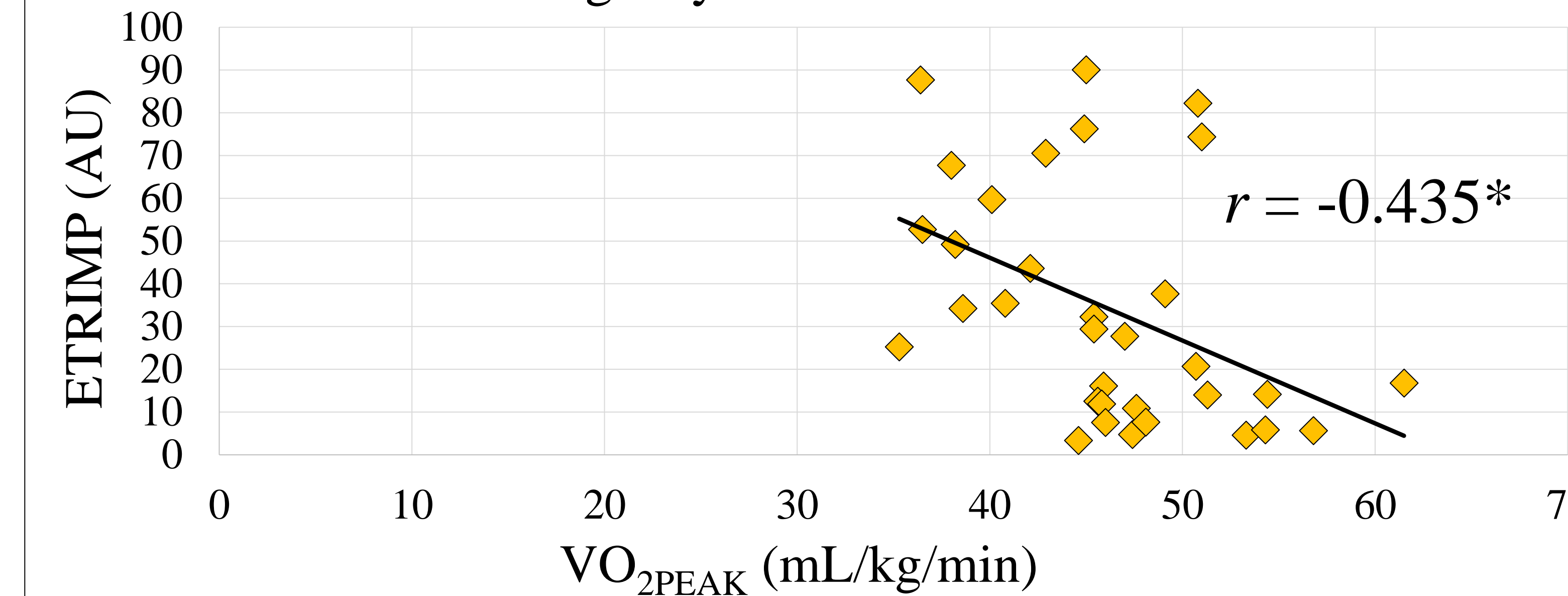
IMPULSE (N*s)	ETRIMP (AU)	SRPE (AU)
2394.20 ± 1211.69	34.30 ± 27.64	246.92 ± 319.52

Table 2. Relationships Between Workload and Fitness

	IMPULSE	ETRIMP	SRPE
VO _{2PEAK}	-0.178	-0.435*	-0.210

RESULTS

Figure 1. Relationship between aerobic capacity and physiological workload of a fire emergency.



CONCLUSIONS

- Although cardiovascular fitness is unrelated to the external load completed by FFs for a fire tone call, FFs with lower cardiovascular fitness levels demonstrated greater physiological internal loads to the work demands.
- Thus, while there were uniform amounts of work completed by FFs of varying fitness levels, the internal response varied based on cardiovascular fitness.

PRACTICAL APPLICATIONS

- The subjective measure of SRPE may allow individuals that elicit a greater cardiovascular response to job demands to reflect internal loads similar to those that required a lesser cardiovascular load.
- In turn, firefighters who have greater cardiovascular recovery needs and subsequently may have greater cardiovascular risk, including individuals with lower aerobic capacities, may go unnoticed.
- Utilization of a physiological internal load measure, such as ETRIMP, may more adequately reflect the intrinsic response to fire tone call demands and allow for enhanced identification of individual recovery needs.

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