

CAREER FIREFIGHTERS' REAL-TIME PHYSIOLOGICAL RESPONSE TO FIREFIGHTING TASKS OVER 6 MONTHS: Implications for injury prevention

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FIREWELL

Introduction

- Firefighting is a physically demanding job⁽¹⁾
 - Non-cyclical
 - Nature of the tasks
 - Personal Protective Equipment (PPE)⁽²⁾
 - Extreme conditions & challenging work environments



Introduction

- Firefighters are exposed to a number of injury risk factors⁽³⁾
 - High physical demands (force/exertion, awkward postures)
- High rates of musculoskeletal (MSK) injury



Leading cause: **OVEREXERTION**⁽⁴⁾



EXCEEDS



Research Problem

- Previous literature:
 - Highly controlled environment (i.e., Lab-based)
 - Controlled tasks (i.e., treadmill protocols)
- Unique components of this study:
 - Multiple time points
 - Effects of load over time
 - Applied research

Purpose

The purpose of this study was to determine career firefighters' real-time physiological response to two firefighting tasks over 6-months with a view on firefighter injury prevention.

Methods: Context

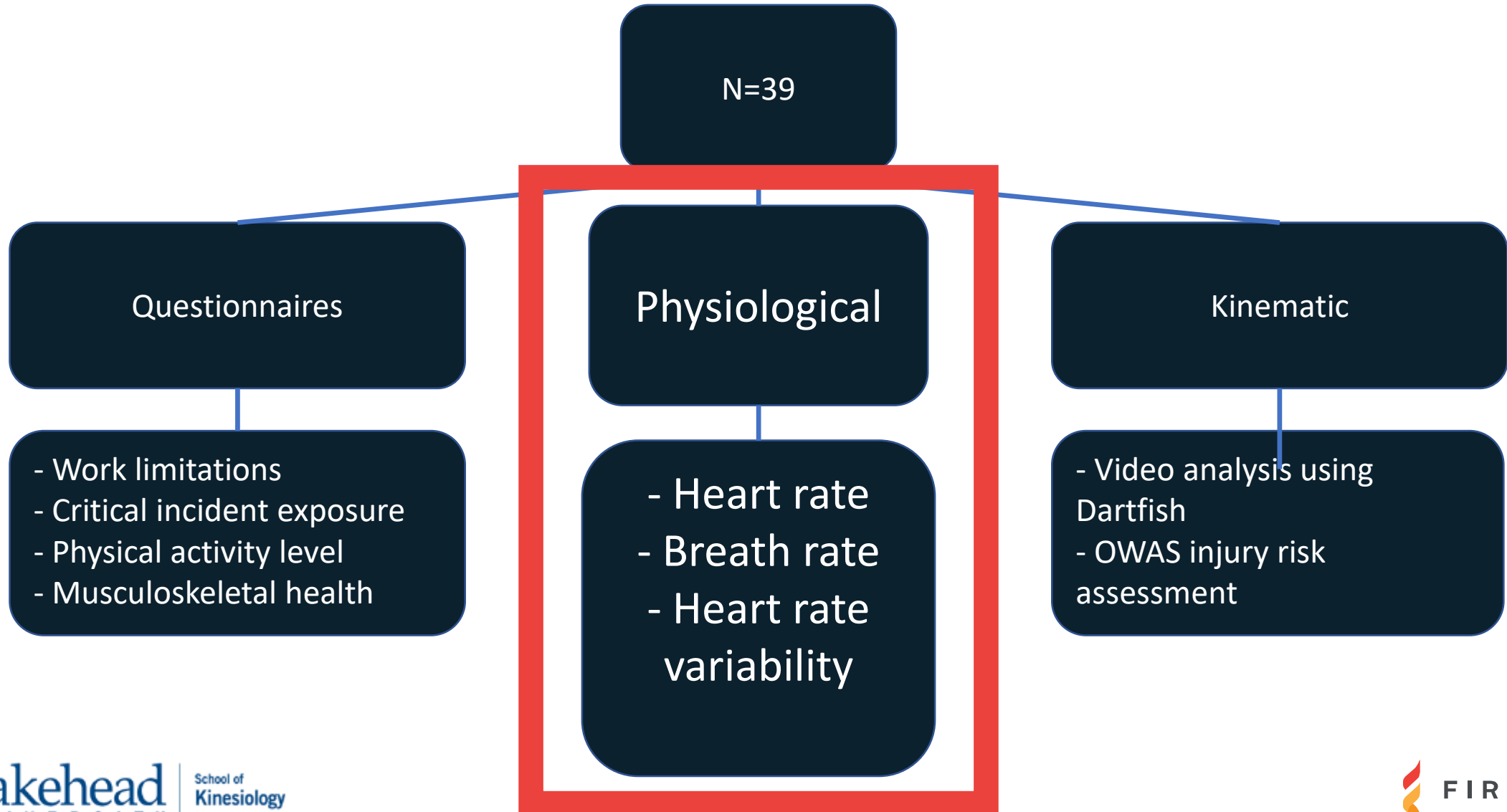
CONTEXT: Thunder Bay Fire Rescue and the Thunder Bay Professional Firefighters Association

STUDY DESIGN:

- Cohort with Repeated Measures
 - Baseline - November 2017
 - 6 months – May 2018
- Sample = 20 male active-duty, career firefighters



Methods



Methods: Protocol

- Demographic information was collected prior to task performance
 - Age, height, weight, years of service
- Zephyr BioHarness used to collect physiological measures ⁽⁵⁾
 - Heart rate (HR), breath rate (BR), heart rate variability (HRV)
- Full bunker gear including the self-contained breathing apparatus (SCBA)
- Performed two tasks (Hose Drag & Patient Transfer)



Methods: Protocol

- The hose drag task was performed using a charged line (905kpa)



Methods: Protocol

- Paired lift to transfer a weighted manikin (68kg) from the ground into a stair chair
- Each participant performed two lifts
 - Lift at the head (heavy)
 - Lift at the feet (light)



Methods: Data Analysis

Between
Task

- Hose drag vs. Patient Transfer

Between
Timepoints

- Baseline vs. 6-months

Results: Demographic Characteristics

	Mean (SD)	Min.	Max.
Age (yrs)	39.8 (7.8)	27	58
Height (cm)	183.95 (8.23)	167.64	198.12
Weight (kg)	99.6 (23.7)	78.5	187.96
Years of Service	11.6 (7.2)	3	26

Table 1: Demographics (n=20)

Results - Baseline

- Heart Rate Variability (HRV) significantly decreased from rest to end of task completion ($t(19) = 2.473, p < .05$)
- Heart rate (HR) increased throughout task completion ($t(19) = -3.347, p = .003$)
- Breath rate decreased throughout task completion $t(19) = 2.491, p = .022$.

	Rest	End	Hose Drag	Patient Transfer
HRV (ms)	78.5 (35.8)	57.4 (25.1)	80.2 (39.3)	55.7 (24.1)
HR (bpm)	97.4 (21.9)	110.8 (17.2)	118.1 (17.8)	106.6 (17.1)
BR (bpm)	20.4 (6.4)	16.1 (4.8)	18.9 (5.4)	17.6 (4.1)

Table 2: Physiological response from initiation of firefighting tasks (hose drag) to completion (patient transfer) and between firefighting tasks [\bar{X} (SD)]

Results – 6 months

- Heart rate significantly decreased during performance of patient transfer ($t(17) = 26.34, p < .001$)
- Breathing rate significantly decreased by the end of task completion ($t(18) = 2.117, p < .05$)

	Rest	End	Hose Drag	Patient Transfer
HRV (ms)	60.0 (35.3)	62.6 (38.7)	60.4 (33.4)	66.0 (37.1)
HR (bpm)	99.7 (19.5)	105.6 (12.7)	125.2 (15.1)	103.8 (12.5)
BR (bpm)	18.8 (4.0)	15.3 (5.5)	19.4 (3.6)	17.0 (5.0)

Table 3: Physiological response from initiation of firefighting tasks (hose drag) to completion (patient transfer) and between firefighting tasks [\bar{X} (SD)]

Results: Comparing Baseline and 6 months

- Heart Rate Variability (HRV) significantly decreased over 6 months $t(13) = -2.289, p < .05$
- Average HR significantly increased over 6 months $t(17) = 2.559, p < .05$

Table 4: Physiological response for baseline and 6 month timepoint [\bar{X} (SD)]

Hose Drag Task

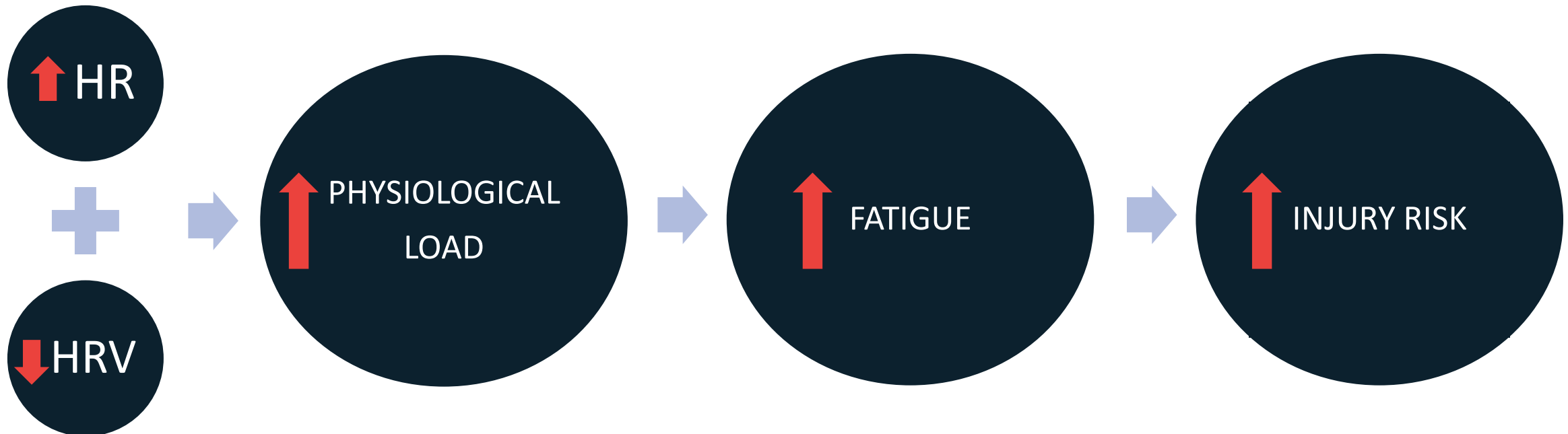
	Baseline	6 month
HRV (ms)	80.2 (39.28)	60.4 (33.38)
HR (bpm)	118.1 (17.78)	125.2 (15.11)
BR (bpm)	18.9 (5.38)	19.4 (3.65)

Patient Transfer Task

	Baseline	6 month
HRV (ms)	55.7 (24.09)	66.0 (37.07)
HR (bpm)	106.6 (17.12)	103.8 (12.51)
BR (bpm)	17.6 (4.05)	16.1 (12.52)

Discussion

- Decreased HRV linked to increase in sympathetic activity of the autonomic nervous system (ANS) ⁽⁶⁾
 - Often observed with an increase in HR
 - Indicative of physiological or psychological stress



Conclusion

Key Findings

- High physiological demands associated with firefighting tasks
- Findings suggest a higher physiological load associated with a hose drag task
- Cumulative effect of physiological load and decrease in tolerance over time

Future Directions

- Effect of temperature (seasonal) on overexertion
- Relationship between physiological overexertion and MSK injury
- Explore strategies aimed to reduce physiological load

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Acknowledgements

This work was supported by Lakehead University's Senate Research Council through a Research Development Grant.

We would also like to thank the Thunder Bay Fire Rescue and the Thunder Bay Professional Firefighters Association for all of their support, time, and dedication to this work.

