

Assessments of Cardiovascular Functions of Firefighters on A Very Long (72-hour) Shift: A Field Feasibility Study

BongKyoo Choi, Javier Garcia-Rivas, Peter Schnall, Marnie Dobson, Hyoungryoul Kim, Frank Zaldivar, Leslie Israel, Dean Baker

Background – HAWKS study

Many firefighters do additional 24-hr shifts beyond their standard 24-hr shifts, which generally results in consecutive 24-hr shifts (e.g., 72-hr of work). We observed in our research of firefighters in Southern California that they work on average thirteen 24-hr shifts per month. Moreover, a substantial number of firefighters, 56%, worked 72 consecutive hours, while 22% worked 96 consecutive hours at least one time per month.

However, little is known about the impact of consecutive 24-hr shifts on the cardiovascular functions of firefighters. Also, there have been no standard field methods for assessing the cardiovascular changes that result from consecutive 24-hr shifts.

HAWKS (Heart And Work Shift) study:

This project was supported through the UCI-ICTS by Grant Number UL1 RR031985 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH), and the NIH Roadmap for Medical Research and Grant Number R21OH009911 from the National Institute for Occupational Safety and Health (NIOSH). Its contents are solely the responsibility of the authors and do not necessarily represent the official view of NCRR, NIH, or NIOSH. Also this project was supported by the Center for Social Epidemiology and the Center for Occupational and Environmental Health, University of California Irvine. This study was approved by the Orange County Fire Authority (OCFA) and International Association of Fire Fighter (IAFF) Local 3631.

Objective

The study aims to test the feasibility of 5 direct and indirect ambulatory parameters of cardiovascular functions in firefighters on a very long (72-hr) shift.

- Heart Rate
- Beat-to-Beat (R-R Interval) Heart Rate Variability
- Blood Pressure
- Salivary Cortisol
- Salivary C-reactive Protein (CRP)

7 Firefighters

- Had at least one Wellness and Fitness (WEFIT) exam at UCI-COEH clinic
- Scheduled for a 72-hr shift in the coming months
- 5 non-hypertensive and 2 hypertensive (under treatment) firefighters.

Ambulatory Measures On a 72-hr Shift

- Measures on two 24-hr periods (1st 24-hr and 3rd 24-hr shifts of three consecutive 24-hr shifts). A 24-hr shift of the firefighters starts at 8:00 AM and ends at 8:00 AM of the next day.
- For each 24-hr period,
- Heart Rate (with a Polar S810 heart rate monitor for 24 hours including sleep time).
 - Beat-to-Beat (RR Interval) Heart Rate Variability (with a Polar S810 heart rate monitor for 24 hours including sleep time).
 - Blood Pressure (with an Omron HEM-670 wrist blood pressure monitor in a sitting position at a fire station, every 30 minutes from 8:00 AM to bedtime).
 - Salivary Cortisol (with Salimetric salivary cortisol kits at 8:00 AM, 10:00 AM, 8:00 PM, 10:00 PM or bedtime, awaking, and 30 minutes after awaking)
 - Salivary C-reactive Protein (CRP) (with Salimetric salivary cortisol kits at the same time as in salivary cortisol).
 - A diary for assessing subjective ratings of fatigue and stress on a 100 mm visual analog scale (VAS) at the sampling times of salivary measures and collecting information on exercise, sleep, diet, and number of calls including night calls. Administrative call records were additionally collected.

Table 1. Preliminary results of the differences in heart rate, heart rate variability, blood pressure, cortisol, and CRP among 6 OCFA firefighters (4 males and 1 female without hypertension and 1 male with hypertension)

	Averages (n, sample size)								
	# of calls (n=6)	Stress ^a (n=6)	Mental Fatigue ^a (n=6)	Heart Rate (n=3) ^b	Heart Rate Variability (LF/HF) (N=3) ^b	Systolic Blood Pressure (n=5) ^c	Diastolic Blood Pressure (n=5) ^c	Saliva Cortisol (n=5) ^d	Saliva CRP (n=5) ^d
1 st 24-hour shift	5.5	18.42 mm	28.91 mm	73.3 bpm	4.75	114.84 mm Hg	71.41 mm Hg	0.24 ug/dL	330.75 pg/mL
3 rd 24-hour shift	5.5	19.00 mm	31.80 mm	78.7 bpm	6.07	117.91 mm Hg	73.57 mm Hg	0.31 ug/dL	298.44 pg/mL

^aSelf-rated stress and fatigue on a 100 mm visual analog scale (VAS), assessed 6 times (0800, 1000, 2000, 2200, after awakening, and 30 minutes after awakening). ^bDuring the 5 minutes just after awakening on each 24-hr shift. The higher values indicate decreased heart rate variability. Only partial data in 3 firefighters due to technical issues (e.g., non-availability of EKG gel at the beginning of the field study). ^cDay-time blood pressure, measured every 1 hr from 0800 hr to 2200 hr or bedtime. 1 hypertensive firefighter under medication showed slightly higher blood pressure than the other 4 normotensive firefighters. Only 3rd shift data in 1 normotensive firefighter. ^dAssessed 6 times (0800 hr, 1000 hr, 2000 hr, 2200 hr or bedtime, after awakening, and 30 minutes after awakening). Data from 1 firefighter under analysis.

Conclusions and Implications

- The five ambulatory parameters have great potential for being further developed as biomarkers of cardiovascular functions in firefighters on consecutive 24-hr shifts.
- We observed in the group of 6 firefighters that as expected, self-rated stress and mental fatigue, heart rate, systolic and diastolic blood pressure increased (Table 1), while a frequency-domain measure of decreased heart rate variability (Low Frequency/High Frequency Power Ratio in Table 1) increased from the 1st 24-hr shift to the 3rd 24-hr shift, indicating an increased sympathetic nervous system over parasympathetic nervous system. However, contrary to our expectations the average of salivary CRP decreased during the period, though its diurnal pattern was much flatter during the same period (in fact, the averages of saliva CRP at 10:00 AM increased during the period. CRP is supposed to be the lowest at mid-day). The sample size is too small to make definitive conclusions.
- A larger field study is needed to examine a day-by-day change in the cardiovascular parameters in firefighters working a long (> 48 hours) shift and more importantly find effect modifiers (see Figure 1). Contact: Dr. BongKyoo Choi (b.choi@uci.edu).

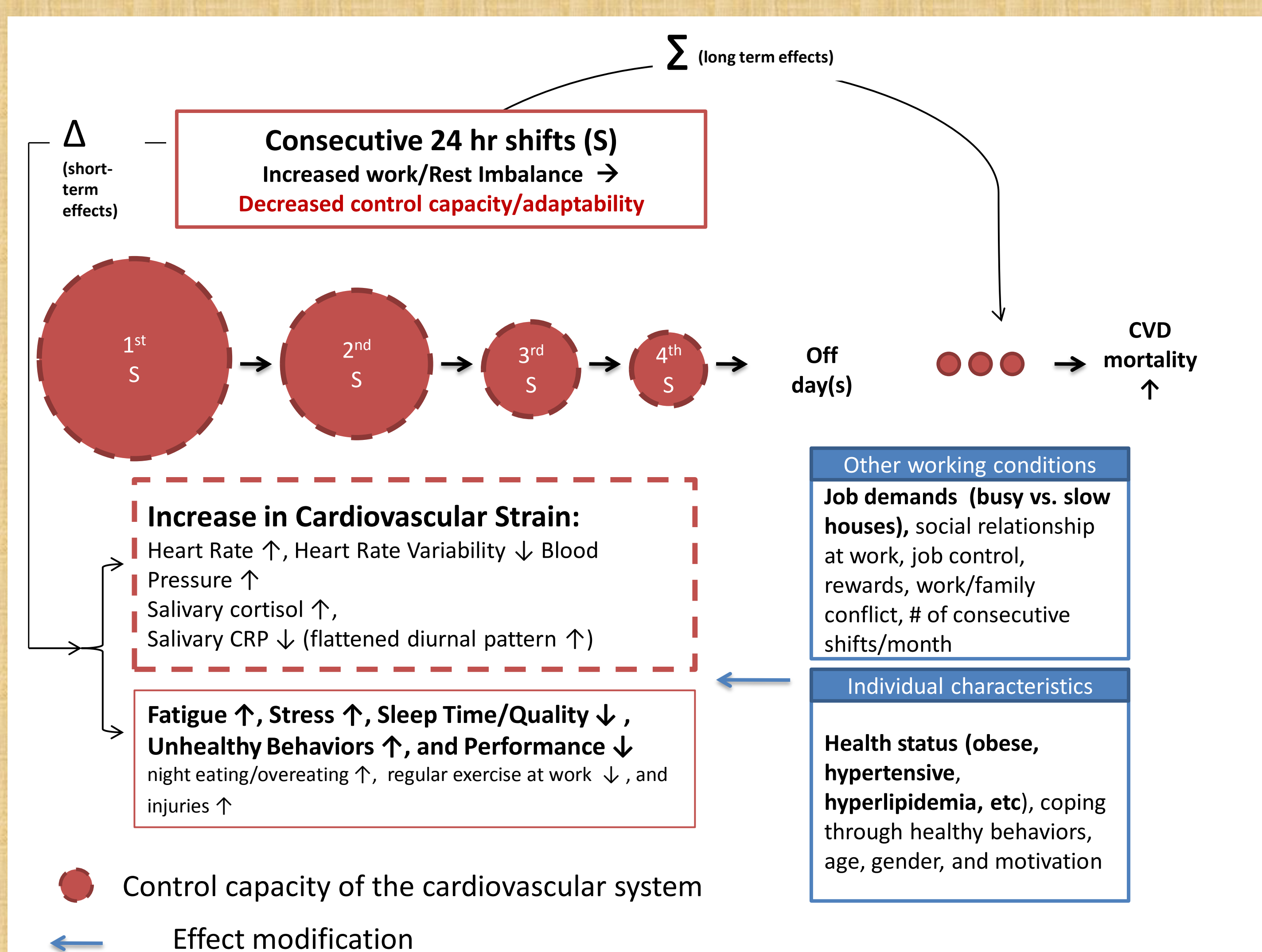


Figure 1. A theoretical framework for studying the impact of consecutive 24-hr shifts on the cardiovascular system in firefighters.