Comparing Health Status and Exposure Risk In Career vs. Voluntary Firefighters

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Physical Readiness in First Responders

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NORA PRIORITY AREA

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NORA Priority Area

- Davis & Gallagher (2014) noted the near maximal heart rate (HR) that can be experienced while conducting tasks relative to firefighting while wearing full turnout gear; and therefore could potentially be associated with an increased risk of experiencing a cardiovascular event, such as a myocardial infarction (MI).
- Calavalle et al. (2013) reported that the main factors that influence the performance of a firefighting simulated stair-climbing test are the ability to carry a heavy load (22.8% of total variance), effect of excessive body fat (19.6% of total variance), age (19.3% of total variance), and fitness level (16.4% of total variance).
  - This implies that while fitness level is important to performance of tasks related to firefighting, the carrying of a load (which is common in firefighting) and potential excesses of body mass are the most important variables to consider.
- This supports previous findings by Perroni et al. (2010) that even firefighters who are considered experts in their field can experience a severe physiological challenge based on unpredictable environmental conditions, especially if they lack an adequate level of fitness.

➢ Combining these results together, performing heavy physical labor while wearing full turnout gear can elicit near maximal HRs that, for a person who is considered overweight or obese, can substantially increase the likelihood of experiencing a cardiac event. (Calavalle et al., 2013; Davis et al., 1982; Walker et al., 2015)

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NORA Priority Area

- This study aimed to address a research question within the Public Safety sector that includes members of the firefighting profession.
- Some firefighting departments are composed of professional firefighters (career firefighters) while some smaller towns cannot fully fund a professional firefighting department and rely on their citizens to volunteer their time and put their lives at risk to perform fire suppression and other related firefighting tasks when those events arise.

- Considering the financial dedication that is directed towards professional fire fighters, it can be expected that these fire fighters undergo much more rigorous physical training and on-the-job training to perform tasks related to firefighting.
- To the best of the authors' knowledge, **no study to-date have directly compared the physical fitness or health status of firefighters from professional departments versus those firefighters who are members of a volunteer department**.

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SPECIFIC AIM #1

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Purpose, Aims, & Hypotheses

Purpose: The purpose of this study is to assess the potential similarities and differences in health and physical fitness profile between career firefighters and volunteer firefighters.

Specific Aim

- *Specific Aim 1* – To evaluate potential differences in health and physical fitness status between members of a volunteer firefighting department vs. members of a professional firefighting department.

Hypothesis

- *Hypothesis 1* – Measures of health and physical fitness status for members of a volunteer firefighting department will be markedly poorer vs. members of a professional firefighting department.

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Research Methods & Study Design

- Participants were recruited to the study through the respective chiefs of each fire department.
- The career firefighters (CFF) were all members of the Bowling Green Fire Department in Bowling Green, KY.
- The voluntary firefighters (VFF) were all members of the Warren County Fire Department (Warren County, KY) and were either stationed at the Woodburn Volunteer Fire Department or Richardsville Volunteer Fire Department.
- The total sample size consisted of 139 firefighters comprised of 120 CFF and 19 VF.

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Research Methods & Study Design

- **Fitness Testing** with firefighters employs a protocol based on criteria included in the International Association of Firefighters (IAFF)/International Association of Fire Chiefs (IAFC) Wellness/Fitness Initiative (WFI). (Drew-Nord et al., 2011; Dolezal et al., 2015; IAFF, 2008)
  1. Body Composition (skinfold measurements)
  2. Grip Strength Test (using hand dynamometer)
  3. Push-ups (max reps to metronome set at 80 bpm; up on one beat, down on another beat; so 40 rep/minute pace).
  4. Plank (to failure; "timing out" is 4 minutes)
  5. Sit-and-reach Test
  6. Treadmill or Stair Climber Submaximal VO_2 (Aerobic Capacity) Test (using WFI protocol – also called Gerkin Protocol).

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Results

- An independent *t*-test showed evidence of a significant difference between groups for the following variables:
  - Height ($p = 0.034$)
  - Fat mass (FM) ($p = 0.002$)
  - Body fat % ($p < 0.0005$)
  - VO_2 max ($p = 0.006$)
  - Push-ups completed ($p = 0.025$)
  - plank time ($p < 0.0005$)
  - Absolute grip strength ($p = 0.027$)
- There were not shown to be any significant differences between groups for the following variables:
  - Age ($p = 0.299$)
  - Body mass ($p = 0.165$)
  - Body mass index (BMI) ($p = 0.056$)
  - Fat-free mass (FFM) ($p = 0.282$)
  - Flexibility ($p = 0.103$)
  - Relative grip strength ($p = 0.893$)

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Results

Table 1. Physical Characteristics of Career vs. Voluntary Firefighters

	Group	Mean	SD
Age (years)	CFF	38.2	7.3
	VFF	34.7	14.0
Height (m)	CFF	1.81[a]	0.07
	VFF	1.77[b]	0.08
Body mass (kg)	CFF	92.4	13.9
	VFF	102.8	30.8
FFM (kg)	CFF	74.2	9.1
	VFF	69.6	17.9
FM (kg)	CFF	18.1[a]	6.4
	VFF	33.7[b]	19.0
BMI (kg/m^2)	CFF	28.4	4.0
	VFF	32.4	8.5
Body fat (%)	CFF	19.3[a]	4.5
	VFF	29.4[b]	7.7

Overweight

Class I, Obesity

55th Percentile

9th Percentile

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Results

Table 2. Physical Fitness of Career vs. Voluntary Firefighters

	Group	Mean	SD
VO_2 max (mL/kg/min)	CFF	47.8[a]	6.1
	VFF	38.9[b]	7.2
Push-ups	CFF	34.9[a]	10.0
	VFF	25.0[b]	17.1
Plank (min)	CFF	2.23[a]	1.1
	VFF	0.99[b]	0.7
Flexibility (in)	CFF	12.1	3.4
	VFF	10.0	5.0
Absolute Strength (kg)	CFF	100.7[a]	15.0
	VFF	109.4[b]	22.0
Relative Strength	CFF	1.11	0.2
	VFF	1.11	0.3

69th Percentile

36th Percentile

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Discussion & Conclusions

- Firefighters from the BGFD are required to perform exercise training as part of their daily work regimen. The exercise programming is designed and implemented by trainers and instructors who have national certifications relevant to exercise programming.
  - These fitness trainers have a variety of training backgrounds and certifications including nationally-relevant and legitimate bodies including the ACSM, NSCA, and ACE.
  - These trainers are also members of the BGFD as well so they are well-versed on the physical requirements of a firefighter to perform their job safely and effectively.

- In contrast, the VFF of the WCFD are not required to perform any fitness training as part of their job.
  - Due to the nature of the VFF performing their jobs on a volunteer basis, whether they decide to perform exercise training on their own or not is entirely up to them.

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Future Research

- Future studies should target volunteer firefighting departments for potential exercise interventions to improve the level of fitness of their firefighters.

- Despite the lack of financial commitment that volunteer firefighting departments tend to see relative to their career counterparts, they are having to perform similar job responsibilities with the same inherent dangers.
  - The BGFD is responsible for the coverage of 35.6 miles^2 of city limits while WCFD is responsible for the rest of the county (512.4 miles^2).
  - When taking these values into consideration, the BGFD is responsible for approximately 6.5% of Warren County while WCFD is responsible for the rest of the county (93.5%).

➢ **Despite the financial and commitment status of volunteer firefighting departments, they perform an equally dangerous and important job as firefighters of professional/career firefighting departments and more attention should be directed at developing the fitness and performance of these firefighters as well.**

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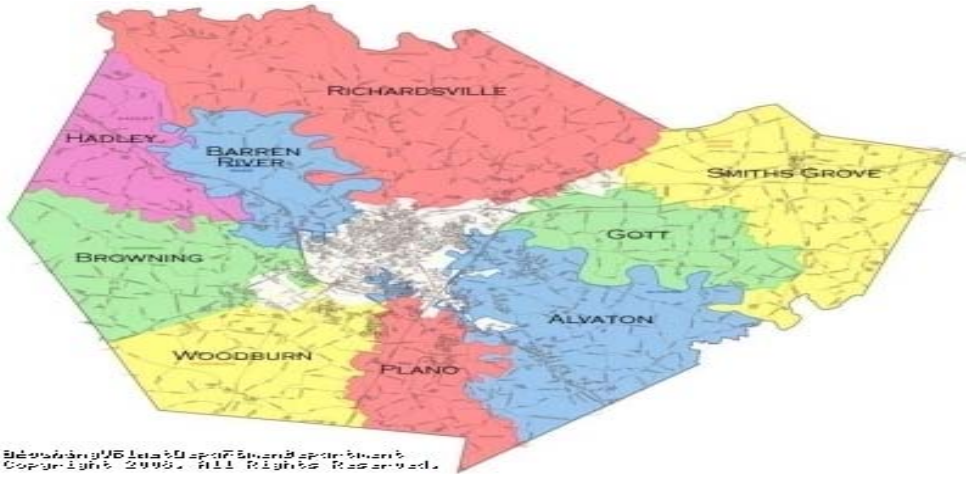
Future Research



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SPECIFIC AIMS #2 & 3

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Introduction & Background

- Wearing PPE can have a profound impact on how firefighters are able to move within and interact with their environment, which at times can be quite hostile and unpredictable.
- It has been established that the restrictions inherent to donning PPE could be subjecting firefighters to an increased risk for certain types of injuries commonly occurring while performing necessary tasks on the fireground.
  - Full PPE leads to a reduction in heat dissipation via encapsulation, and alterations in firefighters' center of gravity (COG), which lead to less-preferred compensatory gait patterns. (Chiou et al., 2012; Coca et al., 2010; Park, Trejo, et al., 2015; Park, Kim, et al., 2015; Park et al., 2011; Smith et al., 2008; Vu et al., 2017)
- One factor in need of further investigation is the effect that this protective gear has on the biomechanics utilized by firefighters.
  - While a number of researchers have evaluated the physiological abilities and work capacities of professional firefighters, either during standard physical fitness testing or simulated fire suppression tasks, **very few studies have evaluated how gait pattern is affected by the donning of a standard PPE ensemble**.

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Purpose, Aims, & Hypotheses

Purpose: The purpose of this study is to assess to what degree lower body kinematics and kinetics are affected while wearing PPE and in response to a physiologically-taxing workload.

Specific Aims

- *Specific Aim 2* – To evaluate if firefighters will exhibit an increase in markers of physiological stress during a simulated tactical occupation workload while wearing personal protective equipment compared to when performing the tactical occupation workload in standard athletic attire.
- *Specific Aim 3* – To evaluate if firefighters will exhibit a significant alteration in gait patterning during a simulated tactical occupation workload while wearing personal protective equipment compared to when performing the tactical occupation workload in standard athletic attire.

Hypotheses

- *Hypothesis 2* – Firefighters will exhibit a significant elevation in markers of physiological stress during a simulated tactical occupation workload while wearing personal protective equipment compared to when performing the tactical occupation workload in standard athletic attire.
- *Hypothesis 3* – Firefighters will exhibit a significant alteration in gait patterning a tactical occupation workload while wearing personal protective equipment compared to when performing the tactical occupation workload in standard athletic attire.

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Research Methods & Study Design

- In two separate visits, each participant completes an exercise workload that briefly simulates the physiological demands of a first responder who has tactical-style occupation.
- While wearing proper testing attire, each participant completes a Simulated Fire Stair Climb (SFSC) by completing two consecutive 3-min workloads on a Matrix C7xe ClimbMill at a stepping rate of 60 steps/min.
  - A warm-up of 30 seconds at 50 steps/min was completed prior to the SFSC.
  - Following previously published protocols. (Garner et al., 2013; Huang et al., 2009; Morris et al., 2018)

➢ The only difference between conditions was the wearing of PPE (or no PPE). Determination of condition order is determined through counterbalancing and each visit is separated by at least 48 hours.

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Research Methods & Study Design

- During the SFSC, the following variables are measured:
  1. HR is measured continuously using a HR monitor.
  2. Rating of perceived exertion (RPE) is conducted at the end of each minute of exercise.
  3. Blood lactate (following the completion of each 3-min bout of exercise).
  4. Kinematic data (joint angles of the hip, knee, and ankle; gait patterning) recorded continuously (using reflective markers and video analysis) but evaluated at 6 evenly spaced time points throughout the bout.
  5. Center of pressure (COP) trajectory (using in-shoe plantar pressure sensors).
  6. Degree of plantar pressure (using in-shoe plantar pressure sensors).

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Research Methods & Study Design

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Research to Practice (R2P) Statement

- Based on data received by the National Fire Protection Association (NFPA) from responses to the 2016 National Fire Experience Survey, Haynes and Molis (2017) reported that an estimated 62,085 firefighter injuries occurred in the year 2016 alone, with 39.2 percent of these injuries occurring on the fire ground.
- While the leading cause of fire ground injuries in the 2016 survey was overexertion or strain (27.1 percent), another leading cause of injury was due to falls, jumps, or slips (21.0 percent) (Haynes & Molis, 2017).
- While the overall prevalence of firefighter injuries has declined in recent years compared with past rates, the number of injuries from slips, trips, and falls (STFs) has remained consistent and, therefore, accounts for a higher percentage of firefighter injuries.

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Research to Practice (R2P) Statement

- It should also be noted that injuries of this kind often result in a considerable amount of lost work time, creating expenses for the injured firefighter, the employer having to replace the firefighter during lost work time, and the insurer.

- When examining worker's compensation rates, it was found that an injury from a STF cost an average of $8,662 and a maximum of up to $174,394 to treat (Kong et al., 2013).
  - If one were to consider the estimated 5,108 fire ground injuries resulting from STFs in 2016 alone and the average cost of $8,662 to treat such injuries, it is shown that eliminating this type of injury could have saved over $44.2 million.

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QUESTIONS?

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