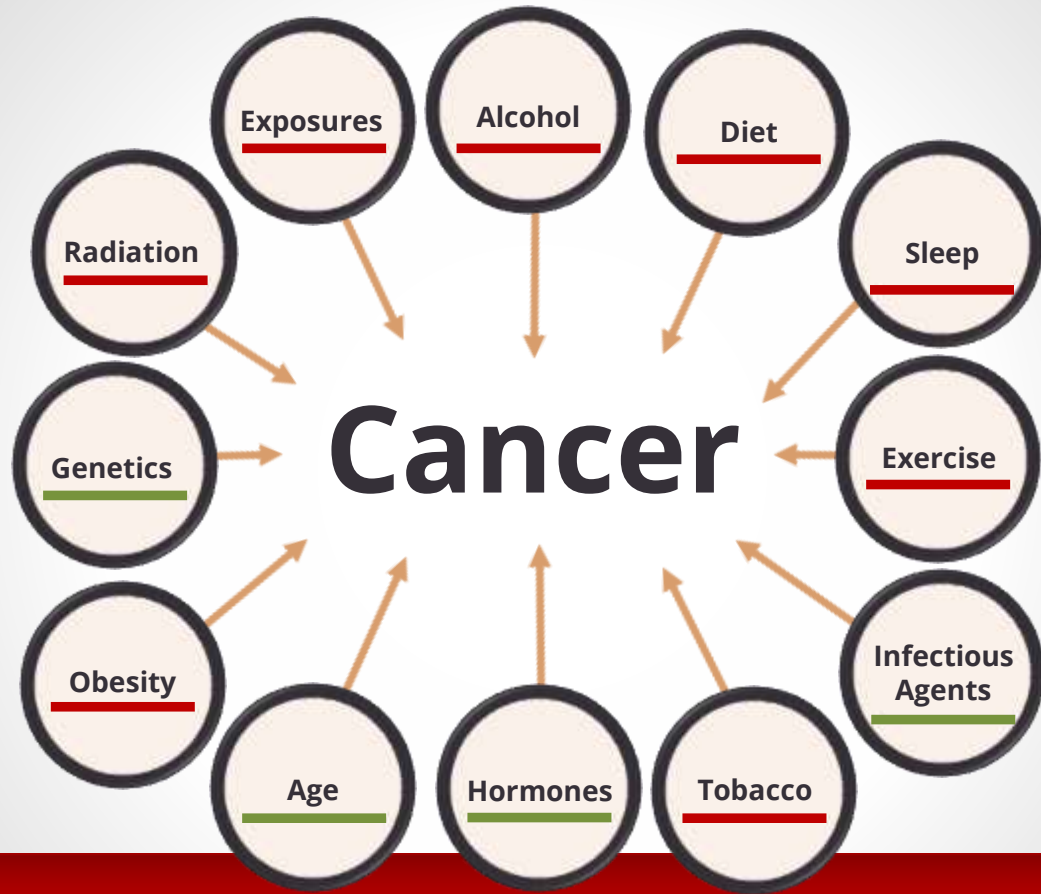


Risks Beyond the Fireground: How Everyday Choices Contribute to Cancer Risk

SARA A. JAHNKE, PH.D.

CENTER FOR FIRE, RESCUE & EMS HEALTH RESEARCH



Making the Case: Why Modifiable Risk Factors Matter



Case Summary

Workers Compensation Claim

| | |
|-------------------------|---------------------------------|
| Name | XXXX |
| Department | XX Fire Department |
| Diagnosis | Esophageal Adenocarcinoma |
| Age at Diagnosis | 53 |
| Age at Death | 54 |
| Ethnicity | White |
| Tobacco | Never |
| Alcohol | No alcohol |
| Obesity Status | BMI 31.8, worked out 3x week |
| Elevated Risks, Studies | Daniels, Tsai |
| Exposures Linked to Dx | PAH, Asbestos, Styrene, Benzene |

Document Review

- Medical records
- Depositions – department liabilities (e.g. physicals, mitigation, culture)
- SOGs/SOPs
- Exposure records

Obesity

- Fitness
- Nutrition

Alcohol Use

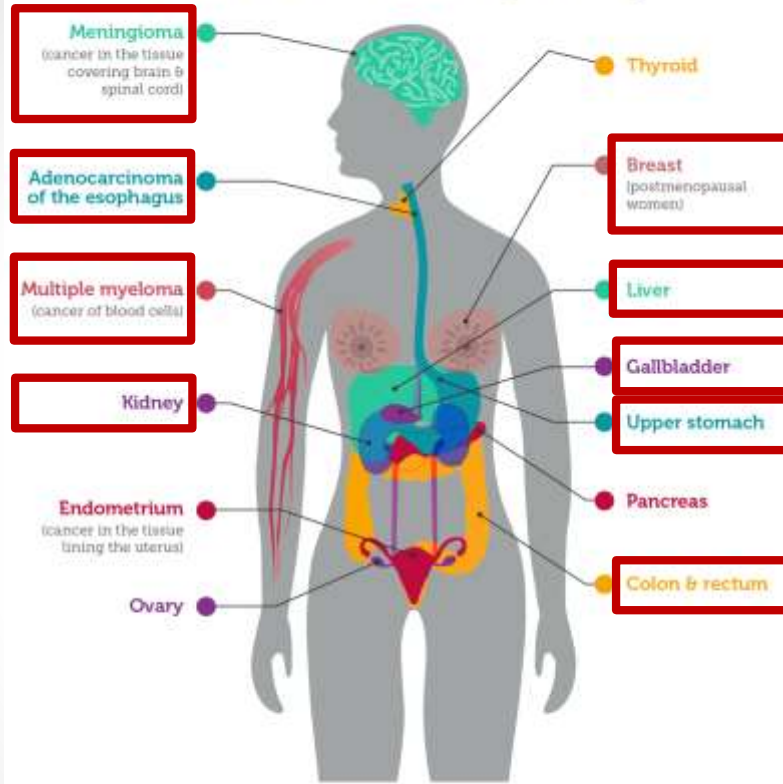
Tobacco Use

Sleep

Exposures



Cancers Associated with Overweight & Obesity



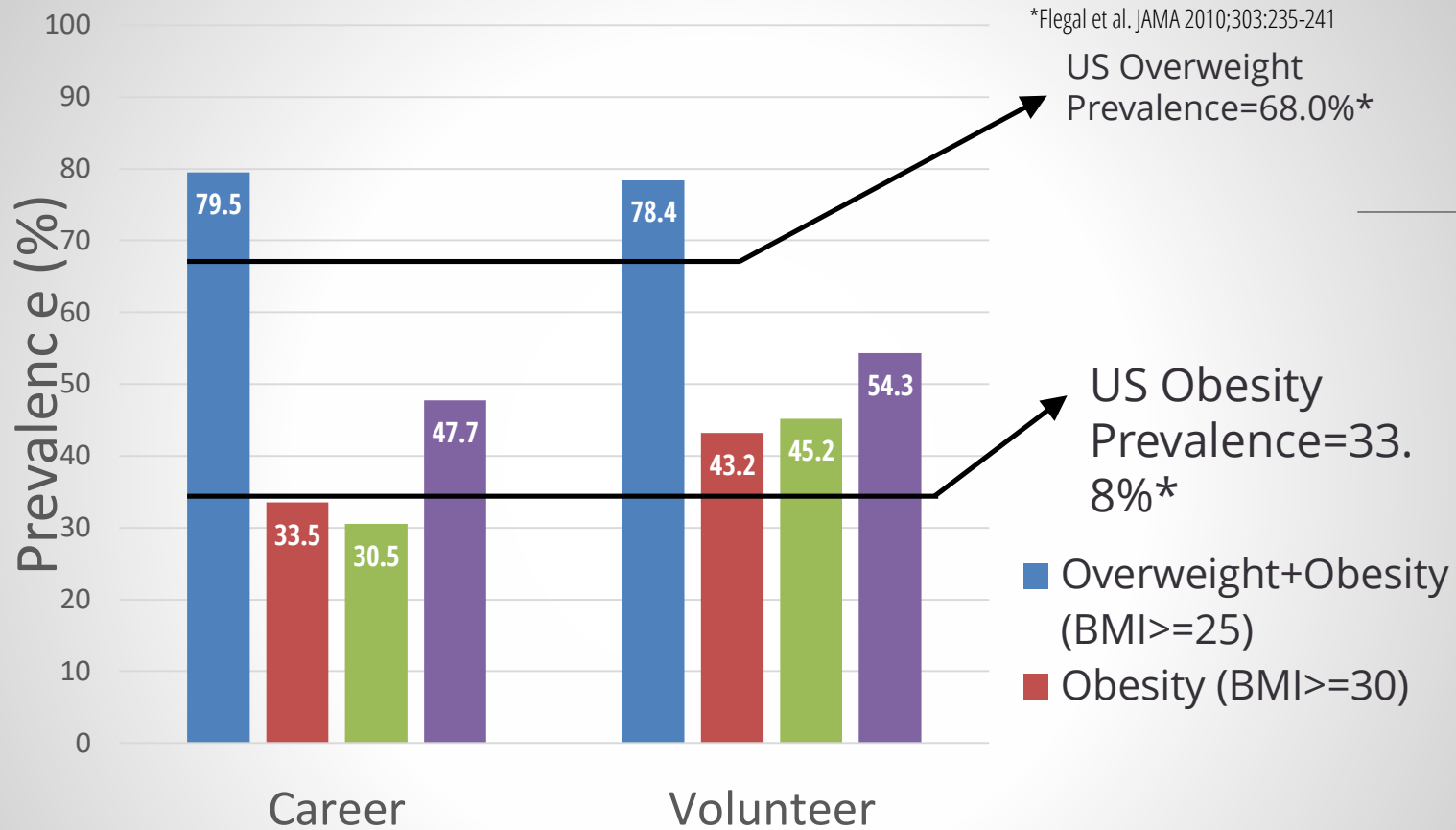
cancer.gov/obesity-fact-sheet

Adapted from Centers for Disease Control & Prevention

Cancers found to be elevated among firefighters in one or more studies (Daniels, LeMasters, Tsai, Ma)

Obesity & Cancer

| Cancer Type | Elevation in Firefighters | Elevation, Overweight/Obesity |
|-------------|--|---|
| Kidney | 27% higher (Daniels et al., 2013) | 28% higher/77% higher (Wang & Xu, 2014) |
| Esophageal | 62% higher (Daniels et al., 2013) | 54% higher/139%– 376% higher (Hoyo et al., 2012) |
| Liver | 30% higher mortality (Daniels et al., 2013) | 48% higher/83% higher (Chen et al., 2012) |



BMI (kg/m²)

- Overweight = BMI ≥ 25 and < 30
- Class I = BMI ≥ 30 and < 35
- Class II = BMI ≥ 35 and < 40
- Class III = BMI ≥ 40

Body Fat Percentage

- Men, BF% > 25
- Women, BF% > 30

Waist Circumference

- Men WC > 40 inches
- Women WC > 35 inches



Obesity and Body Composition of Firefighters



12.0 METS*



*Donovan R, Nelson T, Peel J, Lipsey T, Voyles W, Israel RG. Cardiorespiratory fitness and the metabolic syndrome in firefighters. *Occup Med (Lond)*. 2009;59:487-492.

Is BMI a Perfect Indicator of Body Composition?

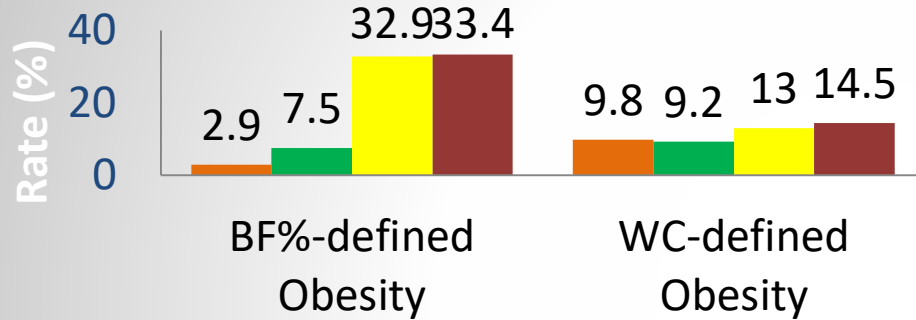


Ronnie Coleman, Mr. Olympia x 8
Height= 5'11", Weight= 295
BMI=41.1



Approximate BMI > 40.0

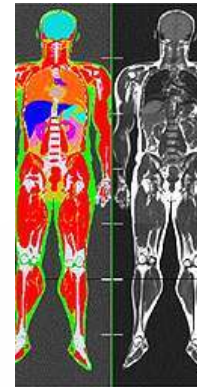
Is BMI Inaccurate in Career Firefighters?



- FIRE False Positives
- F2F False Positives
- FIRE False Negatives
- F2F False Negatives



False Positive = “High BMI, Low Body Fat” – BMI says they are obese, but body fat or WC says they are not



False Negative = “Skinny Fat” – BMI says they are normal, but body fat or WC says they are obese

Addressing the Epidemic of Obesity in the United States Fire Service

A Report Prepared for the National Volunteer Fire Council



Reasons

Nutrition Environment in the fire house
Irregular eating, portion size, traditions,
availability

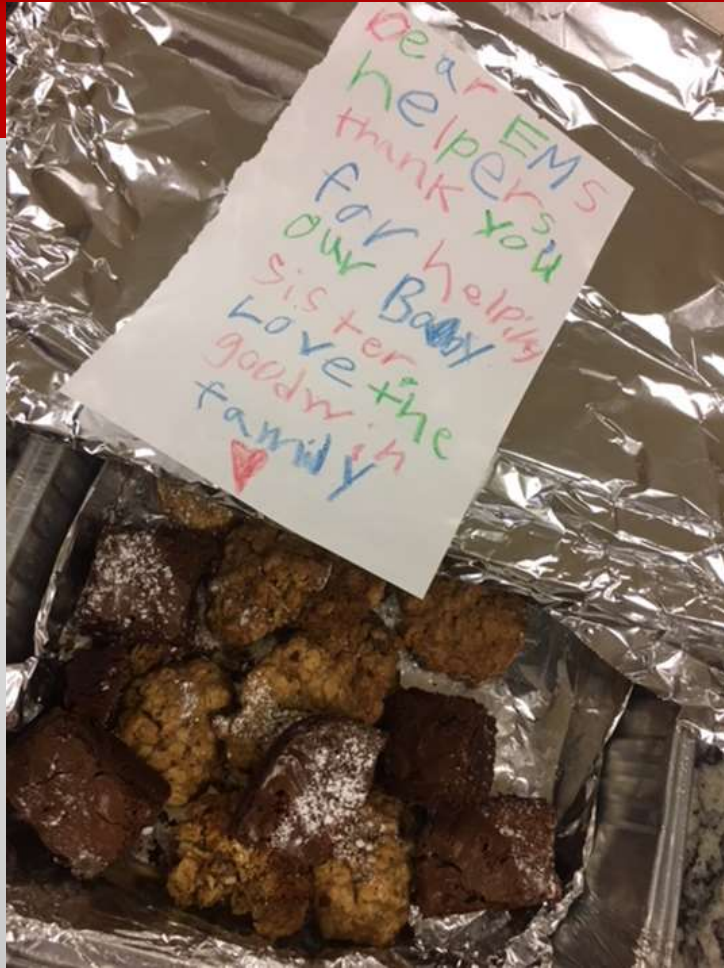
Metabolic impact of shift work

Lack of support for physical activity

Time constraints for healthy behaviors

Behavioral health concerns

Eating = coping?



- Irregular eating patterns
- Traditions
- Food availability

Meals as Bonding



"...just eating with them on those days I put on some weight and it's very difficult to do that because part of the fire service family is built around that kitchen table. That's where it takes place. That's where real problems are solved."

"Yeah, at some stations, just everybody just brings their own food in...You know, they have problems in their groups and they don't seem to cook up as much...just like guys that don't get along together."

Best Potato Soup - Feeds 6-8 people or 4-6 firefighters

- 4 Cups potatoes, diced but unpeeled
- 1/4 LB butter
- 2 Cups finely diced yellow onions
- 1/2 Cup flour 1 Quart warm water
- 1/4 Cup chicken bouillon
- 1 Cup potato flakes
- 4 Cups half and half
- 1/2 tsp. Tabasco sauce
- Salt, Pepper, Garlic powder and Dried Basil to taste

Sauté onions in melted butter for 10 minutes in large kettle.

Add flour to onions and butter and cook for 5 minutes, stirring until flour is absorbed.

In a separate container combine, water, chicken bouillon, potato flakes, and seasonings.

Stir until no lumps remain.

Add to onion mixture, 1 cup at a time.

Add half and half, stirring until smooth and lightly thickened.

Reduce heat and simmer for 15 minutes.

In a separate pan, the potatoes should be covered with water and brought to a boil, and simmered for 20 minutes.

Drain potatoes and add to soup to complete. If too thick for taste, milk may be added to thin down.

Serve with chopped green onions and cheese ! sprinkled on top.

Cook time approx. 40 minutes

Top 6 Sources of Calories

#1



#3



#5



#2



#4



#6



Alcohol & Cancer

| Cancer Type | Elevation in Firefighters | 3.5+ drinks/day |
|-------------|---|---|
| Colon | 14% higher (Jalilian et al., 2019) | 25% higher (McNabb et al., 2019) |
| Esophageal | 59-62% higher (Tsai et al., 2015; Daniels et al. 2013) | 213% higher hazard ratio (Choi et al., 2017) |

1 drink =

12 fl oz of
regular beer

=

5 fl oz of
table wine

=

1.5 fl oz shot of
80-proof spirits
(whiskey, gin, rum,
vodka, tequila, etc.)



about 5%
alcohol



about 12%
alcohol




about 40%
alcohol


WHAT IS BINGE DRINKING?

CONSUMING ALCOHOL
UNTIL THE BLOOD-ALCOHOL
CONCENTRATION LEVEL IS

0.08%
OR MORE.



THIS USUALLY
MEANS **FIVE OR
MORE** DRINKS IN A
SINGLE OCCASION
FOR MEN



AND **FOUR OR MORE**
DRINKS FOR
WOMEN, GENERALLY
WITHIN ABOUT TWO
HOURS.

SHORT REPORT

Alcohol use among firefighters in the Central United States

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| | |
|--------------------|--|
| Background | Although the US National Fire Service is concerned about alcohol use among firefighters, little research has been conducted on the topic. |
| Aims | To survey alcohol use patterns among career and volunteer firefighters. |
| Methods | Data were from a population-based cohort study of male firefighters conducted in randomly selected career and volunteer departments. Data were collected from 2008 to 2010. |
| Results | There were 656 participants from 11 career and volunteer 15 departments included in the study with a response rate of 97%. Career firefighters drank approximately 10 days per month (just about half of their off duty days) and drank relatively heavily on those days. Fifty-eight per cent of career and 40% of volunteer firefighters averaged three or more drinks and similar percentages reported binge drinking on the days they consumed alcohol. In general, firefighters who drink but did not binge drink tended to have the best health outcomes, while those who binge drink typically were at highest risk of negative health outcomes. Nine per cent of career and 10% of volunteer firefighters who drink self-reported driving while intoxicated in the previous 30 days. |
| Conclusions | Given the high rates of heavy and binge drinking, local and nationally coordinated efforts to increase the surveillance of drinking behaviour among firefighters and the development of targeted prevention interventions are critically needed. |
| Key words | Drinking, fire service, health. |

Introduction

Studies demonstrate a J-shaped relationship between alcohol intake and health, where moderate use is protective, while heavy consumption results in negative outcomes. Heavy alcohol use is associated with injuries [1], neurological impairment [2], social problems [3], liver disease [4] and cancer [5]. Given their critical role in public safety, the National Fire Service (NFS) is concerned about alcohol use by firefighters [6]. This study provides the first population-based examination of patterns of alcohol use in the NFS.

Methods

The data are from a large cohort study examining risk factors for injury among firefighters in the International Association of Fire Chief's Missouri Valley Region (Colorado, Iowa, Kansas, Missouri, North Dakota,

Nebraska, South Dakota and Wyoming). Data were collected in 2008–10. Sampling methodology are presented in detail in a previous report [7].

The protocol was approved by the National Development and Research Institute Review Board. Eleven career and 11 volunteer departments were randomly selected and contributed data to this study. The research team met with crews to overview the project, and of firefighters solicited, 97% agreed to participate. The survey was confidential and no individual results were provided to the department. Given the very small number of females, only data from male firefighters are presented.

Measurement items were modelled after previous occupational surveys. Items included the following: alcohol use—'During the past 30 days, have you had at least one drink of any alcoholic beverage such as beer, wine, a malt beverage, or liquor?'; amount drunk—'During the past 30 days, on the days when you drank, about how many drinks did you drink on the average?';

Binge Drinking

- 56% career
- 45% volunteers

About 10% of firefighters reported driving while intoxicated in the past month

Survey (All participants)

Heavy Drinking: 44.7%

Binge Drinking: 50.2%

Average daily intake: 3.5 drinks



Dietary Recall (Off duty days)

Beer Drinks: 3.9

Wine Drinks: 2.0

Liquor Drinks: 6.8

Calories from alcohol:

Average = 551.4 kcals

Range = 12.5 to 3,404

Shift Schedule: “One thing that's different with us, though, I mean we work ten days a month, so we got a lot of days that we don't work the next morning. That's one reason why - maybe that's my excuse, I don't know.” Firefighter, Career

Camaraderie: “I use it as an excuse to unwind on the four days, you know what I mean? You get together in a big group, go out, have a drink, tell war stories, laugh about stuff we did. Just act - act like exactly we did at the station, except do it with beer - with a drink.” Firefighter, Career

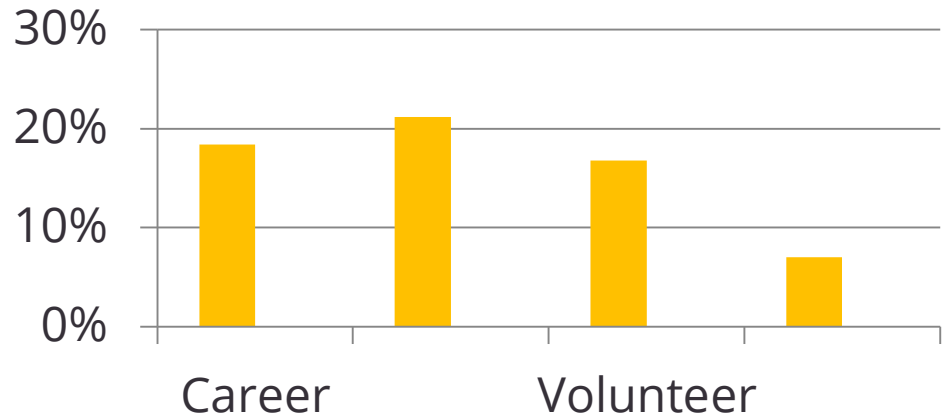
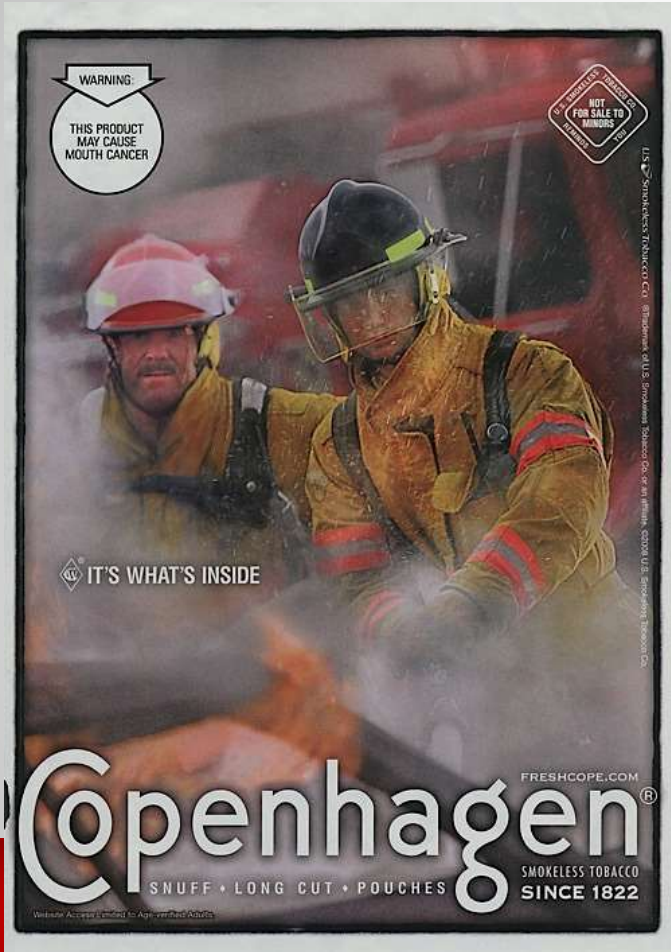
Stress Management: “The stress of the job...when you get off...you want something that will help you unwind.” Firefighter, Career

Tradition: “They (firefighters) all seem to be social and if you look back throughout the history of the fire service when my great grandfather was on up through the ranks what's union hall if there wasn't an open bar or a party somewhere.” Chief, Career

Alcohol Use Reasons

**“Tobacco is the leading cause
of cancer and death from cancer.”**

~ National Cancer Institute



SLT Users Were:

- Younger
- Had fewer years in the Fire & Emergency Services
- A small percent (15.7%) used because of departmental restrictions on smoking

Tobacco Use Among Firefighters in the Central United States

C. Keith Haddock, PhD,¹ Nattinee Jitnarin, PhD,² Walker S.C. Poston, PhD, MPH,¹ Brianne Tuley, BS,¹ and Sara A. Jahnke, PhD¹

Background: This study provides a comprehensive, population-based examination of tobacco use among both career and volunteer firefighters.

Methods: Data are from a population-based cohort study of randomly selected career ($N = 11$) and volunteer ($N = 11$) departments comprised of 677 male firefighters.

Results: Unadjusted rates of smoking were 13.6% and 17.4% for career and volunteer firefighters, respectively. Smoking rates were less than a comparable occupational group (military personnel) and adult males in the states represented. Smokers were more likely to have been diagnosed with an anxiety disorder (OR = 5.8; $P = 0.010$), have an elevated CAGE alcohol problem score (OR = 2.9; $P = 0.040$), and more likely to report driving after drinking too much (OR = 4.3; $P = 0.020$) compared to never-smokers. Large percentages of career (18.4%) and volunteer (16.9%) firefighters used smokeless tobacco.

Conclusions: Smoking among firefighters is associated with other significant health and safety risks. High rates of smokeless tobacco use suggest that the fire service is an important target for intervention. Thus, despite strong statements against smoking by the fire service, the need to maintain high levels of health and fitness and relatively low smoking rates, a significant proportion of firefighters continue to use tobacco products. *Am. J. Ind. Med.* © 2011 Wiley-Liss, Inc.

KEY WORDS: firefighters; fire service; tobacco; smoking; cigarettes; cigars; smokeless

INTRODUCTION

Firefighters are a vital component of our nation's emergency and disaster response systems and are charged with protecting the citizens and property in the communities they serve. The nature of this profession makes firefighting a physically and mentally demanding occupation.

Firefighters must respond to emergencies on a moment's notice and often face dangerous and challenging work conditions. Because of this, there has been a strong emphasis on health promotion in the fire service, including encouraging firefighters to be tobacco free. For instance, the Fire Service Joint Labor Management Wellness Fitness Initiative (WFJ, 2006), the national model for health promotion in fire departments, suggests that all departments adopt the following policies toward tobacco use:

All new fire department candidates shall be tobacco free upon appointment and throughout their length of service to the department.
Current fire department uniformed personnel shall not use tobacco products (cigarettes, cigars, and/or chewing tobacco) inside the work-site, within or on fire department apparatus, or inside training facilities.

¹Center for Fire, Rescue, & EMS Health Research, National Development and Research Institute, Inc., Loveland, Colorado
²Contract grant sponsor: Federal Emergency Management Agency in the Department of Homeland Security (Contract grant number: FEMA-2007-PP-02071)
³Contract grant sponsor: Dr. C. Keith Haddock, PhD, Center for Fire, Rescue, & EMS Health Research, National Development and Research Institute, Inc., 3032 West 104th Street, Suite 105, Loveland, CO 80537. E-mail: haddock@firehealth.com; haddock@nldr.org

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DOI 10.1002/ajim.21917; Published online 6 May 2011 in Wiley Online Library (wileyonlinelibrary.com).



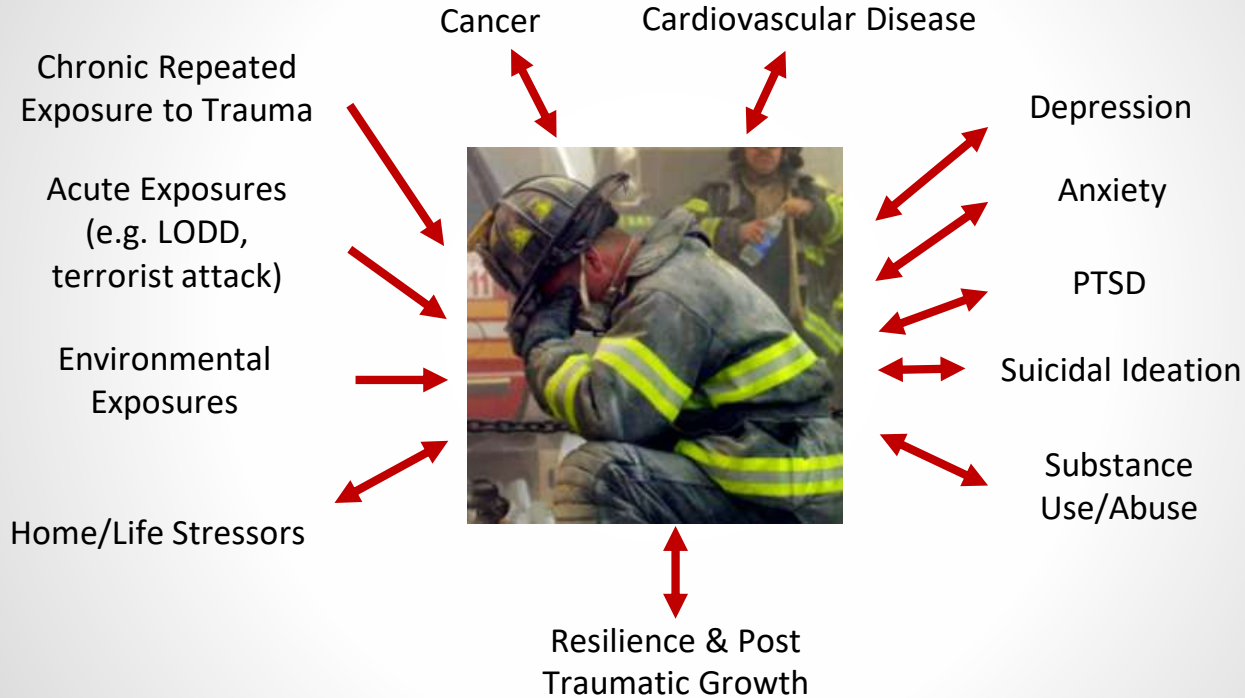
Unadjusted Rates of Current Smoking
13.6% for Career Firefighters
17.4% for Volunteer Firefighters



“Your worst
day is our
everyday”

~Into the Fire (2005)

Behavioral Health



Shift Work/Sleep/Circadian Rhythm Disruption

HERO!



Hero vs. Heroic

Firefighting and mental health: Experiences of repeated exposure to trauma

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Received 9 October 2013

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Abstract.

BACKGROUND: Firefighters must be ready to respond to a broad range of emergencies every day. In the course of many of these emergencies, firefighters witness events which have the potential to induce emotional trauma, such as badly injured people, deceased children, and individuals who are highly distraught. Previous research suggests that repeated exposure to these traumas (RET) may have negative impacts on the emotional and mental health of fire service personnel. Research on the mental health of firefighters has been limited to small surveys reporting the prevalence of specific mental health problems such as depression and post-traumatic stress disorder among firefighters.

OBJECTIVE: Despite the likelihood that RET leads to negative outcomes in firefighters, data is lacking on how exposure impacts fire service personnel. The current study examines the experiences of firefighters related to RET.

METHODS: Using formative research methods, we examined the beliefs and experiences of firefighters and administrators from across the United States regarding the impact of RET on firefighter health.

RESULTS: Study findings highlight the cumulative psychological toll of repeated exposure to traumatic events including desensitization, flashbacks, and irritability.

CONCLUSION: Results of the current study suggest that RET is a significant concern for emergency responders that warrants additional research and attention. It is likely that the long term consequences of RET are closely intertwined with other mental health outcomes and general well-being of this important occupational group.

Keywords: Firefighters, mental health, depression, post-traumatic stress, trauma, EMS

1. Introduction

With significant declines in the number of fires nationally over the past several decades (e.g., only 5% of calls being were actual fires in 2011; [1]), firefighters' responsibilities have shifted from primarily engaging in fire suppression activities to include a broad range of emergency response operations. Present-day firefighters are responsible for

rescue operations, hazardous materials management, responding to natural disasters and domestic attacks, and providing emergency medical services. Medical calls typically include a range of needs from simple sprains and strains on a baseball field to wide variety of potentially traumatic events including a parent who is experiencing a heart attack, a child who has drowned in a swimming pool, a car accident that has mutilated an adolescent, a fire with possible trapped victims, or a terrorist attack. A common saying in the fire service, as quoted by the 2005 documentary *Into the Fire* is that "Your worst day is our everyday" [2]. Not surprisingly, it has been suggested that regular exposure to these events may have a negative psychological toll on firefighters' mental health.

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"..just the stress that follows stress. You know, just any call that day that's hard to shake and you collect that over a career. You know, it doesn't go away." ~ Career, Chief

"We had an accident on one of our main highways where we were working to try to get this car open, and the lady died before we could open it. It goes home with you. I mean, you don't stop thinking about it ever. I mean, there's not a day that goes by in my life where I don't close my eyes and think about every person we've lost."

Volunteer, Firefighter

Desensitization



“Well, I mean, after you see enough people die and enough carnage, you go, "Oh well." And then, you don't really reflect on it much. You know? You don't really say, "Oh, that's terrible." Like my wife will say, "Oh, that's horrible." You know? And I'm like, going... How do respond to that? You know? Well, I mean, you start getting...cold.” ~Career, Firefighter

“You just get numb to it. You go to these stuff and you don't - don't let it bother you.” ~Career, Firefighter

Flashbacks

"I know that for myself, my calls, like at the very beginning of when I started this or when I started EMS, like I'll get flashbacks or something. One little thing, like I'll see a little kid or something and I'll remember that from a call that I had when I was, um, you know, 18 or 19 years old.

~Career, Firefighter

"I can say that, I think one part for me, because I'm a medic, and a lot of times I go on a call ...from store to store. I've visualized a person that was laying there dead. That's a problem for me a lot of times. I remember how this man was laid out and he was out. And - and, so every time I go to the bank, I visualize him dead. Or, I go to a store when I drive past the store, I'm like, "Oh, that's where that person got shot in the leg." Or, "That's where that baby got hit," or "That's where..." I tend to associate people with buildings." ~Career, Firefighter



Cynicism



“I think dealing with, like, dealing with, like, rough and tough city people, it just makes you way more cynical in your personal life. You're - I'm far more aggressive with people than I was five years ago. I - I was happy go lucky. I don't care what they're doing. Now, it's like somebody can really just set me off.” ~Career, Firefighter

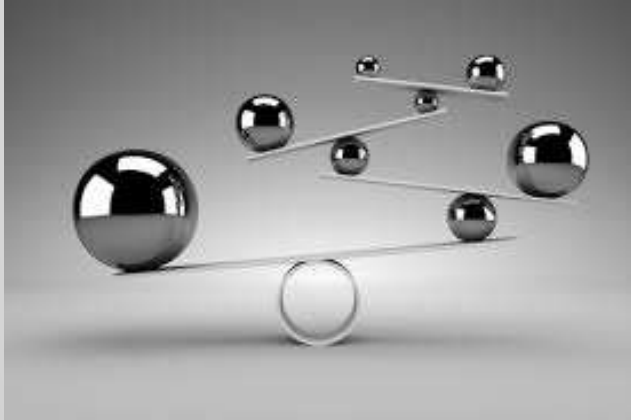
Family & Social Impact

"I think you get desensitized to a lot more than that because you know, being here, you actually see stuff that's actually an emergency. And then, you know, I go home, and the girlfriend completely freaks out because, "Holy crap! We forgot milk at the store!" And if - we get in fights all the time because she freaks out about stuff and I'm just like, "Are you - are you serious?" So, I think that - that affects your life just - I know like XXXX was said, it's, you kind of get desensitized." ~Career, Firefighter



"So, when something happens outside this job, your reaction is a stark contrast to what your spouse or family would think a normal person's reaction would be, therein lies some conflict sometimes. You know, like, you don't think this is a big deal because to you, it's not. It's not an emergency to you, but, you know, everyone's perception of what an emergency is different for them. So, I've gotten into some issues just in - over my reaction or lack thereof of a reaction to something when it should have been much bigger. I should be really upset, and I'm not." ~Career, Firefighter

Other Considerations



Serving in one's own community

Current life experiences

Current/past military service

Coping



“I've had a number of my friends ask me how I can do this and do it for so many years. And the way I describe it is, I can go to the scene, and I - I draw a curtain across the event, and like, put the event behind that curtain. But like, it was just mentioned, once in a while that event comes out from behind the curtain. And there's a couple of events that I've dealt with a gentleman here that will never be gone. And, because, you know, the curtain's there, but things just sneak through.” ~Volunteer, Firefighter

“we might see an incident where somebody's shot up or somebody's, you know, lost a limb or - we see all these - these things that people consider extremely gruesome, but we get up and go look at it and come back and eat dinner. You know? And when you really, really think about it, that's kind of, like, not normal. So, we all have this - we all have our ways of coping, whether we want to believe it or not.” ~Career, Firefighter

“You just replay it nonstop in your head thousands of times and it finally just gets easier.” ~Career, Firefighter

| Variable | Tertiles of Harassment-Discrimination Severity | | | p-value |
|--|--|-----------------|---------------|---------|
| | Low n=603 | Medium n=578 | High n=592 | |
| Demographic Characteristics | | | | |
| Age (years; M±SD) | 40.3±9.2 | 40.4±8.9 | 39.8±8.9 | 0.452 |
| Race (% White, Non-Hispanic) | 86.3 | 88.7 | 86.6 | 0.420 |
| Marital Status (% Married, domestic partnership, or civil union) | 56.0 | 58.7 | 51.8 | 0.059 |
| Sexual Orientation (% Heterosexual) | 79.8 | 81.3 | 77.1 | 0.204 |
| Education (% At least some college or higher) | 95.0 | 97.2 | 96.7 | 0.117 |
| Income (% \$50,000 or more) | 91.1 | 91.5 | 88.4 | 0.146 |
| | | | | |
| Occupational Characteristics | | | | |
| Years in the Fire Service (years; M±SD) | 13.4±8.1 | 13.7±8.0 | 13.7±7.6 | 0.783 |
| Rank (% Any firefighter rank) | 71.5 | 67.6 | 69.8 | 0.452 |

| Variable | Tertiles of Harassment-Discrimination Severity | | | p-value |
|---|--|-----------------|---------------|---------|
| | Low n=603 | Medium n=578 | High n=592 | |
| 1. Physical Health | | | | |
| Obesity (% BMI _≥ 30 kg/m ²) | 13.5 | 14.5 | 12.6 | 0.653 |
| Number of Poor Physical Health Days (M±SD) [¥] | 2.8±6.7 | 2.9±6.7 | 4.0±7.3 | <0.001 |
| Injuries Reported in Last Year (% 1 or more) [*] | 36.8 | 44.1 | 56.3 | <0.001 |
| | | | | |
| 2. Mental Health | | | | |
| Current Depression (CESD-10 Depression Cutoff; % _≥ 4) [*] | 15.1 | 23.6 | 43.3 | <0.001 |
| Current Anxiety Symptoms (MHI Anxiety Score Total; M±SD) ^{**} | 16.4±6.5 | 17.7±5.9 | 21.1±7.6 | <0.001 |
| Current PTSD Symptoms (TSQ Cutoff; % _≥ 6) [*] | 6.9 | 8.5 | 16.5 | <0.001 |
| | | | | |

| Variable | Tertiles of Harassment-Discrimination Severity | | | p-value |
|--|--|-----------------|---------------|---------|
| | Low n=603 | Medium n=578 | High n=592 | |
| 3. Health Behaviors (Substance Use, Physical Activity) | | | | |
| CAGE Cutoff (%\geq2)* | 13.4 | 18.6 | 19.2 | 0.027 |
| Binge Drinker (% yes) | 45.5 | 52.9 | 47.4 | 0.056 |
| Drove While Intoxicated (% yes)* | 2.2 | 5.7 | 4.4 | 0.014 |
| Smoke Cigarettes (% current) | 4.0 | 5.9 | 4.8 | 0.120 |
| Smokeless Tobacco Use (% current) | 1.5 | 1.2 | 1.2 | 0.846 |
| Physical Activity Level (SRPA; M\pmSD) | 5.7 \pm 1.4 | 5.5 \pm 1.5 | 5.5 \pm 1.5 | 0.787 |
| | | | | |
| 5. Family Well-Being | | | | |
| Role as a Firefighter Places Stress on Family (% agree/strongly agree)* | 24.0 | 32.3 | 55.1 | <0.001 |

| Variable | Tertiles of Harassment-Discrimination Severity | | | p-value |
|--|--|-----------------|---------------|---------|
| | Low n=603 | Medium n=578 | High n=592 | |
| 4. Job Outcomes (Efficacy/Stress/Satisfaction) | | | | |
| FFSE Score Total (M±SD)** | 118.8±14.3 | 115.4±12.3 | 113.8±13.0 | <0.001 |
| How Much Stress at Work (% a lot)* | 16.7 | 23.4 | 40.3 | <0.001 |
| Stress Interferes With Work (% a lot)* | 1.0 | 1.7 | 6.4 | <0.001 |
| Optimistic about future success in fire department (% agree/strongly agree)* | 82.1 | 71.4 | 51.5 | <0.001 |
| Satisfied with job in fire department (% agree/strongly agree)* | 89.2 | 80.0 | 59.9 | <0.001 |
| Happy with choice to be a firefighter (% agree/strongly agree)* | 93.4 | 90.1 | 84.3 | <0.001 |
| Would recommend being a firefighter to other women (% agree/strongly agree)* | 82.6 | 72.9 | 59.7 | <0.001 |
| Happy to spend the rest of career with fire department (% agree/strongly agree)* | 88.7 | 77.3 | 59.3 | <0.001 |

Shift Work & Cancer

Policy Watch

Carcinogenicity of shift-work, painting, and fire-fighting

On 17 October 2002, 22 scientists from ten countries met at the International Agency for Research on Cancer (IARC), Lyon, France, to assess the carcinogenicity of shift work, painting, and fire-fighting. These assessments will be published as volume 88 of the IARC Monographs.

Since 15,000 of the working population in Europe and the USA is engaged in shift-work that involves nightwork, which is most prevalent above 5000 in the health-care, industrial manufacturing, mining, transport, communications, fishing, and hospitality sectors. Among the many different patterns of shift work, those involving nightwork are the most disruptive to the circadian clock.

In a night epidemiological studies have shown a significant increase in mortality in those engaged in shift work at night. This risk is consistently increased in all cancer sites in long-term exposures compared with those who are not engaged in shiftwork at night. These studies are limited by potential confounding and inconsistent definitions of shift work with several focused on a single profession. The incidence of breast cancer and the mortality increased in most cohorts of female firefighters' who also experience circadian disruption by frequently working time zones. Limitations of studies in these high-attention include the potential for detection bias (high measures of exposure and potential confounding) and lack of information by reproductive factors and genetic factors.

Several different rodent models have been used to test the effect of disruption of the circadian system on tumour development. More than 20 studies investigated the effect of constant light, the light at night, constant darkness (during or interruption) of carcinogen, and they showed a major increase in tumour incidence. The clear effect was seen for light administration in constant darkness. A similar number of studies investigated the effect of reduced restricted melatonin concentrations, as revealed by the pineal gland, but evidence is not clear in tumour development and most showed increases in the incidence or growth of tumours.

Exposure to light at night disrupts the circadian system with alterations of sleep and body patterns, suppression of melatonin production, and disruption of circadian gene-mutated systems (circadian pacemaker) of the circadian Period gene. By promoting tumour development in mice and human breast and endometrial tumours, the suppression of melatonin is considered to be a critical mechanism. Exposure can lead to changes in the epigenetic profile of the human, sleep deprivation and the evening melatonin suppression lead to carcinogenicity. In the context of sleep deprivation exposure, epidemiological studies and changes in the pineal gland system are also considered.

On the basis of limited evidence in humans for the carcinogenicity of shiftwork that disrupts circadian rhythms and melatonin secretion in experimental animals for the carcinogenicity of light during the dark period (biological night), the Working Group concluded that shift-work that involves circadian disruption is probably carcinogenic to humans (Group 2A) (Straif et al., Lancet Oncol, 8:1065-66, 2007).

Shift Work
by Richard Stevens: PhD

Citation for most recent IARC review
IARC Monograph 98, in preparation

Current evaluation
Conclusion from the previous Monograph:
On the basis of "limited evidence in humans for the carcinogenicity of shift-work that involves nightwork", and "sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night)", the Working Group concluded that "shift-work that involves circadian disruption is probably carcinogenic to humans" (Group 2A) (Straif et al., Lancet Oncol, 8:1065-66, 2007)

Exposure and biomonitoring
Exposure to 'Shift Work' is common in the industrialized world (Costa, 2003), and increasing in prevalence worldwide. About 27% of the European Union work force works an evening shift 5 or more evenings per month, and about 10% work the night shift 5 or more nights per month (EWCS, 2005). The sectors with the highest percentage of workers on a non-day shift are Hotels and Restaurant, Agriculture, Health, and Transport and Communication. Of all workers, about 6% are on a permanent non-day shift whereas about 8% are on a rotating shift schedule. In the United States about 15% of workers are on non-day shifts, with 3.2 % on night shift and 2.5% on rotating shifts (BLS, 2004). Although there is less variability in number of hours worked per week among non-day shift workers compared to day workers, there is also considerably less autonomy on the job.

Occupational exposure
The 'exposure' is by definition occupational. However it is based on a theory that light at night (LAN) would disrupt circadian rhythms and that this disruption might increase cancer risk.

Environmental exposures
Other exposures to LAN are many and include short sleep duration, late-night reading or television, nocturnal awakening and consequent exposure to light for example in the bathroom, strong street lights at night shining thru the window shade of the bedroom.

May be due to interruption of circadian rhythms

Suppression of melatonin at night

World Health Organization – Shift work is "Probable Carcinogen"



World Health Organization

Sleep & Cancer



- Irwin et al.
 - Healthy young men
 - Single night of 4 hour sleep
 - 70% decrease in natural killer cells in immune system
- Shift work found to increase risk of breast cancer, prostate cancer, cancer of the uterus, colon cancer
- Sympathetic nervous system turned on leads to inflammation
- **Who routinely sleeps less than 6 or 7 hours a night?**
 - Diminishes immune system
 - Doubles risk of cancer

Maternal and Child Health Among Female Firefighters in the U.S.

**Sara A. Jahnke, Walker S. C. Poston,
Nattinee Jitnarin & Christopher
K. Haddock**

Maternal and Child Health Journal

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- Recent research: Miscarriage rates amongst female firefighters were at least 2.3 times higher among firefighters compared to the U.S. National average of 10% (Jahnke, 2018)
- Preterm birth was higher among female firefighters than the general population

Original Contribution

Infertility in a Cohort of Male Danish Firefighters: A Register-Based Study

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Our aim in this study was to examine infertility among male firefighters in Denmark. Thus, we established a cohort of 4,710 past and present male Danish firefighters through personnel and membership records obtained from employers and trade unions. Information on vital status and infertility from the Danish Civil Registration System, the In Vitro Fertilization Register, and the National Patient Register for the period 1984–2017 was linked to cohort members using their Danish personal identification numbers. Hazard ratios and corresponding 95% confidence intervals were estimated for male-factor infertility and overall infertility through Cox regression analyses comparing the firefighters with 2 reference groups: a sample of employees and military men. Among the full-time firefighters, the risk of male-factor infertility was increased in comparison with the sample of employees (In Vitro Fertilization Register model: hazard ratio = 1.46 [95% confidence interval: 1.10, 1.94]; National Patient Register model: hazard ratio = 1.53 [95% confidence interval: 1.18, 1.98]). Results were less consistent using the military men as the reference group. Further, the increase in infertility seemed restricted to duration of time employed as a firefighter. No increase in risk of either male-factor infertility or overall infertility was seen among the part-time/volunteer firefighters. Thus, full-time firefighting was associated with a greater risk of being diagnosed with male-factor infertility in our cohort.

cohort studies; firefighters; heat; infertility; occupational exposure

Abbreviations: CI, confidence interval; CPR, Central Person Register; HR, hazard ratio; ICD-8, *International Classification of Diseases, Eighth Revision*; ICD-10, *International Classification of Diseases, Tenth Revision*; IVF, In Vitro Fertilization; NPR, National Patient Register.

In the line of duty, firefighters face a wide range of imminent and obvious threats to both safety and health. While exposure at the scene of a fire potentially involves a multitude of different chemicals, several commonly present compounds have documented reproductive toxicity in humans (1, 2). In addition, firefighters are frequently at risk of hyperthermia—either by being directly affected by the heat from fires, during strenuous physical activity while wearing heavy turnout gear, or through subsequent use of saunas for chemical detoxification (3). Resulting genital heat stress may impair spermatogenesis and ultimately the quality of semen in males (4). Finally, emotional strain and night-shift work may also hypothetically influence fertility among firefighters (3).

Despite potential occupational exposure to reproductive hazards, no existing studies have specifically explored infertility among firefighters, to our knowledge. Only a few countries in the world have the advantage of nationwide registers with

individualized information on measures of infertility. In Denmark, all fertility treatments administered in both public and private clinics are registered through a mandatory and virtually complete reporting system (5). Fertility treatments in Denmark are generally free of charge, with a female age limit of 40 years and a restriction on use of in vitro techniques to couples without common children (5). Referral for treatment follows the internationally accepted clinical definition of infertility as failure to conceive after 1 year of trying (6). In addition, the Danish National Patient Register (NPR) contains information on sterilization procedures, conditions potentially related to infertility, and actual diagnoses of infertility from hospital contacts (7, 8).

Thus, our aim in this study was to examine infertility in relation to occupational firefighting exposure in a cohort of male Danish firefighters, through the use of data from several objective national registers.



In Vitro
Fertilization
Register model:
Hazard ratio =
1.46 (95%
confidence
interval: 1.10,
1.94)