Knowledge, Behaviors, and Attitudes Related to Gear Cleaning Among Central North Carolina Firefighters

by

Jean Gleason

Duke Global Health Institute

Duke University

Date: _____

Approved:

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Truls Østbye, Supervisor

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Laura Fish

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Kearsley Stewart

_____

Candice Johnson

Thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science in the Duke Global Health Institute
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ABSTRACT

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Abstract

Background: Persistent organic pollutants, combustion byproducts, and chemical contamination are just some of the occupational hazards that firefighters are exposed to both from dermal exposure when responding to fires and from contamination of their own personal protective equipment (PPE). Although the National Fire Protection Association (NFPA) 1851 PPE Care and Maintenance guidelines provide recommendations about how firefighters should clean their gear after a fire, there is variability in gear cleaning, and current gear cleaning practices are less than optimal. Understanding potential influences of knowedge, behaviors, and attitudes such as each fire department's resources, shift logistics, and culture is a critical step in developing policies and interventions to improve gear cleaning practices. The aims of this study were: 1) to describe gear cleaning knowledge, behaviors, and attitudes among North Carolina firefighters, and 2) to explore demographic factors related to knowledge, behaviors, and attitudes.

Methods and measures: 5 firehouse departments in North Carolina were surveyed for their gear cleaning attitudes, behaviors, and knowledge. 4 linear regression models were used to determine potential demographic predictors, and explore their potential association with our firefighter's knowledge, behaviors, and attitudes related to gear cleaning.

Results: Overall, indirect attitudes towards gear cleaning were positive, but behavior scores did not reflect firefighter's knowledge. Race, education, and age were shown to be significant predictors, but years on the job failed to.

Conclusions: While this is a novel study that addressed an understudied population, policies and interventions need further research to address gaps between knowledge and behaviors related to gear cleaning.

There are several potential factors that could be influencing this gap such as differences in resources between each fire department, shift logistics, and firefighter culture that need to be reflected in future policies and interventions to improve gear cleaning practices.

Contents

List of Tables

List of Figures

Acknowledgements

I express my immense gratitude to all my mentors for guiding and interesting in me and this thesis in such a short span of time. I would also like to thank all 5 North Carolina firehouse departments for participating in the Duke Cancer Institute (DCI) Firefighter Partnership, and for Duke University for institutionally funding this project.

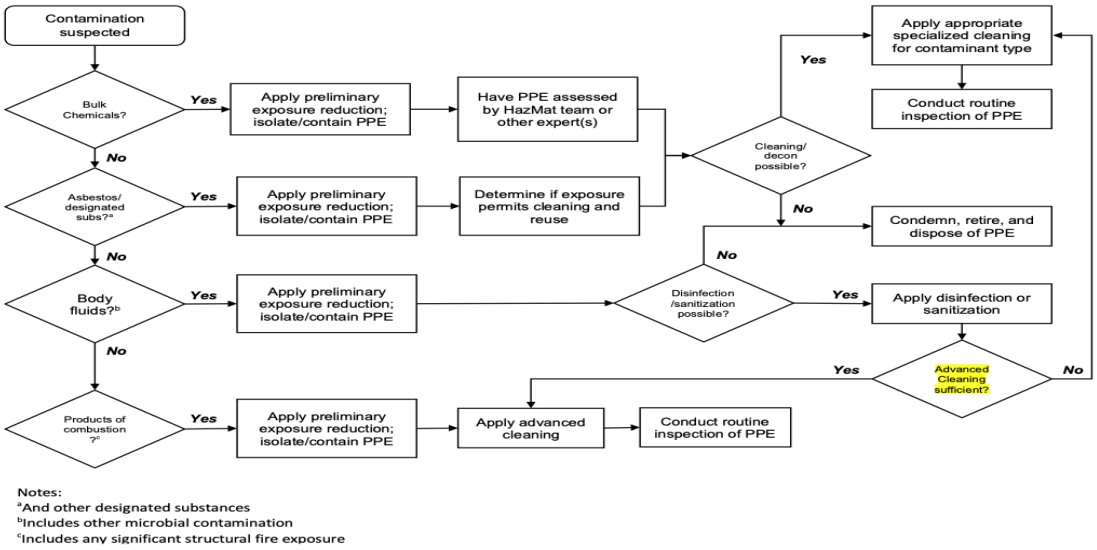
1. Introduction

Firefighters are among the first responders who are routinely exposed to hazardous chemicals as part of their job. Activities can range in duration of time exposed to hazards, but the levels of exposure are still high for the same firefighter who goes into a house after the fire is put out compared to the first fighter who enters the burning house [1]. Concerning hazards include organic chemicals, toxic gasses, and particulates through respiratory and dermal pathways [2]. For example, a house fire may have items in the house such as carpet and furniture, which all contain synthetic materials that release toxic chemicals when burned [3]. Two byproducts from synthetic materials being burned are volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) that are associated with cancer [4]. Both VOCs and PAHs are well documented as carcinogenic in laboratory animals and humans that reported higher incidences of cancers such as skin, lung, and stomach after being exposed [5]. One study found their firefighters were found to have had three to five times the number of by-products of PAHs in urine samples after a fire compared to before they went onsite [6]. Another study in 2015, found elevated levels of VOCs in firefighter's urine and breath showing that exposure can happen through skin absorption with dirty gear, wearing their properly fitted gear [7]. Compared to the general population, firefighters have a 9% higher risk of being diagnosed with cancer and a 14% increased lifetime cancer risk [8]. Compared to the general population, firefighters are at 39% increased risk of skin

cancer, 21% increased risk of colon cancer, and 14% increased risk of leukemia [9]. How firefighters can protect themselves from such hazards is through correctly wearing and thoroughly cleaning their personal protective equipment (PPE) [10].

The National Fire Protection Association (NFPA) issued the Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting [11]. PPE such as hoods, gloves, helmets, and breathing apparatuses are specifically manufactured to reduce the risk of chemical exposure [12]. However, cleaning and storing PPE properly is just as important as wearing it. It was not until 2020, that NFPA updated its guidelines to two advanced cleanings every year, and advanced cleaning every time it is exposed to combustion [13]. Figure 1 outlines the NFPA's cleaning and decontamination approach that includes two of the main occupational concerns for firefighters; suspected contamination of bulk chemicals and product of combustion [14].

Figure 1: NFPA's Approach for Deciding Handling, Cleaning, and Disposition of Ensemble Elements



Recent research has shown carcinogens are found on PPE not only when firefighters are not wearing their gear correctly, but even when they are wearing it correctly [15,16,17]. One of the main challenges is the lack of adherence to guidelines on gear storage, wearing, and cleaning [18]. A 2016 study in the United States found that nearly 40% of firefighters did not do regular PPE cleaning [19]. Additionally, more than 40% of firefighters were found to have been improperly wearing their gear in a 2014 study in the United States [20].

Gear cleaning processes such as water and soap combined have been shown to reduce gear contamination, which is thought to reduce the risk for cancer. In 2017, Fent et al found that cleaning gear with soap and water reduced PAH contamination on gear

by 85% [21]. In contrast, Calvillo et al, in 2019, found that using a water-only decontamination process resulted in an overall 42% increase in PAHs on the gear [22]. Thus, regular, and proper gear cleaning procedures are essential steps to reduce exposures and reduce cancer risk for firefighters.

Few studies have focused on firefighter's knowledge, behaviors, and attitudes related to gear cleaning. One of the well-known studies dates to 2018 for Florida firefighters by Moore et al. Out of 250 participants, 65% said that they had cleaned their gear in the last year, and 75% of firefighters said they showered within the hour after a fire response [23]. Another study, Harrison et al, investigated firefighter attitudes and behaviors, and their results showed overall positive attitudes and behaviors towards gear cleaning [24]. Both Moore and Harrison had the same consistent decontamination behavior, which was the firefighters showered within the hour, but 100% is the ideal number of firefighters who shower within the hour [25, 26]. Policies and interventions are needed to lower the risk of hazardous exposures among firefighters by strengthening gear cleaning practices.

There are several potential factors that influence firefighter gear practices that Harrison et al address such as resource allocations that may vary across each fire department, shift logistics, and firefighter culture [27]. Other factors include lack of recourses, shift logistics, and firefighter culture. Policies and interventions should consider all these potential factors.

This study examines central North Carolina firefighters, a population in which little is known about gear cleaning attitudes and behaviors. The aims of this study were: 1) to describe gear cleaning knowledge, behaviors, and attitudes among North Carolina firefighters, and 2) to explore demographic factors related to knowledge, behaviors, and attitudes.

2. Methods

2.1 Participants and Procedures from the Duke Cancer Institute (DCI) Firefighter Partnership

The data that is being analyzed for this thesis was collected as part of the Duke Cancer Institute (DCI) Firefighter Partnership, which included firefighters who worked for fire departments in Raleigh, Greensboro, Durham, Morrisville, and Chapel Hill. This project collected data through an online survey on occupational exposures, health behaviors, attitudes, and practices among firefighters.

The target population for the DCI Firefighter Partnership study were firefighters who were 18 years and older, current full-time career firefighters, employed at a firehouse in one of the five central North Carolina cities, and had access to a cell phone with internet. Recruitment happened through being emailed the survey through each firehouse department's fire chief, and a flyer. The flyer outlined relevant information on the study and the contact information of the study staff. A QR code was printed on the flyer to direct interested participants to a project-specific landing page that included project branding (e.g., study logo, name, and Duke University association), a simple contact form with name, phone number, address, email and two simple screening questions ("Are you a firefighter?" and "Do you work in a city in central NC (Greensboro, Chapel Hill, Durham, Raleigh, Morrisville)". Once this data was collected, researchers were able to determine, through programming in REDCap, if the firefighters

meet the criteria for participation in the study. If so, they were linked to the REDCap electronic consent form to read, sign, and proceed with the survey if they agreed to participate. Once participation was complete, participants were given a gift card worth $15 for completing the firefighter survey. All study procedures were approved by the Duke University Health System Institutional Review Board.

2.2 Measures

Due to the lack of research on this topic, the instruments that were used in this study were adapted from previous studies [28,29].

2.2.1 Demographic Factors

Race, education, age, and years on the job were used as potential predictors. While gender is noted in Table 3, due to the small female population size of less than 8%, gender was excluded as a demographic factor. Years on the job is the number of years each participant worked as a firefighter among those who only reported holding one firefighting job in their lifetime (data for those who worked multiple jobs were unavailable at the time of this analysis). Race was categorized into; “white,” “black,” and “other.” Due to the small number of participants who classified themselves as a category besides “white” or “black,” Hispanic, Native American or Alaskan Native, and Asian or Pacific Islander were grouped as “other.” Education was asked as a 5-category question, but collapsed into either being a non-college graduate, or being a college graduate for this analysis.

2.2.2 Likert-Type Scale

All the listed items in the below sections for knowledge, direct attitudes, indirect attitudes, and behaviors were developed based on qualitative data collected from previous studies with acceptable reliability [30]. All the firefighter's responses were measured on a 7-point Likert scale.

2.2.3 Knowledge

Measures for knowledge related to gear clearing questions were ranked as 1 (Strongly Disagree), 2 (Disagree), 3 (Somewhat Disagree), 4 (Neither Agree or Disagree), 5 (Somewhat Agree), 6 (Agree), and 7 (Strongly Agree). Originally, there were 4 measures for knowledge as seen in Table 1. However, not all 5 of our fire departments practiced advanced gear cleaning so, the measures "I know exactly how to send my gear out for advanced gear cleaning," and "I know exactly when I should send my gear out for advanced cleaning," were excluded from our analysis. The remaining 2 measures were looked at individually, and not as a scale, so we did not perform a test of reliability by calculating the Cronbach Alpha [31].

Table 1: Measures for Knowledge Related to Gear Cleaning

Knowledge
I know how to do an effective gross field decontamination

I know all of the steps involved with a routine cleaning on my gear
I know exactly how to send my gear out for advanced cleaning
I know exactly when I should send my gear out for advanced cleaning

2.2.4 Behaviors

Measures for behaviors related to gear cleaning questions were ranked as 1 (Never), 2 (Rarely), 3 (Occasionally), 4 (Sometimes), 5 (Frequently), 6 (Usually), and 7 (Always). The number of measures we had access to were 10, but 3 were chosen; "I complete gross decontamination of my gear in the field," "I swap out my hood," and "I shower within the hour." Table 2 outlines all the measures of behaviors. Similar to knowledge, we did not calculate for the Cronbach Alpha, so we looked at the 3 measures individually.

Table 2: Measures for Behaviors Related to Gear Cleaning

Behaviors
I swap out my hood
I complete gross decontamination of my gear in the field
I shower within the hour
I use wipes to clean my face, hands, and arms

I do routine cleaning and scrub my gear with detergent and a brush when I get back to the station
I clean my gear in some other way
I send my gear out for advanced/professional cleaning
I bag my gear before transport back to the station
I clean my gear before transporting in my personal vehicle
I use a sealed container or bag to transport my gear in my personal vehicle

2.2.5 Direct and Indirect Attitudes

Direct measures focused on their own current attitudes towards gear cleaning while indirect measures focused on being from a third-party perspective [32]. Each measure was scored as 1 (Strongly Disagree), 2 (Disagree), 3 (Somewhat Disagree), 4 (Neither Agree or Disagree), 5 (Somewhat Agree), 6 (Agree), and 7 (Strongly Agree). Direct and indirect attitudes had the largest number of measures we were able to analyze. Out of 5 direct measures, we used 4, and out of 11 indirect we were able to use 10. Table 3 outlines all the measures that were available. Both direct and indirect attitudes had enough measures for us to test their internal consistency to see if using them as a scale would be a strong enough indication [33]. Both scales showed acceptable reliability; direct attitudes ($\alpha = 0.84$), and indirect attitudes ($\alpha = 0.86$).

Table 3: Measures for Direct and Indirect Attitudes Related to Gear Cleaning

Direct Attitudes
I like having dirty gear
I like having clean gear
I enjoy cleaning my gear
Cleaning my gear is important to me
Cleaning my gear will help reduce my chances of getting cancer
Indirect Attitudes
Dirty gear is a badge of honor
Firefighters with dirty gear are reliable
I trust firefighters with dirty gear
Dirty gear is a sign of experience
Firefighters with dirty gear are dinosaurs
Firefighters with dirty gear are putting themselves at risk
Firefighters with dirty gear are bad role models to other firefighters
Clean gear is a sign of professionalism
I trust firefighters who keep their gear clean
Clean gear is a badge of honor
Firefighters with the dirtiest gear are the hardest working firefighters

2.3 Analysis

The data used in this thesis was analyzed using STATA 17 (StataCorp LLC, College Station TX). 4 linear regression models were performed to describe knowledge, behaviors, and attitudes related to gear cleaning among North Carolina firefighters, and to explore this study population's demographic factors (race, education, age, and years on the job) related to their knowledge, behaviors, and attitudes. The statistical measures that were reported were the mean, standard deviation, p-value, beta coefficient, and Cronbach Alpha.

3. Results

Demographics and work history for North Carolina firefighter participants are as follows: the majority were White (92.1%), roughly 2/3 of participants were college graduates, average age was 40 years old, and 11 years was the average for years on the job as a career firefighter.

Table 4: Demographic Factors of our North Carolina Firefighter Participants

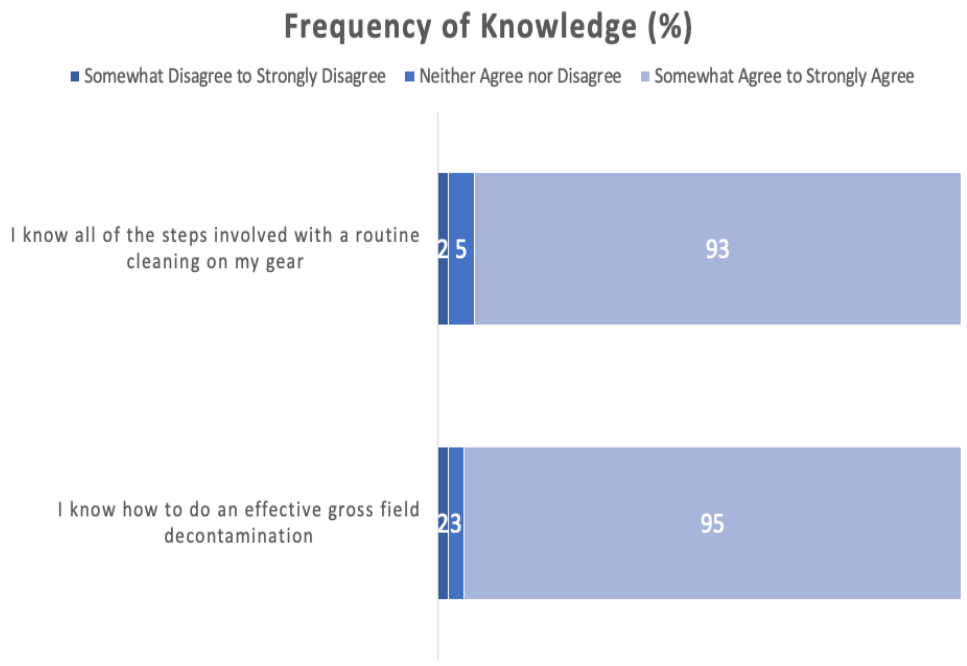
	N	Percent
Race		
White	527	83.25
Black	70	11.06
Other	36	5.8
Education		
College Graduate	418	66.14
Non-college Graduate	214	33.86
	M	SD
Age	39.85	9.20
Years on the Job	10.71	7.72

Note: The differences between groups and subgroups are credited to missing values
N = number of participants, M = mean, SD = standard deviation

3.1 Aim 1: Describe Gear Cleaning Knowledge, Behaviors, Direct, and Indirect Attitudes Related to Gear Cleaning Among North Carolina Firefighters

Overwhelmingly, our firefighters reported high knowledge of decontamination activities as illustrated in Figure 2. For knowing all the steps involved with routine cleaning of gear, 93% reported that they somewhat to strongly agree know how to, and 95% reported that they somewhat to strongly agree know how to do an effective gross field decontamination.

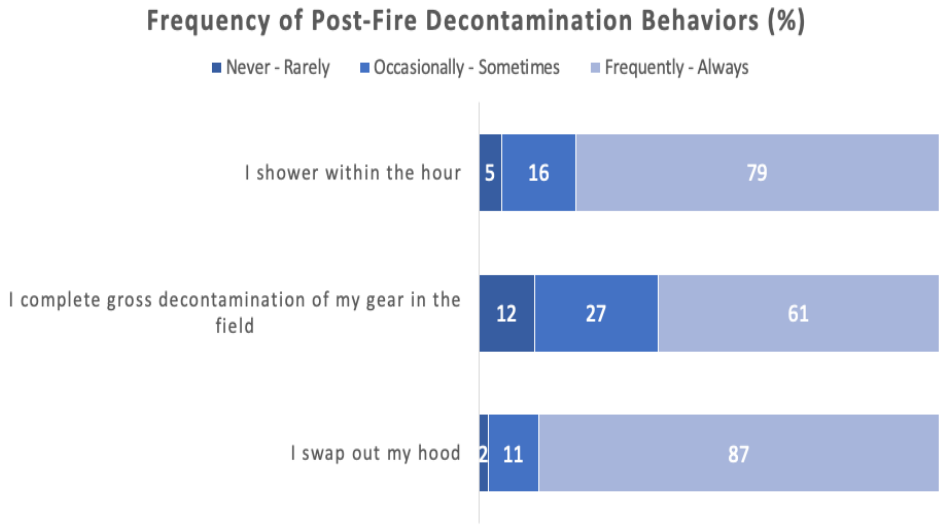
Figure 2: Frequency of Knowledge (%)



95% of our firefighters know how to do an effective gross field decontamination. However, only 61% of them are frequently to always performing that task. Additionally,

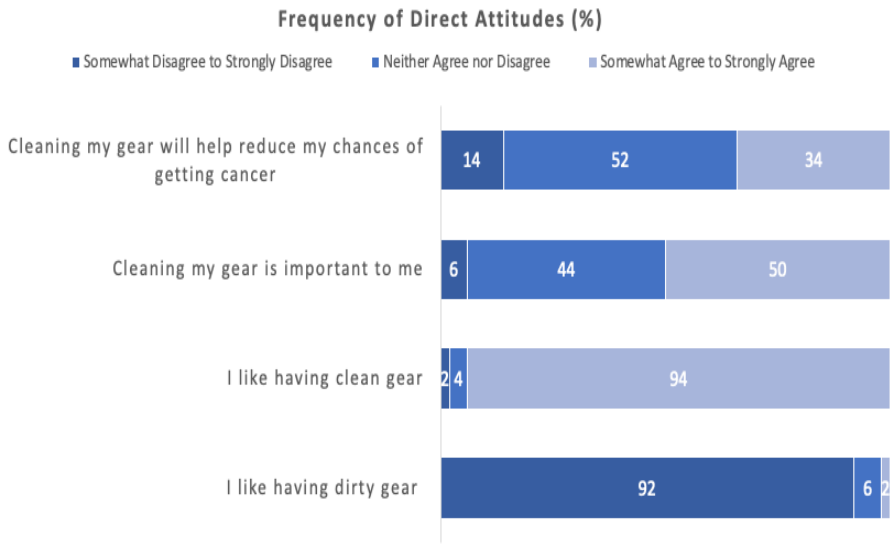
more than 20% of firefighters reported not showering within the hour, and 13% reported not swapping out their hood after a fire activity.

Figure 3: Frequency of Post-Fire Decontamination Behaviors (%)



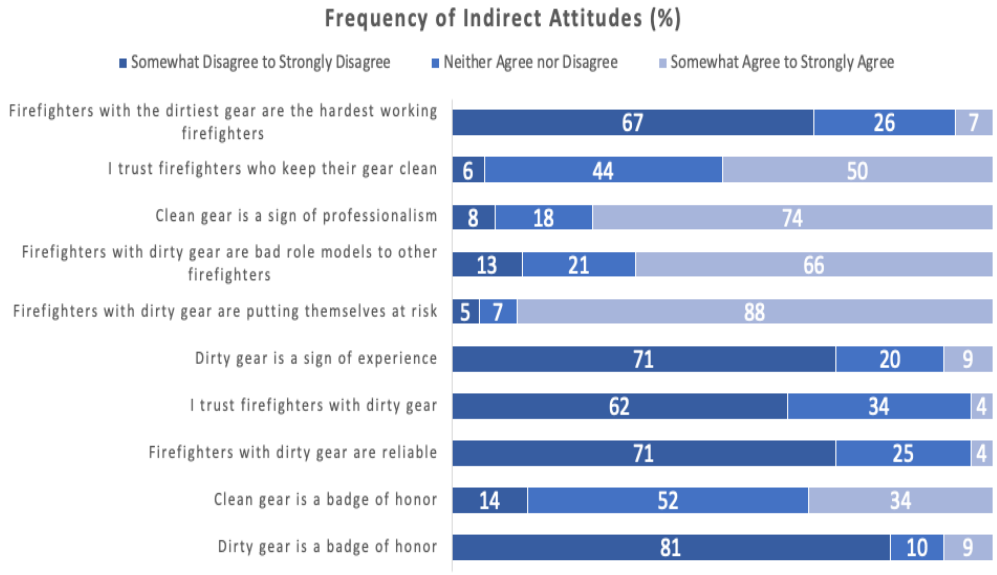
Firefighters surveyed reported generally positive direct and indirect attitudes towards gear clearing.

Figure 4: Frequency of Post-Fire Decontamination Direct Attitudes (%)



The scores for frequency of indirect attitudes were overall positive. However, there was a significant finding between "clean gear is a badge of honor," and "dirty gear is a badge of honor." "Dirty gear is a badge of honor" had a score of 81% somewhat to strongly disagreeing to this measure. When asked the opposite of this measures, "clean gear is a badge of honor," we expected about the same frequency of 81% somewhat to strongly agreeing. However, only 34% somewhat to strongly agreed as seen in Figure 5.

Figure 5: Frequency of Post-Fire Decontamination Indirect Attitudes (%)



3.2 Aim 2: Explore Demographic Factors Related to Gear Cleaning Knowledge, Behaviors, Direct, and Indirect Attitudes Among North Carolina Firefighters

We examined the relationship between 4 key demographic factors (race, education, age, and years on the job) and gear cleaning knowledge, attitudes, and behaviors.

Being a college graduate and race were the overall most significant factors related to firefighter's knowledge, behavior, direct, and indirect attitudes. College graduates had a high beta coefficient score of 0.88 for knowing how to do an effective gross field decontamination compared to non-college graduates. Firefighters who identified themselves as black had more positive direct attitudes than other racial groups, and a statistically significant p-value and beta coefficient score for direct

attitudes (β = 0.32, p = 0.002). When compared to non-college graduates, college graduates had a higher mean score for both direct and indirect attitudes as well as statistically significant p-value and beta coefficient score for indirect attitudes (β = 0.56, p = 0.05).

A one-year increase in age was associated with a 0.06 increase in the indirect attitudes score (e.g., a 20-year increase was associated with a 1.2-point increase in indirect attitude score), demonstrating that older firefighters had more positive indirect attitudes towards gear cleaning. Years on the job was not a significant predictor.

Table 5: Demographic and Work Related to Attitudes Towards Gear Cleaning

	Direct				Indirect							
	M	SD	P	Beta	M	SD	P	Beta				
Race												
White	6.08	0.81	Ref	Ref	5.31	0.92	Ref	Ref				
Black	6.41	0.78	0.002	0.32	5.49	0.86	0.13	0.17				
Other	6.06	0.75	0.84	-0.03	5.39	0.84	0.63	0.08				
College												
College Graduate	6.16	0.76	0.10	0.11	5.35	0.92	0.05	0.56				
Non-college Graduate	6.04	0.90	Ref	Ref	5.31	0.90	Ref	Ref				
Years on the job	-	-	0.98	-0.0002	-	-	0.74	0.002				
Age	-	-	0.06	0.001	-	-	0.002	0.06				
Knowledge												

	I know how to do an effective gross field decontamination				I know all of the steps involved with a routine cleaning on my gear							
	M	SD	P	Beta	M	SD	P	Beta				
Race												
White	5.85	0.86	Ref	Ref	5.88	0.76	Ref	Ref				
Black	5.64	1.08	0.07	-0.21	5.80	1.03	0.40	-0.08				
Other	5.78	0.76	0.64	-0.07	5.89	0.52	0.97	0.005				
College												
Non-college Graduate	5.76	1.00	Ref	Ref	5.80	0.91	Ref	Ref				
College Graduate	5.85	0.81	0.24	0.88	5.91	0.71	0.09	0.11				
Years on the job	-	-	0.61	0.004	-	-	0.34	0.01				
Age	-	-	0.08	0.03	-	-	0.01	0.04				
Behaviors												
	I swap out my hood				I complete gross decontamination of my gear in the field				I shower within the hour			
	M	SD	P	Beta	M	SD	P	Beta	M	SD	P	Beta
Race												
White	6.17	1.27	Ref	Ref	4.95	1.73	Ref	Ref	5.68	1.43	Ref	Ref
Black	6.16	1.37	0.96	-0.01	5.19	1.71	0.29	0.24	5.90	1.51	0.23	0.22
Other	6.00	1.17	0.45	-0.17	4.86	1.82	0.77	-0.9	5.86	1.38	0.47	0.18
College												
Non-college Graduate	6.16	1.26	Ref	Ref	4.94	1.75	Ref	Ref	5.76	1.49	Ref	Ref
College Graduate	6.16	1.29	1.00	-0.001	5.00	1.73	0.75	0.05	5.70	1.41	0.56	-0.07
Years on the job	-	-	0.28	-0.01	-	-	0.19	-0.02	-	-	0.55	-0.01
Age	-	-	0.63	-0.01	-	-	0.70	0.01	-	-	0.66	0.01

4. Discussion

The North Carolina firefighters in this study have generally positive attitude towards cleaning their gear, one of the main ways they can reduce their risk of developing cancer. Despite this positivity, there is room for improvement in gear cleaning behavior. Approximately 20% of firefighters report not showering within the hour for post-fire decontamination less than frequently or always, and 13% are not swapping out their hoods post-fire. Similarly, 35% of firefighters did not immediately shower after returning from a fire activity in another study [34]. Alarmingly, there are 40% do not complete gross decontamination of their gear in the field [35]. This is inconsistent with recently revised standards by the NFPA calling for completing gross contamination of gear after every fire event [36].

There are several explanations for the disconnect between our findings on gear cleaning knowledge, attitudes, and behaviors. Some include lack of resources such as funding to buy more gear, logistics of shifts such as being too busy to not be able to shower within the hour, and firefighter culture in general. Previous studies have noted how historically, firefighter culture has prided itself on being resilient in the wake of endangerment [37]. This culture, however, may be a barrier to practices that can reduce occupational hazards that firefighters face. An example of this would be how firefighters have perceived dirty gear as a source of pride and as a "cultural artifact" as it showed a person had performed a potentially dangerous fire activity [38]. Priding themselves in

the notion that dirty gear means more experience could have influenced two important findings in this study. The first is how we had to exclude the indirect attitude question "firefighters with dirty gear are dinosaurs" because of the strong ambivalence and disagreement when we would expect agreement if they supported clean gear. The second finding was about the knowledge question "I know how to do an effective gross field decontamination" and these firefighter's behavior. 95% of our firefighter somewhat to strongly agreed to knowing how to do an effective gross field decontamination. However, 27% "occasionally/sometimes", and alarmingly 12% "never/rarely" do it. While these scores are important, the relationship between knowledge and behavior is not linear meaning that although our firefighters may know how to do an effective gross field decontamination, their behavior does not reflect the same frequency scores. Systematic reviews have shown that to improve participants behaviors, using traditional knowledge-based approaches, such as educational interventions, have failed to significantly impact participant's behaviors [39]. Going beyond these measurements, further examination into system level factors that may impact firefighter's ability to complete gross decontamination needs to be addressed.

4.1 Study strengths and limitations

One of the main strengths was how this was a novel study addressing attitudes, behaviors, and knowledge around gear cleaning in a population that has not been studied before. We were able to analyze 634 responses which are one of the largest

sample sizes for this topic compared to one study that had 250 responses, and another study that had 485 responses [40, 41]. All survey questions were developed using previously tested measures from national and regional studies with firefighters, allowing comparison with previous results.

Despite the successful response rate and structure, every survey done will have social desirability bias which has 2 components [42, 43]. The first is to purposely present oneself to fit a certain mold such as answering how they think the researcher would want them to answer [44]. The second component is wanting to maintain a positive self-image with oneself [45]. However, our results suggest that there was limited bias such as in the alarming number of firefighters not practicing gear cleaning behaviors, and not viewing clean gear to reduce their risk of cancer.

Another limitation was needing to exclude gender in the analysis as females made up less than 8% of the total population across all 5 departments. Because of this, we were not able to describe or explore gender differences in gear cleaning knowledge, behaviors, and attitudes. This is on par with similar studies that excluded gender due to the small number of female firefighters.

While our use of a linear regression model was suitable, it did have some limitations. The outcome variables (knowledge, behavior, and attitudes) were skewed. While modeling for the mean was appropriate, another appropriate approach would have been to model for the median.

4.2 Implications for policy and interventions

Several of our findings point to the need for policies and interventions to address concerning areas on an individual, group, and system level. Most of our firefighters know the steps they need to do to clean their PPE, but there is 64% of them that do not see their risk of developing cancer as an issue if they do not clean their gear. Interventions that could address increasing risk perceptions on an individual level is emphasizing how dirty gear not only puts themselves at risk for cancer, but their fellow firefighters as well. On a group level, interventions and policies need to go beyond one size-fits all approach [46]. Each fire department has different personalities and cultures. Each fire department should have "champions" who represent them. What is meant by "champion" is someone who their department thinks represents their organizational culture, and socialization process the best [47].

Each fire department may have different amounts of funding and participate in different gear decontamination as seen when the know measures about advanced gear cleaning had to be excluded because not all 5 departments practiced them. Because of this, on a system level, when creating policies and interventions such as mandating gear cleaning practices, each fire department's ability needs to be factored in. One important question that should be considered specifically for our 5 departments is "what kind of resources can be allocated to help support gear cleaning regardless of funding?" One recommendation that all 5 of our fire departments can do, regardless of differences in

funding, it through storage after a fire activity. For example, all departments having fire trucks that have compartments. 2 of our 5 departments take advantage of the compartments by putting their contaminated gear in them before they return to their station from a fire activity. This not only reduces occupational exposures for them and their fellow firefighters, but it also does not require the need for more funding to do. Making this into a policy may decrease their risks of cancers.

Another consideration when creating policies and interventions is to consider how busy each fire department is. In our results, 20% of firefighters are not showering within the hour. If for example, a department usually has extremely busy shifts, they may not have the time to shower within the hour when they get back to their station, or they just may not think it is a priority. Having a policy that mandates showering within the hour is a system-based approach that does not require additional funding.

4.3 Implications for further research

Further research is needed to understand how organizational culture is affecting firefighter's attitudes, behaviors, and knowledge towards gear cleaning. Another gap is that there is limited research on how firefighter's health is affected by PPE contamination and how effective current gear cleaning guidelines are especially for carcinogenic decontamination.

5. Conclusion

This study is one of the first, if not the first, study to describe gear cleaning patterns, and to explore demographic factors related to attitudes, behaviors, and knowledge among central North Carolina firefighters. PPE has been cited in numerous studies as a carcinogen carrier. Results in this study show overall positivity in indirect attitudes towards gear cleaning, but gaps in firefighters applying their knowledge of how to clean their gear to acting performing the task. There are several factors that may influence this gap such as lack of recourses, shift logistics, and firefighter culture. Policies and interventions should consider all three of these potential factors.

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