

Assessment of Para-Occupational Exposure Pathways Among Firefighters: A Pilot Study of PPE Practices and Residential Air Quality

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Background

- Firefighters are exposed to hazardous airborne contaminants including Particulate Matter (PM), Volatile Organic Compounds (VOC), and Polycyclic Aromatic Hydrocarbons (PAH).
- These contaminants are associated with increased risks of respiratory disease and cancer.
- Limited research has examined exposures from contaminated PPE transported into homes.
- This pilot study investigated potential exposure pathways associated with PPE storage, handling, and decontamination practices among firefighters in Texas

Methods

- A cross-sectional study design was used among active-duty firefighters from eight Texas fire stations.
- The study included 30 firefighters between 18 and 50 years of age.
- Participant demographic characteristics and occupational behaviors were collected through a questionnaire.
- Continuous variables were reported using the median and interquartile range (IQR) to describe their central tendency and variability.
- Categorical variables, including participant characteristics and PPE-related practices, were summarized using frequencies and percentages.

Results

Table 1: Participant Characteristics and Questionnaire Responses

Characteristic	n (%)
Age (years)	
20-29	12 (40.0)
30-39	11 (36.7)
≥40	7 (23.3)
Gender	
Male	24 (80.0)
Female	6 (20.0)
Race/Ethnicity	
White	14 (46.7)
Hispanic/Latino	14 (46.7)
Other	2 (6.6)
Education	
≤ Some College	7 (23.4)
Associate’s degree	8 (26.7)
Bachelor's Degree or Higher	15 (50.0)
Regular Physical Exercise (≥3 times/week)	30 (100.0)
Fire Service Experience	
1-5 years	16 (53.3)
≥6 years	14 (46.7)
Career Firefighter (any role)	28 (93.3)
PPE Practices	
Full structural PPE with SCBA	28 (93.3)
Remove SCBA during overhaul	19 (63.3)
Remove remaining PPE during overhaul	10 (33.3)
Wear PPE during both fire and non-fire activities	16 (53.3)
Store turnout gear in station locker	27 (90.0)
Gear Cleaning Practices	
Clean based on visible contamination/exposure	27 (90.0)
Use extractor washer	22 (73.3)
Professional cleaning service	19 (63.3)
Air-dry turnout gear	10 (33.3)

Table 2. Monitored environmental measurements collected from take-home apparatus across fire stations

Station	VOC (ppm)	AQS	Temp (C)	RH (%)	Pressure (hPa)	PM1 (µg/m³)	PM10 (µg/m³)	PM2.5 (µg/m³)
1	0.21 (0.15-0.26)	87	23	43	976.6	2 (1-4)	4 (3-6)	3 (2-5)
2	0.18 (0.11-0.28)	86	22	43	988.4	2 (1-5)	5 (4-8)	4 (2-7)
3	0.33 (0.28-0.49)	80	20	40	991.8	3 (2-8)	7 (4-12)	5 (3-11)
4	0.29 (0.23-0.40)	82	22	48	986.9	1 (1-2)	4 (3-5)	3 (2-4)
5	0.28 (0.20-1.55)	82	23	39	986.4	1 (1-2)	3 (3-5)	2 (1-4)
6	0.64 (0.26-1.09)	63	22	39	977.6	1 (1-1)	3 (2-5)	2 (1-3)
7	0.35 (0.17-0.93)	76	21	42	991.1	1 (1-3)	4 (3-6)	3 (1-5)
8	0.24 (0.12-0.58)	85	22	41	989.2	2 (1-3)	4 (3-6)	3 (2-5)

Key Findings

- More than half of the firefighters (53.3%) reported having 1-5 years of fire service experience.
- Educational attainment was relatively high, with 50.0% of participants reporting a bachelor's degree or higher.
- Most firefighters (63.3%) reported removing their SCBA during overhaul activities.
- All participants reported regular physical exercise.
- VOC concentrations are more indicative of take-home exposure compared to PM.

Recommendations

- Future studies with larger sample sizes, direct measurements of residential PAHs and other fire-related contaminants, and evaluation of interventions to improve PPE storage, transportation, and decontamination practices to reduce household exposure risks.