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Pennsylvania First Responder Assessment of Chemical Exposure Survey following the East Palestine, Ohio Train Derailment Identifies Job Duties with Chemical Exposures that Contribute to Specific Health Outcomes

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Abstract

Objectives: A train derailment in East Palestine, Ohio, near the Ohio-Pennsylvania border on February 3, 2023, resulted in the release of hazardous substances and chemical exposures among residents and Pennsylvania first responders. We aimed to analyze data collected from an Assessment of Chemical Exposure (ACE) survey to better understand unique exposures and health symptoms among Pennsylvania first responders and identify additional safety measures to protect responders in future hazardous materials spill events.
Methods: Descriptive statistics for ACE survey results from 114 Pennsylvania first responders were produced and relationships between exposures, health symptoms, and occupation type were examined using logistical regression models.
Results: First responder occupation title and job duties were determinants of chemical exposure types, and specific chemical exposure types were associated with unique health outcomes. Firefighters and those with a job duty to suppress the fire were more likely to report contact with vapor/gas compared to all other roles and those with a duty of environmental monitoring. Contact with vapor/gas was associated with increased likelihood of reporting 2 or more health symptoms.
Conclusions: This analysis highlights the necessity of tailoring emergency response action plans and personal protective equipment considering first responder occupation title and to the specific duties conducted within their role.

On February 3, 2023, a Norfolk Southern train derailed outside of East Palestine, Ohio (OH), approximately a quarter mile west of the Ohio-Pennsylvania (PA) border. Of the 38 derailed train cars, 11 were carrying hazardous substances. Hazardous substances were released during the February 3 crash and also during a subsequent vent and burn (along with combustion byproducts) on February 6, 2023.[1] Due to the location of the incident, it is estimated that at least 90 PA first responders were deployed to assist with initial emergency response efforts at the derailment site; as a result, there was a high risk of exposure to hazardous substances among these individuals.

The hazardous substances present in the train cars, and released into the environment, included liquefied vinyl chloride, isobutylene, butyl acrylate, ethylene glycol monobutyl ether, and ethylhexyl acrylate.[2] These chemicals are most often used in the manufacturing of polyvinyl chloride (PVC), butyl rubber, and various thermoplastics and adhesives.[3–7] Documented exposures to these chemicals have been associated with symptoms of dizziness, fainting, poor circulation, headache, and upper respiratory irritation, among others.[3,6–9]

To better understand chemical exposures and health outcomes among those who responded to the East Palestine train derailment, the Pennsylvania Department of Health (PA DOH) collaborated with the Centers for Disease Control and Prevention (CDC), Agency for Toxic Substances and Disease Registry (ATSDR), and Ohio Department of Health (ODH) to develop an Assessment of Chemical Exposure (ACE) survey. The ACE survey was administered to PA first responders between March 5 and 31, 2023 and collected information on demographics, health symptoms, training, and the job duties conducted, and chemical exposures experienced during response work. PA DOH worked closely with ODH to develop and release the ACE survey to both OH and PA first responders; the following data represents PA responders only.

ACE investigations are often utilized in cases of chemical spills or emergencies to assess the event, exposure and symptom histories, public health response, and potential learnings for future incidents.[10] A similar incident to that of East Palestine occurred in Paulsboro, New Jersey in

November 2012, when a freight train derailed near a refinery and released approximately 24,000 gallons of liquefied vinyl chloride. Paulsboro residents and emergency responders attending to the crash site were exposed to vinyl chloride through inhalation. An ACE and other health surveys found that many individuals experienced acute symptoms related to vinyl chloride exposure; commonly reported symptoms included headache, upper and lower respiratory irritation, cough, nausea, and neurologic symptoms.[11,12] The Paulsboro train derailment is a useful historical counterpart to the East Palestine derailment, considering their similarity in hazardous chemicals released and the impact on emergency responders.

The ACE survey results from the East Palestine train derailment were similarly used to understand first responder chemical exposures and associated symptoms and to develop recommendations to better prepare responders for future chemical spill events. Uniquely, this study aimed to explore ACE results and the relationship between reported exposures and reported symptoms and how these varied by both first responder occupation and specific job duties. This provided important insights to first responder populations at risk of specific chemical exposure types and health symptoms during an emergency chemical spill event.

Methods

Assessment of Chemical Exposure (ACE) Survey Development and Implementation

An ACE survey was developed in collaboration with ATSDR, CDC, and ODH to capture the chemical exposures and health symptoms experienced among PA first responders. The survey was available online, via weblink through the REDCap Cloud secure database (hosted at the Pennsylvania Department of Health), from March 5-31, 2023. To participate in the survey, individuals were required to be adult (≥ 18 years) PA residents who worked as a first responder on the incident during any time from the initial derailment (February 3, 2023) to survey close (March 31, 2023). The survey included questions on demographic, occupational, and chemical exposure characteristics, duration and timing of response work, use of personal protective equipment (PPE) and preparedness to respond, health impacts, and concerns about response work (Supplementary Material Appendix A). Survey links were distributed to first responders via local first responder leadership (fire chiefs, etc.) and other electronic distribution lists including working with County Emergency Management.

Data analysis

Descriptive statistics were produced to describe and summarize survey responses. Relationships among variables contributing to the type and number of health symptoms were analyzed by Fisher's Exact Test. Binary and multivariate logistic regressions were used to assess the association between reported chemical exposure (type and odor characteristics) and presence of a new or worsening symptom since the derailment including the types and numbers of health symptoms experienced.

Reported contact with (1) odor characteristics (odor smelled or strength of the odor) and (2) chemical exposure types (smoke, vapor/gas, and/or dust) were used as proxies for exposure. Specifically, the analysis examined the relationship between odor characteristics and job titles/duties (Table 2), chemical exposure types and job titles/duties (Table 3), and odor characteristics/exposure types with number/type of new or worsening health symptoms reported (Table 4). Respondents could indicate more than one symptom, chemical contact type (i.e., smoke, vapor/gas, dust), and odor. Multivariate models were adjusted for age, gender, responder occupation, cigarette smoking status, and smokeless tobacco use.

To better understand responder role beyond occupation title, qualitative data from an open-ended question "What were your job tasks or responsibilities as an incident responder?" were analyzed. Participant responses were manually coded using open coding in Microsoft Excel. Axial coding was used to identify major categories of job duties between the open codes. Additional multivariate models were conducted to determine associations between occupation title/job duty and chemical exposures. Those with an occupation title "other than firefighter" and a job duty of "environmental monitoring" were considered to be least likely to have come in contact with chemicals during response work and were used as the reference groups for models.

To minimize excessive stratification and small cell sample size, certain responses were grouped for specific variables (Supplemental Material Table S1). For "Yes/No/Unsure/Prefer not to answer" responses, those that answered "Unsure" and "Prefer not to answer" were grouped with those that answered "No". The number or respondents that answered "Unsure/Prefer not to answer" was negligible.

This investigation was not considered research and was determined to be exempt from institutional review board review at both the PA DOH and CDC/ATSDR. Survey data were analyzed with SAS Enterprise Guide software version 7.1. Surveys were checked for duplication to ensure that individuals were only represented once. Surveys that were incomplete or completed by a non-PA resident, were excluded from the analysis.

Results

Demographics

One hundred and fourteen individuals completed the survey. A total number of PA first responders that responded to the train derailment could not be obtained; however, it was estimated that at least 90 PA responders were deployed during the initial emergency response (estimated by Beaver County Emergency Services). The additional respondents captured likely represents those that conducted response work beyond the immediate days following the incident. One hundred and one (88.6%) respondents were male, and 113 (99.1%) respondents were white. The median age of respondents was 39 years, with a range from 18-72 years. Additional demographic characteristics are presented in Table 1. During the train derailment response, 78 (68.4%) respondents had a responder occupation of firefighter, of which 70 (89.7%) were volunteer (Table 1).

Table 1. Demographic characteristics of PA first responders (*N* = 114)

Characteristic	*N*	%
Sex		
Male	101	88.6
Female	13	11.4
Age		
18–24	13	11.4
25–34	27	23.7

(*Continued*)

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Table 1. (*Continued*)

Characteristic	*N*	%
35–44	35	30.7
45–54	23	20.2
55+	16	14.0
Race		
White	113	99.1
Native Hawaiian or Pacific Islander	1	0.9
Ethnicity		
Not Hispanic or Latino	114	100.0
Smoking status		
Yes	16	14.0
No	98	86.0
E-cigarette use		
Yes	29	25.4
No	85	74.6
Primary job is responder		
Yes	37	32.5
No	77	67.5
Responder occupation		
Firefighter	78	68.4
Government worker	13	11.4
Hazmat	10	8.8
Police officer	10	8.8
Other*	5	4.4
Job duties		
Water tender	43	37.8
Fire suppression	22	19.3
Environmental monitoring	18	15.8
Traffic control / evacuation	8	7.0
Other*	23	20.2
Missing	2	1.8
Location where the majority of response work was conducted		
Site of derailment	67	58.8
Incident command location	11	9.6
Residential areas	11	9.6
Other*	21	18.4
Unsure / Prefer not to answer	4	3.5

*Other category for responder occupation is represented by those working in Rehab, US EPA contractor, 911 dispatcher, and Emergency Management Agency (EMA). Other category for job duties is represented by communications support, standby, rehabilitation, equipment decontamination, and technician. Other physical locations include Beaver County Airport, traffic control points, Unity OH, Clark Street Fire Station, Taggart Road, and tanker and fill stations a few miles away and just outside the 1-mile radius.

Other occupations consisted of government workers (11.4%), HAZMAT (8.8%), police officers (8.8%) and other (4.4%, Table 1). Specific job duties during the response consisted of working as a water tender (37.8%, representing those that manage a water tender/tanker that is used to collect water and transport it to the incident), suppressing the fire (19.3%), environmental monitoring (15.8%), traffic control and/or evacuation (7.0%), and all other duties (20.2%, Table 1). Job duties were mutually exclusive. Sixty-seven (58.8%) respondents conducted most of their response work at the site of derailment. A total of 16 (14.0%) reported tobacco usage and 29 (25.4%) reported smokeless tobacco usage at the time of survey completion (Table 1). Of the 29 respondents that reported using smokeless tobacco and 16 that reported cigarette use, 26 (89.7%) and 16 (100%) were firefighters, respectively (Fisher's $P < 0.01$, Supplementary Material, Table S2). When exploring distribution among job duties, 20 (75%) respondents using smokeless tobacco and 12 (75%) respondents using cigarettes had a job duty as water tender (Fisher's $P < 0.05$, Supplementary Material Table S2).

Chemical Exposure Characteristics

Ninety-eight (86.0%) respondents reported smelling an odor, of which 76 (77.6%) reported a chemical smell, 33 (33.7%) reported a smoke smell, and 26 (26.5%) reported a sweet smell. When respondents reported smelling an odor, 16 (16.3%) respondents described the odor as light, 36 (36.7%) described it as moderate, and 46 (46.9%) described it as strong.

Firefighters were 3.33 [95% CI 1.01-11.03] times more likely to report smelling an odor and 3.52 [95% CI 1.20-10.31] times more likely to describe an odor as strong, compared to all other responder occupations (Table 2).

When exploring specific contact exposure types, 78 (68.4%) respondents reported contact with smoke, 58 (51.0%) reported contact with vapor/gas, and 38 (33.3%) reported contact with dust. Firefighters were 5.41 [95% CI: 2.09-13.99] and 2.48 [95% CI: 1.00-6.14] times more likely to report contact with smoke and/or vapor/gas, respectively, compared to all other occupations (Table 3). Specifically, those working to suppress the fire and water tenders were more likely to report contact with smoke compared to those with job duties in environmental monitoring (Table 3). Those with job duties to suppress the fire were 8.92 [1.01-78.88] times more likely to report contact with vapor/gas, while those with job duties of traffic/evacuation were 12.14 [95% CI: 1.40-104.99] times more likely to report contact with dust compared to those conducting duties related to environmental monitoring (Table 3).

Reported Symptoms

Fifty-four (47.4%) respondents reported at least 1 new or worsening symptom and 46 (40.4%) reported 2 or more new or worsening symptoms. Among total symptomatic respondents, 42 (77.8%) respondents reported a symptom of the ears, nose, and throat, of which 29 (53.7%) reported stuffy nose and sinus congestion, 21 (38.9%) reported burning nose or throat, and 20 (37%) reported runny nose (Supplementary Material Table S3). Twenty-four (44.4%) respondents reported a symptom of the heart and lungs of which 16 (29.6%) reported coughing, 9 (16.7%) reported wheezing in the chest, and 8 (14.8%) reported difficulty breathing/feeling out of breath (Supplementary Material Table S3). Fifteen (27.8%) respondents reported eye symptoms of which 14 (25.9%) reported irritation/pain/burning in the eyes (Supplementary Material Table S3). Responder occupation, job duty, smokeless tobacco usage, and cigarette usage were not found to be associated with the number of new or worsening symptoms or a specific symptom category (Fisher's Test $P > 0.05$, Supplementary Material Table S4).

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Table 2. Adjusted odds ratios of odor exposure characteristics by responder occupation and duties

	Smelled an odor (*N* = 114)		Strong odor (*N* = 97)		Moderate odor (*N* = 97)		+ Chemical odor (*N* = 114)		+ Smoke odor (*N* = 114)		+ Sweet odor (*N* = 114)	
	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Responder occupation												
All other occupations	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Firefighter	3.33*	1.01–11.03	3.52*	1.20–10.31	0.51	0.18–1.47	2.65*	1.07–6.57	1.16	0.44–3.06	0.56	0.20–1.54
Job duties												
Environmental monitoring	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
traffic control / Evacuation	2.06	0.17–24.58	0.87	0.07–11.43	3.91	0.32–48.15	6.69	0.64–70.27	0.617	0.05–7.12	0.45	0.06–3.19
Fire suppression	1.02	0.04–30.08	3.59	0.32–40.64	0.8	0.04–14.59	2.87	0.29–28.70	---	---	0.31	0.03–3.62
Water tender	0.34	0.02–6.24	3.35	0.32–35.08	0.42	0.02–7.28	1.4	0.17–11.18	---	---	0.13	0.01–1.48
Other	0.59	0.10–2.07	2.83	1.40–19.94	0.21	0.02–2.49	0.65	0.14–3.10	2.32	0.43–12.58	0.25	0.04–1.75

Abbreviations: Ref, Reference group; +Type of Odor smelled is not mutually exclusive. Models are run separately and are adjusted for age, gender, responder occupation, cigarette smoking and smokeless tobacco use., **P* value ≤0.05. --- models do not converge.

Table 3. Adjusted odds ratios of contact exposure type by responder occupation and duties

	+Contact with Smoke		+ Contact with Vapor/Gas		+ Contact with Dust	
Predictors	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Responder occupation						
All other occupations	Ref	Ref	Ref	Ref	Ref	Ref
Firefighter	5.41**	2.09–13.99	2.48*	1.00–6.14	2.06	0.65–1.27
Job duties						
Environmental monitoring	Ref	Ref	Ref	Ref	Ref	Ref
Traffic control / Evacuation	2.39	0.39–14.72	1.95	0.31–12.24	12.14*	1.40–104.99
Fire suppression	72.89**	4.53–999.99	8.92*	1.01–78.88	4.98	0.45–55.26
Water tender	16.36**	1.98–135.06	8.09	0.99–66.19	0.91	0.08–9.90
Other	4.92	0.96–25.26	2.01	0.40–9.98	4.73	0.66–34.11

Abbreviations: Ref, Reference group; Adjusted OR, Adjusted odds ratio; 95% CI, 95% Confidence Interval; +Contact exposures are not mutually exclusive. Models are run separately and are adjusted for age, gender, responder occupation, cigarette smoking and smokeless tobacco use. ***P* value ≤0.01, **P* value ≤0.05. --- models do not converge.

Exposure and Reported Symptoms

Respondents who reported smelling an odor, specifically a chemical smell and smoke smell were 3.10 [95% CI 1.26-7.63] and 2.68 [95% CI 1.10-6.54] times more likely to report at least 1 new or worsening symptom, respectively (Table 4). Those that reported a chemical smell [OR: 2.62, 95% CI 1.04-6.59] or sweet smell [OR: 2.60, 95% CI 1.01-6.65] were more likely to report two or more symptoms (Table 4). Reporting a smoke smell [OR: 2.83, 95% CI: 1.16-6.93] and/or a chemical smell [OR: 3.91, 95% CI: 1.44-10.59] significantly increased the likelihood of reporting a symptom of the ears, nose, and throat (Table 4).

Among reports of odor strength, those who reported moderate odors [OR 7.95, 95% CI: 1.61-39.20] and strong odors [OR 10.58, 95% CI: 2.19-51.14] were more likely to report at least one new or worsening symptom compared to those that smelled a light odor (Table 4). Those that reported smelling a strong odor were 8.57 times [95% CI: 1.66-44.39] more likely to report ≥ 2 new or worsening symptoms compared to those that reported smelling a light odor. Smelling a moderate or strong odor increased the likelihood of reporting a symptom of the ears, nose and throat by 8.83 [95% CI: 1.49-52.39] and 9.57 times [95% CI: 1.69-54.29] respectively. However, strength of the odor did not impact reporting a symptom of the heart and lungs.

Respondents who reported contact with vapor/gas [OR: 4.80, 95% CI: 2.04-11.28], smoke [OR: 4.44, 95% CI: 1.64-12.01], and dust [OR: 2.45, 95% CI: 1.03-5.82], were more likely to report at least one new or worsening symptom. A similar relationship was found between contact exposure and increased likelihood to report ≥ 2 new or worsening symptoms among vapor/gas, smoke, and dust exposure types (Table 4). Debris and liquid exposure did not have an impact on likelihood of reporting a symptom.

Specific contact exposure also impacted the likelihood of reporting at least 1 new or worsening symptom of the ears, nose, and throat and heart and lungs. Exposure to vapor/gas had the greatest

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Table 4. Adjusted odds ratios of symptom frequency and type by exposure

	At least 1 new or worsening symptom		Two or more symptoms		At least 1 symptom of the ears, nose, and throat		At least 1 symptom of the heart and lungs	
Predictors	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Odor description[+]								
No smell	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Chemical Smell	3.10*	1.26–7.63	2.62*	1.04–6.59	3.91**	1.44–10.59	0.76	0.26–2.24
Smoke Smell	2.68*	1.10–6.54	1.97	0.83–4.71	2.83*	1.16–6.93	2.61	0.97–7.02
Sweet Smell	1.82	0.72–4.62	2.60*	1.01–6.65	2.33	0.91–5.99	0.65	0.19–2.17
Odor strength								
Light	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Moderate	7.95*	1.61–39.20	7.06*	1.33–37.37	8.83*	1.49–52.39	---	---
Strong	10.58**	2.19–51.14	8.57*	1.66–44.39	9.57*	1.69–54.29	---	---
Contact exposure[+]								
No contact	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Smoke	4.44**	1.64–12.01	3.91*	1.39–10.97	4.15**	1.44–11.96	3.41	0.85–13.66
Dust	2.45*	1.03–5.82	3.52**	1.47–8.43	4.16**	1.70–10.19	0.73	0.26–2.09
Vapor/gas	4.80**	2.04–11.28	4.02**	1.68–9.58	4.24**	1.74–10.33	1.83	0.68–4.92
Debris/liquid	0.69	0.24–2.03	1.06	0.36–3.14	1.35	0.47–3.91	0.97	0.27–3.46

Abbreviations: Ref, Reference group; Adjusted OR, Adjusted odds ratio; 95% CI, 95% Confidence Interval; +Odor description and contact exposures are not mutually exclusive. Models are run separately and are adjusted for age, gender, responder occupation, cigarette smoking and smokeless tobacco use. ***P* value ≤ 0.01, **P* value ≤0.05. --- models do not converge.

impact on the likelihood of reporting a symptom of the ears, nose, and throat [OR: 4.24, 95% CI: 1.74-10.33]. This was followed by dust [OR: 4.16, 95% CI: 1.70-10.19], then smoke [OR: 4.15, 95% CI: 1.44-11.96] exposure.

Limitations

There were several limitations to this study. A delay in the development and implementation of the ACE survey as well as news and media coverage of the derailment may have resulted in recall bias. Question syntax limited analysis. For example, responders were asked if they have experienced a new or worsening symptom since the incident, but they were not asked when the symptoms began, the duration of symptoms, nor the severity of symptoms. Reported symptoms could have occurred anytime during or after work on the response. Additionally, syntax of PPE questions may have made it difficult for firefighters to differentiate between a self-contained breathing apparatus (SCBA) and other standard fire gear (helmet, boots, leather gloves, turnout pants, and jacket). Reported PPE use may be misrepresented and was therefore omitted from the current analysis. Additional medical history was not obtained and could therefore not be considered as potential confounders. Responders that answered "Unsure" and "Prefer not to answer" were grouped with individuals that answered "No." Although these individuals accounted for a minute proportion of the survey population, there is a possibility of misrepresentation.

Discussion

Analysis of the PA Responder ACE survey revealed the unique exposures and symptoms among first responders working the East Palestine, OH train derailment. Identified relationships between response roles (including both occupation title and job duties), and exposures and reported symptoms provided critical insight for worker populations that would benefit from job-specific PPE and chemical spill action plans. This is particularly important in the context of responding to railway incidents as many companies rely on trains to transport hazardous substances. Specifically, from 2018-2022 there have been 9,057 train-related accidents in the US, of which 67% were derailments.[13] Additionally, few studies are available that examine chemical exposure types and health symptoms specific to first responder occupation and job duties during a chemical spill emergency, further highlighting the importance of this work.

Nearly half of the respondent population reported at least 1 new or worsening symptom since conducting response work. Most respondents that reported a symptom did not receive health care to treat symptoms. One individual reported being hospitalized, 4 were seen in an emergency department, and 8 consulted a health care provider via phone or video conferencing. The most common symptoms reported included those of the ears, nose, and throat and heart and lungs. These symptoms are consistent with the known acute side effects of exposure to vinyl chloride, phosgene gas (combustion byproducts), and butyl acrylate.[3,6,8,9] The reported symptoms were also consistent with reported symptoms following a 2012 train derailment in Paulsboro, NJ that resulted in the release of vinyl chloride.[11,12]

The likelihood of reporting a symptom was impacted by chemical exposures, odor smelled, and strength of the odor. Both strong and moderate odors had the greatest impact on increasing likelihood of reporting at least 1 or ≥ 2 symptoms. Data collected after the 2012 Paulsboro derailment similarly showed that those who reported smelling odors were more likely to report experiencing symptoms.[12] A 2013 review showed that among patients with potential chemical exposure, detecting an odor is not necessarily

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a predictor of chemical exposure.[14] Our study, however, showed a distinct pattern among identifying an odor and reporting specific symptoms, which can be indicative of a chemical exposure.

Vapor/gas, smoke, and dust contact exposures all increased the likelihood to report 2 or more symptoms ≥ threefold and a symptom of the ears nose and throat ≥ fourfold. Those that reported contact with vapor/gas were most likely to report symptoms compared to those that reported contact with smoke and/or dust. These distinct exposure pathways emphasize the importance of determining appropriate PPE for use in an emergency response, based on the hazards present.

Interestingly, odor strength, along with most contact exposure types, did not have an impact on reporting a symptom of the heart and lungs. However, smoke exposure increased this likelihood by fourfold [Unadjusted odds ratio 4.12, 95% CI: 1.12-14.63] in an unadjusted model. Exposure to smoke has been found to cause numerous symptoms of the heart and lungs, including difficulty breathing/shortness of breath, exacerbation of asthma or an asthma attack, and an increased/regular heartbeat.[15]

The first responder occupation title, which was categorized as firefighter, police officer, government worker, etc., did not have an impact on reporting a symptom or a type of symptom. However, when examining firefighters versus all occupations, firefighters were more likely to report smelling a strong odor and/or a chemical smell, as well as report contact with smoke and/or vapor/gas. Exploring job duties, which were provided as free text, further enhanced understanding of the context of specific exposures. For example, most firefighters had job duties to suppress the fire or as water tenders. Individuals working to suppress the fire were significantly more likely to come into contact with vapor/gas compared to those in environmental monitoring but had close to the same likelihood of coming into contact with vapor/gas as water tenders.

Among all job duties, those with job duties in traffic control and evacuation were most likely to come into contact with dust compared to those in jobs related to environmental monitoring, suggesting that individuals in this group likely had unique exposures. Similarly, in an unadjusted model, those with job duties as water tenders were more likely [Unadjusted odds ratio: 4.75, 95% CI: 1.14-19.73] to describe an odor as strong compared to job duties of environmental monitoring, which may be attributed to the type of PPE used. A 2019 study explored a similar topic of various responder occupations (professional firefighter, volunteer firefighter, police officer, EMS, etc.) during chemical incident emergency responses and found a differential occurrence of adverse health effects and symptoms between occupations.[16] For example, respiratory system problems were highly prevalent among all occupations, whereas heart problems were disproportionately concentrated among career and volunteer firefighters.[16]

Here, firefighters were not more likely to report symptoms of the heart and lungs. However, those with an occupational title of firefighter, especially those that had a job duty of fire suppression, were more likely to report contact with smoke, which is known to cause adverse health outcomes associated with the heart and lungs. This also underscores the importance of catering emergency response training to a specific job cohort in order to improve emergency response preparedness.[16] This suggestion complies with the Occupational Safety and Health Administration (OSHA) standard on hazardous waste operations and emergency response (HAZWOPER). The HAZWOPER standard provides guidance for the required levels of training for various occupations, including general site workers at hazmat sites, responders to hazardous emergency situations, and on-site managers/supervisors.[17,18] However, the standard does not provide occupation or duty-specific training guidelines within emergency response (i.e., different training protocol for firefighters vs. police officers).

Conclusions

The ACE survey provided important details regarding chemical exposures and health symptoms among PA first responders. Exposure types and routes unique to responder occupation title and job duties play a key role in experiencing a health symptom, highlighting the critical need to collect more nuanced occupation-related information (such as job duties) during follow-up investigations. Understanding these relationships can improve action plans in the event of a future chemical spill and help to ensure that appropriate PPE is provided, and measures are taken to protect first responders from chemical exposures. Detailed exposure data among specific populations related to job duties, rather than occupation title alone, may also aid in determining long-term health implications and can support public health agencies in generating relevant educational material.

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