OPEN ACCESS

Original research

National examination of occupational hazards in emergency medical services

Jonathan R Powell [1,2] Rebecca E Cash,[3] Jordan D Kurth,[4] Christopher B Gage,[1,2] Christopher B Mercer,[5] Ashish R Panchal[1,6]

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/oemed-2023-109053).

[1]Research Department, National Registry of Emergency Medical Technicians, Columbus, Ohio, USA
[2]Division of Epidemiology, The Ohio State University College of Public Health, Columbus, Ohio, USA
[3]Harvard Medical School, Massachusetts General Hospital, Boston, Massachusetts, USA
[4]Department of General Internal Medicine, Penn State College of Medicine, Hershey, Pennsylvania, USA
[5]Combat Paramedic Program, US Army Medical Center of Excellence, Fort Sam Houston, Texas, USA
[6]Department of Emergency Medicine, The Ohio State University Wexner Medical Center, Columbus, Ohio, USA

Correspondence to
Jonathan R Powell, National Registry of Emergency Medical Technicians, Columbus, OH 43226, USA;
jpowell@nremt.org

This work was presented at the 2021 National Association of Emergency Medical Services Physicians Annual Meeting, virtual, 11–16 January 2021.

Received 27 June 2023
Accepted 19 September 2023
Published Online First 13 October 2023

Check for updates

To cite: Powell JR, Cash RE, Kurth JD, *et al*. *Occup Environ Med* 2023;**80**:644–649.

ABSTRACT

Objective Emergency medical services (EMS) clinicians operate in environments that predispose them to occupational hazards. Our objective was to evaluate the frequency of occupational hazards and associations with mitigation strategies in a national dataset.

Methods We performed a cross-sectional analysis of currently working, nationally certified civilian EMS clinicians aged 18–85 in the USA. After recertifying their National EMS Certification, respondents were invited to complete a survey with questions regarding demographics, work experience and occupational hazards. Three multivariable logistic regression models (OR, 95% CI) were used to describe associations between these hazards and demographics, work characteristics and mitigation strategies. Models were adjusted for age, sex, minority status, years of experience, EMS agency type, service type and EMS role.

Results A total of 13 218 respondents met inclusion criteria (response rate=12%). A high percentage of EMS clinicians reported occupational injuries (27%), exposures (38%) and violence (64%) in the past 12 months. Odds of injury were lower with the presence of a lifting policy (0.73, 0.67–0.80), lift training (0.74, 0.67–0.81) and always using a powered stretcher (0.87, 0.78–0.97). Odds of exposure decreased with chemical, biological and nuclear exposure protection training (0.75, 0.69–0.80). Training in de-escalation techniques was associated with lower odds of experiencing violence (0.87, 0.79–0.96).

Conclusions Occupational hazards are commonly experienced among EMS clinicians. Common mitigation efforts are associated with lower odds of reporting these hazards. Mitigation strategies were not widespread and associated with lower odds of occupational hazards. These findings may present actionable items to reduce occupational hazards for EMS clinicians.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Emergency medical services (EMS) clinicians work in dynamic environments that can lead to occupational hazards such as injuries, biological exposures and violence. Prior to this study, a nationally representative assessment of EMS clinicians' experiences with occupational hazards and their associations with mitigation strategies had not been completed.

WHAT THIS STUDY ADDS

⇒ We found that occupational hazards are common for EMS clinicians, with odds of experiencing these hazards lower in the presence of some mitigation measures (eg, training in patient lifting, de-escalation techniques and personal protective equipment).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study informs current efforts and advises future steps to maintain a healthy and resilient EMS clinician workforce.

INTRODUCTION

Emergency medical services (EMS) clinicians (emergency medical technician (EMT), advanced emergency medical technician (AEMT), paramedic) in the USA operate at the intersection of emergency medicine, public health and public safety.[1 2] Tasked with providing life-saving care in the prehospital setting, EMS clinicians may be placed into unpredictable and often unsafe environments.[3 4] Ensuring scene and clinician safety via mitigation strategies, such as training in appropriate lifting techniques or staging away from the scene if danger is suspected, is prioritised in initial and continuing education.[5 6] However, despite extensive training and preparation, the safety dynamics of an EMS scene can change with little to no warning.[7]

Accordingly, the potential for occupational injury, biological exposure and workplace violence are daily considerations for prehospital clinicians.[3 8 9] Previous research demonstrates that EMS clinicians are at a considerable risk of occupational and individual hazards.[10] For example, past assessments of violence towards US EMS clinicians found that over two-thirds of respondents had experienced verbal or physical violence, while an international analysis of physically assaulted EMS clinicians revealed that 32% believed the incident could have been predicted.[3 11] An emergency department-based evaluation of records from 2010 to 2014 found that exposures to harmful substances, bodily injury and assaults/violence are common reasons for EMS clinicians to seek care.[12] Additionally, 57% of injury cases among a localised analysis of EMS clinicians led to days away from work or restricted activity.[13]

A better understanding of the national prevalence of occupational hazards, and their associations with mitigation measures, is necessary to maintain the health and safety of EMS clinicians, thereby maintaining a resilient workforce.[12] Our objectives

were to evaluate the prevalence of EMS occupational injuries, exposures and violence in a national sample of EMS clinicians. Further, we examined associations between occupational injuries, exposures and violence with workforce characteristics and commonly employed mitigation strategies.

METHODS

Study design, setting and population

We conducted a cross-sectional survey of nationally certified EMS clinicians in the USA. As part of the biennial recertification process, those EMS clinicians who complete a recertification application are invited to participate in a voluntary survey. The National Registry of Emergency Medical Technicians (National Registry) conducts the voluntary survey annually, with approximately 100 000 EMS clinicians eligible to participate after completing a recertification application. As of 2023, there were 484 902 nationally registered EMS clinicians.[14] Recertification of National Registry certification occurs in a biennial process with two separate yearly cohorts of EMS clinicians who elect to remain nationally certified or are required to remain nationally certified due to state policy. No incentives were offered to complete the survey, which was included as an optional survey after recertification completion. Each recertifying cohort is a representative sample of the overall National EMS Certification database in terms of demographic and work-related characteristics, as determined by comparing of each individual cohort against the others at differing time points since recertification data began being collected.[1 15]

All non-military EMS clinicians at the EMT, AEMT and paramedic certification levels that recertified during the 2019–2020 cycle (spanning from 1 October 2019 to 30 June 2020) were eligible to participate. Military personnel and those certified at the emergency medical responder level were recertified using a different process and thus excluded. Respondents included for analysis were those currently working in EMS and aged 18 years and older. This examination was deemed exempt by the American Institutes for Research Institutional Review Board (Arlington, Virginia, USA).

Measures

The survey assessed EMS-related characteristics, experiences relating to occupational injuries, exposures, and violence in the prior 12 months, and potential mitigation strategies. Additional respondent demographics and EMS-related characteristics were obtained via National Registry provider demographic and work characteristic profiles and linked to survey responses using the National EMS Certification database unique identifier. Demographics included age, sex, race/ethnicity and education level. EMS-related characteristics included certification level (basic life support (BLS) or advanced life support (ALS)), years of EMS experience, employment status (part-time or full time), community size of main EMS agency (urban or rural) and type and service provided at the respondent's main EMS agency (eg, primarily fire-rescue response, municipal third-service EMS response).

Occupational injury was defined by an affirmative response if they had any occurrence of an on-the-job injury in the past 12 months. Occurrence was self-defined by the respondent. Those who responded negatively to this question but then reported a positive needlestick, back injury, lifting injury or other injury in the past 12 months were also included. Mitigation strategies for reducing occupational injury assessed were the presence of a lift policy, lifting training in the past 12 months and use of a powered stretcher. Lift policy was measured with a dichotomous yes/no variable responding to the question, 'Does your main EMS agency have a policy for patient lifting practices?' Lift training in the past 12 months was assessed as a dichotomous yes/no variable. Use of a powered stretcher was assessed categorically as never, sometimes or always.

Occupational exposure was assessed by asking respondents if they had been exposed to blood, hazardous chemicals or smoke when on the job over the past 12 months. Exposure was self-defined by the respondent. Respondents who responded affirmatively to one of these three exposures were classified as having occupational exposure. A mitigation strategy for reducing occupational exposure was whether the clinician received training on personal protective equipment or chemical, biological and nuclear (PPE/CBN) materials in the past 12 months (dichotomous variable).

Occupational violence was assessed by asking respondents if they had experienced cursing, biting, spitting, punching, striking with an object, stabbing or shooting from a patient in the past 12 months. Experiencing violence was self-defined by the respondent. Respondents who responded affirmatively to one of these violent encounters were classified as experiencing violence in the past 12 months. Mitigation strategies for reducing occupational violence assessed were de-escalation training in the past 12 months and restraint training in the past 12 months. Both strategies were assessed as a dichotomous yes/no variable.

Data analysis

Descriptive statistics were calculated to describe the overall sample. Separate multivariable logistic regression models were fit for occupational injury, exposure and violence outcomes. In each model, we included the covariates of age, sex, education level, certification level, years of EMS experience, employment status, community size, service type and agency type. We also included mitigation factors specific to the outcome (eg, lifting policies for injury, training for injury and exposure, and de-escalation training for violence). Variables were selected a priori based on prior literature and substantive reasoning.[3 12] Model fit and calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test and area under the receiver operator curves. Multicollinearity was assessed using variance inflation factor (VIF), with a VIF <10 considered acceptable. Missing data were handled using complete case analysis. All analyses were conducted with Stata IC V.17 (StataCorp, College Station, Texas).[16]

RESULTS

Sample characteristics

A total of 13 218 EMS clinicians responded to the survey (response rate=12%) (table 1). The sample had a median age of 36 years (IQR 29–47) and was majority male and non-Hispanic white. The majority of respondents' education included some college (31%), associate degree (23%) and bachelor's degree (26%). ALS clinicians comprised 58% of the sample, with the largest proportion of clinicians having ≥8 years of experience in EMS. More respondents worked full time (73%) compared with part-time, worked in urban communities (88%) compared with rural and worked in an agency providing any 9-1-1 response services (84%).

Prevalence of occupational hazards and mitigation strategies

Any occupational injury in the past 12 months was experienced by 27% of the sample (table 2). Of these, 17% involved the clinician's back and 2% involved accidental needle injury. To mitigate

Table 1 Demographic and EMS-related employment characteristics of sample (n=13 218)

Characteristic	n (%)
Age, median (IQR)	36 (29–47)
Age category (years)	
<30	3591 (27)
30–39	4100 (31)
40–49	2972 (22)
≥50	2555 (19)
Missing	0
Sex	
Female	3682 (28)
Male	9508 (72)
Missing or not reported	28
Race/ethnicity	
Non-Hispanic white	11 354 (87)
Other*	1650 (13)
Missing or not reported	214
Education level	
High school/GED	1698 (13)
Some college	4149 (31)
Associate degree	2999 (23)
Bachelor's degree	3446 (26)
Graduate degree	925 (7)
Missing	1
EMS certification level	
BLS	5532 (42)
ALS	7686 (58)
Missing	0
EMS experience (years)	
<3	4211 (32)
3–7	4132 (31)
≥8	4851 (38)
Missing	24
Employment status	
Part-time (<40 hours/week)	3513 (27)
Full time (≥40 hours/week)	9599 (73)
Missing or not reported	106
Community size of main EMS agency	
Rural	1583 (12)
Urban	11 435 (88)
Missing or not reported	200
Agency type of main EMS agency	
Fire	5102 (39)
Third service (municipal, non-fire)	1748 (13)
Private	3209 (24)
Hospital	1842 (14)
Other	1253 (10)
Missing or not reported	64
Service type of main EMS agency	
Any 9-1-1 response	11 108 (84)
Other	2061 (16)
Missing or not reported	49

*Other race/ethnicity consists of those who selected black, non-Hispanic; Hispanic; non-Hispanic other.
ALS, advanced life support; BLS, basic life support; EMS, emergency medical services; GED, General Education Diploma.

Table 2 Prevalence of occupational hazards and mitigation strategies

Occupational safety concern	n (%)
Any occupational injury in the past 12 months	3608 (27)
Type of occupation injury* (>1 possible)	
Back injury	2220 (17)
Needlestick	227 (2)
Other	1831 (14)
Any occupational exposure in the past 12 months	4994 (38)
Type of occupational exposure† (>1 possible)	
Blood	3649 (28)
Hazardous chemicals	715 (5)
Smoke	2535 (19)
Any occupational violence experienced in the past 12 months	8444 (64)
Type of occupational violence experienced‡ (>1 possible)	
Cursing	8228 (62)
Punching	3687 (28)
Spitting	3290 (25)
Biting	1504 (8)
Struck with an object	1706 (8)
Stabbing	229 (2)
Shooting	70 (1)
Mitigation strategies	
Patient lifting policy	8706 (66)
Patient lifting training	9301 (71)
Use of powered stretcher	
Never	2559 (19)
Sometimes	3492 (27)
Always	7100 (54)
PPE/CBN training	8374 (36)
De-escalation training	5713 (43)
Patient restraint (physical and/or chemical) training	6571 (50)

*Among those reporting any occupational injury. A total of 838 (6%) respondents reported >1 type of injury.
†Among those reporting any occupational exposure. A total of 4694 (36%) respondents reported >1 type of exposure.
‡Among those reporting any occupational violence. A total of 1557 (12%) respondents reported >1 type of violence.
CBN, chemical, biological and nuclear; PPE, personal protective equipment.

injury risk, 66% of respondents reported a patient lifting policy, 71% had lifting training in the past 12 months and 54% always used a powered stretcher.

Occupational exposures were experienced by 38% of the sample in the past 12 months (table 2), with 28% of clinicians exposed to blood, 19% to smoke and 5% to hazardous chemicals. PPE/CBN training in the prior 12 months to mitigate exposure risk was reported by 36% of the sample.

Occupational violence in the past 12 months was experienced by 64% of the sample (table 2), with participants experiencing cursing (62%), punching (28%), spitting (25%), biting (8%), being struck with an object (8%), stabbing (2%) and shooting-related violence (1%). For violence risk mitigation, 43% of respondents had de-escalation training and 50% received training in patient restraint in the past 12 months, respectively.

Factors associated with occupational hazards

To determine associations with occupational hazards and clinician demographics/workplace characteristics we calculated

Table 3 Factors associated with any occupational injury in the past 12 months

	Occupational injury	
Variable	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Patient lifting policy		
No	1.00 (referent)	1.00 (referent)
Yes	0.67 (0.62, 0.73)	0.73 (0.67, 0.80)
Patient lifting training		
No	1.00 (referent)	1.00 (referent)
Yes	0.60 (0.55, 0.65)	0.74 (0.67, 0.81)
Use of powered stretcher		
Never	1.00 (referent)	1.00 (referent)
Sometimes	1.08 (0.96, 1.21)	1.07 (0.95, 1.21)
Always	0.92 (0.83, 1.02)	0.87 (0.78, 0.97)
Age (years)		
<30	1.00 (referent)	1.00 (referent)
30–39	0.93 (0.84, 1.03)	0.80 (0.72, 0.89)
40–49	0.90 (0.81, 1.01)	0.78 (0.68, 0.88)
≥50	0.64 (0.57, 0.72)	0.61 (0.53, 0.70)
Sex		
Female	1.00 (referent)	1.00 (referent)
Male	0.90 (0.83, 0.98)	0.88 (0.80, 0.97)
EMS certification level		
BLS	1.00 (referent)	1.00 (referent)
ALS	1.76 (1.63, 1.91)	1.55 (1.41, 1.70)
Employment status		
Part-time	1.00 (referent)	1.00 (referent)
Full time	1.92 (1.74, 2.11)	1.66 (1.50, 1.85)
Community size of main EMS agency		
Rural	1.00 (referent)	1.00 (referent)
Urban	1.73 (1.52, 1.98)	1.07 (0.94, 1.21)
Agency type of main EMS agency		
Fire	1.00 (referent)	1.00 (referent)
Third service (municipal, non-fire)	1.43 (1.27, 1.62)	1.46 (1.28, 1.66)
Private	1.49 (1.35, 1.65)	1.58 (1.42, 1.77)
Hospital	1.75 (1.56, 1.97)	1.75 (1.53, 1.99)
Other	1.03 (0.89, 1.19)	1.12 (0.95, 1.32)
Service type of main EMS agency		
Other	1.00 (referent)	1.00 (referent)
Primarily 9-1-1 response	0.93 (0.84, 1.03)	1.06 (0.94, 1.21)
EMS experience (years)		
<3	1.00 (referent)	1.00 (referent)
3–7	1.03 (0.94, 1.13)	1.03 (0.93, 1.15)
≥8	0.93 (0.85, 1.02)	1.04 (0.92, 1.16)

Hosmer-Lemeshow goodness of fit p=0.16.
ALS, advanced life support; BLS, basic life support; EMS, emergency medical services.

adjusted ORs for any occupational injury (table 3). ALS clinicians, compared with BLS clinicians, had higher odds of injury. Similarly, full-time clinicians had higher odds of injury than part-time clinicians, and third-service, private and hospital agencies had higher odds of injury than fire agencies. Compared with the youngest age category of <30 years, all age categories had lower odds of injury. Males, compared with females, had lower odds of injury. Mitigation strategies were also associated with lower odds of injury: patient lifting policy (OR 0.73, 95% CI 0.67–0.80), patient lifting training in the past 12 months (OR 0.74, 95% CI 0.67–0.81) and always using a powered stretcher (OR 0.87, 95% CI 0.78–0.97).

Table 4 Factors associated with any occupational exposure in the past 12 months

	Occupational exposure	
Variable	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
PPE/CBN training		
No	1.00 (referent)	1.00 (referent)
Yes	0.75 (0.70, 0.81)	0.75 (0.69, 0.80)
Age (years)		
<30	1.00 (referent)	1.00 (referent)
30–39	0.95 (0.87, 1.04)	0.93 (0.84, 1.03)
40–49	0.81 (0.73, 0.89)	0.81 (00.72, 0.91)
≥50	0.60 (0.54, 0.67)	0.65 (0.57, 0.73)
Sex		
Female	1.00 (referent)	1.00 (referent)
Male	0.93 (0.86, 1.01)	0.92 (0.85, 1.01)
EMS certification level		
BLS	1.00 (referent)	1.00 (referent)
ALS	1.18 (1.10, 1.27)	1.12 (1.03, 1.22)
Employment status		
Part-time	1.00 (referent)	1.00 (referent)
Full time	1.33 (1.23, 1.44)	1.26 (1.15, 1.38)
Community size of main EMS agency		
Rural	1.00 (referent)	1.00 (referent)
Urban	1.45 (1.29, 1.62)	1.30 (1.14, 1.46)
Agency type of main EMS agency		
Fire	1.00 (referent)	1.00 (referent)
Third service (municipal, non-fire)	1.16 (1.03, 1.29)	1.15 (1.02, 1.29)
Private	1.17 (1.07, 1.28)	1.11 (1.00, 1.23)
Hospital	1.36 (1.22, 1.51)	1.29 (1.15, 1.46)
Other	0.92 (0.81, 1.05)	0.96 (0.84, 1.11)
Service type of main EMS agency		
Other	1.00 (referent)	1.00 (referent)
Primarily 9-1-1 response	1.00 (0.91, 1.10)	1.08 (0.97, 1.21)
EMS experience (years)		
<3	1.00 (referent)	1.00 (referent)
3–7	1.00 (0.92, 1.09)	1.05 (0.95, 1.15)
≥8	0.77 (0.72, 0.85)	0.92 (0.82, 1.02)

Hosmer-Lemeshow goodness of fit p=0.43.
ALS, advanced life support; BLS, basic life support; CBN, chemical, biological and nuclear; EMS, emergency medical services; PPE, personal protective equipment.

We also calculated the adjusted odds of experiencing any occupational exposure (table 4). Odds of exposure were higher for full-time clinicians compared with part-time and urban responders compared with rural. Third-service, private and hospital agency types had higher odds of exposure than fire agencies. Odds of exposure were progressively lower as clinician age category decreased, with the youngest age category of <30 years as the referent. Odds of exposure were lower for ALS clinicians compared with BLS clinicians. The mitigation strategy of PPE/CBN training in the past year was associated with lower odds of exposure (OR 0.75, 95% CI 0.69–0.80).

Lastly, adjusted ORs for occupational violence were calculated (table 5). Odds of violence, similar to odds of exposure and injury, were progressively lower as age increased compared with those aged <30 years. Male sex, ALS certification, full-time employment and working at an urban EMS agency all had higher odds of violence than their respective referents. Third-service, private and hospital-based agencies had higher odds of

Table 5 Factors associated with any occupational violence in the past 12 months

	Occupational violence	
Variable	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
De-escalation training		
No	1.00 (referent)	1.00 (referent)
Yes	0.87 (0.81, 0.93)	0.87 (0.79, 0.96)
Patient restraint training		
No	1.00 (referent)	1.00 (referent)
Yes	0.98 (0.91, 1.05)	1.03 (0.94, 1.13)
Age (years)		
<30	1.00 (referent)	1.00 (referent)
30–39	0.81 (0.74, 0.89)	0.63 (1.32, 1.70)
40–49	0.61 (0.55, 0.68)	0.46 (0.41, 0.53)
≥50	0.38 (0.34, 0.42)	0.34 (0.29, 0.38)
Sex		
Female	1.00 (referent)	1.00 (referent)
Male	0.89 (0.83, 0.97)	0.84 (0.76, 0.92)
EMS certification level		
BLS	1.00 (referent)	1.00 (referent)
ALS	2.25 (2.10, 2.42)	2.17 (1.99, 2.37)
Employment status		
Part-time	1.00 (referent)	1.00 (referent)
Full time	2.10 (1.94, 2.28)	1.66 (1.51, 1.82)
Community size of main EMS agency		
Rural	1.00 (referent)	1.00 (referent)
Urban	2.79 (2.51, 3.11)	1.91 (1.69, 2.15)
Agency type of main EMS agency		
Fire	1.00 (referent)	1.00 (referent)
Third service (municipal, non-fire)	1.40 (1.25, 1.57)	1.50 (1.32, 1.70)
Private	1.78 (1.62, 1.96)	1.94 (1.74, 2.17)
Hospital	2.24 (1.99, 2.53)	2.48 (2.16, 2.85)
Other	0.74 (0.65, 0.83)	0.96 (0.83, 1.11)
Service type of main EMS agency		
Other	1.00 (referent)	1.00 (referent)
Primarily 9-1-1 response	1.20 (1.09, 1.33)	1.52 (1.35, 1.71)
EMS experience (years)		
<3	1.00 (referent)	1.00 (referent)
3–7	0.96 (0.87, 1.05)	1.07 (0.97, 1.19)
≥8	0.75 (0.69, 0.82)	1.04 (0.93, 1.17)

Hosmer-Lemeshow goodness of fit p=0.17.
ALS, advanced life support; BLS, basic life support; EMS, emergency medical services.

violence than fire agencies. De-escalation training was associated with lower odds of violence (0.87, 0.79–0.96), while restraint training was not (1.03, 0.94–1.13).

DISCUSSION

Many studies have evaluated the concepts of occupational injury, exposure and violence in EMS clinicians individually or in non-representative samples. This work examined a range of hazards in a single, nationally representative sample.[3] In this national sample of EMS clinicians, we found that approximately one-quarter reported an occupational injury, one-third reported an occupational exposure and two-thirds reported experiencing occupational violence in the past 12 months. Further, we found that some mitigation strategies were effective and were associated with lower odds of reporting these occupational hazards. Surprisingly, mitigation strategies to combat these hazards were uncommon. Our findings confirmed that occupational hazards are a common workplace experience for EMS clinicians, as seen in previous studies,[3] and there is substantial work needed to promote the widespread implementation of mitigation strategies.

In this sample, increased age, but not increased experience in EMS, had lower odds of experiencing all three hazards, indicating that there may be some unknown protective indicator that also increases with age. The hierarchical structure of some EMS systems may contribute to younger clinicians having an increased exposure to hazards, such as lifting more than their older counterparts, but this is unclear. ALS clinicians, compared with BLS clinicians, had lower odds of exposure but higher odds of injury and violence. This finding suggests that the additional training at high certification levels may protect against exposure but not injury and violence. There were no gender differences for odds of exposure but were noted for injury and violence. Interestingly, agencies classified as third service, hospital based and private all had higher odds of each hazard when compared with agencies classified as fire based. While fire-based agencies may have more opportunities for hazards due to their cross-training in fire and EMS, they also have additional safety standards regarding fitness, health, exposures, active shooters, hostile patients and minimum number of personnel on apparatus.[17] We encourage further work to understand the differences in exposure and response to hazards among these unique subgroups in order to understand the best approaches for mitigation.

Though EMS clinicians experienced high rates of injuries and exposures in this examination, we also noted the clear benefit of mitigation strategies. This was evidenced by lower adjusted odds of injury being associated with a lifting policy, providing lifting training and when clinicians *always* use a powered stretcher compared with never. Further, we also observe lower adjusted odds of exposures associated with PPE/CBN training and lower adjusted odds of violence associated with de-escalation training. However, there was a low prevalence overall of mitigation strategies, demonstrating a substantial opportunity to improve the stability and resilience of the workforce by promoting interventions that have the potential to prevent injuries, exposures and violence. Regarding occupational exposure mitigation, nationally certified EMS clinicians are required to have training in PPE/CBN materials every 2 years to maintain their certification, indicating that the difference noted here (OR 0.75, 95% CI 0.69–0.80) is the difference with a 1-year increase in PPE/CBN training. This decrease in training from 2-year to 1-year intervals may allow EMS administrators to lower the odds of their clinicians experiencing occupational exposure.

High prevalence of workplace hazards and the apparent effectiveness of targeted mitigation strategies have implications for future EMS clinician safety and workforce stability. The majority of workplace injuries from assaults that require days off from work occur in the healthcare and social services area, which includes emergency medical personnel.[18] Further, 37% of injuries and exposures among EMS clinicians treated in the emergency department reported missing one or more work days afterward.[12] These types of hazards, not exclusive to EMS clinicians, were also estimated to have societal and economic costs of $1100 per worker due to preventable injury in 2020.[19] Experiencing these occupational hazards can sideline clinicians and strain overall EMS system preparation for emergent and non-emergent responses. Considering the current national discussions on workforce challenges, these continued exposures further exacerbate current problems and may contribute to the high turnover of EMS clinicians. Lack of prepared and available EMS clinicians is also a critical discussion point regarding

staffing challenges that continue to dominate national policy discussion.[15 20 21]

Limitations

There are several limitations to our study that should be noted. First, the cross-sectional design makes temporality between mitigation strategies and outcomes difficult to establish, making our results observational and associational, not causal. Second, the survey instrument elicited information about events occurring over the past 12 months, indicating the potential for recall and self-reporting bias. Third, while verbal assault was included in the violence measure, the inclusion of psychological injuries was not specifically addressed. Fourth, additional hazard prevention strategies, different from those assessed here, may not be captured in this examination, and their possible association with reduced odds of experiencing hazards. Fifth, the outcome measures were dichotomised and, therefore, do not describe the frequency with which each hazard was encountered. Lastly, while our sample was representative of the nationally certified EMS population (online supplemental appendix 1), differences could be present between those nationally certified and those not. These differences are difficult to measure due to the lack of a national database of EMS clinicians.

CONCLUSION

Occupational hazards are commonly experienced in the workplace among nationally certified EMS clinicians. These hazards are associated with demographic characteristics such as age and sex, and workplace characteristics such as agency type and level of certification. Common mitigation efforts were not widespread, but when present were associated with lower odds of reporting these occupational hazards. Promotion and implementation of mitigation strategies may be an actionable approach to reduce occupational hazards for EMS clinicians.

Twitter Jonathan R Powell @jreadyp, Jordan D Kurth @JordanDKurthPhD and Christopher B Gage @gagecb3

Contributors REC and ARP conceived and designed the study. ARP collected the data. JRP, REC, JDK, CBG and ARP analysed the data and drafted the manuscript. All authors contributed substantially to the interpretation of data and revision of the manuscript. JRP takes responsibility as guarantor for the paper as a whole.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was deemed exempt by the American Institutes of Research (EX00493). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

ORCID iD

Jonathan R Powell http://orcid.org/0000-0003-3443-0247

REFERENCES

1 Rivard MK, Cash RE, Mercer CB, *et al*. Demography of the national emergency medical services workforce: a description of those providing patient care in the prehospital setting. *Prehosp Emerg Care* 2021;25:213–20.
2 EMS Agenda for the Future. A people-centered vision for the future of emergency medical services. In: *EMS Agenda 2050*. Washington, D.C: National Highway Traffic Safety Administration, 2019. Available: https://www.ems.gov/pdf/EMS-Agenda-2050.pdf
3 Gormley MA, Crowe RP, Bentley MA, *et al*. A national description of violence toward emergency medical services personnel. *Prehosp Emerg Care* 2016;20:439–47.
4 Taylor JA, Davis AL, Barnes B, *et al*. Injury risks of EMS responders: evidence from the national fire fighter near-miss reporting system. *BMJ Open* 2015;5:e007562.
5 National Registry of Emergency Medical Technicians. Recertification guide. 2019. Available: https://www.nremt.org/Document/Recertification
6 National Highway Travel and Safety Administration. 2021 National emergency medical services education standards; 2021.
7 Koser BW, Siddiqui DI, Kropp AM. Statpearls. In: *EMS Care In A Hostile Environment*. Treasure Island (FL), StatPearls Publishing LLC, 2023.
8 Friedenberg R, Kalichman L, Ezra D, *et al*. Work-related musculoskeletal disorders and injuries among emergency medical technicians and paramedics: a comprehensive narrative review. *Archives of Environmental & Occupational Health* 2022;77:9–17.
9 Jenkins JL, Hsu EB, Zhang A, *et al*. Current evidence for infection prevention and control interventions in emergency medical services: a scoping review. *Prehosp Disaster Med* 2023;38:371–7.
10 Kearney J, Muir C, Smith K. Occupational injury among paramedics: a systematic review. *Inj Prev* 2022;28:175–84.
11 Maguire BJ, O'Neill BJ, O'Meara P, *et al*. Preventing EMS workplace violence: a mixed-methods analysis of insights from assaulted medics. *Injury* 2018;49:1258–65.
12 Reichard AA, Marsh SM, Tonozzi TR, *et al*. Occupational injuries and exposures among emergency medical services workers. *Prehosp Emerg Care* 2017;21:420–31.
13 Maguire BJ, Hunting KL, Guidotti TL, *et al*. Occupational injuries among emergency medical services personnel. *Prehosp Emerg Care* 2005;9:405–11.
14 National Registry of Emergency Medical Technicians. National Registry data, dashboard, & maps. 2022. Available: https://nremt.org/maps
15 Kurth JD, Powell JR, Gage CB, *et al*. Evaluating changes in the emergency medical services workforce: a preliminary Multistate study. *J Am Coll Emerg Physicians Open* 2023;4:e12975.
16 Stata. Stata 1996-2023. Available: https://www.stata.com [Accessed 28 Feb 2023].
17 National Fire Protection Association. List of NFPA codes and standards. 2023. Available: https://www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/List-of-Codes-and-Standards
18 Occupational safety and health administration. Guidelines for preventing workplace violence for healthcare and social service workers. 2016.
19 National Safety Council. Work injury costs 2020. n.d. Available: https://injuryfacts.nsc.org/work/costs/work-injury-costs
20 Baird S, Evans B. Congressional letter on the EMS workforce shortage. American Ambulance Association; 2021. Available: https://ambulance.org/2021/10/04/workforceshortage/
21 Ball M, Powell JR, Gage CB, *et al*. Paramedic educational program attrition accounts for significant loss of potential EMS workforce. *J Am Coll Emerg Physicians Open* 2023;4:e12917.