



HHS Public Access

Author manuscript

Policing. Author manuscript; available in PMC 2023 May 24.

Published in final edited form as:

Policing. 2022 May 24; 45(5): 881–891. doi:10.1108/pijpsm-02-2022-0022.

Proportionate mortality and national rate of death from COVID-19 among US law enforcement officers: 2020

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Abstract

Purpose —The goal of the present study is to determine the proportionate mortality and national rate of duty-related deaths from COVID-19 among US law enforcement officers during the year 2020.

Design/methodology/approach —Data for the current study were obtained from the National Law Enforcement Officer Memorial Fund (NLEOMF) database for the year 2020. The database contains deaths designated as caused by incidents that occurred while in the line of duty. The chi-square test and two-sample *t*-test were used to compare characteristics of officers who died of COVID-19 versus other causes of death. Both the proportionate mortality and rates of death were calculated. To compute the *rate* of death, the authors obtained data on the total number of law enforcement officers employed in the United States (and therefore at risk) for the year 2020 from Bureau of Labor Statistics.

Findings —COVID-19 deaths ($n = 182$) accounted for 62% of all duty-related law enforcement officer deaths during 2020. The national rate of death due to COVID-19 (12.8/100,000 per year) for law enforcement officers was higher compared to all other causes of death combined (8.0/100,000 per year).

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Research limitations/implications —A limitation of the study is the uncertainty of a definitive assessment that the viral infection was acquired through work (versus at home or other non-work-related community settings). Although highly unlikely, deaths designated as duty related entail financial benefits for the survivors and may be a potential source of bias. Given the complexity of personal exposures, the percentage of COVID-19 deaths attributed to duty may represent an over or under estimation of the actual value. Therefore, the data should be interpreted cautiously.

Practical implications —These findings provide police organizations with information needed to understand the risk of death among officers during the COVID-19 pandemic and to make informed decisions about future preparedness strategies.

Originality/value —There are presently no published scientific studies that examine both the proportionate mortality and national rate of death from COVID-19 among law enforcement officers for the year 2020.

Keywords

COVID-19; Law enforcement officer deaths; Work exposures; National rates

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) rapidly spread throughout the world during 2020 causing the COVID-19 global pandemic. As of December, 2021, the virus had infected 277 million people and caused 5.3 million deaths worldwide (Centers for Disease Control and Prevention, 2021). First responders and health care professionals such as physicians, nurses, and hospital personnel have been significantly challenged by the COVID-19 outbreak. In the public service arena, law enforcement faced formidable challenges brought about by this pandemic. A recent survey indicated that 35% of police departments had suspended their police academies, 12% had increased overtime hours, and approximately 30% had to furlough staff due to COVID-19 (Lum *et al.*, 2020a). Law enforcement officers interact with the public every day, increasing their risk of exposure as well as that of their family. During most of 2020, officers were expected to coordinate local shutdowns, encourage physical distancing, and enforce stay-at-home laws, challenges compounded by understaffing and underfunding. Operational issues during this time period included reduced staff, insufficient safety measures and equipment to deal with COVID-19 and poor organizational support (Alexander and Ekici, 2020).

Similar to other first responders, officers have close contact with people in public settings and during arrest situations. As a result, they are at increased risk of becoming infected with SARS CoV-2. Although there have been various estimates on the number of police deaths due to COVID-19, there is little information from verifiable sources or on the rate of death relative to the entire US police population. The goal of this study is to determine the proportionate mortality and rate of death from COVID-19 among law enforcement officers utilizing the National Law Enforcement Officers Memorial Fund (NLEOMF) database. Only deaths related to COVID-19 are included in this database; illnesses related to COVID-19 are not captured. Other factors related to deaths from COVID-19 were also examined, including

age, race/ethnicity, time in police service, type of policing, and region. The year 2020 was the focus of this investigation, as the first confirmed case of COVID-19 reported in US was at the beginning of this year.

Methods

Data source

Data for the current study were obtained from the National Law Enforcement Officer Memorial Fund (NLEOMF) database (2021). The NLEOMF is a non-profit organization founded in 1984, which tracks and maintains a comprehensive database on US law enforcement officers who died in the line of duty. The population of law enforcement officers included in the NLEOMF database consisted of federal, state, local, special jurisdiction, and corrections officers.

For a deceased officer to be considered for inclusion in the National Law Enforcement Officers Memorial database, a data form (<https://nleomf.org/wp-content/uploads/2020/03/officer-data-form-fillable-2020.pdf>) about the officer must be completed by an official representative of the department for which the officer served and signed by the head of the agency. The data form includes demographic information of the deceased officer, date and time of incident, date of death, circumstances of the death, whether the decedent was a duly sworn officer with full arrest powers, and additional documents such as death certificates, which includes the contributing cause of death and autopsy report (if available). Officer Data Forms and any supporting documentation are reviewed for accuracy and completeness by the Memorial Fund's Research Department and then forwarded to a committee of the Memorial Fund Board of Directors which thoroughly reviews each case to determine if the circumstances of the death met the criteria for inclusion on the National Memorial and ultimately approve or deny each case. Deaths caused by disease, accidents, untoward events, or any work exposure that is related to the death are reviewed by the Armed Forces Institute of Pathology or other medical personnel with similar skill and expertise to determine whether the officer died because of infectious disease contracted while performing official duties. Further details on the approval process are located at the NLEOMF website (<https://nleomf.org/memorial/fallen-heroes/the-process-and-how-it-works/>). Medical personnel certifying deaths conduct comprehensive investigations as to the origins of causes of death to ensure that the death was due to an incident that occurred while on duty (i.e. while engaged in regular work). This is accomplished by reviewing police reports, medical history, medical records, and interviews with coworkers and family.

To be included in the NLEOMF database, the decedent must have been a duly sworn law enforcement officer with full arrest powers and employed by a law enforcement agency of the United States or its territories. The law enforcement officer must have died as a direct and proximate result of a personal injury, disease, or adverse event sustained while on duty. This also includes: (1) law enforcement officers who, while in an off-duty capacity, act in response to a law violation, (2) law enforcement officers who, while in an off-duty capacity, were enroute to or from a specific emergency or responding to a particular request for assistance, (3) law enforcement officers who, as required or authorized by law or condition of employment, driving his or her employer's vehicle to or from work, and (4) law

enforcement officers who, as required by law or condition of employment driving his or her own personal vehicle at work and is killed while enroute to or from work.

The NLEOMF data used are not considered research as stated in 45CFR 46.1102(I). It is not a public health agency but a private memorial fund for law enforcement officers. The data are in the public domain.

The present study examined all the deaths that occurred in the year 2020 (January 1, 2020 to December 31, 2020, the latest available at the time of data collection). To be included in the current analyses, the date of death of the officer must have occurred within this one-year period. The variables of interest in the current analyses include sex, age, years of law enforcement service, rank, region of residence, date of death, cause of death (shooting, auto accident, terrorism, COVID-19 infection, etc.), and circumstances of death (accidental, felonious).

Statistical methods

Causes of death were categorized in to two major groups: (1) COVID-19 related deaths, and (2) other causes of death (gunshot, automobile crash, heart attack, cancer, heat stroke, pulmonary disease, fall, struck by a vehicle, drowning, motorcycle crash, aircraft crash, and beating). The demographic characteristics of the deceased officers were summarized using descriptive statistics and compared between the two major causes of death (COVID-19 vs other causes). Differences in distribution of categorical characteristics between the two groups were compared using the chi-square test of independence while mean values of continuous characteristics were compared using the two-sample *t*-test. We estimated the proportionate mortality as well as the national rate of death due to COVID-19 and all other specific causes of death. Proportionate mortality (PM) was computed as follows: $PM = (\text{number of deaths due to a specific cause} / \text{total number of deaths}) \times 100$; where the numerator is the number of duty-related deaths caused by a particular cause during the year 2020 while the denominator is the total number of deaths from all causes during the year 2020.

To compute the national rate of death, we obtained data on the total number of law enforcement officers employed in the United States (and therefore at risk) at mid-point of 2020 from the Occupational Employment Statistics (OES) survey conducted by the Bureau of Labor Statistics (BLS, 2020). The overall annual rate of death (crude death rate), and cause-specific rate of death were then computed as follows: $\text{Rate of death} = (\text{frequency} / \text{population at risk}) \times 100,000$; where frequency is the number of duty-related deaths due to a particular cause and population at risk is the size of US law enforcement officers employed at mid-point of 2020 which is estimated to be 1,418,480 (U S. Bureau of Labor Statistics, 2020). We also examined the monthly frequencies of death due to COVID-19 and other specific causes of death.

Results

All causes of death combined

In 2020, there were 295 duty-related law enforcement fatalities reported to NLEOMF that occurred between January 1, 2020 and December 28, 2020 (Table 1). Majority of the deceased officers were male (92%), Non-Hispanic White (52%), over the age of 50 (52%), and had more than 10 years of experience (74%). Officers with lower rank (patrol and corrections officers) accounted for majority of the deaths (56%).

COVID-19 deaths

COVID-19 related deaths ($n = 182$) accounted for nearly 62% of all on-duty related law enforcement fatalities for 2020 (the proportionate mortality) (Table 2). The national rate (12.8/100,000 per year) was higher for COVID-19 deaths compared to all other types of death (Table 2). COVID-19 related deaths occurred between March 24, 2020 and December 28, 2020. The majority of officers who died from COVID-19 were males (94%), older than 50 years (61.6%), had more than 20 years of service (54%), were lower ranked police or corrections officers (50.0%), and resided in southern region of US (50%). Predominantly, the COVID-19 deaths occurred during spring and summer months (68%) (Table 1, Figure 1).

Causes of death other than COVID-19

Other causes of police fatalities included gunshot, automobile crash, physical stress (heart attack, cancer, heat stroke, pulmonary disease, fall), being struck by a vehicle, drowning, motorcycle crash, aircraft crash, and beatings which all together accounted for 38% of the deaths (Table 2). The leading causes of death other than COVID-19 were gunshot (15%), automobile crash (9%) and physical stress (7%) (Table 2). Officers who died of other causes were primarily male (89%), non-Hispanic White (71%), 40 years of age or younger (50%), had less than 10 years of service (51%), had a lower rank (66%), primarily resided in the south (50%), and the deaths primarily occurred during the spring months (31%) (Table 1). The rate of death from other causes of death was 8 per 100,000 officers (Table 2).

COVID-19 deaths vs other causes of death

On average, officers who died of COVID-19 were significantly older (53.0 ± 8.7 vs 41.3 ± 12.7 $p < 0.001$) and had more years of experience (21.3 ± 9.2 vs 12.7 ± 11.0 , $p < 0.001$) compared to officers who died of other causes of death (Table 1). There was a major difference in the racial composition by cause of death; the proportion of people who were non-Hispanic White was lower among COVID-19 deaths (40.0%) than deaths from other causes (71%) ($p < 0.001$). Differences in death for patrol and corrections officers were also apparent between the two causes of death. COVID-19 deaths accounted for 35 (97%) of 36 deaths among corrections officers, as compared with 56 (43%) of 130 deaths among patrol officers ($p < 0.001$, Table 1).

Regional differences in death by cause of death were driven by deaths among Federal police, a group considered separate due to dispersed jurisdictions throughout the country. Federal police accounted for 12% of COVID-19 deaths but only for 4% of deaths by other causes ($p = 0.037$).

Discussion

The goal of this study was to determine the proportionate mortality and national rate of death from COVID-19 among law enforcement officers in the United States, along with their demographic characteristics. COVID-19 was the leading cause of duty-related deaths reported to the NLEOMF in the year 2020, accounting for 62% of all causes of death.

On average, officers who died of COVID-19 were significantly older and had more years of experience compared to officers who died of other causes. Hispanic and non-Hispanic Black officers accounted for a significantly higher proportion of COVID-19 deaths relative to non-COVID-19 deaths. The majority of officers who died from COVID-19 were older than 50 (62%), while half of those who died from other causes were younger than 40 (50%). Other causes of death in 2020 included gunshot, automobile crashes, physical stress (heart attack, cancer, heat stroke, pulmonary disease, fall), being struck by a vehicle, drowning, motorcycle crash, aircraft crash, and beatings.

In terms of racial disparity in proportionate mortality, our data indicates COVID-19 deaths accounted for 48% of deaths (73 of 153) among non-Hispanic Whites, 77% of deaths (66 of 86) among non-Hispanic Blacks, and 82% of deaths (37 of 45) among Hispanic or Latino officers (Table 1). This result is consistent with the findings from a recent systematic review on racial disparities in COVID-19 deaths (Mude *et al.*, 2021) which reported that Blacks and Hispanics experienced a higher rate of death from COVID-19 compared to Whites.

Police are challenged with multiple stressors such as social stigmatization, lack of protective equipment, and witnessing human suffering and death (Lum *et al.*, 2020a, 2020b; Vena *et al.*, 2014). Our findings demonstrate that COVID-19 illnesses are another important source of stress on an occupational group that already faces numerous stressors. The COVID-19 outbreak has persisted with the Delta and Omicron variants which may lead to further exposure and long-term mental issues such as PTSD, depression, or anxiety. Psychological issues, in turn are associated with worsened job attitudes, higher turnover, decreased job performance, and health issues (Kim *et al.*, 2011; Violanti, 2014).

The majority of COVID-19 deaths were among older officers. Older persons have a higher risk of comorbidities and are more likely to be at risk for death (Sanyaolu *et al.*, 2020). While there are no data on comorbidities in the NLEOMF database, it is possible that they existed among older officers who died from COVID-19 (Sanyaolu *et al.*, 2020). For example, previous research found that 82% of circulatory deaths among older officers were from an on-duty heart attack (Violanti *et al.*, 2020). Relative to the general population, officers are more likely to be obese or have comorbidities such as diabetes that increases their risk for COVID-19 (Gu *et al.*, 2014).

Interestingly, COVID-19 deaths accounted for 97% (35 of 36) of 36 deaths among corrections officers. There may be several reasons for this finding. First, it could be argued that incarcerated persons are at higher risk for COVID-19 due to overcrowding in prisons and high rates of comorbidity. A study by Irvine *et al.* (2020) developed a model of potential COVID-19 outbreaks in Immigration and Customs Enforcement facilities. Results indicated that 72% of individuals were expected to be infected by day 90 under the optimistic

scenario, while nearly 100% of individuals were expected to be infected by day 90 under a more pessimistic scenario. Although asynchronous outbreaks were more likely, day 90 estimates provided an approximation of total positive cases after all facility outbreaks. Secondly, physical distancing is difficult under crowded corrections facility conditions. A study of sixteen Massachusetts jails and prisons found that the rate of COVID-19 infection was 44.3 cases per 1,000 persons among incarcerated individuals and staff – 2.91 times higher than the Massachusetts general population and 4.8 times the US general population (Jimenez *et al.*, 2020). A recent study by the Marshall project (2021) found that corrections employees are refusing vaccines at alarming rates, causing some public health experts to worry about the prospect of controlling the pandemic both inside and outside of correctional institutions. According to this study, prison staff were resistant to wearing masks and enforcing physical distancing. Officers were concerned about the long-term effects of the vaccine and distrusted prison administration. In addition, Khorasani *et al.* (2021) found that 59% of people incarcerated in jail did not want the COVID-19 vaccine, further increasing the risk of corrections officers who do not get vaccinated.

There are limitations in the present study. The COVID-19 deaths in law enforcement officers reported to the NLEOMF are only for those that were caused due to exposure while in the line of duty. As a result, the rate of mortality among law enforcement officers from COVID-19 is likely higher than reported. A recent study (Hawkins *et al.*, 2021) found that COVID-19 death rates among workers in high-risk occupations was higher than the rate for workers overall.

The data are descriptive and should be interpreted cautiously. Although there are no official death records included in this database, each death is thoroughly reviewed by the Armed Forces Institute of Pathology or by other medical personnel with similar skill and expertise. The NLEOMF database contains all deaths of law enforcement officers that occurred while the officer was “on duty” including death as result of being exposed to COVID-19. No information or details are provided that would specify what caused the COVID-19 exposure, only that it was considered an on-duty related death defined by the regulations specified by the federal government (Hometown Heroes Act, 2018). If it were determined that the death was a result of a non-duty occurrence, then the officer would not be included in the database. This program provides the surviving family a monetary stipend only if the death occurred due to on-duty activities. It is worth mentioning that the first cases of death from COVID-19 in the U.S. did not occur until weeks into the year and that the risk was not uniform throughout the country. This may affect the mortality rate comparison between COVID-19 vs other causes of death (which had the opportunity to occur in all months of the year and are considered more consistent across the country); the true COVID-19 mortality rate for the year may be higher.

As previously mentioned, the Armed Forces Institute of Pathology or other medical personnel with similar expertise determined whether the officer died as a result of COVID-19 infection. How and why they arrived at their medical based decision is not specified in the database. The NLEOMF database does not contain information on personal medical data of officers. It was therefore not possible to determine any comorbidities that may have added to the risk of COVID-19 deaths. Information such as obesity, smoking, diet,

comorbidities, and other lifestyle factors were not available. Additionally, the NLEOMF database do not contain information on whether the various law enforcement departments had available preventive mechanisms such as regular COVID-19 testing, mask policies, counseling, and support for stress and trauma. Finally, we have no way of knowing the methods used by Medical Examiners for certifying COVID-19 deaths were consistent with guidance for certifying deaths due to COVID-19 by the National Center for Health Statistics (<https://www.cdc.gov/nchs/data/nvss/vsrg/vsrg03-508.pdf>).

Conclusion

Nearly 62% of all police deaths reported to the NLEOMF for the year 2020 were due to COVID-19. The COVID-19 mortality rate of 12.8 deaths per 100,000 officers per year from COVID-19 was higher compared to rate from all other causes of death (8.0 deaths per 100,000 officers per year). There are important findings in this study that call for evaluation and development of strategies to reduce the risk of police deaths from future pandemics. Vaccinations are one important way to help reduce the risk of COVID-19 among police officers, including severe illness and death (CDC, 2021). However, there is hesitancy among police to get vaccinated. Police vaccination rates are presently lower than or about the same as those of the general public, according to data made available by some of the nation's largest law enforcement agencies (Washington Post, 2021). Police departments are hesitant to mandate vaccinations due to conflicts with officers and police unions. Some cities are turning to incentives as a possible solution to boost participation.

These results add credence to the supposition that other first responder populations similarly exposed may be affected. Mental and physical well-being are key to successful societal functioning of law enforcement, therefore, taking care of officer's overall well-being is important. The government and police organizations need to understand the risk of death among police while working in a disaster-framed environment for prolonged time and make informed decisions about preparedness strategies that may help in mitigating such risks during dynamic extreme events (Syed *et al.*, 2020).

A fundamental limitation of the study is the uncertainty of a definitive assessment that the viral infection was acquired through work (versus at home or other non-work-related community settings). Furthermore, deaths designated as duty-related entail financial benefits for the survivors which could be a potential source of bias. A likely result is that the percentage of COVID-19 deaths attributed to duty may represent an overestimation of the actual value. Therefore, the data should be interpreted cautiously.

Future research might consider examining the course of exposure and death among officers that have been affected by this virus. Routine collection of data on occupation would help to improve understanding of COVID-19 deaths in first responders (Kelly-Rief *et al.*, 2021). Also, data gathered through nontraditional epidemiological surveillance such as NLEOMF database may help to provide insight into risk factors and potential mitigation strategies among occupations (Tomasi *et al.*, 2021).

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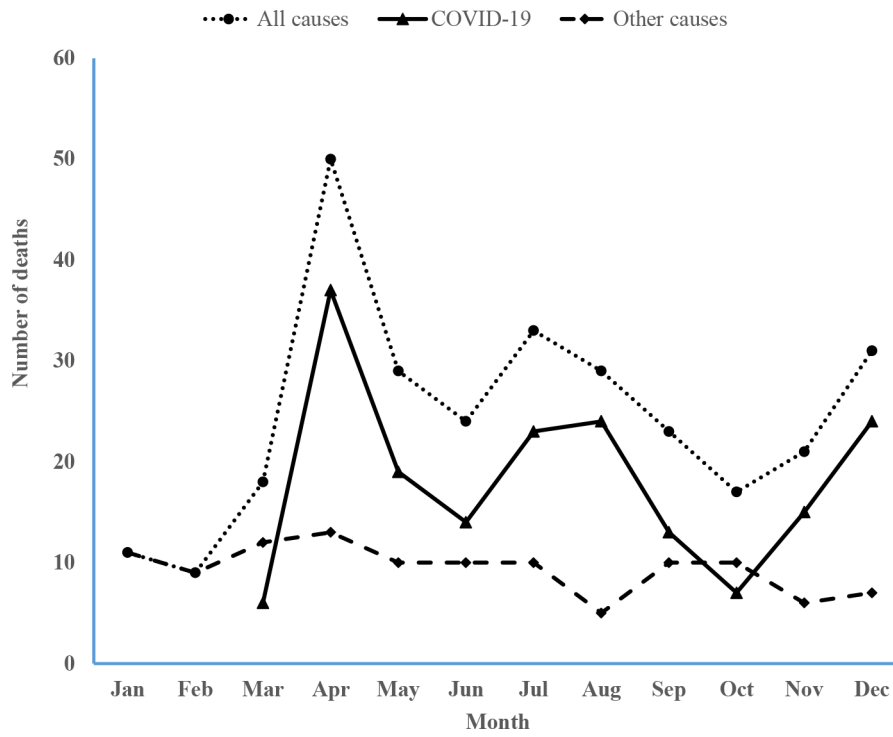


Figure 1. Monthly frequency and type of US law enforcement officer duty related deaths, 2020

Table 1.

Characteristics and type of US law enforcement officers who suffered duty related deaths, 2020

Characteristics	All causes (<i>n</i> = 295) <i>n</i> (%)	Cause of death COVID-19 ^a (<i>n</i> = 182) <i>n</i> (%)	Other causes ^b (<i>n</i> = 113) <i>n</i> (%)	<i>p</i> -value
<i>Sex</i>				0.0954
Male	271 (91.9)	171 (94.0)	100 (88.5)	
Female	24 (8.1)	11 (6.0)	13 (11.5)	
<i>Race/ethnicity</i>				<0.001
Non-Hispanic White	153 (51.9)	73 (40.1)	80 (70.8)	
Non-Hispanic Black	86 (29.2)	66 (36.6)	20 (17.7)	
Hispanic or Latino	45 (15.3)	37 (20.3)	8 (7.1)	
Other ^c	11 (3.7)	6 (3.3)	5 (4.4)	
<i>Age group</i>				<0.001
40	72 (24.4)	16 (8.8)	56 (49.6)	
41– 50	83 (28.1)	54 (29.7)	29 (25.7)	
51–<60	90 (30.5)	70 (38.5)	20 (17.7)	
60	50 (17.0)	42 (23.1)	8 (7.1)	
<i>Years of service</i>				<0.001
5	51 (17.3)	9 (5.0)	42 (37.2)	
6–<10	25 (8.5)	9 (5.0)	16 (14.2)	
10–<20	85 (28.8)	65 (35.7)	20 (17.7)	
20	134 (45.4)	99 (54.4)	35 (31.0)	
<i>Rank</i>				<0.001
Patrol officer	130 (44.1)	56 (30.8)	74 (65.5)	
Corrections officer	36 (12.0)	35 (19.2)	1 (0.88)	
Sergeant	37 (12.5)	26 (14.3)	11 (9.7)	
Lieutenant	10 (3.4)	6 (3.3)	4 (3.5)	
Captain	10 (3.4)	9 (5.0)	1 (0.88)	
Detective	26 (8.8)	17 (9.3)	9 (8.0)	
Executive	16 (5.4)	10 (5.5)	6 (5.3)	
Federal police	21 (7.1)	18 (9.9)	3 (2.7)	
Other	9 (3.1)	5 (2.8)	4 (3.5)	
<i>Region of residence</i>				0.0368
Northeast	44 (14.9)	31 (17.0)	13 (11.5)	
Midwest	43 (14.6)	23 (12.6)	20 (17.7)	
South	147 (49.8)	90 (49.5)	57 (50.4)	
West	34 (11.5)	16 (8.8)	18 (15.9)	
Federal police	27 (9.2)	22 (12.1)	5 (4.4)	
<i>Season</i>				0.0382
Winter	51 (17.3)	24 (13.2)	27 (23.9)	
Spring	97 (32.9)	62 (34.1)	35 (31.0)	
Summer	86 (29.2)	61 (33.5)	25 (22.1)	

Characteristics	All causes (<i>n</i> = 295) <i>n</i> (%)	Cause of death COVID-19 ^a (<i>n</i> = 182) <i>n</i> (%)	Other causes ^b (<i>n</i> = 113) <i>n</i> (%)	<i>p</i> -value
Autumn	61 (20.7)	35 (19.2)	26 (23.0)	
<i>Incident type</i>				<0.001
Accidental	230 (78.0)	182 (100.0)	48 (42.5)	
Felonious	65 (22.0)	0 (0.0)	65 (57.5)	
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (yrs.)	48.5 ± 11.8	53.0 ± 8.7	41.3 ± 12.7	<0.001
Years of service (yrs.)	18.0 ± 10.7	21.3 ± 9.2	12.7 ± 11.0	<0.001

Note(s): The *p*-values compare whether the distribution (for categorical variables) or mean (for continuous variables) of the characteristics of interest is significantly different between the two causes of death (COVID-19 vs Other causes) and was generated using the chi-square test of independence (for categorical variables) and two sample *t*-test (for continuous variables)

^aDeath due to COVID-19 infectious disease

^bDeath due to other causes (gun shot, automobile crash, heart attack, cancer, heat stroke, pulmonary disease, fall, struck by a vehicle, drowning, motorcycle crash, aircraft crash, and beating)

^cIncludes non-Hispanic Asian, non-Hispanic American Indian or Alaska Native, and non-Hispanic Native Hawaiian or Other Pacific Islander

Table 2.

Specific causes of duty related US law enforcement officer deaths, 2020

Cause of death	Frequency (<i>n</i>)	Percent (%) ^{<i>b</i>}	Rate of death per 100,000 officers ^{<i>c</i>}
COVID-19 infectious disease	182	61.7	12.8
<i>Other</i>			
Gun shot	45	15.3	3.2
Automobile crash	25	8.5	1.8
Physical stress ^{<i>a</i>}	21	7.1	1.5
Struck by a vehicle	14	4.7	1.0
Drowning ^{<i>d</i>}	3	1.0	0.2
Motorcycle crash ^{<i>d</i>}	3	1.0	0.2
Aircraft crash ^{<i>d</i>}	1	0.3	0.1
Beating ^{<i>d</i>}	1	0.3	0.1
Total	113	38.2	8.0
Total	295	100	20.8

^{*a*}Physical stress related causes include heart attack, cancer, heat stroke, pulmonary disease, fall

^{*b*}Percent (%) is the proportionate mortality

^{*c*}Rate per 100,000 officers is computed using an estimate of 1,418,480 total employed law enforcement officers at mid-point of year 2020 (estimated using data from the Bureau of Labor Statistics)

^{*d*}Percent and rate for specific causes with less than five counts are unreliable and should not be used as estimates in the population