Behind the Flames: A Comparative Analysis of Fatality Risk Among U.S. Wildland and Municipal Firefighters

UC San Diego
Herbert Wertheim School of Public Health and Human Longevity Science

Jenna Yamami, Eric Landin, Ethan Chay

Herbert Wertheim School of Public Health & Human Longevity Science

Objective: To assess whether variations in occupational exposures by departmental rank and geographic region are associated with differences in fatality between wildland firefighters and municipal firefighters.

Background

The US firefighter workforce includes municipal firefighters (**MFFs**) who serve in urban and suburban areas, and wildland firefighters (**WFFs**) who work in natural terrains, such as forests or grasslands.[1,2]

Differences between WFFs and MFFs:

- **MFFs** comprise most of the 1.2 million US firefighters, work year-round, undergo standardized training, and receive adequate PPE.[2,4]
- **WFFs** are comprised of ~100,000 workers, primarily work during the summer for 12-16 hours per shift for up to 14 consecutive days, and often lack training and PPE.[1,10]
  - WFF injuries most commonly occur during the peak and end of wildfire seasons (May-October), when job stress is highest.[10]

Increased Fatality Risk for WFFs

- Compared to MFFs, existing research on the association between occupational exposures and fatality outcomes is limited.[1,7]
- **Climate Change** driven by human activity causes drier conditions and higher temperatures.[10]
  - Most severe multiple fatality incidents occur at wildland fires.[10]
  - Annual acreage burned rose 50%: 4.6M acres in 1990 to 10.1M acres in 2020.[3]

Methods

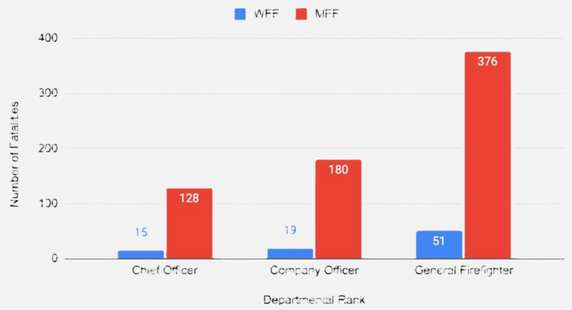
- **Secondary Study**
  - **Retrospective Cohort Analysis:** utilized the Fire Fighter Investigation and Prevention Program's 2015-2024 data set
- **Exposure Variables**
  - **Firefighter Type:** Wildland (WFF), municipal (MFF)
  - **Rank:** Chief officer, company officer, general firefighter
  - **Region:** West, Midwest, South, and Northeast
- **Outcome:** Fatality rates of MFFs and WFFs
- **Data Analysis**
  - **Program for Analysis:** SPSS v29
  - **Type of Test:** Chi-Square Test, Kruskal Wallis Test

Results

Table 1. *Demographics of Firefighters (N=886, 2015-2024)*

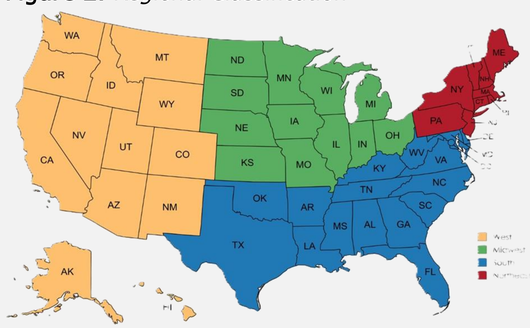
Age of Death	
<21	17 (1.9%)
21-30	88 (9.9%)
31-40	142 (16%)
41-50	210 (23.7%)
51-60	225 (25.4%)
61-70	132 (14.0%)
71-80	57 (6.4%)
>80	15 (1.7%)
Sex of Deceased	
Male	862 (97.8%)
Female	19 (2.2%)
Fatalities by Department	
MFF	767 (88.6%)
WFF	119 (13.4%)

Figure 1. *WFF and MFF Fatalities by Departmental Rank (2015-2024)*



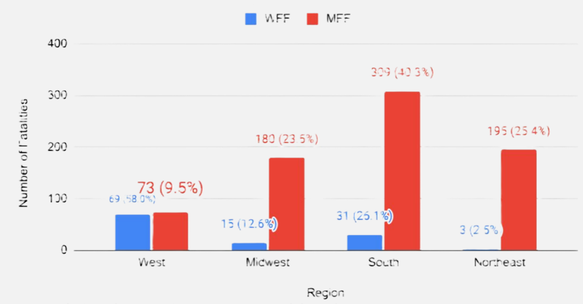
Death frequency by firefighter rank among WFFs and MFFs. The rank of 'General Firefighter' has the highest fatality rates among both groups, accounting for 60% of WFF (n=51) and 55% (n=376) of MFF deaths.

Figure 2. *Regional Classification*



Regions in this analysis follow the US Census Bureau's 2025 regional classification.[13]

Figure 3. *WFF and MFF Fatalities by US Region (2015-2024)*



Fatalities by region separated by department type. In every region, MFFs exceed WFF fatalities. Largest proportion (58%) of WFF fatalities occur in the West. Total firefighter fatalities were highest in the South for both WFFs and MFFs.

Kruskal Wallis Test: assessed whether firefighter rank is associated with fatality rates.

- **Results:** firefighter departmental rank was significantly associated with fatalities in both MFFs ($\chi^2 = 165.126$, $p < 0.001$) and WFFs ($\chi^2 = 23.768$, $p < 0.001$), with a stronger association for MFFs.
- **Suggests** fatality risk differs by department rank, especially for MFFs.

Chi-Square Test: determined association between region and firefighter fatality rates.

- **Results:** region was significantly associated with fatalities in both MFFs ($H = 9.375$. $p = 0.025$) and WFFs ($H = 18.408$, $p < 0.001$), with a stronger association for WFFs.
- **Suggests** firefighter's geographic region of work influences fatality risk, especially for WFFs.

Conclusions

- Wildland (WFF) and municipal (MFF) fatality rates significantly vary by rank
  - Rank influences responsibilities and exposure levels
  - Lower ranking roles, especially General Firefighters face increased fatality risk and should be prioritized for targeted interventions
- WFF and MFF fatality rates significantly vary by region
  - West: highest number of WFF fatalities, largely due to fires in Wildland Urban Interfaces (WUIs), or areas where development meets flammable vegetation[1]
  - Worsening climate change and expanding development into WUIs increase WFF fatality risk
- From 2015-2024, there were more MFF fatalities than WFF fatalities, likely due to MFFs representing a larger proportion of the total US firefighter population[2]
  - Growing WFF fatality risks: WFF fatalities have had a 500% relative increase in their share of total firefighter deaths from 2% in 1990-2000 to 10% in 2013-2022[7]

Policy Implications

- Partner with San Diego Fire-Rescue, CalFire, and Golden Eagle Hotshots to establish field-testing environments for PPE, evaluate risk mitigation strategies, and improve fireline decontamination protocols to mitigate against hazards materials exposure
- Partner with existing research centers (e.g. University of Arizona's Center for Firefighter Health) to advance research in long-term occupational health risks (e.g. cumulative stress, carcinogen and hazardous materials exposure)

References