





# Prevalence and predictors of skin cancer screening among a sample of US volunteer firefighters

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## Abstract

**Background:** Firefighters have a higher risk of melanoma incidence and mortality compared to the general population. In the United States (US), the National Fire Protection Association recommends all firefighters receive annual skin cancer screening through visual skin examination by a clinician. However, there is limited information on skin cancer screening practices among volunteer firefighters who comprise two-thirds of the US fire service.

**Methods:** This cross-sectional study of 552 US volunteer firefighters estimated the prevalence of skin cancer screening and evaluated associations with their fire service experience, demographics, sun protection practices, and cancer risk perception.

**Results:** The prevalence of receiving skin cancer screening among volunteer firefighters was 26.1% (95% confidence interval [CI]: 22.4, 29.8). The odds of being screened for skin cancer, compared to not being screened, were twice as high for firefighters who used sunscreen (odds ratio [OR]: 2.35, 95% CI: 1.48, 3.73) and who perceived their skin likely to burn with prolonged sun exposure (OR: 1.81, 95%

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CI: 1.10, 3.00). Older age, some college education, and family history of skin cancer were also positively associated with skin cancer screening. A positive exposure-response relationship was observed between more monthly firefighting calls and receiving screening. Cancer risk perception was not associated with screening.

**Conclusion:** To our knowledge, this is the first large study to assess skin cancer screening among US volunteer firefighters. Our findings suggest gaps in skin cancer prevention efforts in the volunteer fire service. Additional assessment of skin cancer prevention practices within volunteer fire departments could help address these gaps.

#### KEYWORDS

cancer screening, clinical visual skin examinations, firefighters, occupational cancer prevention and control, skin cancer

## 1 | INTRODUCTION

Current evidence supports that firefighters have an excess risk and mortality from melanoma compared to the general population.<sup>1,2</sup> Firefighters may be occupationally exposed to ultraviolet radiation from the sun as well as skin cancer-causing agents such as benzene and polycyclic aromatic hydrocarbons found in flame retardants and combustion by-products.<sup>3</sup> In 2022, the International Agency for Research on Cancer (IARC) classified occupational exposure as a firefighter as “carcinogenic to humans” (Group 1),<sup>4</sup> including a positive association between occupational exposure as a firefighter and increased risk of melanoma.<sup>2</sup> A meta-analysis from this IARC working groups reported 19% excess incidence of melanoma among studies of firefighters compared to the uniformed service or working populations, a 27% excess incidence for studies that compared firefighters to the general population, and 36% excess incidence for studies that compared firefighters to all studies combined.<sup>2</sup>

The United States Preventive Services Task Force (USPSTF) does not make recommendations for skin cancer screening for the general population based on insufficient evidence for the effectiveness of clinical visual skin examinations.<sup>5</sup> However, the National Fire Protection Association, which sets firefighter health and safety standards in the United States (US), recommends that firefighters have annual skin examinations from a clinician.<sup>6</sup>

Across the estimated one million US firefighters, 65% are volunteer firefighters.<sup>7</sup> Volunteers primarily serve in rural and suburban communities where higher incidence and mortality from melanoma are observed in relation to urban areas.<sup>8</sup> Compared to their employed, shift-based, career counterparts, volunteer firefighters have similar firefighting duties but may have fewer opportunities for reducing exposure risk and participating in health promotion activities. This may be due to factors such as inadequate fire department resources, the need to be available for firefighting calls at any time, and having additional full-time employment responsibilities.<sup>7,9</sup> This cross-sectional study examines the prevalence of skin cancer screening in a convenience sample of US volunteer firefighters in association with their fire service experience,

demographics, employment characteristics, sun protection practices, and their cancer risk perception.

## 2 | MATERIALS AND METHODS

### 2.1 | Study population and data sources

The Firefighter Cancer Assessment and Prevention Study (CAPS) is an ongoing prospective cohort study of volunteer firefighters' cancer risk and prevention which began in 2019. CAPS uses methodology adapted from the National Fire Fighter Cancer Cohort Study.<sup>10,11</sup> Incumbent volunteer firefighters, aged 18 years or older, were enrolled from 41 US volunteer or combination (both volunteer and career) fire departments in Connecticut, Illinois, Kansas, Maryland, Maine, Missouri, New Jersey, Tennessee, and Washington. Fire department membership ranged in size from <10 to over 250 members. Participants completed informed consent by signing an online form and completed a comprehensive electronic health survey about their fire service experience, employment, personal and family cancer history, cancer screening practices, and health behaviors. Data were collected between July 2019 and January 2023, and stored on REDCap, a secure survey management system.

We defined participants who reported ever receiving a skin examination from a clinician as being screened for skin cancer. Participants who had any history of skin cancer were excluded. For fire service characteristics, we examined years of volunteer and career fire service, average number of monthly firefighting calls responded to, and the longest-held department rank (firefighter, chief, or other leadership). We included employment characteristics such as longest-held primary occupation and percent of time spent working outdoors. For sun protection practices, we assessed use of hats, long sleeve shirts, long pants, and sunscreen. We also assessed the number of sunburns a firefighter had in the past 12 months, their perceived skin's reaction to prolonged sun exposure, and their perceived cancer risk compared to nonfirefighter adults.

**TABLE 1** Skin cancer screening and characteristics of CAPS volunteer firefighters (*n* = 552).

| Characteristics   | All volunteer firefighters<br>( <i>n</i> = 552) |              | Received skin cancer screening<br>( <i>n</i> = 144) |              | Did not receive skin cancer screening<br>( <i>n</i> = 408) |              |
|---|---|--------------|---|--------------|--|--------------|
|   | <i>n</i> (%)                                    | 95% CI       | <i>n</i> (%)  | 95% CI       | <i>n</i> (%)   | 95% CI       |
| <b>Age</b>  |   |              |   |              |  |              |
| 18–34 years   | 205 (37.1)                                      | (33.1, 41.2) | 27 (18.8)   | (12.3, 25.2) | 178 (43.6)   | (38.8, 48.5) |
| 35–49 years   | 155 (28.1)                                      | (24.4, 31.8) | 31 (21.5)   | (14.7, 28.3) | 124 (30.4)   | (25.9, 34.9) |
| ≥50 years   | 192 (34.8)                                      | (30.8, 38.8) | 86 (59.7)   | (51.6, 67.8) | 106 (26.0)   | (21.7, 30.3) |
| <b>Sex, male</b>  |   |              |   |              |  |              |
|   | 496 (89.9)                                      | (87.3, 92.4) | 132 (91.7)  | (87.1, 96.2) | 364 (89.2)   | (86.2, 92.2) |
| <b>Race/ethnicity, non-Hispanic white</b>                   |   |              |   |              |  |              |
|   | 501 (90.8)                                      | (88.3, 93.2) | 135 (93.8)  | (89.7, 97.8) | 366 (89.7)   | (86.7, 92.7) |
| <b>Education</b>  |   |              |   |              |  |              |
| Highschool graduate or GED or lower                         | 138 (25.0)                                      | (21.4, 28.7) | 25 (17.4)   | (11.1, 23.6) | 113 (27.8)   | (23.4, 32.1) |
| Some college, technical school, or associates degree        | 230 (41.7)                                      | (37.6, 45.9) | 54 (37.5)   | (29.5, 45.5) | 176 (43.2)   | (38.4, 48.1) |
| College graduate or higher                                  | 183 (33.2)                                      | (29.3, 37.2) | 65 (45.1)   | (36.9, 53.4) | 118 (29.0)   | (24.6, 33.4) |
| <b>Annual household income, ≥\$75,000</b>                   |   |              |   |              |  |              |
|   | 322 (61.8)                                      | (57.6, 66.0) | 29 (21.0)   | (14.1, 27.9) | 170 (44.4)   | (39.4, 49.4) |
| <b>Health insurance</b>                                     |   |              |   |              |  |              |
| Through fire service or local/state government              | 151 (27.4)                                      | (23.6, 31.1) | 44 (30.6)   | (22.9, 38.2) | 107 (26.2)   | (21.9, 30.5) |
| Through employer, workplace, or union                       | 270 (48.9)                                      | (44.7, 53.1) | 69 (47.9)   | (39.7, 56.2) | 201 (49.3)   | (44.4, 54.1) |
| Through direct purchase or spouse                           | 62 (11.2)                                       | (8.6, 13.9)  | 19 (13.2)   | (7.6, 18.8)  | 43 (10.5)  | (7.5, 13.5)  |
| None or not sure  | 69 (12.5)                                       | (9.7, 15.3)  | 12 (8.3)  | (3.8, 12.9)  | 57 (14.0)  | (10.6, 17.3) |
| <b>Has a primary health care provider</b>                   |   |              |   |              |  |              |
|   | 446 (80.8)                                      | (77.5, 84.1) | 134 (93.1)  | (88.9, 97.3) | 312 (76.5)   | (72.3, 80.6) |
| <b>Visited a health care provider in the past 12 months</b> |   |              |   |              |  |              |
|   | 495 (89.7)                                      | (87.1, 92.2) | 136 (94.4)  | (90.7, 98.2) | 359 (88.0)   | (84.8, 91.2) |
| <b>Ever been a career firefighter</b>                       |   |              |   |              |  |              |
|   | 98 (17.8)                                       | (14.6, 21.0) | 33 (22.9)   | (16, 29.9)   | 65 (15.9)  | (12.4, 19.5) |
| <b>Years of firefighting service<sup>a</sup></b>            |   |              |   |              |  |              |
| ≤ 10 years  | 218 (39.5)                                      | (35.4, 43.6) | 31 (21.5)   | (14.7, 28.3) | 187 (45.8)   | (41, 50.7)   |
| 11–29 years   | 203 (36.8)                                      | (32.7, 40.8) | 51 (35.4)   | (27.5, 43.3) | 152 (37.3)   | (32.5, 42.0) |
| ≥30 years   | 131 (23.7)                                      | (20.2, 27.3) | 62 (43.1)   | (34.9, 51.2) | 69 (16.9)  | (13.3, 20.6) |
| <b>Monthly firefighting calls</b>                           |   |              |   |              |  |              |
| ≤5  | 154 (28.0)                                      | (24.2, 31.8) | 31 (21.7)   | (14.8, 28.5) | 123 (30.2)   | (25.7, 34.7) |
| 6–10  | 124 (22.5)                                      | (19.0, 26.0) | 29 (20.3)   | (13.6, 26.9) | 95 (23.3)  | (19.2, 27.5) |
| 11–20   | 153 (27.8)                                      | (24.1, 31.6) | 47 (32.9)   | (25.1, 40.7) | 106 (26.0)   | (21.8, 30.3) |
| >20   | 119 (21.6)                                      | (18.2, 25.1) | 36 (25.2)   | (18, 32.4)   | 83 (20.4)  | (16.5, 24.3) |
| <b>Longest-held firefighting rank</b>                       |   |              |   |              |  |              |
| Firefighter   | 372 (67.4)                                      | (63.5, 71.3) | 86 (59.7)   | (51.6, 67.8) | 286 (70.1)   | (65.6, 74.6) |
| Chief or company officer                                    | 108 (19.6)                                      | (16.2, 22.9) | 35 (24.3)   | (17.2, 31.4) | 73 (17.9)  | (14.2, 21.6) |
| Other leadership  | 72 (13.0)                                       | (10.2, 15.9) | 23 (16.0)   | (9.9, 22.0)  | 49 (12.0)  | (8.8, 15.2)  |
| <b>Longest-held occupation</b>                              |   |              |   |              |  |              |
| Construction or manufacturing                               | 156 (28.3)                                      | (24.5, 32.0) | 36 (25.0)   | (17.8, 32.2) | 120 (29.4)   | (25.0, 33.9) |
| Government or clerical                                      | 169 (30.6)                                      | (26.8, 34.5) | 51 (35.4)   | (27.5, 43.3) | 118 (28.9)   | (24.5, 33.3) |
| Service provider  | 157 (28.4)                                      | (24.7, 32.2) | 39 (27.1)   | (19.7, 34.4) | 118 (28.9)   | (24.5, 33.3) |
| Other   | 70 (12.7)                                       | (9.9, 15.5)  | 18 (12.5)   | (7.0, 18.0)  | 52 (12.7)  | (9.5, 16.0)  |

(Continues)

TABLE 1 (Continued)

| Characteristics  | All volunteer firefighters<br>(n = 552) |              | Received skin cancer screening<br>(n = 144) |              | Did not receive skin cancer screening<br>(n = 408) |              |
|--|---|--------------|---|--------------|--|--------------|
|  | n (%)                                   | 95% CI       | n (%)                                       | 95% CI       | n (%)  | 95% CI       |
| ≥50% of time spent working outdoors                                | 255 (46.2)                              | (42.0, 50.4) | 58 (40.3)                                   | (32.2, 48.4) | 197 (48.3)   | (43.4, 53.2) |
| Sun protection practices <sup>b</sup>                              |   |              |   |              |  |              |
| Use sunscreen  | 162 (29.3)                              | (25.5, 33.2) | 65 (45.1)                                   | (36.9, 53.4) | 97 (23.8)  | (19.6, 27.9) |
| Use hat  | 286 (51.8)                              | (47.6, 56.0) | 83 (57.6)                                   | (49.5, 65.8) | 203 (49.8)   | (44.9, 54.6) |
| Use ankle-length pants   | 167 (30.3)                              | (26.4, 34.1) | 33 (22.9)                                   | (16.0, 29.9) | 134 (32.8)   | (28.3, 37.4) |
| Number of sunburns in the past 12 months                           |   |              |   |              |  |              |
| 0  | 151 (27.4)                              | (23.6, 31.1) | 39 (27.1)                                   | (19.7, 34.4) | 112 (27.5)   | (23.1, 31.8) |
| 1–3  | 340 (61.6)                              | (57.5, 65.7) | 89 (61.8)                                   | (53.8, 69.8) | 251 (61.5)   | (56.8, 66.3) |
| >3   | 61 (11.1)                               | (8.4, 13.7)  | 16 (11.1)                                   | (5.9, 16.3)  | 45 (11.0)  | (8.0, 14.1)  |
| Perception of skin's reaction to prolonged sun exposure            |   |              |   |              |  |              |
| Likely to burn   | 367 (66.5)                              | (62.5, 70.4) | 112 (77.8)                                  | (70.9, 84.6) | 255 (62.5)   | (57.8, 67.2) |
| No effect or likely to tan   | 185 (33.5)                              | (29.6, 37.5) | 32 (22.2)                                   | (15.4, 29.1) | 153 (37.5)   | (32.8, 42.2) |
| All cancer risk perception compared to nonfirefighters of same age |   |              |   |              |  |              |
| Higher perceived risk  | 345 (62.5)                              | (58.4, 66.6) | 93 (64.6)                                   | (56.7, 72.5) | 252 (61.8)   | (57.0, 66.5) |
| Similar or lower perceived risk                                    | 207 (37.5)                              | (33.4, 41.6) | 51 (35.4)                                   | (27.5, 43.3) | 156 (38.2)   | (33.5, 43.0) |
| Biological parent(s) had history of skin cancer                    | 45 (8.2)                                | (5.9, 10.4)  | 23 (16.0)                                   | (9.9, 22.0)  | 22 (5.4)   | (3.2, 7.6)   |

Note: Cell values may not add to total sample size due to missing data.

Abbreviations: CAPS, Firefighter Cancer Assessment and Prevention Study; CI, confidence interval; GED, General Educational Development.

<sup>a</sup>Accounts for both volunteer and career firefighting experience, and their possible overlap.

<sup>b</sup>Proportion of volunteer firefighters who reported following sun protection practices “always” or “most of the times” when in the sun for ≥1 h. <5% of participants reported using long sleeve shirts.

## 2.2 | Statistical analysis

We estimated skin cancer screening status (ever vs. never/not sure) prevalence and 95% confidence intervals (CIs) by overall and by demographics, fire service characteristics, employment, sun protection practices, and cancer risk perception. We assessed associations with multivariable logistic regression and calculated adjusted odds ratios (ORs) and 95% CIs. Age and years of firefighting service were included as continuous variables. We used SAS software for all analyses (version 9.4, SAS Institute).

## 3 | RESULTS

Among the 569 enrolled volunteer firefighters, 17 participants were excluded due to a history of skin cancer ( $n = 7$  for melanoma) leaving a sample size of 552 firefighters. Participants were predominantly non-Hispanic white (90.8%), male (89.9%) with an average age of 42.8 years and had an average firefighting experience of 17.6 years. The overall prevalence of skin cancer screening was 26.1% (95% CI: 22.4, 29.8). Most firefighters had

health insurance (87.5%), 27.4% had insurance from the fire service or government programs (Table 1). College education or higher was more common among firefighters who had been screened than those who had not been screened (45.1% vs. 29.0%). There was no difference in screening by departmental role. Less than a third of the firefighters reported routine sunscreen use (29.3%), however, 46.2% reported spending half or more of their working time outdoors. The proportion of those who had a primary care physician was greater among those who were screened compared to those who were not screened.

In multivariable analysis, the odds of receiving skin cancer screening were greater with older age and with having at least some college education compared to those who did not receive screening (Table 2). Firefighters who used sunscreen or who perceived themselves likely to get burned with prolonged sun exposure had almost twice the odds of being screened as those who did not. Odds of receiving screening had a positive exposure-response relationship with responding to more monthly firefighting calls and was positively associated with having a family history of skin cancer. We did not observe an association between receiving screening and years of firefighting or with cancer risk perception.

**TABLE 2** Association of ever receiving skin cancer screening with characteristics of CAPS volunteer firefighters ( $n = 549$ ) assessed by multivariable logistic regression.

| Predictors  | OR (95% CI)       |
|---|-------------------|
| Demographics  |                   |
| Age <sup>a</sup>  | 1.05 (1.03, 1.08) |
| Education ( $\geq$ some college education vs. $\leq$ highschool graduate) | 1.80 (1.04, 3.12) |
| Family skin cancer history (yes vs. no)                                   | 3.64 (1.80, 7.37) |
| Firefighting service  |                   |
| Firefighting service <sup>a</sup>   | 1.01 (0.99, 1.03) |
| Monthly firefighting calls  |                   |
| 6–10 calls vs. $\leq 5$ calls   | 1.10 (0.58, 2.08) |
| 11–15 calls vs. $\leq 5$ calls  | 1.84 (0.93, 3.65) |
| >15 calls vs. $\leq 5$ calls  | 1.76 (0.99, 3.11) |
| Fire department rank (firefighter vs. leadership)                         | 1.07 (0.66–1.73)  |
| Sun exposure and protection   |                   |
| % time spent working outdoors ( $\geq 50\%$ vs. $< 50\%$ )                | 1.01 (0.65, 1.57) |
| Sunscreen use (always/most times vs. sometimes/never)                     | 2.35 (1.48, 3.73) |
| Hat use (always/most times vs. sometimes/never)                           | 1.37 (0.87, 2.16) |
| Ankle-length pants use (always/most times vs. sometimes/never)            | 0.81 (0.48, 1.38) |
| Risk perception   |                   |
| Perceived skin's reaction to prolonged sun exposure <sup>b</sup>          | 1.81 (1.10, 3.00) |
| Cancer risk perception <sup>c</sup>                                       | 0.94 (0.59, 1.50) |

Note: Total sample size is less than  $n = 552$  as  $n = 3$  were missing data for monthly firefighting calls or education.

Abbreviations: CAPS: Firefighter Cancer Assessment and Prevention Study; OR: odds ratio (adjusted for other model predictors).

<sup>a</sup>Age and years of firefighting service included as continuous variables.

<sup>b</sup>Likely to burn versus no effect/likely to tan.

<sup>c</sup>Cancer risk perception compared to same-aged nonfirefighters (high vs. lower/similar).

## 4 | DISCUSSION

To our knowledge, this is the first large US study to investigate the prevalence and predictors of skin cancer screening among volunteer firefighters. The prevalence of ever receiving skin cancer screening in this study of volunteer firefighters (26.1%) was almost half that reported from a cross-sectional study of 2399 male career firefighters from Florida (47.3% screened).<sup>12</sup> Compared to the volunteer firefighters in our study, these career firefighters were similar in age but had fewer years of firefighting (14.7 years).<sup>12</sup> In both studies, the proportion of respondents using sunscreen and who perceived

themselves as more likely to burn with prolonged sun exposure were similar. The higher screening prevalence in the Floridian firefighters may be due to their access to occupational screening programs or alternatively, because prevalence of ever being screened for skin cancer is higher in Florida than other US regions.<sup>13</sup>

The CAPS participants also had a lower estimated prevalence of skin cancer screening compared to US military veterans. A cross-sectional study using the 2015 National Health Interview Survey data for skin cancer screening by physicians among US military veterans reported that 30.8% of veterans had received screening.<sup>14</sup> Similar to the CAPS participants, these veterans were predominantly non-Hispanic white (79.6%), male (91.3%), over two-thirds (69.6%) had some college or higher education, and just over half (52.5%) perceived themselves to get sunburnt with prolonged sun exposure. However, about half of the veterans (51.6%) were 65 years or older. In contrast, the prevalence of skin cancer screening was lower among CAPS participants compared to the US general population based on a cross-sectional study using the 2017 Health Information National Trends Survey data which reported that 36.7% of adult males and 43.3% of adult females in the US ever received skin cancer screening.<sup>15</sup>

While annual skin cancer screening is recommended for firefighters, it may not be covered by their insurance based on USPSTF recommendations. Caban-Martinez et al. adapted a Total Worker Health approach, which aims to address protection of workers from health hazards associated with their work, while simultaneously promoting efforts to prevent illnesses and enhance their well-being,<sup>16</sup> for career firefighter skin exposure assessment and cancer prevention. This approach suggests that fire departments should support annual skin cancer screenings and make them convenient for their membership.<sup>17</sup> A similar approach could benefit volunteer firefighters, especially with further assessment of cancer prevention strategies available or accessible through their fire departments. Within this prevention framework, volunteer fire departments' leadership could also engage with their membership by providing skin cancer prevention education, promoting screening, and working with their municipalities to provide skin cancer screening resources. Additionally, volunteer firefighters should be encouraged to discuss their firefighting roles and exposures with their primary health care providers as they pertain to skin cancer, and more broadly cancer prevention.

The USPSTF recommends skin cancer prevention through behavioral counseling such as minimizing exposure to ultraviolet radiation among those 24 years of age or younger, among those with fair skin types, and selectively offering this counseling to those older than 24 years of age.<sup>18</sup> This recommendation should also be adapted by volunteer fire departments based on membership demographics.

While this study had several strengths, including the sample size, geographic coverage, and representation from rural and suburban departments, there are limitations to consider. Given the cross-sectional study design and that the survey did not collect information on when the screening occurred, the timing of screening and some of the exposures of interest (e.g., using sunscreen) cannot be discerned.



As such, there may also be a reverse causality bias, for example, those who were screened may be more likely to use sunscreen. There is a possibility of some selection bias due to our sampling approach, specifically that fire departments with leadership and members who are more aware of health conditions related to firefighting may be more likely to enroll than those less aware. As such these findings may overestimate skin cancer screening prevalence.

Only a quarter of volunteer firefighters had skin cancer screening, despite screening recommendations and higher risk of melanoma. Additional assessment of skin cancer control and prevention practices within volunteer fire departments will help to address gaps in cancer screening among this understudied firefighter population.

## AUTHOR CONTRIBUTIONS

**Conceptualization:** Nimit N. Shah, Judith M. Graber, and Michael B. Steinberg. **Formal analysis:** Nimit N. Shah. **Writing—original draft:** Nimit N. Shah and Judith M. Graber. **Writing—review and editing:** Nimit N. Shah, Michael B. Steinberg, Alberto J. Caban-Martinez, Elena Austin, Jefferey L. Burgess, Brittany S. Hollerbach, Derrick L. Edwards, Taylor M. Black, Kathleen Black, Kaleigh M. Hinton, Brian S. Kubiak, and Judith M. Graber. **Project administration:** Taylor M. Black, Kaleigh M. Hinton, Kathleen Black, and Nimit N. Shah.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

## DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

## DATA AVAILABILITY STATEMENT

Requests for a limited data set will be reviewed on a case-by-case basis by the principal investigator (PI), Judith Graber, PhD, MS who can be reached at judith.graber@rutgers.edu. Any data sharing would require a fully executed institutional Data Use Agreement as well as approval by the PI's institutional review boards and the Rutgers Cancer Institute of New Jersey Scientific Review Board.

## ETHICS APPROVAL AND INFORMED CONSENT

The work described in this manuscript was performed as part of the Firefighter Cancer Assessment and Prevention Study (CAPS) at the Rutgers School of Public Health, Rutgers, The State University of New Jersey, Piscataway, New Jersey, USA. CAPS is a partner of the Fire Fighter Cancer Cohort Study. The work in this manuscript was approved by the University of Miami Institutional Review Board. Electronic informed consent was obtained for each participant.

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## REFERENCES

- Jalilian H, Ziaei M, Weiderpass E, Rueegg CS, Khosravi Y, Kjaerheim K. Cancer incidence and mortality among firefighters. *Int J Cancer*. 2019;145(10):2639-2646. doi:10.1002/ijc.32199
- DeBono NL, Daniels RD, Beane Freeman LE, et al. Firefighting and cancer: a meta-analysis of cohort studies in the context of cancer hazard identification. *Saf Health Work*. 2023;14:141-152. doi:10.1016/j.shaw.2023.02.003
- IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. *Painting, firefighting, and shiftwork*. 2010. International Agency for Research on Cancer. World Health Organization. IARC monographs on the evaluation of carcinogenic risks to humans. International Agency for Research on Cancer; Distributed by WHO Press: viii, 804.
- Demers PA, DeMarini DM, Fent KW, et al. Carcinogenicity of occupational exposure as a firefighter. *Lancet Oncol*. 2022;23:985-986. doi:10.1016/s1470-2045(22)00390-4
- United States Preventive Services Task Force, Mangione CM, Barry MJ, Nicholson WK, Chelmow D, et al. Screening for skin cancer: US preventive services task force recommendation statement. *JAMA*. 2023;329(15):1290-1295. doi:10.1001/jama.2023.4342
- National Fire Protection Association. NFPA 1582 Standard on Comprehensive Occupational Medical Program for Fire Departments. 2022.
- Fahy REB, Stein G. *US Fire Department Profile 2020*. 2022. <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Emergency-responders/osfdprofile.pdf>
- Blake KD, Moss JL, Gaysynsky A, Srinivasan S, Croyle RT. Making the case for investment in rural cancer control: an analysis of rural cancer incidence, mortality, and funding trends. *Cancer Epidemiol Biomarkers Prevent*. 2017;26(7):992-997. doi:10.1158/1055-9965.EPI-17-0092
- National Fire Protection Association. *The Fifth Needs Assessment of the US Fire Service*. 2021. <https://www.nfpa.org/News-and-Research/Data-research-and-tools/Emergency-Responders/Needs-assessment>
- Kadiwar P, Shah N, Black T, et al. Dietary intake among members of a volunteer fire department compared with US daily dietary recommendations. *J Occup Environ Med*. 2021;63(2):147-150. doi:10.1097/JOM.0000000000002102
- Graber JM, Black TM, Shah NN, et al. Prevalence and predictors of per- and polyfluoroalkyl substances (PFAS) serum levels among members of a suburban US volunteer fire department. *Int J Environ Res Public Health*. 2021;18(7):3730. doi:10.3390/ijerph18073730

12. Moore KJ, Caban-Martinez AJ, Kirsner RS, et al. Firefighter skin cancer and sun protection practices: evidence from the florida firefighter cancer initiative. *JAMA Dermatol.* 2018;154(2):219-221. doi:10.1001/jamadermatol.2017.4254
13. Fernandez CA, McClure LA, Leblanc WG, et al. Comparison of Florida skin cancer screening rates with those in different US regions. *South Med J.* 2012;105(10):524-529. doi:10.1097/SMJ.0b013e318268cf63
14. Coups EJ, Xu B, Heckman CJ, Manne SL, Stapleton JL. Physician skin cancer screening among U.S. military veterans: results from The National Health Interview Survey. *PLoS One.* 2021;16(5):e0251785. doi:10.1371/journal.pone.0251785
15. Merten JW, Hamadi H, Wheeler M. Cancer risk perception predictors for total body skin examinations: a cross-sectional study using Health Information National Trends Survey (HINTS) 2017 data. *Int J Dermatol.* 2020;59(7):829-836. doi:10.1111/ijd.14935
16. Schill AL, Chosewood LC. The NIOSH total worker health program: an overview. *J Occup Environ Med.* 2013;55(12 suppl):S8-S11. doi:10.1097/JOM.0000000000000037
17. Caban-Martinez AJ, Hughes J, Bator C. A total worker health approach to skin exposure assessment: experiences from the firefighter cancer initiative. *Ann Work Expo Health.* 2021;65(2):143-147. doi:10.1093/annweh/wxaa066
18. Grossman DC, Curry SJ, Owens DK, et al. Behavioral counseling to prevent skin cancer: US preventive services task force recommendation statement. *JAMA.* 2018;319(11):1134-1142. doi:10.1001/jama.2018.1623

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