

Impact of Organizational-level Factors on Cancer Screening Activities in Fire Departments: A Cross-sectional Study from the Sylvester Firefighter Cancer Initiative



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Abstract

Despite known individual-level facilitators of cancer screening, the impact of work-related organizational-level characteristics on cancer screening is unknown particularly in the firefighter workforce who is experiencing a disproportionate burden of cancer. We examine the association between fire service organizational-level factors and implementation of cancer screening activities within Florida fire departments. We used a cross-sectional observational study design to survey fire department leaders attending the Florida Fire Chiefs' Association Health and Safety conference about cancer screening activities implemented by their fire departments. Measures assessing organizational-level characteristics include: fire department workforce size, total health and safety officers, fire department geographic location, employment type, leadership support and capacity. Among the 126 fire departments participating (response rate = 47.7%), approximately 44% reported

some type of cancer screening activity in the 12 months prior to survey administration. The proportion of fire departments with two or more health and safety officers was significantly greater among those with cancer screening activities as compared with departments without cancer screening activities (46.3% vs. 24.2%; $P = 0.016$). There were no statistical differences noted for cancer screening activities among all other organizational-level characteristics including workforce size, fire department geographic location, employment type, leadership support, and individual capacity measures. Most organizational-level characteristics of a fire department evaluated in this study were not associated with cancer screening activities; however, having two or more dedicated health and safety officers supports the delivery of cancer screening activities. These officers may be a key to improving availability of cancer screening activities at work.

Introduction

Firefighters in the United States are at increased risk of site-specific cancers from the respiratory, digestive, and urinary tract organ systems when compared with the general U.S. population (1, 2). The International Agency for Research on Cancer (IARC) reviewed 42 studies and reported significant risks for non-Hodgkin lymphoma and

prostatic and testicular cancers, concluding that firefighter exposures were possibly carcinogenic to humans (Group 2B; refs. 3, 4). Firefighters can be exposed to hazardous contaminants from fires that are known or suspected to cause cancer (5, 6). These contaminants include combustion by-products generated during a fire, such as benzene and formaldehyde, and materials in debris including asbestos from older structures (7–9). While much research and occupational safety efforts are underway to reduce exposures to workplace carcinogens (10, 11), little is known about facilitators and barriers to cancer screening in firefighters, a necessary component to cancer control and prevention.

The work environment can provide a unique space for clinicians and researchers to engage working communities at high-risk for specific cancers to conduct prevention and screening activities. Cancer screening, for example, has been shown to be effective at reducing cancer morbidity and mortality (12–14); however, screening can be complex

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as it requires interfaces between patients, providers, work, and health care organizations. While there is limited epidemiologic data on cancer screening behaviors among first responders, preliminary data on Florida firefighters self-reporting prostate-specific antigen (PSA) and colorectal cancer screening show lower rates of cancer screening when compared with the general U.S. male population (15, 16). One qualitative study exploring perceptions of health and cancer risk among Florida firefighters documented that firefighter would preference a visit to a doctor for an injury rather than for routine care or for chronic disease management (17). Despite the known individual-level facilitators of cancer screening, the impact of work-related organizational-level characteristics on cancer screening is unknown, particularly in the firefighter workforce, which is experiencing a disproportionate burden of cancer. Existing resources within a fire department can be leveraged to expand the scope of fire department initiatives to address cancer risk factors and disparities. Changes to the physical and social characteristics of work environments are likely to have greater impact than individual firefighter health education alone.

Few studies explore the role of organizational factors on intra- and interorganizational cancer screening processes (18–20). There is a growing literature demonstrating associations between structural and functional factors of organizations with their willingness or readiness to adopt and implement a variety of innovations, including some epidemiologic studies that have specifically examined implementation of organizational-level cancer screening and occupational safety and health (OSH) standards (21–23). Results from these studies suggest that organizational factors such as company size, industrial sector, existence of top leadership support, and organizational capacity, in terms of dedicated staff, budgets, and committees can influence the implementation of OSH and cancer screening.

Observational studies conducted in different job settings have documented specific risk and protective cancer factors that could be modified through efforts targeting the work environment, including facilities, services, and policies (14). For example, risk factors in the work environment include exposure to known carcinogens (e.g., diesel exhaust), higher levels of which are often permitted in the workplace compared with the general community environment (24). Others include behaviors (e.g., alcohol or tobacco use) or chronic conditions (e.g., obesity) that may increase cancer risk (25). There are also protective factors (e.g., physical activity, fitness, diet) that may reduce cancer risk (26, 27). These factors affect a high percentage of U.S. workers, so even small changes leveraged through the work environment could have a large impact at the population level. In the U.S. fire service, little is known about risk and protective factors that support cancer screening from an organizational-level perspective.

This study is responsive to the call from the Centers for Disease Control and Prevention (CDC)'s worksite wellness initiatives to evaluate the impact of risk and protective factors for cancer control and prevention in the work environment as it relates to firefighters (28, 29). It investigates relationships between fire department organizational characteristics (i.e., workforce size, health/safety officers, geographic location, leadership support and capacity) and the extent of implementation of cancer screening activities in 126 Florida fire departments. We also examine whether high numbers of OSH activities are correlated with cancer screening activities in fire departments.

Materials and Methods

Study design and participant recruitment

This cross-sectional observational study is part of a larger statewide firefighter cancer initiative aimed at preventing and reducing the burden of cancer within the Florida fire service (30). Our research team distributed an anonymous paper-based survey among registered attendees of the Florida Fire Chiefs' Association Health and Safety Conference held on December 4–6, 2017 in Orlando, Florida. The annual conference is open to all firefighters in the State of Florida and is comprised of attendees from senior level positions within Florida fire services, including the fire chiefs, assistant chiefs, fire prevention officers, shift officers, individual firefighters/paramedics, health and safety officers, and fire investigators. A booth strategically placed next to the registration desk and adjacent to the only main conference entry way was staffed by our research team who approached conference attendees to complete the survey. The conference organizers made an announcement to attendees on the main stage twice a day encouraging completion of the survey. No incentive was provided to the firefighter for completing the survey.

Survey instrument and study measures

We designed a 56-item survey instrument, Firefighter Assessment of Strategies Trumping Cancer (FAST-C), with the goal of documenting organizational-level characteristics of the fire department that impact occupational health and safety, cancer screening, and decontamination practices in firefighters. Measures were adapted from previously validated or administered surveys of occupational safety and health and worksite health promotion (21, 23, 31).

Cancer screening

We assessed cancer screening activities, our primary outcome, in the fire department with the question "During the last 12 months, did the fire department offer firefighters cancer screenings (e.g., full body skin exams, colorectal, or cervical cancer screening)?" with dichotomous response option (yes, no).

Implementation of OSH

The questions assessing the number of OSH activities were based on the Occupational Safety and Health Administration's (OSHA) 1995 Occupational Safety and Health Program Evaluation Profile survey previously used by the research team (31). While the original OSHA survey contained 10 items, the survey instrument administered in this study used 9 items following content/face validity testing with a smaller group of firefighters prior to administering the final survey at the firefighter health and safety conference. The extent of implementation of OSH programs and policies refers to the number of "yes" responses to 9 questions with a dichotomous response option of yes = 1 or no = 0, and the sum of the responses to 9 questions from each firefighter could range from 0 to 10.

Organizational characteristics

We considered six organizational characteristics of the fire department: (i) workforce size, (ii) total health and safety officers, (iii) fire department geographic location, (iv) employment type, (v) leadership support, and (vi) occupational health and safety capacity. Workforce size was defined as the number of active firefighters (non-administrative positions) employed within the fire department. Total health and safety officers was defined as the total number of health and safety officers employed within the fire department, where the officer is a firefighter whose job function includes the health and safety of their fire department workforce. The geographic location where the fire department is located within Florida was operationalized as rural area only, urban area only, suburban area only and mixed area (urban, suburban, and rural). Employment type was a measure assessing if the fire department was comprised of career firefighters only, volunteer only or mixed career/volunteer. Leadership support measures for OSH and cancer screening were adapted from Cinite and colleagues (32); separate questions inquired whether there was a person in top fire department leadership who was a strong supporter of OSH and cancer screening. Response options were dichotomous (yes, no). We assessed the fire department's capacity to enact OSH and cancer screening activities using three items: dedicated budgets, staff, and fire department committees. Each of these three items' response options was dichotomous (yes = 1, no = 0). We estimated each individual capacity item separately. Following Hannon and colleagues (22), we combined each of the three individual items to develop a OSH capacity sum score (possible range of 0–3). We estimated means OSH implementation and capacity scores stratified by availability of a cancer screening activity.

Data analysis

Descriptives and correlations. We conducted explanatory statistical data analyses for continuous variables, expressed as mean with its SE, and for categorical variables, represented as frequency and percent of the sample. We exam-

ined the main outcome of fire department cancer screening activity stratified by workforce size, total health and safety officers, fire department geographic location, employment type, leadership support, and capacity. For categorical data, we conducted χ^2 analyses to compare groups, and used *t* tests for continuous data. We used a Levene test of homogeneity of variance across groups for each variable (33). We used Pearson product-moment correlation to examine the relationship between number of OSH and organizational continuous characteristics in fire departments.

Bivariate analyses. We conducted a two-way ANOVA to determine whether significant differences existed for either main effect of number of capacity factors (range of 0–3) or existence of leadership support for implementation of OSH, while adjusting for the other significant factor. After running the model, if either of the main effects (i.e., leadership support or capacity) was significant, we used a Tukey *post hoc* test to identify specific group differences. The significance level is set to 5%. All statistical analyses were done on SPSS v21 (IBM Corp). This study research protocol was reviewed and approved by the University's Institutional Review Board.

Results

A total of 264 firefighters registered to attend the Florida Fire Chiefs' Association 2017 Health and Safety conference of which 126 firefighters from unique Florida fire departments submitted the survey (response rate = 47.7%). Among respondents, the firefighters were employed as shift officers (36.5%), Fire department chiefs (24.6%), health and safety officer (20.6%), firefighter/paramedic (13.5%), fire prevention (3.2%), and fire investigator (1.6%).

Cancer screening and organizational characteristics

Approximately 44% of Florida fire services report some type of cancer screening activity in the 12-month prior to survey administration (Table 1). The proportion of fire departments with two or more health and safety officers was significantly greater for those with cancer screening activities as compared with those departments without cancer screening activities (46.3% vs. 24.2%; $P = 0.016$). There were no statistical differences noted for cancer screening activities among all other organizational-level characteristics including workforce size, fire department geographic location, employment type, leadership support, and individual capacity measures. Organizational support for cancer screening includes top leadership support and capacity (defined as having a dedicated budget, staff, committee for OSH). As indicated in Table 1, fire departments with cancer screening activities reported a higher mean implementation (5.54 ± 1.98 vs. 4.67 ± 2.37 ; $P = 0.031$) and capacity score (mean score = 1.91 ± 0.75 SEs vs. 1.44 ± 0.81 ; $P = 0.001$) for

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Table 1. Descriptive organizational characteristics and occupational health and safety implementation activity and capacity of Florida Fire Departments by availability of cancer screening program ($n = 126$)

Organizational characteristics	Total sample, <i>N</i> (%) ^a	Cancer screening program		<i>P</i> ^b
		Present, <i>N</i> (%) ^a	Absent, <i>N</i> (%) ^a	
Total	126 (100.0)	56 (44.4)	70 (55.6)	
Department workforce size				0.274
Small (1–100 Firefighters)	56 (44.8)	25 (44.6)	30 (44.1)	
Medium (101–500 Firefighters)	49 (39.2)	19 (33.9)	30 (44.1)	
Large (>500 Firefighters)	20 (16.0)	12 (21.4)	8 (11.8)	
Total health & safety officers				0.016
None	20 (16.5)	10 (18.5)	10 (15.2)	
One officer	60 (49.6)	19 (35.2)	40 (60.6)	
Two or more officers	41 (33.9)	25 (46.3)	16 (24.2)	
Department geographic location				0.313
Rural area only	8 (6.3)	2 (3.6)	6 (8.6)	
Urban area only	34 (27.0)	13 (23.2)	21 (30.0)	
Suburban area only	32 (25.4)	18 (32.1)	14 (20.0)	
Mixed area (urban/sub/rural)	52 (41.3)	23 (41.1)	29 (41.4)	
Department employment type				0.662
All career	102 (81.0)	46 (82.1)	56 (80.0)	
All volunteer	1 (0.8)	0 (0.0)	1 (1.4)	
Mixed career and volunteer	23 (18.3)	10 (17.9)	13 (18.6)	
Leadership support				0.265
Yes	101 (84.9)	48 (88.9)	53 (81.5)	
No	18 (15.1)	6 (11.1)	12 (18.5)	
OHS Capacity measures				
Dedicated staff for OSH activities	77 (65.3)	39 (70.9)	38 (60.3)	0.228
OSH Committee	105 (89.0)	51 (94.4)	54 (84.4)	0.082
Dedicated OSH budget	26 (27.4)	17 (37.0)	9 (18.4)	0.062
Mean scoring occupational health & safety (OSH) activity	Mean ± SE	Mean ± SE	Mean ± SE	
OSH Implementation	5.06 ± 2.24	5.54 ± 1.98	4.67 ± 2.37	0.031
OSH Capacity	1.65 ± 0.81	1.91 ± 0.75	1.44 ± 0.81	0.001

^aDifferences in subtotal population sample due to item nonresponse or missing.^b*P* values are calculated from either χ^2 test for association for categorical variables or two-sample independent Student *t* test for means.

OSH, as compared with fire departments without any cancer screening activities.

OSH polices and cancer screening

All fire departments with cancer screening activities reported that they had at least one OSH activity; the number of OSH activities ranged from 1 to 8 (Table 2). Over 75% of fire departments with cancer screening reported having at least 5 OSH policies, training efforts, and programs. The proportion of fire departments who updated their OSH program regularly was significantly greater for those with cancer screening activities than for departments without cancer screening activities (74.5% vs. 48.4%; $P = 0.005$). Across all OSH policies, programs, and practices, slightly fewer fire departments without cancer screening programs reported having supervisors or managers who provided OSH training (41.8%) compared with fire departments with cancer screening (43.1%).

In bivariate analyses, only total health and safety officers, OSH implementation, and capacity were significantly related to implementation of cancer screening activities. Hence, these were the three sole organizational characteristics investigated in ANOVA. As indicated in Table 3, having higher capacity factors ($P < 0.001$), higher OSH implementation ($P = 0.031$) and higher numbers of OSH

health and safety officers ($P = 0.006$) are individually associated with cancer screening activity implementation. In the last column in Table 3, we see that a fire department's capacity factors (OSH committee, dedicated staff, budget) explain 8.2% of the variance found in cancer screening activity offerings and availability of health and safety officers accounts for 26.3% of the variance.

Discussion

Fire departments across the United States have become increasingly concerned about the unique and disproportionate burden of specific cancer types observed in the fire service (34). This attention to cancer in the fire service has given rise law to U.S. House Resolution 931, the Firefighter Cancer Registry Act of 2018 establishing a national cancer registry dedicated to fire fighters. Increasing attention of cancer control and prevention efforts beyond individual level health education interventions such as those that leverage the work environment and organizational characteristics for cancer screening are needed. This study contributes to our knowledge that workforce size, geographic location, and employment type does not impact cancer screening activities conducted in the work environment. Fire department leadership often taut their rural location,

Table 2. Occupational safety and health and worksite health promotion programs, policies, and practices among Florida Fire Departments, December 2017 (*n* = 126)

Policies, programs, and practices	Total sample, <i>N</i> ^a	Cancer screening program		<i>P</i> ^b
		Present, <i>N</i> (%) ^a	Absent, <i>N</i> (%) ^a	
Occupational safety & health program present	124	52 (92.9)	54 (81.8)	0.072
OSH Program updated regularly	113	38 (74.5)	30 (48.4)	0.005
Written OSH program policy statement	109	39 (81.3)	41 (67.2)	0.100
Management sets safety goals at worksite	116	30 (56.6)	36 (57.1)	0.953
Managers held accountable for OSH	111	39 (76.5)	39 (65.0)	0.188
Employees can report safety hazards/problems	122	53 (96.4)	64 (95.5)	0.816
Feedback to employees reporting hazards/problems	102	37 (82.2)	40 (70.2)	0.160
Supervisors/managers provided OSH training	106	22 (43.1)	23 (41.8)	0.891
Top leader supportive of OSH	119	48 (88.9)	53 (81.5)	0.265

^aDifferences in subtotal population sample due to item nonresponse or missing.

^b*P* values are calculated from χ^2 test for association.

or workforce size as barriers to implementing a cancer screening activity in their fire department (35, 36). However data from this study suggest that only having two or more dedicated health and safety officers supports the delivery of cancer screening activities in the fire service.

As part of a comprehensive occupational health and safety program, we found that across nine organizational policies, programs and practices assessed, an OSH program that is updated regularly occurred more frequently among fire departments with cancer screening activities than those without cancer screening activities. This finding is consistent with those of McLellan and colleagues, who similarly in small- to medium-sized general U.S. businesses found that implementation ability was high among businesses that have an OSH program and update the program periodically (21). We found that fire departments offering cancer screening activities were able to implement on average one more OSH activity than those without a cancer screening activities suggesting that occupational health and safety activities are related to cancer screening activity in a fire department.

Workforce size was not significantly related to the implementation of cancer screening activities within the fire department. This observation contrasts with the results of other epidemiologic studies' in that implementation levels of OSH activities increase with increasing workforce size (23, 37, 38). Poston and colleagues found in a national U.S. study on fire department health promotion programs that the size of the fire department did not impact their ability to have a strong wellness program (39). This observation supports the notion that even smaller fire departments can effectively implement occupational health and safety programs as well as health promotion activities like cancer screening when compared with large fire depart-

ments. For many cancers, early-stage disease can be effectively treated with good chance for cure, whereas late-stage disease is generally incurable (40). U.S. firefighters, both career and volunteer, generally have high insurance rates, partially mitigating access issues although convenient workplace screening opportunities could further enhance early detection and lower worker compensation costs (41)

While other studies have examined workforce size in relation to implementation of cancer screening and OSH activities (21, 23, 37, 38), this study also investigated the role of health and safety officers and fire department capacity. Similar to other champion model studies (42), the presence of health and safety officers was associated with the availability of cancer screening activities. This observation is supported by the bivariate analyses results that indicate that capacity, and not top leadership support, was significantly associated with a greater proportion of fire departments implementing cancer screening activities. While a fire department with capacity in terms of budget, staff, and a committee appears to have no impact on implementation of cancer screening, having two or more health and safety officers and an OSH program that is updated periodically is associated with cancer screening activities with the fire services. Health and Safety officers in a fire department are encouraged to translate the OSH vision into tangible organizational resources, including budgets, committees, and staff to further the success of cancer screening implementation efforts.

This observational study is not without limitations. All study measures are self-report where fire department leadership, depending on the rank and level of leadership, may not be acutely aware of all policies, programs, and activities occurring department wide. The primary outcome measure of cancer screening activities is limited in that the quality of the cancer screening activity nor the success of the activity was measured by the survey instrument. In addition, all OSH activities listed in the survey were given an equal weight in analyses, which could be a limitation. We are not aware of a weighting schema for individual OSH activities that would weigh the strength of an OSH activity higher than another; however, we evaluated activities from recognized firefighter sources. An additional limitation is that no standard measures exist for top leadership support and

Table 3. Organizational characteristics associated with fire departments offering cancer screening activities: analyses of variance of Florida Fire Departments (*n* = 126)

Characteristic	Mean of square	F value	<i>P</i> value	Partial Eta ²
Capacity factors ^a	6.81	11.137	0.001	0.082
Implementation	23.24	4.776	0.031	0.037
Health/safety officers	158.21	7.895	0.006	0.263

^aCapacity factors = number of factors of existence of dedicated staff, committee, budget for Occupational Health and Safety.

capacity, although the capacity item we use has been used previously in the OSH literature. Finally, the measure on cancer screening activity is broad; a more specific measure assessing specific types of cancer screening would have been more insightful.

The study has several strengths. This study contributes to understanding the impact organizational characteristics have on cancer screening and OSH activities by focusing on fire department in one large populous state. While there is a national firefighter cancer cohort study assessing individual-level factors, there is no national firefighter organizational-level study assessing cancer screening barriers and facilitators, therefore it is important to investigate implementation at state and regional levels to begin to develop an understanding of these organizational-level factors on cancer screening issues. The focus on fire department-wide organizational activities is also novel and important as most firefighters are volunteers and have different organizational barriers when compared with career firefighters. The fire departments surveyed came from a wide variety of geographic locations in Florida, including all seven emergency response regions, and were representative of Florida fire departments. Finally, this investigation is the first to examine organizational-level characteristics of leadership support and capacity and their important relationships to cancer screening activities.

Conclusions

Our study contributes important information about organizational-level factors influencing the implementation of cancer screening activities in fire departments. Comparable data across U.S. fire departments would be useful; however, current national firefighters' studies have strictly focused on individual firefighter behaviors and practices and traditionally have not included organizational-level characteristics. Existing national firefighter health and cancer surveys should include questions about organizational characteristics and factors related to implementation of cancer screening activities that could support a comprehensive cancer control and prevention program for U.S. firefighters. Our results suggest that further investiga-

tion of the roles of fire department capacity and health and safety officers for implementation of cancer screening activities is warranted.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

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References

- Daniels RD, Kubale TL, Yiin JH, Dahm MM, Hales TR, Baris D, et al. Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950–2009). *Occup Environ Med* 2014;71:388–97.
- Daniels RD, Bertke S, Dahm MM, Yiin JH, Kubale TL, Hales TR, et al. Exposure–response relationships for select cancer and non-cancer health outcomes in a cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950–2009). *Occup Environ Med* 2015;72:699–706.
- Straif K, Baan R, Grosse Y, Secretan B, El Ghissassi F, Bouvard V, et al. Carcinogenicity of shift-work, painting, and fire-fighting. *Lancet Oncol* 2007;8:1065–6.
- International Agency for Research on Cancer. *Painting, firefighting, and shiftwork*, volume 98. Lyon, France: International Agency for Research on Cancer; 2010.
- Moen BE, Øvrebø S. Assessment of exposure to polycyclic aromatic hydrocarbons during firefighting by measurement of urinary 1-hydroxypyrene. *J Occupat Environ Med* 1997;39:515–9.
- Brandt-Rauf P, Fallon L, Tarantini T, Idema C, Andrews L. Health hazards of fire fighters: exposure assessment. *Occupat Environ Med* 1988;45:606–12.
- Bolstad-Johnson DM, Burgess JL, Crutchfield CD, Storment S, Gerkin R, Wilson JR. Characterization of firefighter exposures during fire overhaul. *AIHAJ* 2000;61:636–41.

8. Caux C, O'Brien C, Viau C. Determination of firefighter exposure to polycyclic aromatic hydrocarbons and benzene during fire fighting using measurement of biological indicators. *Appl Occupat Environ Hyg* 2002;17:379–86.
9. Fent KW, Eisenberg J, Snawder J, Sammons D, Pleil JD, Stiegel MA, et al. Systemic exposure to PAHs and benzene in firefighters suppressing controlled structure fires. *Ann Occupat Hyg* 2014; 58:830–45.
10. Burgess J, Caban-Martinez A, Fent K, Grant C, Griffin SC, Solle N, et al. 517 The firefighter multicenter cancer cohort study: framework development and testing. *Occup Environ Med* 2018;75: A117.
11. Caban-Martinez AJ, Kropa B, Niemczyk N, Moore KJ, Baum J, Solle NS, et al. The "Warm Zone" cases: environmental monitoring immediately outside the fire incident response arena by firefighters. *Safety Health Work* 2018;9:352–5.
12. Winawer S, Fletcher R, Rex D, Bond J, Burt R, Ferrucci J, et al. Colorectal cancer screening and surveillance: clinical guidelines and rationale—update based on new evidence. *Gastroenterology* 2003;124:544–60.
13. Chou AF, Rose DE, Farmer M, Canelo I, Yano EM. Organizational factors affecting the likelihood of cancer screening among VA patients. *Med Care* 2015;53:1040–9.
14. Nahmias Z, Townsend JS, Neri A, Stewart SL. Worksite cancer prevention activities in the national comprehensive cancer control program. *J Commun Health* 2016;41:838–44.
15. Caban-Martinez AJ, Solle NS, Koru-Sengul T, Santiago KM, Moore KJ, Miao F, et al. Disparities in cancer screening between Latino and non-Latino firefighters: Evidence from the Sylvester Firefighter-Cancer Initiative [abstract]. In: Proceedings of the American Association for Cancer Research Annual Meeting 2018; 2018 Apr 14–18; Chicago, IL. Philadelphia (PA): AACR; 2018. Abstract nr 4249.
16. Hall IJ, Tangka FK, Sabatino SA, Thompson TD, Graubard BI, Breen N. Patterns and Trends in Cancer Screening in the United States. *Prev Chronic Dis* 2018 Jul 26;15:E97. doi: 10.5888/pcd15.170465.
17. Schaefer Solle N, CabanMartinez AJ, Levy RA, Young B, Lee D, Harrison T, et al. Perceptions of health and cancer risk among newly recruited firefighters in South Florida. *Am J Ind Med* 2018; 61:77–84.
18. Zapka JG, Taplin SH, Solberg LI, Manos MM. A framework for improving the quality of cancer care: the case of breast and cervical cancer screening. *Cancer Epidemiol Preven Biomark* 2003;12:4–13.
19. Fernández ME, Gonzales A, Tortolero-Luna G, Partida S, Bartholomew LK. Using intervention mapping to develop a breast and cervical cancer screening program for Hispanic farmworkers: Cultivando La Salud. *Health Promot Pract* 2005; 6:394–404.
20. Sorensen G, Barbeau E, Stoddard AM, Hunt MK, Kaphingst K, Wallace L. Promoting behavior change among working-class, multiethnic workers: results of the healthy directions—small business study. *Am J Public Health* 2005;95:1389–95.
21. McLellan DL, Cabán-Martinez AJ, Nelson CC, Pronk NP, Katz JN, Allen JD, et al. Organizational characteristics influence implementation of worksite health protection and promotion programs: evidence from smaller businesses. *J Occup Environ Med* 2015;57:1009.
22. Hannon PA, Garson G, Harris JR, Hammerback K, Sopher CJ, Clegg-Thorp C. Workplace health promotion implementation, readiness, and capacity among mid-sized employers in low-wage industries: a national survey. *J Occup Environ Med* 2012;54:1337.
23. Linnan L, Bowling M, Childress J, Lindsay G, Blakey C, Pronk S, et al. Results of the 2004 national worksite health promotion survey. *Am J Public Health* 2008;98:1503–9.
24. Froines JR, Hinds WC, Duffy RM, Lafuente EJ, Liu W-CV. Exposure of firefighters to diesel emissions in fire stations. *Am Ind Hyg Assoc J* 1987;48:202–7.
25. Sorensen G, Stoddard AM, LaMontagne AD, Emmons K, Hunt MK, Youngstrom R, et al. A comprehensive worksite cancer prevention intervention: behavior change results from a randomized controlled trial (United States). *Cancer Causes Control* 2002; 13:493–502.
26. Byers T, Nestle M, McTiernan A, Rock CL, Demark-Wahnefried W, Bandera EV, et al. American Cancer Society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin* 2002;52:92–119.
27. Friedenreich CM, Orenstein MR. Physical activity and cancer prevention: etiologic evidence and biological mechanisms. *J Nutr* 2002;132:3456S–64S.
28. Matson-Koffman DM. The CDC worksite health scorecard; an assessment tool for employers to prevent heart disease, stroke, & related health conditions. Atlanta, GA: Centers for Disease Control and Prevention; 2012. Available from: https://www.cdc.gov/dhdsp/pubs/docs/hsc_manual.pdf.
29. Baicker K, Cutler D, Song Z. Workplace wellness programs can generate savings. *Health Affairs* 2010;29:304–11.
30. Moore KJ, Caban-Martinez AJ, Kirsner RS, Schaefer-Solle N, Lee DJ, Koru-Sengul T, et al. Firefighter skin cancer and sun protection practices: evidence from the Florida firefighter cancer initiative. *JAMA Dermatol* 2018;154:219–21.
31. Barbeau E, Roelofs C, Youngstrom R, Sorensen G, Stoddard A, LaMontagne AD. Assessment of occupational safety and health programs in small businesses. *Am J Ind Med* 2004; 45:371–9.
32. Cinite I, Duxbury LE, Higgins C. Measurement of perceived organizational readiness for change in the public sector. *Br J Manag* 2009;20:265–77.
33. Rosner B. *Fundamentals of biostatistics*. Boston, MA: Nelson Education; 2015.
34. Fritschi L, Glass DC. Firefighters and cancer: where are we and where to now? *Occup Environ Med* 2014;20:265–77.
35. Petrovic N, Carlson JA. A decision-making framework for wildfire suppression. *Int J Wildland Fire* 2012;21:927–37.
36. Gorte R, Economics H. *The rising cost of wildfire protection*. Bozeman, MT: Headwaters Economics; 2013.
37. Sinclair RC, Cunningham TR. Safety activities in small businesses. *Safety Sci* 2014;64:32–8.
38. Tremblay PA, Nobrega S, Davis L, Erck E, Punnett L. Healthy workplaces? A survey of Massachusetts employers. *Am J Health Promotion* 2013;27:390–400.
39. Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Day RS. An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health* 2013;13: 805.
40. DeSantis CE, Lin CC, Mariotto AB, Siegel RL, Stein KD, Kramer JL, et al. Cancer treatment and survivorship statistics, 2014. *CA Cancer J Clin* 2014;64:252–71.
41. Sen S, Palmieri T, Greenhalgh D. Cardiac fatalities in firefighters: an analysis of the US fire administration database. *J Burn Care Res* 2016;37:191–5.
42. Kuehl H, Mabry L, Elliot DL, Kuehl KS, Favorite KC. Factors in adoption of a fire department wellness program: champ and chief model. *J Occup Environ Med* 2013;55:424.

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