

Cancer Risk and Mortality among Firefighters: A Meta-Analytic Review

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Cancer risk and mortality among firefighters: a meta-analytic review

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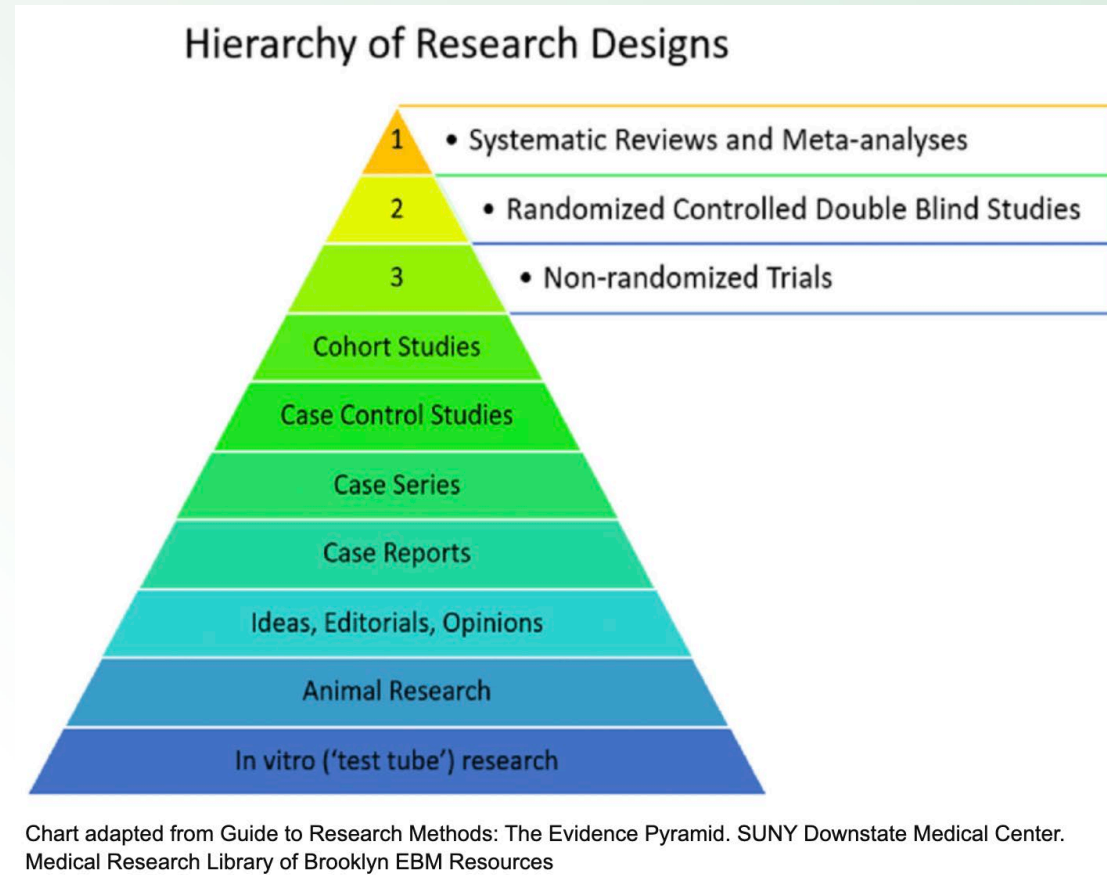

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Introduction

- Firefighting is a hazardous occupation that is associated with **an increase in the risk of select cancers.**
- The earlier IARC report on occupational exposures in firefighters included a meta-analysis which found increased risks for **prostate, testicular, and non-Hodgkin lymphoma cancers**
- Most recent meta-analyses on this topic reveal mixed findings.



What is meta-analysis?



Methods and Materials

1. A series of **comprehensive electronic searches** were conducted using multiple databases including **ERIC, PsychINFO, ProQuest Dissertation & Theses, PUBMED, and MEDLINE via EBSCO.**
2. Performed **citation searches** using various online search engines including **Embase, Web of Science Core collection, Google Scholar, and SCOPUS.**

Methods and Materials

3. We also searched **multiple websites including government, cancer registries, and the Cochrane Library.**

Keywords being used in all our searches are a combination of the following terms: (Cancer OR tumor OR malignancy OR neoplasm OR mutation) & (fire inspector OR fire inspectors OR fire rescue OR fire-rescue OR firefighter OR firefighters OR "fire fighter" OR "fire fighters" OR paramedic OR paramedics OR emergency medical technician OR "first responder").

Two independent reviewers were responsible for determining if studies were eligible with a third author confirming any discrepancies in whether a study met eligibility criteria.

Methods and Materials

Each study initially considered for the present meta-analysis was reviewed and coded, including:

- (1) **design characteristics** (i.e., cohort, cross-sectional, longitudinal, mixed, and other)
- (2) **outcome type** (i.e., incidence and mortality)
- (3) **cancer coding system** (i.e., International Classification of Diseases (ICD) ICD-8, ICD-9, ICD-10, International Classification of Disease for Oncology (ICD-O), ICD-O-2, ICD-O-3, Surveillance, Epidemiology, End Results (SEER) codes, and others)
- (4) **cancer sites**
- (5) **whether *in situ* cases were excluded in data analyses**
- (6) **source of occupation designations** (i.e., employment, certification, cancer, registry, death certificate, and other)
- (7) **type of incident that firefighters attended**
- (8) **sample characteristics** (i.e., age, employment duration, employment status, gender, race/ethnicity, and smoking status)
- (9) **study characteristics** (i.e., location, publication type, and publication year).

Methods and Materials

Inclusion and Exclusion Criteria

To be included in the current meta-analysis, a study must meet the following inclusion and exclusion criteria, including:

1. A study must be **empirical and quantitative**;
2. A study must be **based on human research**;
3. A **study population must be firefighters**;
4. A study must be **related to firefighters' cancer incidence or mortality**;
5. A study must be **written in English**;
6. A study must **report sufficient statistics** that enable us to compute effect size and its associated standard error.
7. A study must **provide cancer incidence and/or mortality from firefighters that are largely geographically and chronologically independent from those included other studies**;
8. The **study comparison group must be the general population** (e.g., multi-national, national, regional, or local);

Methods and Materials

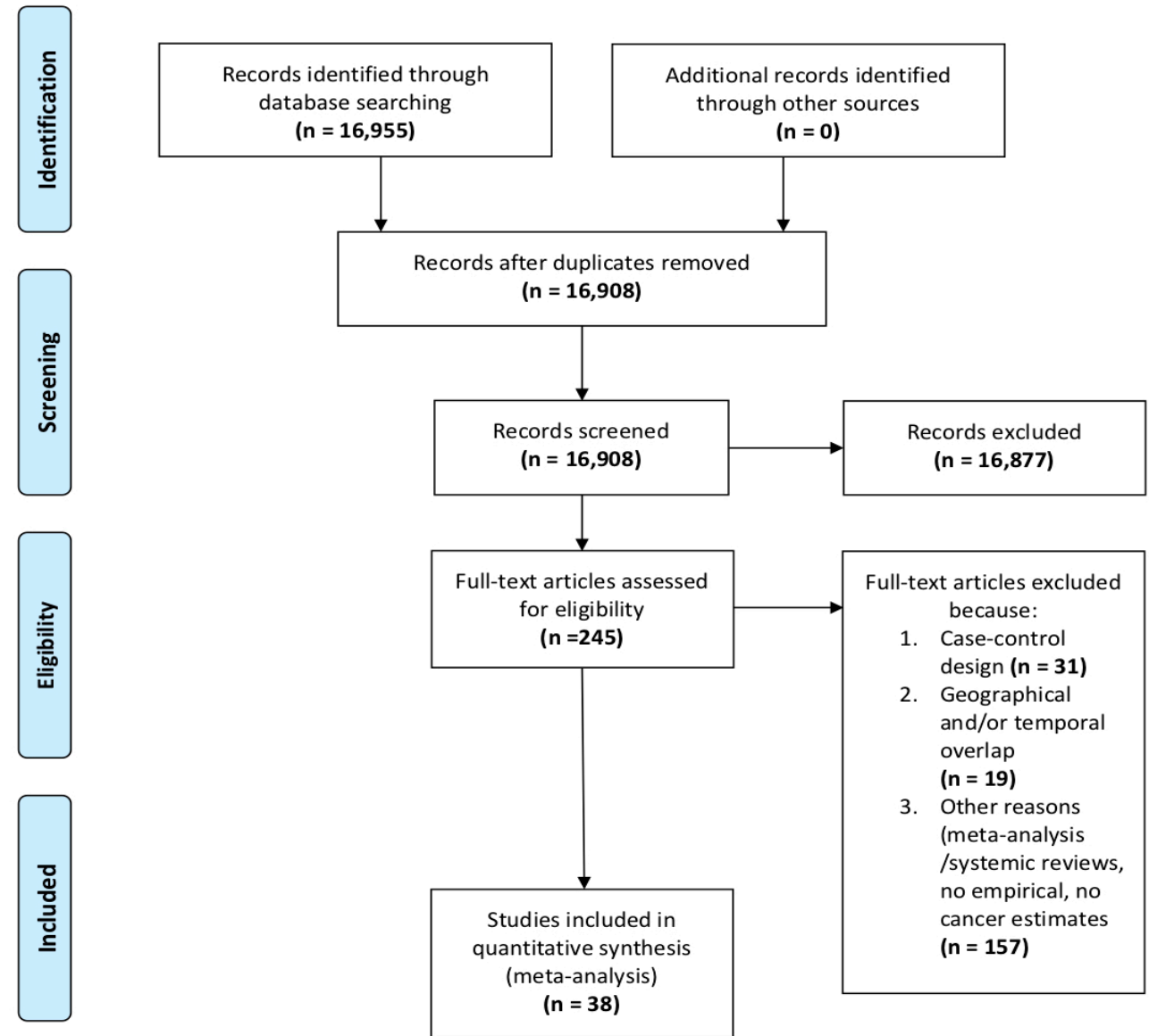
- Two coders independently read the included studies and extracted study information from the **38 studies included in the meta-analysis** based on the final coding instrument through REDCap.

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PRISMA 2009 Flow Diagram



Methods and Materials

- Computed pooled **standardized incidence risk (SIRE)** and **standardized mortality estimates (SMRE)**
- Tested **for publication and other forms of bias**
- Conducted **moderator analyses**

Results

- **Thirty-eight studies** published between **1978 and March 2022** were included for final meta-analysis out of 245 studies that were reviewed for eligibility.

Figure 1. Standardized Incidence Ratio by Cancer Site

Cancer Site	k	SIR	95% CI
All cancers (140-209)	25	0.93	[0.91, 0.95]
Lip, oral cavity, pharynx (140-149)	3	0.8	[0.52, 1.24]
Esophagus (150)	14	0.73	[0.60, 0.88]
Stomach (151)	14	0.91	[0.81, 1.03]
Small intestine (152)	3	1.33	[0.65, 2.73]
Colon (153)	14	0.96	[0.89, 1.04]
Rectum (154)	13	0.97	[0.87, 1.08]
Colorectal (153, 154)	7	0.86	[0.80, 0.93]
Liver (155)	9	0.62	[0.51, 0.75]
Gallbladder (156)	3	1.15	[0.68, 1.96]
Pancreas (157)	17	0.88	[0.76, 1.02]
Nasal cavities, ear, and accessory sinuses (160)	2	1.49	[0.37, 5.93]
Larynx (161)	12	0.65	[0.52, 0.81]
Lung (162)	21	0.67	[0.63, 0.73]
Pleura (163)	10	0.82	[0.62, 1.08]
Bone (170)	4	1.31	[0.53, 3.25]
Connective and other soft tissue (171)	3	1.02	[0.50, 2.05]
Malignant melanoma of skin (172)	20	1.14	[1.08, 1.21]
Other skin (173)	8	1.24	[1.16, 1.32]
Female Breast (174)	2	0.84	[0.39, 1.83]
Male breast (175)	4	1.06	[0.55, 2.05]
Cervix uteri (180)	3	1.3	[0.57, 2.94]
Uterus (179,182)	2	0.9	[0.74, 1.10]
Prostate (185)	14	1.09	[1.04, 1.14]
Testis (186)	12	1.005	[0.83, 1.21]
Bladder (188)	8	0.91	[0.78, 1.07]
Kidney (189)	15	0.93	[0.81, 1.06]
Brain & nervous system (191-192)	11	0.88	[0.74, 1.04]
Thyroid (193)	11	0.95	[0.76, 1.19]
Endocrine (193-194)	4	0.86	[0.65, 1.13]
Non-Hodgkin lymphoma (200, 202)	12	0.91	[0.81, 1.02]
Hodgkin's disease (201)	7	0.94	[0.66, 1.33]
Multiple myeloma (203)	10	0.9	[0.73, 1.12]
Leukemia (204-208)	18	0.87	[0.76, 1.00]
Broader combinations:			
Digestive system (150-159)	11	0.81	[0.76, 0.86]
Respiratory (160-165)	15	0.62	[0.58, 0.67]
Male genital (185-187)	9	1.07	[1.02, 1.12]
Kidney & Bladder (188-189)	13	0.85	[0.77, 0.93]
Endocrine (193-194)	4	0.86	[0.65, 1.13]
Lymphatic and Hematopoietic tissue (200-208)	10	0.82	[0.75, 0.89]

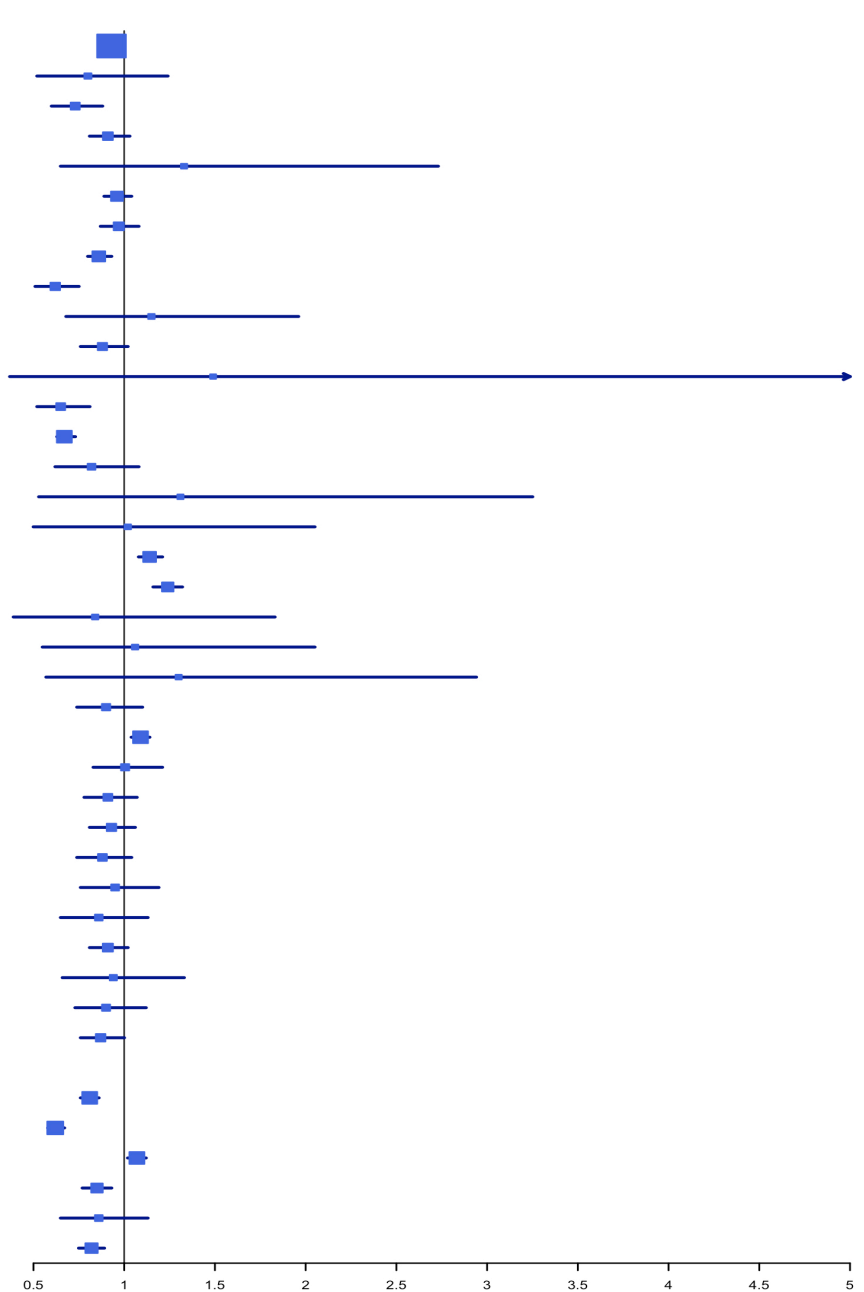
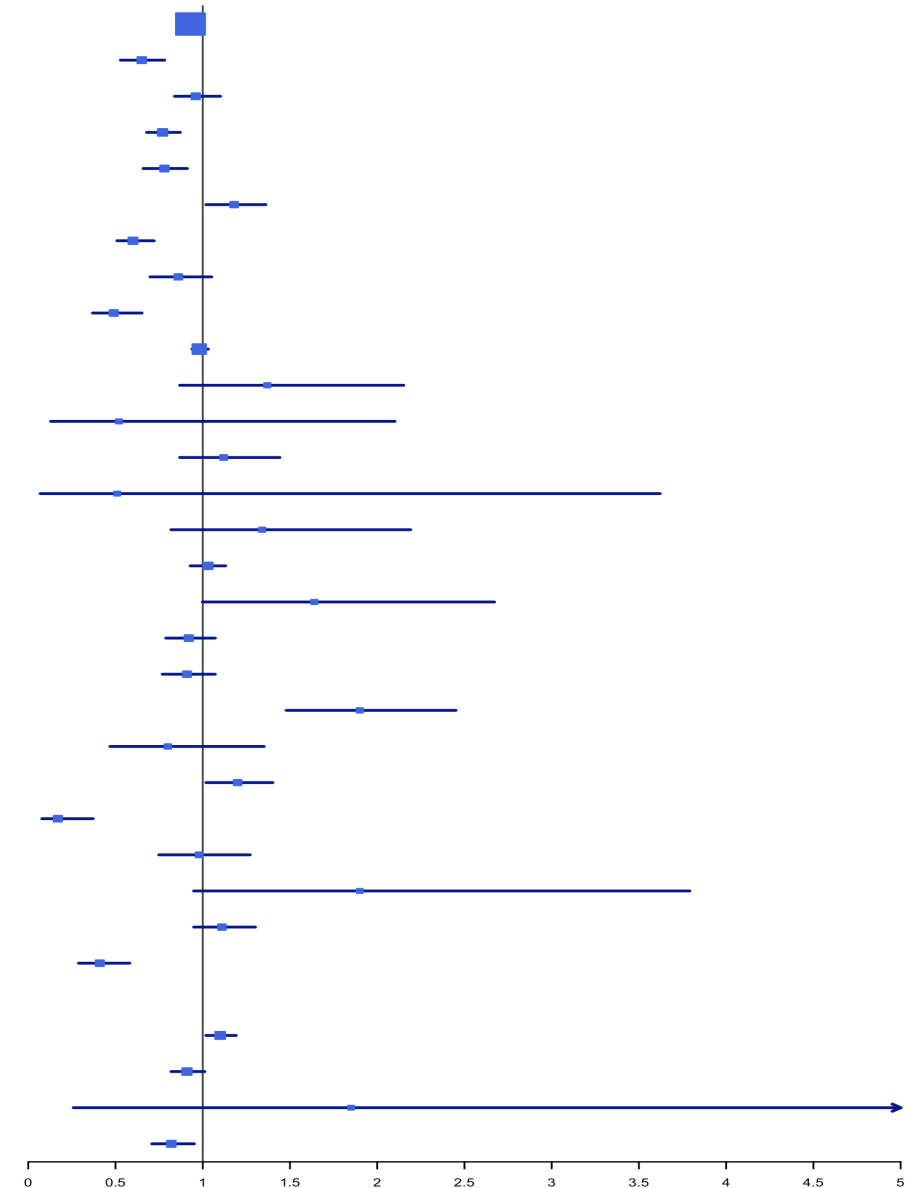


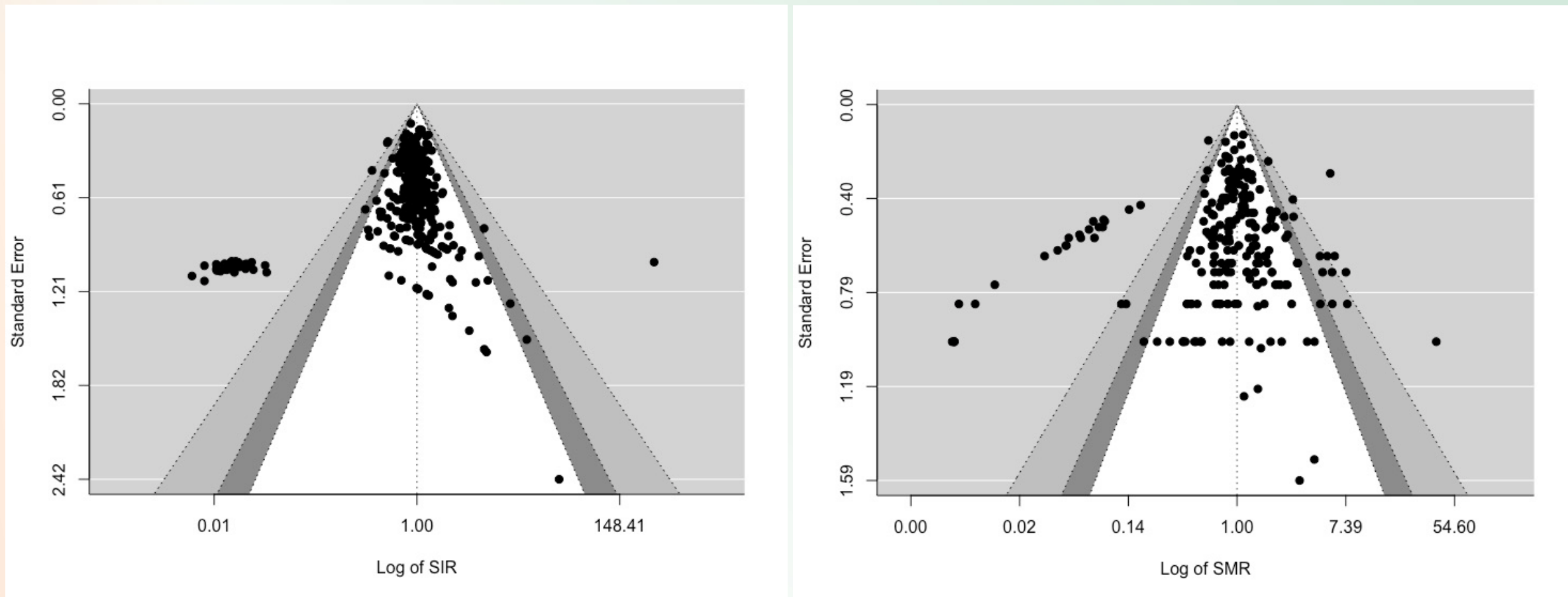
Figure 2. Standardized Mortality Ratio by Cancer Site

Cancer Site	k	SMR	95% CI
All cancers (140-209)	36	0.93	[0.92, 0.95]
Lip, oral cavity, pharynx (140-149)	7	0.65	[0.53, 0.78]
Esophagus (150)	8	0.96	[0.84, 1.10]
Stomach (151)	11	0.77	[0.68, 0.87]
Colon (153)	9	0.78	[0.66, 0.91]
Rectum (154)	10	1.18	[1.02, 1.36]
Liver (155)	7	0.6	[0.51, 0.72]
Pancreas (157)	8	0.86	[0.70, 1.05]
Larynx (161)	7	0.49	[0.37, 0.65]
Lung (162)	11	0.98	[0.94, 1.03]
Pleura (163)	2	1.37	[0.87, 2.15]
Bone (170)	4	0.52	[0.13, 2.10]
Malignant melanoma of skin (172)	14	1.12	[0.87, 1.44]
Female breast (174)	1	0.51	[0.07, 3.62]
Male breast (175)	4	1.34	[0.82, 2.19]
Prostate (185)	11	1.03	[0.93, 1.13]
Testis (186)	11	1.64	[1.00, 2.67]
Bladder (188)	11	0.92	[0.79, 1.07]
Kidney (189)	8	0.91	[0.77, 1.07]
Brain & nervous system (191-192)	13	1.9	[1.48, 2.45]
Thyroid (193)	5	0.8	[0.47, 1.35]
Non-Hodgkin lymphoma (200, 202)	2	1.2	[1.02, 1.40]
Hodgkin's disease (201)	6	0.17	[0.08, 0.37]
Multiple myeloma (203)	3	0.98	[0.75, 1.27]
Lymphoid leukemia (204)	2	1.9	[0.95, 3.79]
Myeloid Leukemia (205)	3	1.11	[0.95, 1.30]
Leukemia (204-208)	5	0.41	[0.29, 0.58]
Broader combinations:			
Digestive system (150-159)	5	1.1	[1.02, 1.19]
Respiratory (160-163)	9	0.91	[0.82, 1.01]
Male genital (185-187)	2	1.85	[0.26, 13.13]
Lymphatic and Hematopoietic tissue (200-208)	12	0.82	[0.71, 0.95]



Results

Figure 3-4. Publication/Other Bias Analyses



SIRE Moderator Analyses

- Pooled SIRE estimates were significantly higher when quality score ratings were higher.
- Pooled SIRE for males was significantly lower than those for females.
- Pooled SIRE were lower when participants with non-malignant tumors (e.g., benign brain tumors and *in situ*) were included.

SMRE Moderator Analyses

- Pooled SMRE estimates were significantly higher when quality score ratings were higher.
- Pooled SMRE for males was significantly higher than those for females.
- Pooled SMRE extracted from non-US studies was significantly higher than those from US studies.

Next Steps

- A **companion meta-analysis** is being performed on firefighters on cancer papers employing case-control and other non-traditional research designs.
- **Thirty-one** papers are undergoing quality assessment review.

Conclusions

- Firefighters are at higher risk for several cancers; to the extent that some (e.g., **melanoma and prostate**) are screening amenable, more study into **firefighter-specific recommendations for cancer surveillance is needed.**
- Despite differences between our study and others, **our results reinforce the associations between firefighting and cancer.**
- Moreover, longitudinal studies with more detailed data on the specific length and types of exposures are necessary, as well as on unstudied subtypes of cancers (e.g., subtypes of brain cancer and leukemias) are needed.

Thank you!

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References

1. Jalilian H, Ziaei M, Weiderpass E, Rueegg CS, Khosravi Y, Kjaerheim K. Cancer incidence and mortality among firefighters. *Int J Cancer*. 2019.
2. Soteriades ES, Kim J, Christophi CA, Kales SN. Cancer Incidence and Mortality in Firefighters: A State-of-the-Art Review and Meta-Analysis. *Asian Pac J Cancer Prev*. 2019;20(11):3221-31.
3. Lee DJ, Koru-Sengul T, Hernandez MN, Caban-Martinez AJ, McClure LA, Mackinnon JA, et al. Cancer risk among career male and female Florida firefighters: Evidence from the Florida Firefighter Cancer Registry (1981-2014). *Am J Ind Med*. 2020;63(4):285-99.
4. Sritharan J, MacLeod J, Harris S, Cole DC, Harris A, Tjepkema M, et al. Prostate cancer surveillance by occupation and industry: the Canadian Census Health and Environment Cohort (CanCHEC). *Cancer Medicine*. 2018;7(4):1468-78.
5. Kirstine Ugelvig Petersen K, Pedersen JE, Bonde JP, Ebbelhoej NE, Hansen J. Long-term follow-up for cancer incidence in a cohort of Danish firefighters. *Occup Environ Med*. 2018;75(4):263-9.
6. Muegge CM, Zollinger TW, Yiqing S, Wessel J, Monahan PO, Moffatt SM. Excess mortality among Indiana firefighters, 1985-2013. *American Journal of Industrial Medicine*. 2018:1- 7.
7. Kullberg C, Andersson T, Gustavsson P, Selander J, Tornling G, Gustavsson A, et al. Cancer incidence in Stockholm firefighters 1958-2012: an updated cohort study. *Int Arch Occup Environ Health*. 2018;91(3):285-91.
8. Petersen KU, Pedersen JE, Bonde JP, Ebbelhoej NE, Hansen J. Mortality in a cohort of Danish firefighters; 1970-2014. *Int Arch Occup Environ Health*. 2018;91(6):759-66.