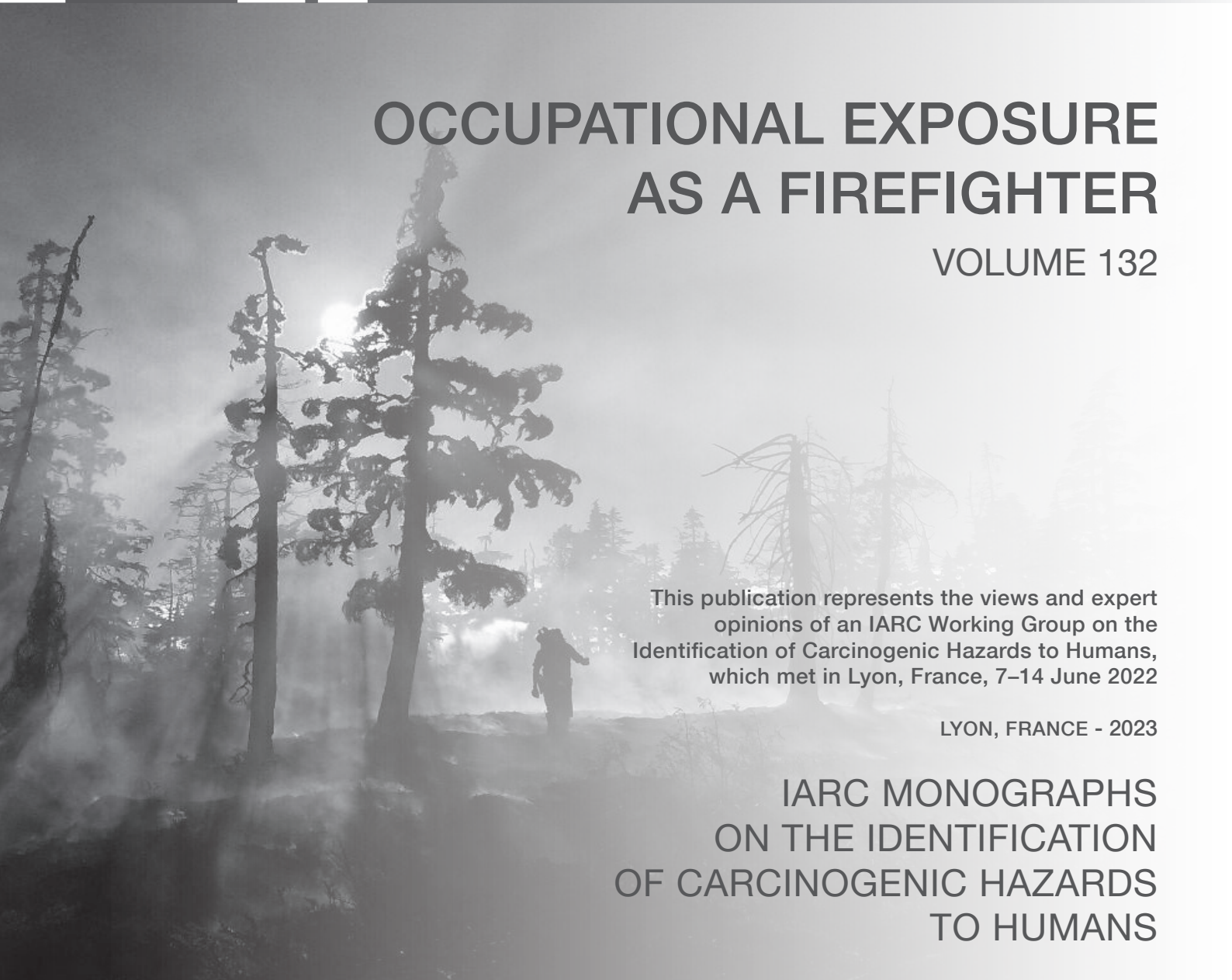


OCCUPATIONAL EXPOSURE AS A FIREFIGHTER

VOLUME 132



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TO HUMANS

Table S2.10 Cohort and case–control studies only reporting ever having worked as a firefighter and cancers of the colon and rectum, oesophagus, stomach, and other sites

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Amadeo et al. (2015) France Enrolment, 1 January 1979/ follow-up, 1979–2008 Cohort	10 829 male professional [career] firefighters employed in France on 1 January 1979, identified from 89 French administrative departments (93% of population) Exposure assessment method: ever employed as firefighter from employment records	Lip, oral cavity, and pharynx, mortality	SMR (French population referent): Firefighters	69	1.15 (0.89–1.46)	Age, calendar year	<i>Exposure assessment critique:</i> Minimal quality. Exposure assessment at only one point in time. Employed as any type of paid [career] firefighter. May include municipal and rural firefighters. <i>Strengths:</i> cohort coverage at the national level; relatively large cohort with long follow-up; robust linkages. <i>Limitations:</i> probable healthy-worker selection bias; includes only the 16% who were career civilian firefighters (79% were volunteers and 5% were military); lack of information on exposure and potential confounders.
		Oesophagus, mortality	SMR (French population referent): Firefighters	40	0.93 (0.67–1.27)		
		Stomach, mortality	SMR (French population referent): Firefighters	29	1.15 (0.77–1.65)		
		Colon, mortality	SMR (French population referent): Firefighters	29	0.73 (0.44–1.04)		
		Rectum and anus, mortality	SMR (French population referent): Firefighters	23	1.36 (0.86–2.04)		
		Pancreas, mortality	SMR (French population referent): Firefighters	42	1.27 (0.92–1.72)		
		Liver (HCC), mortality	SMR (French population referent): Firefighters	46	1.10 (0.80–1.46)		
Breast, mortality	SMR (French population referent): Firefighters	1	0.76 (0.02–4.23)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Deschamps et al. (1995) Paris, France Enrolment, 1 January 1977/ follow-up, 1977 to 1 January 1991 Cohort	830; professional [career] male firefighters with ≥ 5 yr of service in the Paris Fire Brigade before 1977 Exposure assessment method: employed as firefighter with ≥ 5 yr of active fire combat duty from employment records	Pharynx, mortality Digestive (ICD-9, 150–159), mortality	SMR (French population referent): Firefighters SMR (French population referent): Firefighters	2 5	0.81 (0.10–2.93) 1.14 (0.37–2.66)	Age, calendar year	<i>Exposure assessment critique:</i> Satisfactory quality. Duration of active fire combat assessed only for deaths, not used in analyses. Municipal firefighters. <i>Strengths:</i> complete cohort enumeration. <i>Limitations:</i> small study size; probable healthy-worker selection bias; lack of information on exposure and potential confounders; probabilistic linkage of outcome data.
Ma et al. (2006) Florida, USA Enrolment, 1972–1999, follow-up, 1981–1999 Cohort	36 813; all male (34 796) and female (2017) professional [career] firefighters certified in Florida from 1972 to 1999; the certification date was considered to be the date of first exposure Exposure assessment method: ever career firefighter from professional certification records	Lip, oral cavity, and pharynx (ICD-10, C00–C14), incidence Oesophagus, incidence	SIR (Florida population referent): Male firefighters Female firefighters SIR (Florida population referent): Male firefighters Female firefighters	39 0 11 0	0.67 (0.47–0.91) 0 (NR) 0.62 (0.31–1.11) 0 (NR)	Age, calendar year	<i>Exposure assessment critique:</i> Minimal quality. Only one point in time measure of exposure, no indication when exposure stopped. May include municipal and rural firefighters. <i>Strengths:</i> assesses cancer incidence; includes female firefighters; large male cohort. <i>Limitations:</i> probable healthy-worker selection bias; small female cohort; young age at end of follow-up; lacks information on exposure and potential confounders.

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Ma et al. (2006) (cont.)		Stomach, incidence	SIR (Florida population referent):		0.50 (0.25–0.90)	Age, calendar year	
			Male firefighters	14			
			Female firefighters	0	0 (NR)		
		Colon, incidence	SIR (Florida population referent):		1.16 (0.92–1.45)		
			Male firefighters	78			
			Female firefighters	2	2.27 (0.26–8.21)		
		Rectum, incidence	SIR (Florida population referent):		0.88 (0.56–1.32)		
			Male firefighters	23			
			Female firefighters	1	5.26 (0.07–29.30)		
		Liver (HCC), incidence	SIR (Florida population referent):		0.74 (0.32–1.46)		
			Male firefighters	8			
			Female firefighters	0	0 (NR)		
		Pancreas, incidence	SIR (Florida population referent):		0.57 (0.30–1.10)		
			Male firefighters	12			
	Female firefighters	0	0 (NR)				
Bone, incidence	SIR (Florida population referent):		1.02 (0.27–2.61)				
	Male firefighters	4					
	Female firefighters	0	0 (NR)				

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Ma et al. (2006) (cont.)		Breast, incidence	SIR (Florida population referent): Male firefighters	2	0.51 (0.06–1.84)	Age, calendar year	
			Female firefighters	10	0.96 (0.46–1.76)		
		Soft tissue sarcoma, incidence	SIR (Florida population referent): Male firefighters	14	1.00 (0.55–1.69)		
			Female firefighters	1	5.56 (0.07–30.91)		
Ma et al. (2005)	36 813; all male (34 796) and female (2017) professional [career] firefighters certified in Florida from 1972 to 1999 Enrolment, 1972–1999/ follow-up, 1972–1999 Cohort Exposure assessment method: ever career firefighter from professional certification records	Buccal/pharynx, mortality	SMR (Florida population referent): Male firefighters	7	0.42 (0.17–0.87)	Age, calendar period	<i>Exposure assessment critique:</i> Minimal quality. Only one point in time measure of exposure, no indication when exposure stopped. May include municipal and rural firefighters. <i>Strengths:</i> includes female firefighters; large male cohort; multiple linkages to assess vital status; conducted a sensitivity analysis among firefighters with longest tenure (certified 1972–1976). <i>Limitations:</i> probable healthy-worker selection bias; small female cohort; young age at end of follow-up; lacks information on exposure and potential confounders.
			Male firefighters certified 1972–1976	5	0.38 (0.12–0.89)		
			Female firefighters	0	0 (NR)		
		Oesophagus, mortality	SMR (Florida population referent): Male firefighters	10	0.65 (0.31–1.20)		
			Male firefighters certified 1972–1976	7	0.55 (0.22–1.14)		
			Female firefighters	0	0 (NR)		

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments		
Ma et al. (2005) (cont.)		Stomach, mortality	SMR (Florida population referent):			Age, calendar period			
			Male firefighters	12	0.86 (0.52–1.42)				
			Male firefighters certified 1972–1976	10	0.92 (0.68–2.00)				
			Female firefighters	0	0 (NR)				
			Colon, mortality		SMR (Florida population referent):				
			Male firefighters	38	1.14 (0.81–1.56)				
		Male firefighters certified 1972–1976	33	1.22 (0.84–1.72)					
		Female firefighters	1	2.27 (0.03–12.7)					
		Rectum, mortality	SMR (Florida population referent):						
			Male firefighters	7	0.94 (0.38–1.93)				
			Male firefighters certified 1972–1976	6	1.04 (0.38–2.26)				
			Female firefighters	0	0 (NR)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Ma et al. (2005) (cont.)		Liver (HCC), mortality	SMR (Florida population referent):				Age, calendar period	
			Male firefighters	10	0.85 (0.41–1.56)			
			Male firefighters certified 1972–1976	7	0.83 (0.33–1.71)			
		Pancreas, mortality	Female firefighters	0	0 (NR)			
			SMR (Florida population referent):					
			Male firefighters	12	0.57 (0.29–0.99)			
		Bone, mortality	Male firefighters certified 1972–1976	12	0.7 (0.36–1.22)			
			Female firefighters	0	0 (NR)			
			SMR (Florida population referent):					
			Male firefighters	1	0.52 (0.01–2.91)			
		Male firefighters certified 1972–1976	1	1.06 (0.01–5.92)				
		Female firefighters	0	0 (NR)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Ma et al. (2005) (cont.)		Breast, mortality	SMR (Florida population referent): Male firefighters	4	7.41 (1.99–19.0)	Age, calendar period	
			Male firefighters certified 1972–1976	3	6.98 (0.65–1.68)		
			Female firefighters	1	0.51 (0.01–2.82)		
Grimes et al. (1991) Honolulu, Hawaii, USA 1969–1988 Cohort	205 deaths; all male firefighters with ≥ 1 yr of service in the City of Honolulu Fire Department Exposure assessment method: death certificate coding of usual occupation	Stomach, mortality	PMR (state population referent): All firefighters Caucasian [White] firefighters Hawaiian firefighters	[4] [1] [2]	0.79 (0.30–2.09) 1.17 (0.17–8.20) 0.76 (0.19–3.01)	NR	<i>Exposure assessment critique:</i> Minimal quality. Crude, relying on knowledge of usual occupation by death certifier. Possible differential misclassification from missing occupation on death certificates. May include municipal and rural firefighters. <i>Strengths:</i> long follow-up; examined risk by ethnic group (White/Hawaiian). <i>Limitations:</i> probable healthy-worker selection bias; unclear if underlying assumption that PMR will estimate an SMR is valid in this cohort; PMRs were not standardized by age or calendar period; no information on exposure and potential confounders. <i>Other comments:</i> number of deaths calculated by the Working Group.
		Colon, mortality	PMR (state population referent): All firefighters Caucasian [White] firefighters Hawaiian firefighters	[5] [1] [0]	0.91 (0.37–2.20) 0.71 (0.10–5.02) 0 (NR)	NR	

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Musk et al. (1978) Boston, Massachusetts, USA Follow-up, 1915–1975 Cohort	5655 male professional [career] firefighters employed by the Boston Fire Department for ≥ 3 yr since 1915 Exposure assessment method: employed as municipal firefighter ≥ 3 yr from employment records	Digestive (ICD-7, 150–159), mortality	SMR: Firefighters vs Massachusetts male population Firefighters vs US White male population	153 153	[0.80 (0.68–0.93)] [0.99 (0.84–1.16)]	Age, calendar period	<i>Exposure assessment critique:</i> Satisfactory quality. Ever employed as municipal firefighter. Other comments: Death certificates lacked for 7.9% (194) of confirmed deaths. <i>Strengths:</i> long follow-up. <i>Limitations:</i> probable healthy-worker selection bias; lack of information on cause for a proportion of deaths; lack of information on exposure and potential confounders.
Giles et al. (1993) Melbourne, Victoria, Australia Enrolment, 1917–1989/ follow-up 1980–1989 Cohort	2865 operational active male firefighters employed between 1917 and 1989 by the Metropolitan Fire Brigade in Melbourne, Australia Exposure assessment method: ever employed from employment records	Upper aerodigestive tract, incidence Colon and rectum, incidence Colon and rectum, incidence Pancreas, incidence	SIR (Victoria population referent): Firefighters SIR (Victoria population referent): Firefighters Attained age (SIR, Victoria population referent): ≥ 65 yr SIR (Victoria population referent): Firefighters	6 9 6 1	1.46 (0.53–3.18) 1.36 (0.62–2.59) 3.65 (1.13–7.94) 1.03 (0.01–5.75)	Age, calendar period	<i>Exposure assessment critique:</i> Minimal quality. Only ever municipal firefighter exposure. <i>Strengths:</i> assesses cancer incidence. <i>Limitations:</i> probable healthy-worker selection bias; small cohort size; no description of registry linkage methods; lack of information on exposure and potential confounders.

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Eliopoulos et al. (1984) Western Australia Follow-up, 1939–1978 Cohort	990; all men employed as permanent full-time firefighters by the Western Australian Fire Brigade between October 1939 and December 1978 Exposure assessment method: ever employed as a permanent full-time firefighter, and categorical employment duration (years) as firefighters from employment records	All cancers except respiratory organs, mortality	SMR (Western Australia referent): Employment as firefighter	23	1.21 (0.77–1.82)	Age, calendar period	<i>Exposure assessment critique:</i> Satisfactory quality. Unsure if permanent full-time status was maintained throughout study period. Municipal firefighters. <i>Strengths:</i> long follow-up time; low loss to follow-up. <i>Limitations:</i> probable healthy-worker selection bias; small study size; no personal information on exposure or potential confounders.
		Stomach, mortality	PMR (Western Australia referent): Employment as firefighter	5	2.02 (0.65–4.70)		
		Intestinal cancer, mortality	PMR (Western Australia referent): Employment as firefighter	4	1.59 (0.43–4.07)		
		Other digestive cancers, mortality	PMR (Western Australia referent): Employment as firefighter	3	0.88 (0.18–2.58)		
Zhao et al. (2020) Spain Enrolment, 2001/follow-up, 2001–2011 Cohort	9 579 759 (27 365 firefighters); men identified as residing in Spain on 1 November 2001, employed on the census date, and aged 20–64 yr; followed for mortality using a national death registry Exposure assessment method: employed as firefighter in week before census	Oral/pharyngeal combined, mortality	Occupation (MRR): All other occupations	5015	1	Age	<i>Exposure assessment critique:</i> Minimal quality. Firefighting self-reported at one point in time. Years of firefighting. May include municipal and rural firefighters. <i>Strengths:</i> large study size; low loss to follow-up; cohort coverage at the national level. <i>Limitations:</i> occupation determined by self-report at baseline; short follow-up and young cohort age; lack of information on exposure and potential confounders.
			Firefighters	18	1.34 (0.81–2.21)		
			Occupation (MRR): All other occupations	4427	1		
		Oesophagus, mortality	Firefighters	13	1.11 (0.64–1.92)		
			Occupation (MRR): All other occupations	7443	1		
			Firefighters	26	1.32 (0.88–1.98)		
		Stomach, mortality	Occupation (MRR): All other occupations	9778	1		
			Firefighters	17	0.62 (0.37–1.02)		
			Occupation (MRR): All other occupations	3648	1		
		Colon, mortality	Firefighters	10	1.08 (0.57–2.04)		
			Rectum, mortality	Occupation (MRR): All other occupations	10		

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments		
Zhao et al. (2020) (cont.)		Liver (HCC), mortality	Occupation (MRR):			Age			
			All other occupations	5937	1				
		Pancreas, mortality	Firefighters	14	1.01 (0.59–1.74)				
			Occupation (MRR):						
		Bone, mortality	All other occupations	7101	1				
			Firefighters	8	0.43 (0.21–0.88)				
		Breast, mortality	Occupation (MRR):						
			All other occupations	396	1				
					Firefighters			1	1.11 (0.16–7.92)
					Occupation (MRR):				
					All other occupations			128	1
					Firefighters			1	3.04 (0.42–21.78)
Pukkala et al. (2014) Denmark, Finland, Iceland, Norway, Sweden 1961–2005 Cohort	16 422 male professional [career] firefighters in the NOCCA cohort (a registry-based cohort study of Nordic country residents who participated in any computerized population census (1960, 1970, 1980–1981 or 1990) and were followed up through linkage to national cancer registries), aged 30–64 yr, alive, and in the country in the year following census participation Exposure assessment method: employed as firefighter at time of census	Lip, incidence	SIR (national referent):			Country, age, calendar period	<i>Exposure assessment critique:</i> Satisfactory quality. Self-reported firefighter as current job. Includes municipal and rural firefighters. <i>Strengths:</i> large study size; long follow-up time; assesses cancer incidence using high-quality outcome data; contrasts by country, observation period, and age; multiple sensitivity analyses. <i>Limitations:</i> probable healthy-worker selection bias; lack of information on exposure and potential confounders.		
		Oral cavity, incidence	Firefighters	17	0.80 (0.46–1.28)				
			SIR (national referent):						
		Pharynx, incidence	Firefighters	11	0.80 (0.40–1.43)				
			SIR (national referent):						
		Oesophagus, incidence	Firefighters	19	1.00 (0.60–1.57)				
			SIR (national referent):						
		Stomach, incidence	Firefighters	31	0.98 (0.66–1.39)				
SIR (national referent):									
Colon, incidence	Firefighters	128	1.09 (0.91–1.30)						
	SIR (national referent):								
		Firefighters	198	1.14 (0.99–1.31)					

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Pukkala et al. (2014) Denmark, Finland, Iceland, Norway, Sweden 1961–2005 Cohort		Rectum, incidence	SIR (national referent): Firefighters	119	0.99 (0.82–1.19)	Country, age, calendar period	
		Liver and bile ducts, incidence	SIR (national referent): Firefighters	25	0.91 (0.59–1.34)		
		Bile duct/gallbladder, incidence	SIR (national referent): Firefighters	18	1.45 (0.86–2.29)		
		Pancreas, incidence	SIR (national referent): Firefighters	87	1.17 (0.94–1.45)		
		Soft tissue sarcoma, incidence	SIR (national referent): Firefighters	18	1.16 (0.69–1.84)		
Sritharan et al. (2022) Ontario, Canada Enrolment, 1983–2019/ follow-up, 1983–2020 Cohort	2 368 226 (firefighters, 13 642; police, 22 595); workers aged ≥ 15 yr who submitted lost-time workers' compensation injury and disease claims to the Workplace Safety and Insurance Board with known sex, birth date, claim date, and occupation and industry information; incident cases identified using the Ontario Cancer registry Exposure assessment method: records; employed as firefighter at time of workers' compensation claim	Lip, incidence	Referent (HR): Firefighters vs all other workers	11	1.61 (0.89–2.92)	Age at start of follow-up, birth year, sex	<i>Exposure assessment critique:</i> Minimal quality. Duration of firefighter work unclear. May include full-time, part-time, municipal, and rural firefighters. <i>Strengths:</i> large study size; long follow-up time; includes female firefighters; working population used as referent; assesses cancer incidence. <i>Limitations:</i> potential selection bias into claims database, as compensation claims used to identify the cohort may differ by occupation; lack of information on exposure and potential confounders.
			Firefighters vs police	11	1.35 (0.57–3.22)		
		Oral/pharyngeal combined, incidence	Referent (HR): Firefighters vs all other workers	56	1.10 (0.84–1.43)		
			Firefighters vs police	56	1.03 (0.72–1.46)		
		Oesophagus, incidence	Referent (HR): Firefighters vs all other workers	29	1.06 (0.73–1.53)		
			Firefighters vs police	29	0.93 (0.57–1.50)		

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Sritharan et al. (2022) (cont.)		Stomach, incidence	Referent (HR):			Age at start of follow-up, birth year, sex	
			Firefighters vs all other workers	34	0.78 (0.55–1.09)		
		Colon, incidence	Firefighters vs police	34	0.79 (0.51–1.21)		
			Referent (HR):				
		Rectum, incidence	Firefighters vs all other workers	152	1.39 (1.19–1.63)		
			Firefighters vs police	152	0.97 (0.78–1.20)		
		Liver (HCC), incidence	Referent (HR):				
			Firefighters vs all other workers	66	1.18 (0.93–1.51)		
	Firefighters vs police	66	1.19 (0.85–1.68)				
	Referent (HR):						
	Firefighters vs all other workers	25	0.72 (0.49–1.07)				
	Firefighters vs police	25	0.92 (0.54–1.56)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Harris et al. (2018) (cont.)		Colon, incidence	Occupation (HR):			Age, region, education		
			Non-firefighters	NR	1			
		Rectum, incidence	Firefighters	40	0.90 (0.67–1.22)			
			Occupation (HR):					
		Liver (HCC), incidence	Non-firefighters	NR	1			
			Firefighters	30	0.88 (0.61–1.27)			
Pancreas, incidence	Occupation (HR):							
	Non-firefighters	NR	1					
	Firefighters	5	0.54 (0.23–1.31)					
		Occupation (HR):						
		Non-firefighters	NR	1				
		Firefighters	15	1.38 (0.83–2.29)				

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Lee et al. (2020) Florida, USA 1981–2014 Case-control	Cases: firefighters, 3760 men, 168 women; non-firefighters, NR; cancer patients identified via linkage of FCDS and FMO records on firefighter certification and employment Controls: varied by cancer site; control patients are all other cancer types except the cancer of interest Exposure assessment method: employment as firefighter from employment and professional certification records	Oral/pharyngeal combined, incidence	Group (OR for firefighters vs non-firefighters):			Age, year of diagnosis	<i>Exposure assessment critique:</i> Satisfactory quality. Ever firefighter exposure only. May include municipal and rural firefighters. <i>Strengths:</i> large study size (male firefighters); reliable information on firefighting status; includes female firefighters; assesses cancer incidence including tumour staging. <i>Limitations:</i> few female firefighters; cancer cases selected as controls (numerator-based analysis); limited information on exposure and potential confounders.	
			Men	159	0.85 (0.72–0.99)			
			Women	< 10	1.26 (0.47–3.40)			
		Oral/pharyngeal combined, incidence	Tumour stage (OR for firefighters vs non-firefighters):					
			Among men:					
			Early-stage	43	0.75 (0.55–1.01)			
		Oesophagus, incidence	Lage-stage		107	1.07 (0.88–1.30)		
			Group (OR for firefighters vs non-firefighters):					
			Men	53	0.91 (0.69–1.19)			
		Oesophagus, incidence	Women		< 10	NR		
			Tumour stage (OR for firefighters vs non-firefighters):					
			Among men:					
		Stomach, incidence	Early-stage		< 10	0.48 (0.22–1.08)		
Late-stage			37	1.16 (0.84–1.61)				
Group (OR for firefighters vs non-firefighters):								
Stomach, incidence	Men		46	0.78 (0.59–1.05)				
	Women		< 10	1.85 (0.46–7.49)				
	Tumour stage, men (OR for firefighters vs non-firefighters):							
Colon, incidence	Early-stage		< 10	0.78 (0.42–1.45)				
	Late-stage		30	0.85 (0.59–1.22)				
	Group (OR for firefighters vs non-firefighters):							
		Men	238	1.01 (0.88–1.15)				
		Women	< 10	0.78 (0.32–1.90)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Lee et al. (2020) (cont.)		Colon, incidence	Tumour stage, men (OR for firefighters vs non-firefighters):			Age, year of diagnosis		
			Early-stage	79	0.91 (0.72–1.14)			
			Late-stage	144	1.19 (1.00–1.41)			
		Rectum, incidence	Group (OR for firefighters vs non-firefighters):					
			Men	110	0.97 (0.80–1.17)			
			Women	< 10	2.02 (0.90–4.58)			
		Rectum, incidence	Tumour stage, men (OR for firefighters vs non-firefighters):					
			Early-stage	52	1.05 (0.80–1.39)			
			Late-stage	53	0.97 (0.74–1.28)			
		Pancreas, incidence	Group (OR for firefighters vs non-firefighters):					
			Men	71	0.85 (0.68–1.08)			
			Women	< 10	0.47 (0.07–3.29)			
		Pancreas, incidence	Tumour stage, men (OR for firefighters vs non-firefighters):					
			Early-stage	< 10	0.84 (0.38–1.87)			
			Late-stage	53	0.91 (0.69–1.20)			
		Liver and bile ducts, incidence	Group (OR for firefighters vs non-firefighters):					
			Men	50	0.70 (0.54–0.92)			
			Women	< 10	1.03 (0.14–7.39)			
Liver and bile ducts, incidence	Tumour stage, men (OR for firefighters vs non-firefighters):							
	Early-stage	NR	0.30 (0.16–0.56)					
	Late-stage	30	1.10 (0.76–1.58)					
Bone, incidence	Group (OR for firefighters vs non-firefighters):							
	Men	< 10	0.72 (0.36–1.44)					
	Women	< 10	3.90 (0.97–15.71)					

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Lee et al. (2020) (cont.)		Bone, incidence	Tumour stage, men (OR for firefighters vs non-firefighters):			Age, year of diagnosis	
			Early-stage	< 10	0.21 (0.03–1.46)		
			Late-stage	< 10	0.74 (0.24–2.30)		
		Soft tissue including heart, incidence	Group (OR for firefighters vs non-firefighters):				
			Men	30	0.93 (0.65–1.34)		
			Women	< 10	0.69 (0.10–4.95)		
		Breast, incidence	Group (OR for firefighters vs non-firefighters):				
			Women	49	0.73 (0.53–1.03)		
McClure et al. (2021) Florida, USA 1981–2014 Case-control	Cases: firefighters, 3760; non-firefighters, NR; cancer patients identified via linkage of FCDS and FMO records on firefighter certification and employment Controls: varied by cancer site; control patients are all other cancer types except the cancer of interest Exposure assessment method: employment as firefighter from cancer registry records and employment and professional certification records	Digestive system, incidence	Occupation (OR): Non-firefighters Firefighters, FMO employment certification records Firefighters, FCDS occupational data	NR 467 235	1 0.93 (0.85–1.03) 0.96 (0.84–1.10)	Age, year of diagnosis	<i>Exposure assessment critique:</i> Minimal quality. Ever firefighter exposure only. Incorporation of employment and certification records improvement for method 2. May include municipal and rural firefighters. <i>Strengths:</i> large study size; assesses cancer incidence. <i>Limitations:</i> cancer cases selected as controls (numerator-based analysis); minimal information on exposure and potential confounders; completeness of occupation data (from registry records) varied by sociodemographic and diagnostic characteristics.

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Langevin et al. (2020) Boston, Massachusetts, USA 1999–2011 Case–control	Cases: 718 (230 oral cavity, 321 oropharyngeal, 47 hypopharyngeal, 120 laryngeal); male head and neck SCC cases from major teaching hospitals located in Boston and verified via cancer-registry records Controls: 905 controls with no prior history of head and neck cancers enrolled using Massachusetts annual census records and frequency-matched on cases on age (± 3 yr), sex and residence Exposure assessment method: duration (years) of employment as firefighter from coded interview	Head and neck (SCC), incidence Head and neck (SCC), incidence Head and neck (SCC), incidence Oral cavity (SCC), incidence	Firefighter occupational history (OR): Never Ever Per decade as firefighter Firefighter occupational history, < 18.4 pack-years of cigarette smoking (OR): Never Ever Per decade as firefighter Firefighter occupational history, > 18.4 pack-years of cigarette smoking (OR): Never Ever Per decade as firefighter Firefighter occupational history (OR): Never Ever Per decade as firefighter	707 11 11 302 5 5 405 6 6 228 2 2	1 0.92 (0.40–2.13) 0.93 (0.67–1.27) 1 1.33 (0.37–4.74) 1.01 (0.56–1.81) 1 0.74 (0.23–2.38) 0.92 (0.62–1.37) 1 0.44 (0.09–2.04) 0.76 (0.41–1.40)	Age, race, education, smoking status, alcohol consumption, residence	<i>Exposure assessment critique:</i> Satisfactory quality. Possible recall bias for duration of active firefighter work. May include municipal and rural firefighters. <i>Strengths:</i> assesses incident cancers; analysis adjusting for several important risk factors, such as age, race, education, smoking and alcohol consumption, is a notable strength. <i>Limitations:</i> few firefighters participated in the study, stratified analyses were adversely affected by small number; potential for bias from self-report; potential for selection bias given firefighters were less likely to participate as controls.

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Langevin et al. (2020) (cont.)		Oral cavity (SCC), incidence	Firefighter occupational history, > 18.4 pack-years of cigarette smoking (OR):			Age, race, education, smoking status, alcohol consumption, residence	
			Never	132	1		
			Ever	2	0.66 (0.12–3.46)		
		Pharynx (hypopharynx) (SCC), incidence	Firefighter occupational history (OR):				
			Never	45	1		
			Ever	2	3.11 (0.63–15.39)		
		Pharynx (oropharynx) (SCC), incidence	Firefighter occupational history (OR):				
			Never	317	1		
			Ever	4	0.84 (0.27–2.67)		
		Pharynx (oropharynx) (SCC), incidence	Firefighter occupational history, < 18.4 pack-years of cigarette smoking (OR):				
			Never	173	1		
			Ever	2	1.03 (0.19–5.51)		
		Pharynx (oropharynx) (SCC), incidence	Firefighter occupational history, > 18.4 pack-years of cigarette smoking (OR):				
			Never	144	1		
			Ever	2	0.76 (0.15–3.92)		
					Per decade as firefighter		
			Per decade as firefighter	2	1.34 (0.84–2.14)		
			Per decade as firefighter	4	0.88 (0.55–1.40)		
			Per decade as firefighter	2	0.84 (0.36–1.95)		
			Per decade as firefighter	2	0.93 (0.53–1.64)		

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Muegge et al. (2018) Indiana, USA 1985–2013 Case–control	Cases: firefighters, 857; non-firefighters, 11 272; cancer as the underlying cause of death in state death registry among registrants with complete information on year of death, age at time of death, sex, race, ethnicity, industry code, and occupation code; all firefighter cancers were included, but non-firefighter cancers only observed among non-firefighter decedents matched 4:1 to firefighter decedents on age at death, sex, race, ethnicity, and year of death Controls: varied by cancer site; decedents with a cause of death other than the one under study among all firefighter decedents and a sample of non-firefighter decedents matched 4:1 to firefighter decedents on age at death, sex, race, ethnicity, and year of death Exposure assessment method: death certificate coding of usual occupation	Oral/pharyngeal combined, mortality	Death certificate occupation (OR):			Sex, race, ethnicity, age at death, year of death	<i>Exposure assessment critique:</i> Minimal quality. Crude, relying on knowledge of usual occupation by death certifier. Possible differential misclassification from missing occupation on death certificates. May include municipal and rural firefighters. <i>Strengths:</i> matching on race or ethnicity. <i>Limitations:</i> deaths used as controls (numerator-based analysis); lack of information on exposure and potential confounding.	
			Non-firefighters	40	1			
		Firefighters	Death certificate occupation (OR):		21			2.15 (1.19–3.79)
			Non-firefighters	128	1			
		Connective tissue, mortality	Death certificate occupation (OR):		46			1.45 (1.01–2.06)
			Non-firefighters	16	1			
Firefighters	10	2.50 (1.01–5.86)						

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Tsai et al. (2015) California, USA 1988–2007 Case-control	Cases: 378 132 (all cancers); all first malignant primary cancers in the registry restricted to adult male participants (aged 18–97 yr) with industry and occupation information available; cancer sites must have ≥ 10 firefighters among the cases to be analysed Controls: 48 725; cancers of the pharynx, stomach, liver, and pancreas in the registry restricted to men (aged 18–97 yr) with industry and occupation information available Exposure assessment method: employment as firefighter, coded as longest job held from cancer registry	Lip, incidence	Race (OR, firefighters vs non-firefighters):			Age, year of diagnosis, race	<i>Exposure assessment critique:</i> Minimal quality. Ever firefighter exposure only. May include municipal and rural firefighters. <i>Strengths:</i> large study size; assesses incident cancers, with subtypes reported for oesophagus; findings stratified by race/ethnicity. <i>Limitations:</i> no information on the population at risk (numerator-based analysis); occupation missing from nearly 50% of registry cases and more likely for people who were older or of Hispanic ethnicity; lack of information on exposure and potential confounders.
			White	17	1.36 (0.82–2.25)		
			Other	1	6.56 (0.87–49.58)		
		Pharynx, incidence	Race (OR, firefighters vs non-firefighters):				
			White	38	1.03 (0.71–1.48)		
			Other	4	1.35 (0.45–4.05)		
		Oesophagus, incidence	Race (OR, firefighters vs non-firefighters):				
			White	63	1.59 (1.19–2.12)		
			Other	5	2.14 (0.81–5.65)		
		Oesophagus (adenocarcinoma), incidence	Race (OR, firefighters vs non-firefighters):				
			White	44	1.84 (1.32–2.56)		
			Other	2	2.79 (0.66–11.87)		
		Oesophagus (SCC), incidence	Race (OR, firefighters vs non-firefighters):				
			White	10	0.94 (0.49–1.78)		
			Other	2	1.44 (0.34–6.14)		
Stomach, incidence	Race (OR, firefighters vs non-firefighters):						
	White	42	0.73 (0.52–1.03)				
	Other	10	1.61 (0.71–3.65)				
Colon and rectum, incidence	Race (OR, firefighters vs non-firefighters):						
	White	317	1.08 (0.90–1.3)				
	Other	30	1.41 (0.82–2.41)				
		Overall	347	1.10 (0.93–1.31)			

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Tsai et al. (2015) (cont.)	Liver and bile ducts, incidence	Race (OR, firefighters vs non-firefighters):	White	34	1.21 (0.83–1.76)	Age, year of diagnosis, race		
			Other	5	0.51 (0.19–1.39)			
			Overall	39	1.07 (0.75–1.53)			
		Pancreas, incidence	Race (OR, firefighters vs non-firefighters):	White	74			1.14 (0.85–1.54)
				Other	5			0.90 (0.33–2.45)
				Overall	79			1.10 (0.83–1.46)
	Soft tissue including heart, incidence	Race (OR, firefighters vs non-firefighters):	White	24	1.16 (0.75–1.82)			
			Other	2	1.39 (0.32–5.98)			
			Overall	26	1.16 (0.76–1.77)			

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Kang et al. (2008) Massachusetts, USA 1987–2003 Case-control	Cases: NR overall (firefighters, 1881; non-firefighters, NR); White male residents of Massachusetts aged ≥ 18 yr with complete information on “usual occupation” and a diagnosis with one of 25 “cancers of concern” in the Massachusetts Cancer Registry Controls: NR overall (firefighters, 244; non-firefighters, NR); White male residents of Massachusetts aged ≥ 18 yr with complete information on “usual occupation” and a cancer diagnosis not on the list of 25 “cancers of concern” in the cancer registry Exposure assessment method: employment as firefighter coded from longest job held from cancer registry	Lip, incidence	Referent (SMBOR):			Age, smoking status	<i>Exposure assessment critique:</i> Minimal quality. Ever firefighter exposure only. May include municipal and rural firefighters. <i>Strengths:</i> large size; long study period; assesses incident cancers; smoking information available. <i>Limitations:</i> cancer cases used as controls (numerator-based analysis); incomplete information on occupation (38% missing); lack of information on exposure and potential confounders.
			Firefighters vs police	4	1.10 (0.24–5.06)		
		Oral cavity, incidence	Firefighters vs all other occupations	4	1.05 (0.33–3.30)		
			Referent (SMBOR):				
		Pharynx (nasopharynx), incidence	Firefighters vs police	21	0.72 (0.37–1.41)		
			Firefighters vs all other occupations	21	0.66 (0.41–1.06)		
		Oesophagus, incidence	Referent (SMBOR):				
			Firefighters vs police	3	1.17 (0.19–7.17)		
	Firefighters vs all other occupations	3	1.31 (0.32–5.31)				
	Referent (SMBOR):						
	Firefighters vs police	57	0.93 (0.61–1.41)				
	Firefighters vs all other occupations	57	0.64 (0.47–0.87)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments		
Kang et al. (2008) (cont.)		Oesophagus, incidence	Age at diagnosis (SMBOR, firefighters vs police):			Age, smoking status			
			18–54 yr	NR	1.30 (0.52–3.24)				
			55–74 yr	NR	0.70 (0.41–1.20)				
			≥ 75 yr	NR	1.58 (0.56–4.42)				
		Stomach, incidence	Referent (SMBOR):						
			Firefighters vs police	46	0.83 (0.53–1.29)				
			Firefighters vs all other occupations	46	0.97 (0.69–1.35)				
		Colon, incidence	Referent (SMBOR):						
			Firefighters vs police	200	1.36 (1.04–1.79)				
			Firefighters vs all other occupations	200	1.15 (0.93–1.43)				
		Colon, incidence	Age at diagnosis (SMBOR, firefighters vs police):						
			18–54 yr	NR	1.05 (0.55–1.99)				
			55–74 yr	NR	1.24 (0.85–1.81)				
≥ 75 yr	NR		1.73 (1.06–2.84)						
Rectum, incidence	Referent (SMBOR):								
	Firefighters vs police	67	0.86 (0.58–1.26)						
	Firefighters vs all other occupations	67	1.03 (0.77–1.38)						

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments		
Kang et al. (2008) (cont.)		Rectum, incidence	Age at diagnosis (SMBOR, firefighters vs police):			Age, smoking status			
			18–54 yr	NR	0.97 (0.39–2.46)				
			55–74 yr	NR	0.94 (0.57–1.57)				
		Liver and bile ducts, incidence	Referent (SMBOR):						
			Firefighters vs police	19	1.15 (0.55–2.14)				
		Pancreas, incidence	Referent (SMBOR):						
			Firefighters vs police	38	0.86 (0.53–1.40)				
		Soft tissue sarcoma, incidence	Referent (SMBOR):						
			Firefighters vs police	14	1.05 (0.46–2.37)				
		Breast, incidence	Referent (SMBOR):						
			Firefighters vs police	4	0.25 (0.03–2.31)				
				Firefighters vs all other occupations	4		1.28 (0.47–3.47)		

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Sama et al. (1990) Massachusetts, USA 1982–1986 Case-control	Cases: NR; White men aged ≥ 18 yr with information on usual occupation and a diagnosis with one of nine cancers of concern in the Massachusetts Cancer Registry Controls: NR; White men aged ≥ 18 yr with information on usual occupation and a cancer diagnosis for all other cancers, except those of the organ systems of concern (digestive, respiratory, and lymphatic/haematopoietic) Exposure assessment method: employment as firefighter or fire chief from cancer registry records	Colon, incidence	Referent (SMBOR):			Age	<i>Exposure assessment critique:</i> Minimal quality. Ever firefighter exposure only. Use of secondary data sources confirmed occupation for some firefighters. May include municipal and rural firefighters. <i>Strengths:</i> assesses incident cancers; smoking information available. <i>Limitations:</i> small study; cancer cases used as controls (numerator-based analysis); incomplete information on occupation; crude smoking status information; no smoking adjustment; lack of information on exposure and potential confounders.
			Firefighters vs police	33	1.04 (0.59–1.82)		
			Firefighters vs state	33	1.20 (0.80–1.82)		
		Rectum, incidence	Referent (SMBOR):				
			Firefighters vs police	22	0.97 (0.50–1.88)		
			Firefighters vs state	22	1.35 (0.84–2.19)		
	Pancreas, incidence	Referent (SMBOR):					
		Firefighters vs police	6	3.19 (0.72–14.15)			
		Firefighters vs state	6	0.98 (0.42–2.26)			

Table S2.10 (continued)

Reference, location, enrolment/follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments	
Ma et al. (1998) USA 1984–1993 Case-control	Cases: NR; all male cancer deaths with coded industry and occupation on death certificates from 24 states captured in a NIOSH database Controls: NR; all male non-cancer deaths in the NIOSH database Exposure assessment method: death certificate coding of usual occupation	Lip, mortality	Group (MOR):			Year of death, age at death	<i>Exposure assessment critique:</i> Minimal quality. Crude, relying on knowledge of usual occupation by death certifier. Possible differential misclassification from missing occupation on death certificates. May include municipal and rural firefighters. <i>Strengths:</i> large study size (includes 6607 male firefighter deaths); broad geographical population coverage. <i>Limitations:</i> small number of cancer deaths among Black firefighters; non-cancer deaths used as controls (numerator-based analysis); lack of information on exposure and potential confounders.	
			White firefighters	3	5.9 (1.9–18.3)			
			Black firefighters	0	0 (NR)			
		Pharynx (nasopharynx), mortality	Group (MOR):					
			White firefighters	0	0 (NR)			
			Black firefighters	1	7.6 (1.3–46.4)			
		Oesophagus, mortality	Group (MOR):					
			White firefighters	37	0.9 (0.7–1.3)			
			Black firefighters	4	1.4 (NR)			
		Stomach, mortality	Group (MOR):					
			White firefighters	52	1.2 (0.9–1.6)			
			Black firefighters	3	1.2 (NR)			
Colon, mortality	Group (MOR):							
	White firefighters	149	1.0 (0.9–1.2)					
	Black firefighters	9	2.1 (1.1–4.0)					
Rectum, mortality	Group (MOR):							
	White firefighters	27	1.1 (0.8–1.6)					
	Black firefighters	0	0 (NR)					

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Ma et al. (1998) (cont.)		Liver and bile ducts, mortality	Group (MOR):			Year of death, age at death	
			White firefighters	31	1.2 (0.9–1.7)		
			Black firefighters	0	0 (NR)		
			Group (MOR):				
			White firefighters	88	1.2 (1.0–1.5)		
			Black firefighters	5	2.0 (0.9–4.6)		
		Pancreas, mortality	Group (MOR):				
			White firefighters	88	1.2 (1.0–1.5)		
			Black firefighters	5	2.0 (0.9–4.6)		
			Group (MOR):				
			White firefighters	3	1.0 (NR)		
			Black firefighters	0	0 (NR)		
Bone, mortality	Group (MOR):						
	White firefighters	3	1.0 (NR)				
	Black firefighters	0	0 (NR)				
	Group (MOR):						
	White firefighters	14	1.6 (1–2.7)				
	Black firefighters	0	0 (NR)				
Soft tissue sarcoma, mortality	Group (MOR):						
	White firefighters	14	1.6 (1–2.7)				
	Black firefighters	0	0 (NR)				
	Group (MOR):						
	White firefighters	14	1.6 (1–2.7)				
	Black firefighters	0	0 (NR)				

Table S2.10 (continued)

Reference, location, enrolment/ follow-up period, study design	Population size, description, exposure assessment method	Cancer type (histopathology), incidence or mortality	Exposure category or level	Exposed cases or deaths	Risk estimate (95% CI)	Covariates controlled	Comments
Burnett et al. (1994) USA 1984–1990 Mortality surveillance	5744 deaths among firefighters; White male firefighters identified by evaluation of coded occupation on death certificates from 27 states Exposure assessment method: death certificate coding of usual occupation	Rectum, mortality	Group (PMR): Firefighters Firefighters, age < 65 yr at death	37 18	1.48 (1.05–2.05) 1.86 (1.10–2.94)	Age	<i>Exposure assessment critique:</i> Minimal quality. Crude, relying on knowledge of usual occupation by death certifier. Possible differential misclassification from missing occupation on death certificates. May include municipal and rural firefighters. <i>Strengths:</i> large number of deaths; broad geographical population coverage. <i>Limitations:</i> numerator-only (PMR) analysis; errors in death-certificate occupation; lack of information on exposure or potential confounders.

CanCHEC, Canadian Census Health and Environment Cohort; CI, confidence interval; FCDS, Florida Cancer Data System; FMO, Office of the Florida State Marshal; HCC, hepatocellular carcinoma; HR, hazard ratio; ICD, International Classification of Diseases; MOR, mortality odds ratio; MRR, mortality rate ratio; NIOSH, National Institute for Occupational Safety and Health; NOCCA, Nordic Occupational Cancer study; NR, not reported; OR, odds ratio; PMR, proportionate mortality ratio; SCC, squamous cell carcinoma; SIR, standardized incidence ratio; SMBOR, standardized morbidity odds ratio; SMR, standardized mortality ratio; vs, versus; yr, year.

References

- Ahn YS, Jeong KS (2015). Mortality due to malignant and non-malignant diseases in Korean professional emergency responders. *PLoS One*. 10(3):e0120305. doi:[10.1371/journal.pone.0120305](https://doi.org/10.1371/journal.pone.0120305) PMID:[25756281](https://pubmed.ncbi.nlm.nih.gov/25756281/)
- Ahn YS, Jeong KS, Kim KS (2012). Cancer morbidity of professional emergency responders in Korea. *Am J Ind Med*. 55(9):768–78. doi:[10.1002/ajim.22068](https://doi.org/10.1002/ajim.22068) PMID:[22628010](https://pubmed.ncbi.nlm.nih.gov/22628010/)
- Amadeo B, Marchand JL, Moisan F, Donnadiou S, Gaëlle C, Simone MP, et al. (2015). French firefighter mortality: analysis over a 30-year period. *Am J Ind Med*. 58(4):437–43. doi:[10.1002/ajim.22434](https://doi.org/10.1002/ajim.22434) PMID:[25708859](https://pubmed.ncbi.nlm.nih.gov/25708859/)
- Aronson KJ, Tomlinson GA, Smith L (1994). Mortality among fire fighters in metropolitan Toronto. *Am J Ind Med*. 26(1):89–101. doi:[10.1002/ajim.4700260108](https://doi.org/10.1002/ajim.4700260108) PMID:[8074127](https://pubmed.ncbi.nlm.nih.gov/8074127/)
- Bates MN, Fawcett J, Garrett N, Arnold R, Pearce N, Woodward A (2001). Is testicular cancer an occupational disease of fire fighters? *Am J Ind Med*. 40(3):263–70. doi:[10.1002/ajim.1097](https://doi.org/10.1002/ajim.1097) PMID:[11598972](https://pubmed.ncbi.nlm.nih.gov/11598972/)
- Bigert C, Martinsen JI, Gustavsson P, Sparén P (2020). Cancer incidence among Swedish firefighters: an extended follow-up of the NOCCA study. *Int Arch Occup Environ Health*. 93(2):197–204. doi:[10.1007/s00420-019-01472-x](https://doi.org/10.1007/s00420-019-01472-x) PMID:[31463517](https://pubmed.ncbi.nlm.nih.gov/31463517/)
- Burnett CA, Halperin WE, Lulich NR, Sestito JP (1994). Mortality among fire fighters: a 27 state survey. *Am J Ind Med*. 26(6):831–3. doi:[10.1002/ajim.4700260612](https://doi.org/10.1002/ajim.4700260612) PMID:[7892834](https://pubmed.ncbi.nlm.nih.gov/7892834/)
- Daniels RD, Bertke S, Dahm MM, Yiin JH, Kubale TL, Hales TR, et al. (2015). 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*. 72(10):699–706. doi:[10.1136/oemed-2014-102671](https://doi.org/10.1136/oemed-2014-102671) PMID:[25673342](https://pubmed.ncbi.nlm.nih.gov/25673342/)
- Daniels RD, Kubale TL, Yiin JH, Dahm MM, Hales TR, Baris D, et al. (2014). Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950–2009). *Occup Environ Med*. 71(6):388–97. doi:[10.1136/oemed-2013-101662](https://doi.org/10.1136/oemed-2013-101662) PMID:[24142974](https://pubmed.ncbi.nlm.nih.gov/24142974/)
- Demers PA, Checkoway H, Vaughan TL, Weiss NS, Heyer NJ, Rosenstock L (1994). Cancer incidence among firefighters in Seattle and Tacoma, Washington (United States). *Cancer Causes Control*. 5(2):129–35. doi:[10.1007/BF01830258](https://doi.org/10.1007/BF01830258) PMID:[8167259](https://pubmed.ncbi.nlm.nih.gov/8167259/)
- Demers PA, Heyer NJ, Rosenstock L (1992a). Mortality among firefighters from three northwestern United States cities. *Br J Ind Med*. 49(9):664–70. doi:[10.1136/oem.49.9.664](https://doi.org/10.1136/oem.49.9.664) PMID:[1390274](https://pubmed.ncbi.nlm.nih.gov/1390274/)
- Deschamps S, Momas I, Festy B (1995). Mortality amongst Paris fire-fighters. *Eur J Epidemiol*. 11(6):643–6. doi:[10.1007/BF01720297](https://doi.org/10.1007/BF01720297) PMID:[8861847](https://pubmed.ncbi.nlm.nih.gov/8861847/)
- Eliopoulos E, Armstrong BK, Spickett JT, Heyworth F (1984). Mortality of fire fighters in Western Australia. *Br J Ind Med*. 41(2):183–7. doi:[10.1136/oem.41.2.183](https://doi.org/10.1136/oem.41.2.183) PMID:[6722044](https://pubmed.ncbi.nlm.nih.gov/6722044/)
- Feuer E, Rosenman K (1986). Mortality in police and firefighters in New Jersey. *Am J Ind Med*. 9(6):517–27. doi:[10.1002/ajim.4700090603](https://doi.org/10.1002/ajim.4700090603) PMID:[3488681](https://pubmed.ncbi.nlm.nih.gov/3488681/)
- Giles G, Staples M, Berry J (1993). Cancer incidence in Melbourne Metropolitan Fire Brigade members, 1980–1989. *Health Rep*. 5(1):33–8. PMID:[8334236](https://pubmed.ncbi.nlm.nih.gov/8334236/)
- Glass DC, Del Monaco A, Pircher S, Vander Hoorn S, Sim MR (2016b). Mortality and cancer incidence at a fire training college. *Occup Med (Lond)*. 66(7):536–42. doi:[10.1093/occmed/kqw079](https://doi.org/10.1093/occmed/kqw079) PMID:[27371948](https://pubmed.ncbi.nlm.nih.gov/27371948/)
- Glass DC, Del Monaco A, Pircher S, Vander Hoorn S, Sim MR (2017). Mortality and cancer incidence among male volunteer Australian firefighters. *Occup Environ Med*. 74(9):628–38. doi:[10.1136/oemed-2016-104088](https://doi.org/10.1136/oemed-2016-104088) PMID:[28391245](https://pubmed.ncbi.nlm.nih.gov/28391245/)
- Glass DC, Del Monaco A, Pircher S, Vander Hoorn S, Sim MR (2019). Mortality and cancer incidence among female Australian firefighters. *Occup Environ Med*. 76(4):215–21. PMID:[30674605](https://pubmed.ncbi.nlm.nih.gov/30674605/)
- Glass DC, Pircher S, Del Monaco A, Hoorn SV, Sim MR (2016a). Mortality and cancer incidence in a cohort of male paid Australian firefighters. *Occup Environ Med*. 73(11):761–71. doi:[10.1136/oemed-2015-103467](https://doi.org/10.1136/oemed-2015-103467) PMID:[27456156](https://pubmed.ncbi.nlm.nih.gov/27456156/)
- Grimes G, Hirsch D, Borgeson D (1991). Risk of death among Honolulu fire fighters. *Hawaii Med J*. 50(3):82–5. PMID:[2061032](https://pubmed.ncbi.nlm.nih.gov/2061032/)
- Guidotti TL (1993). Mortality of urban firefighters in Alberta, 1927–1987. *Am J Ind Med*. 23(6):921–40. doi:[10.1002/ajim.4700230608](https://doi.org/10.1002/ajim.4700230608) PMID:[8328477](https://pubmed.ncbi.nlm.nih.gov/8328477/)
- Harris MA, Kirkham TL, MacLeod JS, Tjepkema M, Peters PA, Demers PA (2018). Surveillance of cancer risks for firefighters, police, and armed forces among men in a Canadian census cohort. *Am J Ind Med*. 61(10):815–23. doi:[10.1002/ajim.22891](https://doi.org/10.1002/ajim.22891) PMID:[30073696](https://pubmed.ncbi.nlm.nih.gov/30073696/)
- Kang D, Davis LK, Hunt P, Kriebel D (2008). Cancer incidence among male Massachusetts firefighters, 1987–2003. *Am J Ind Med*. 51(5):329–35. doi:[10.1002/ajim.20549](https://doi.org/10.1002/ajim.20549) PMID:[18306327](https://pubmed.ncbi.nlm.nih.gov/18306327/)
- Kullberg C, Andersson T, Gustavsson P, Selander J, Tornling G, Gustavsson A, et al. (2018). Cancer incidence in Stockholm firefighters 1958–2012: an updated cohort study. *Int Arch Occup Environ Health*. 91(3):285–91. doi:[10.1007/s00420-017-1276-1](https://doi.org/10.1007/s00420-017-1276-1) PMID:[29164319](https://pubmed.ncbi.nlm.nih.gov/29164319/)
- Langevin SM, Eliot M, Butler RA, McClean M, Kelsey KT (2020). Firefighter occupation is associated with increased risk for laryngeal and hypopharyngeal squamous cell carcinoma among men from the

- Greater Boston area. *Occup Environ Med.* 77(6):381–5. doi:[10.1136/oemed-2019-106271](https://doi.org/10.1136/oemed-2019-106271) PMID:[32107319](https://pubmed.ncbi.nlm.nih.gov/32107319/)
- Lee DJ, Koru-Sengul T, Hernandez MN, Caban-Martinez AJ, McClure LA, Mackinnon JA, et al. (2020). Cancer risk among career male and female Florida firefighters: evidence from the Florida Firefighter Cancer Registry (1981–2014). *Am J Ind Med.* 63(4):285–99. doi:[10.1002/ajim.23086](https://doi.org/10.1002/ajim.23086) PMID:[31930542](https://pubmed.ncbi.nlm.nih.gov/31930542/)
- Ma F, Fleming LE, Lee DJ, Trapido E, Gerace TA (2006). Cancer incidence in Florida professional firefighters, 1981 to 1999. *J Occup Environ Med.* 48(9):883–8. doi:[10.1097/01.jom.0000235862.12518.04](https://doi.org/10.1097/01.jom.0000235862.12518.04) PMID:[16966954](https://pubmed.ncbi.nlm.nih.gov/16966954/)
- Ma F, Fleming LE, Lee DJ, Trapido E, Gerace TA, Lai H, et al. (2005). Mortality in Florida professional firefighters, 1972 to 1999. *Am J Ind Med.* 47(6):509–17. doi:[10.1002/ajim.20160](https://doi.org/10.1002/ajim.20160) PMID:[15898094](https://pubmed.ncbi.nlm.nih.gov/15898094/)
- Ma F, Lee DJ, Fleming LE, Dosemeci M (1998). Race-specific cancer mortality in US firefighters: 1984–1993. *J Occup Environ Med.* 40(12):1134–8. PMID:[9871891](https://pubmed.ncbi.nlm.nih.gov/9871891/)
- Marjerrison N, Jakobsen J, Demers PA, Grimsrud TK, Hansen J, Martinsen JI, et al. (2022b). A comparison of cancer incidence and mortality in the Norwegian Fire Departments Cohort, 1960–2018. *Occup Environ Med.* oemed-2022–108331. doi:[10.1136/oemed-2022-108331](https://doi.org/10.1136/oemed-2022-108331) PMID:[35589382](https://pubmed.ncbi.nlm.nih.gov/35589382/)
- Marjerrison N, Jakobsen J, Grimsrud TK, Hansen J, Martinsen JI, Nordby KC, et al. (2022a). Cancer incidence in sites potentially related to occupational exposures: 58 years of follow-up of firefighters in the Norwegian Fire Departments Cohort. *Scand J Work Environ Health.* 48(3):210–9. doi:[10.5271/sjweh.4009](https://doi.org/10.5271/sjweh.4009) PMID:[35015085](https://pubmed.ncbi.nlm.nih.gov/35015085/)
- Mastromatteo E (1959). Mortality in city firemen. II. A study of mortality in firemen of a city fire department. *AMA Arch Ind Health.* 20:227–33. PMID:[14422193](https://pubmed.ncbi.nlm.nih.gov/14422193/)
- McClure LA, Koru-Sengul T, Hernandez MN, Caban-Martinez AJ, Kobetz EN, Lee DJ (2021). Comparing cancer risk estimates using occupational record linkage approaches in male Florida firefighters. *Am J Ind Med.* 64(2):78–83. doi:[10.1002/ajim.23205](https://doi.org/10.1002/ajim.23205) PMID:[33283309](https://pubmed.ncbi.nlm.nih.gov/33283309/)
- Muegge CM, Zollinger TW, Song Y, Wessel J, Monahan PO, Moffatt SM (2018). Excess mortality among Indiana firefighters, 1985–2013. *Am J Ind Med.* 61(12):961–7. doi:[10.1002/ajim.22918](https://doi.org/10.1002/ajim.22918) PMID:[30421827](https://pubmed.ncbi.nlm.nih.gov/30421827/)
- Musk AW, Monson RR, Peters JM, Peters RK (1978). Mortality among Boston firefighters, 1915–1975. *Br J Ind Med.* 35(2):104–8. doi:[10.1136/oem.35.2.104](https://doi.org/10.1136/oem.35.2.104) PMID:[656333](https://pubmed.ncbi.nlm.nih.gov/656333/)
- Petersen KU, Pedersen JE, Bonde JP, Ebbelhoej NE, Hansen J (2018a). Long-term follow-up for cancer incidence in a cohort of Danish firefighters. *Occup Environ Med.* 75(4):263–9. doi:[10.1136/oemed-2017-104660](https://doi.org/10.1136/oemed-2017-104660) PMID:[29055884](https://pubmed.ncbi.nlm.nih.gov/29055884/)
- Petersen KU, Pedersen JE, Bonde JP, Ebbelhoej NE, Hansen J (2018b). Mortality in a cohort of Danish firefighters; 1970–2014. *Int Arch Occup Environ Health.* 91(6):759–66. doi:[10.1007/s00420-018-1323-6](https://doi.org/10.1007/s00420-018-1323-6) PMID:[29808435](https://pubmed.ncbi.nlm.nih.gov/29808435/)
- Pinkerton L, Bertke SJ, Yiin J, Dahm M, Kubale T, Hales T, et al. (2020). Mortality in a cohort of US firefighters from San Francisco, Chicago and Philadelphia: an update. *Occup Environ Med.* 77(2):84–93. doi:[10.1136/oemed-2019-105962](https://doi.org/10.1136/oemed-2019-105962) PMID:[31896615](https://pubmed.ncbi.nlm.nih.gov/31896615/)
- Pukkala E, Martinsen JI, Weiderpass E, Kjaerheim K, Lyng E, Tryggvadottir L, et al. (2014). Cancer incidence among firefighters: 45 years of follow-up in five Nordic countries. *Occup Environ Med.* 71(6):398–404. doi:[10.1136/oemed-2013-101803](https://doi.org/10.1136/oemed-2013-101803) PMID:[24510539](https://pubmed.ncbi.nlm.nih.gov/24510539/)
- Sama SR, Martin TR, Davis LK, Kriebel D (1990). Cancer incidence among Massachusetts firefighters, 1982–1986. *Am J Ind Med.* 18(1):47–54. doi:[10.1002/ajim.4700180106](https://doi.org/10.1002/ajim.4700180106) PMID:[2378369](https://pubmed.ncbi.nlm.nih.gov/2378369/)
- Sritharan J, Kirkham TL, MacLeod J, Marjerrison N, Lau A, Dakouo M, et al. (2022). Cancer risk among firefighters and police in the Ontario workforce. *Occup Environ Med.* 79(8):533–539. doi:[10.1136/oemed-2021-108146](https://doi.org/10.1136/oemed-2021-108146) PMID:[35354650](https://pubmed.ncbi.nlm.nih.gov/35354650/)
- Stang A, Jöckel KH, Baumgardt-Elms C, Ahrens W (2003). Firefighting and risk of testicular cancer: results from a German population-based case-control study. *Am J Ind Med.* 43(3):291–4. doi:[10.1002/ajim.10178](https://doi.org/10.1002/ajim.10178) PMID:[12594776](https://pubmed.ncbi.nlm.nih.gov/12594776/)
- Tornling G, Gustavsson P, Hogstedt C (1994). Mortality and cancer incidence in Stockholm fire fighters. *Am J Ind Med.* 25(2):219–28. doi:[10.1002/ajim.4700250208](https://doi.org/10.1002/ajim.4700250208) PMID:[8147394](https://pubmed.ncbi.nlm.nih.gov/8147394/)
- Tsai RJ, Luckhaupt SE, Schumacher P, Cress RD, Deapen DM, Calvert GM (2015). Risk of cancer among firefighters in California, 1988–2007. *Am J Ind Med.* 58(7):715–29. doi:[10.1002/ajim.22466](https://doi.org/10.1002/ajim.22466) PMID:[25943908](https://pubmed.ncbi.nlm.nih.gov/25943908/)
- Vena JE, Fiedler RC (1987). Mortality of a municipal-worker cohort: IV. Fire fighters. *Am J Ind Med.* 11(6):671–84. doi:[10.1002/ajim.4700110608](https://doi.org/10.1002/ajim.4700110608) PMID:[3605104](https://pubmed.ncbi.nlm.nih.gov/3605104/)
- Webber MP, Singh A, Zeig-Owens R, Salako J, Skerker M, Hall CB, et al. (2021). Cancer incidence in World Trade Center-exposed and non-exposed male firefighters, as compared with the US adult male population: 2001–2016. *Occup Environ Med.* 78(10):707–14. doi:[10.1136/oemed-2021-107570](https://doi.org/10.1136/oemed-2021-107570) PMID:[34507965](https://pubmed.ncbi.nlm.nih.gov/34507965/)
- Zeig-Owens R, Webber MP, Hall CB, Schwartz T, Jaber N, Weakley J, et al. (2011). Early assessment of cancer outcomes in New York City firefighters after the 9/11 attacks: an observational cohort study. *Lancet.* 378(9794):898–905. doi:[10.1016/S0140-6736\(11\)60989-6](https://doi.org/10.1016/S0140-6736(11)60989-6) PMID:[21890054](https://pubmed.ncbi.nlm.nih.gov/21890054/)
- Zhao G, Erazo B, Ronda E, Brocal F, Regidor E (2020). Mortality among firefighters in Spain: 10 years of follow-up. *Ann Work Expo Health.* 64(6):614–21. doi:[10.1093/annweh/wxaa036](https://doi.org/10.1093/annweh/wxaa036) PMID:[32253442](https://pubmed.ncbi.nlm.nih.gov/32253442/)