Cancer incidence and HWSE path analysis
GM-UAW Cohort Study

June 10, 2021

This packet summarizes Cox proportional hazard model results relating cumulative exposure to straight, soluble, and synthetic metalworking fluids (MWF), lagged 21 years, to cancer incidence of 14 types and for all sites combined (includes types not shown here) in the UAW-GM Cohort.

- Colon cancer
- Rectal cancer
- Pancreatic cancer
- Esophageal cancer
- Stomach cancer
- Laryngeal cancer
- Lung and bronchial cancers

- Breast cancer
- Prostate cancer
- Kidney and renal pelvic cancers
- Bladder cancer
- Melanoma
- Leukemia
- Non-Hodgkin lymphoma

In addition, path analyses for evidence of the healthy worker survivor effect are presented. These include Cox models relating employment status to cancer incidence and one Cox model relating cumulative MWF exposure to leaving work. In these models, metalworking fluid was lagged 1 year only. The path analyses largely follow the methods outlined in Garcia et al.[1]

The study population, summarized in Table 1, included subjects from the UAW-GM Cohort who were still alive at the start of cancer incidence follow-up. Cancer incidence data were abstracted from Michigan Cancer Registry for all plants from years 1985 onward. Cancer incidence data for plants 1 and 2 were supplemented with data from the Surveillance, Epidemiology, and End Results Program (SEER).

In all analyses, follow-up began three years after hire and no earlier than 1973 for plants 1 and 2 or 1985 for plant 3; follow-up ended upon experiencing the outcome of interest, attaining the oldest observed age at death (considered lost to follow-up), dying, or reaching the year 2015, whichever came first. In path analyses involving employment status, follow-up ended on December 31, 1994 (end of employment records). Missing race was treated as a separate category.

Cancer incidence (including SEER data)

Table 1: Summary of population characteristics. In plants 1 and 2, follow-up for cancer incidence extends from 1973 through 2015. In plant 3, follow-up starts in 1985.

	n	p	
Study population size (person-years)	39 132	1 087 230	
Race			
White	25 119	64%	
Black	6 862	18%	
Unknown	7 151	18%	
Sex			
Male	34 498	88%	
Female	4 634	12%	
Plant$^\sharp$			
Plant 1	11 467	29%	
Plant 2	15 910	41%	
Plant 3	11 755	30%	
Ever exposed to MWFs			
Straight	21 294	54%	
Soluble	34 055	87%	
Synthetic	12 530	32%	
Diagnosed with cancer by end of follow-up	7 809	20%	
	Median	25th %tile	75th %tile
Years of follow-up	39.5	34.3	46.99
Year of birth	1937	1921	1949
Year of hire	1965	1952	1973
Age at hire (years)	24	20	31
Year of leaving work*	1985	1970	1995
Age at leaving work (years)*	46	37	56
Years at work*	15.73	7.65	27.06
Year of first cancer diagnosis	1999	1991	2007
Age at first cancer diagnosis (years)	67	59	74
Cumulative exposure$^\sharp$ to MWFs (mg/m^3·y)			
Straight	0.69	0.21	2.53
Soluble	4.93	1.93	13.31
Synthetic	0.44	0.15	1.56

$^\natural$ Some individuals worked at several sites; plant indicates the site of longest work record time.

* Among those with known date of worker exit.

$^\sharp$ Summary statistics calculated for ever-exposed individuals at end of follow-up only. Exposures were lagged 21 years.

Figure 1: Adjusted hazard ratios associated with exposure to straight metal working fluids in the **UAW-GM Cohort**.

Figure 2: Adjusted hazard ratios associated with exposure to soluble metal working fluids in the **UAW-GM Cohort**.
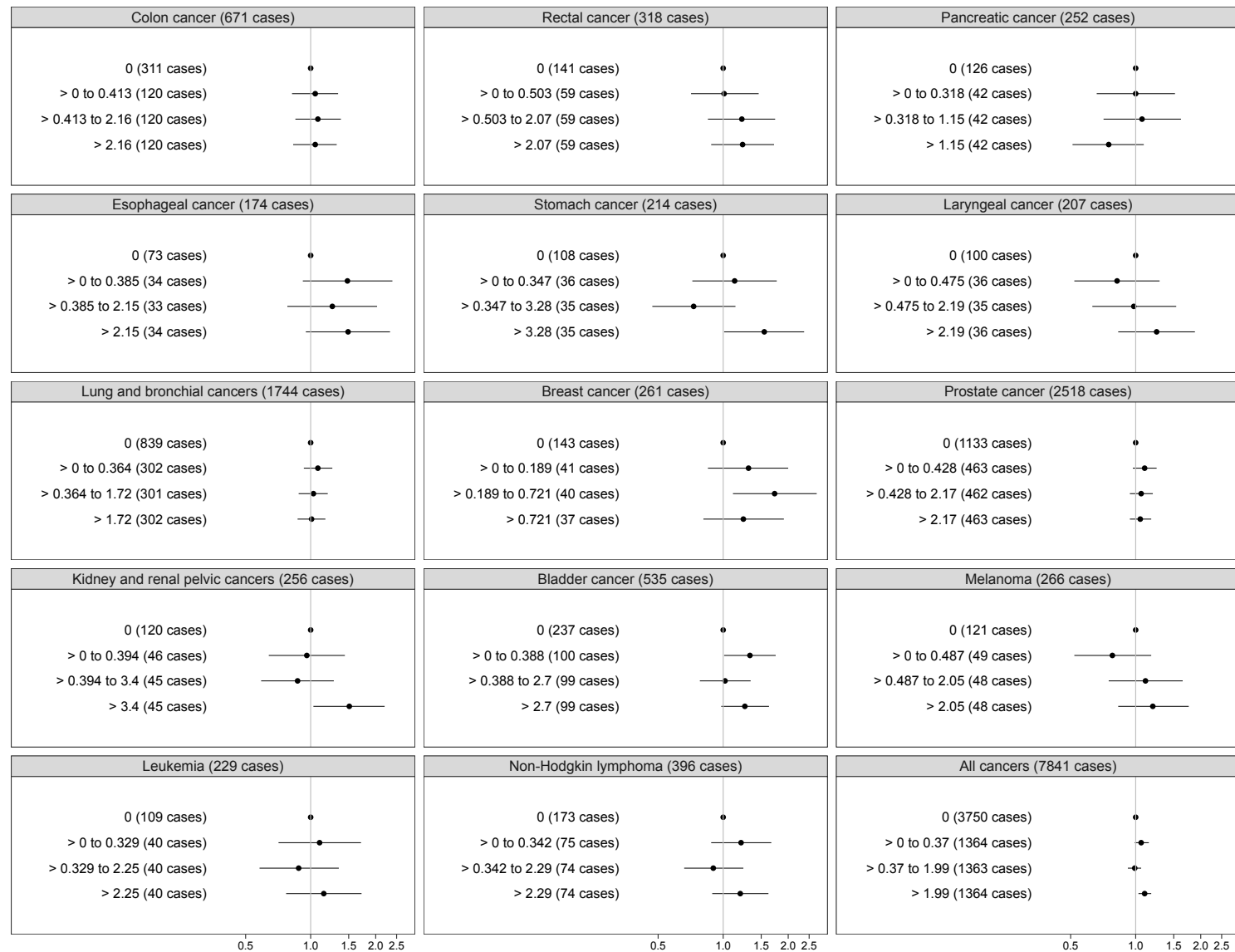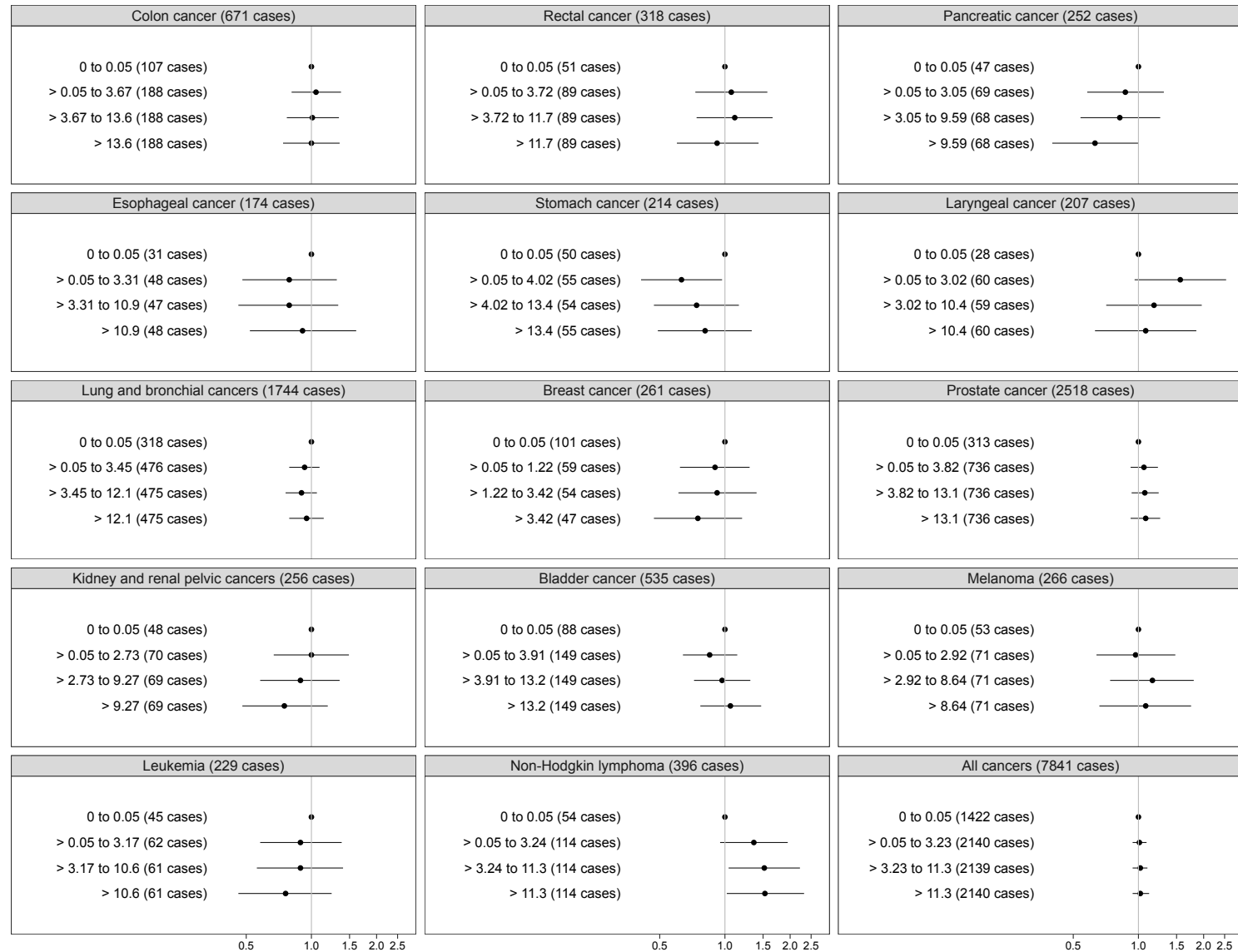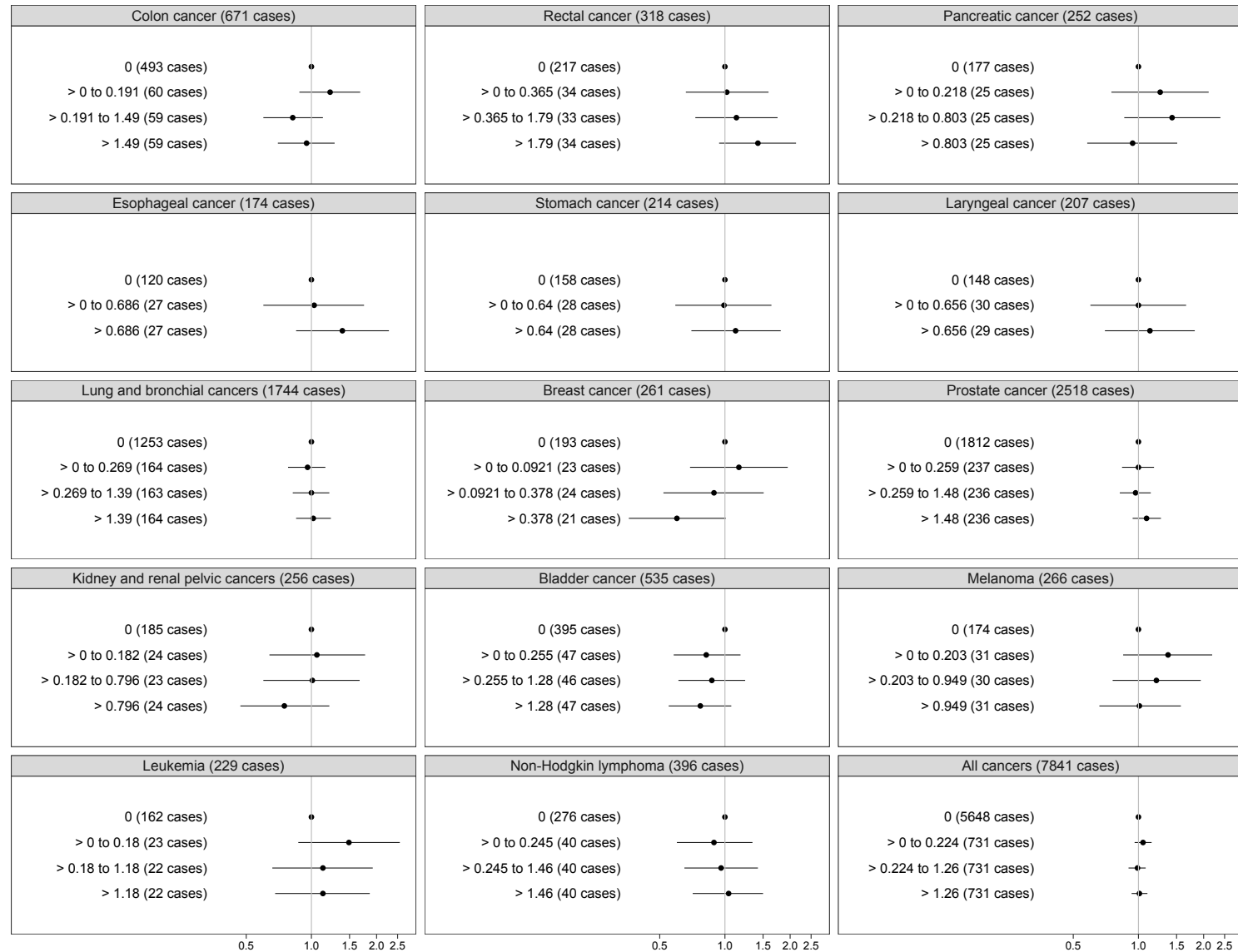
Figure 3: Adjusted hazard ratios associated with exposure to synthetic metal working fluids in the **UAW-GM Cohort**.
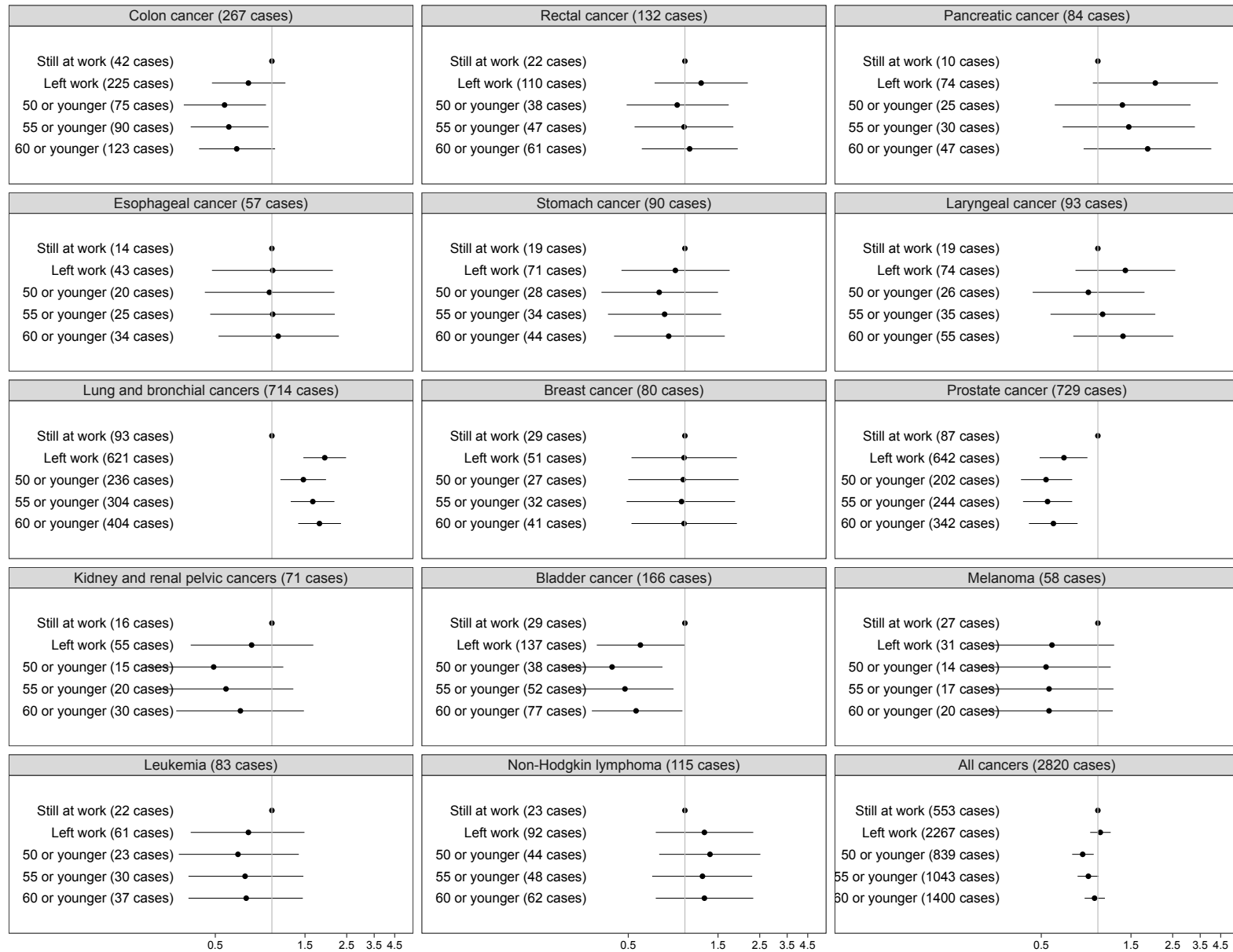
Figure 4: Adjusted hazard ratios for cancer incidence associated with leaving work in the **UAW-GM Cohort** (HWSE Condition 2).

Cancer incidence (including SEER data)

Table 2: Adjusted HR estimates for cancer incidence and employment statuslagged by 1 years.

	n	HR	(95% CI)	p
Colon cancer (189 events)				
Still employed	47	1.00	–	
Not employed	142	1.00	(0.63, 1.60)	0.99
Left work (50 or younger)	50	1.00	(0.44, 2.25)	1.00
Left work (51 or older)	92	1.00	(0.62, 1.61)	0.99
Left work (55 or younger)	59	0.73	(0.37, 1.43)	0.36
Left work (56 or older)	83	1.12	(0.68, 1.86)	0.65
Left work (60 or younger)	86	0.91	(0.54, 1.55)	0.73
Left work (61 or older)	56	1.11	(0.65, 1.89)	0.70
Rectal cancer (95 events)				
Still employed	27	1.00	–	
Not employed	68	1.18	(0.64, 2.20)	0.60
Left work (50 or younger)	32	1.13	(0.41, 3.09)	0.81
Left work (51 or older)	36	1.20	(0.62, 2.30)	0.59
Left work (55 or younger)	39	1.16	(0.52, 2.58)	0.71
Left work (56 or older)	29	1.20	(0.59, 2.42)	0.61
Left work (60 or younger)	48	1.09	(0.55, 2.18)	0.80
Left work (61 or older)	20	1.35	(0.62, 2.94)	0.45
Pancreatic cancer (69 events)				
Still employed	18	1.00	–	
Not employed	51	1.26	(0.61, 2.61)	0.53
Left work (50 or younger)	21	1.53	(0.47, 4.92)	0.48
Left work (51 or older)	30	1.22	(0.58, 2.56)	0.61
Left work (55 or younger)	24	0.95	(0.35, 2.60)	0.92
Left work (56 or older)	27	1.44	(0.65, 3.20)	0.37

Cancer incidence (including SEER data)

Left work (60 or younger)	38	1.62	(0.75, 3.51)	0.22
Left work (61 or older)	13	0.85	(0.35, 2.07)	0.72
Esophageal cancer (47 events)				
Still employed	20	1.00	–	
Not employed	27	0.63	(0.27, 1.46)	0.28
Left work (50 or younger)	13	0.54	(0.12, 2.44)	0.42
Left work (51 or older)	14	0.64	(0.27, 1.51)	0.31
Left work (55 or younger)	19	1.11	(0.39, 3.13)	0.85
Left work (56 or older)	8	0.43	(0.16, 1.15)	0.09
Left work (60 or younger)	22	0.77	(0.31, 1.92)	0.57
Left work (61 or older)	5	0.43	(0.13, 1.39)	0.16
Stomach cancer (65 events)				
Still employed	21	1.00	–	
Not employed	44	1.00	(0.47, 2.13)	0.99
Left work (50 or younger)	19	0.40	(0.11, 1.48)	0.17
Left work (51 or older)	25	1.25	(0.56, 2.82)	0.58
Left work (55 or younger)	26	0.94	(0.36, 2.49)	0.91
Left work (56 or older)	18	1.05	(0.44, 2.47)	0.92
Left work (60 or younger)	34	1.11	(0.49, 2.49)	0.80
Left work (61 or older)	10	0.83	(0.31, 2.20)	0.71
Laryngeal cancer (84 events)				
Still employed	28	1.00	–	
Not employed	56	1.30	(0.69, 2.43)	0.42
Left work (50 or younger)	23	1.26	(0.43, 3.64)	0.67
Left work (51 or older)	33	1.31	(0.68, 2.51)	0.42
Left work (55 or younger)	29	1.02	(0.45, 2.34)	0.95
Left work (56 or older)	27	1.54	(0.74, 3.19)	0.25

Cancer incidence (including SEER data)

Left work (60 or younger)	45	1.53	(0.80, 2.94)	0.20	
Left work (61 or older)	11	0.83	(0.35, 2.01)	0.69	
Lung and bronchial cancers (565 events)					
Still employed	165	1.00	–		
Not employed	400	0.97	(0.75, 1.26)	0.83	
Left work (50 or younger)	182	1.13	(0.74, 1.73)	0.58	
Left work (51 or older)	218	0.95	(0.73, 1.23)	0.68	
Left work (55 or younger)	219	1.00	(0.71, 1.41)	0.99	
Left work (56 or older)	181	0.96	(0.72, 1.27)	0.75	
Left work (60 or younger)	277	0.95	(0.71, 1.26)	0.71	
Left work (61 or older)	123	1.01	(0.74, 1.37)	0.97	
Breast cancer (74 events)					
Still employed	30	1.00	–		
Not employed	44	1.51	(0.75, 3.03)	0.24	
Left work (50 or younger)	22	1.53	(0.62, 3.78)	0.36	
Left work (51 or older)	22	1.50	(0.67, 3.36)	0.33	
Left work (55 or younger)	29	1.77	(0.81, 3.85)	0.15	
Left work (56 or older)	15	1.20	(0.49, 2.93)	0.68	
Left work (60 or younger)	36	1.60	(0.78, 3.29)	0.20	
Left work (61 or older)	8	1.20	(0.42, 3.43)	0.73	
Prostate cancer (485 events)					
Still employed	106	1.00	–		
Not employed	379	0.73	(0.54, 0.98)	0.04	∗
Left work (50 or younger)	136	1.00	(0.58, 1.73)	1.00	
Left work (51 or older)	243	0.73	(0.54, 0.97)	0.03	∗
Left work (55 or younger)	165	0.66	(0.43, 1.00)	0.05	
Left work (56 or older)	214	0.75	(0.55, 1.02)	0.06	

Cancer incidence (including SEER data)

Left work (60 or younger)	231	0.68	(0.48, 0.95)	0.02	*
Left work (61 or older)	148	0.78	(0.56, 1.08)	0.13	
Kidney and renal pelvic cancers (53 events)					
Still employed	20	1.00	–		
Not employed	33	0.58	(0.26, 1.31)	0.19	
Left work (50 or younger)	14	0.28	(0.06, 1.26)	0.10	
Left work (51 or older)	19	0.66	(0.29, 1.55)	0.34	
Left work (55 or younger)	16	0.27	(0.08, 0.98)	0.05	
Left work (56 or older)	17	0.81	(0.33, 1.98)	0.64	
Left work (60 or younger)	24	0.57	(0.23, 1.42)	0.23	
Left work (61 or older)	9	0.60	(0.22, 1.63)	0.32	
Bladder cancer (118 events)					
Still employed	33	1.00	–		
Not employed	85	0.61	(0.34, 1.11)	0.11	
Left work (50 or younger)	30	0.32	(0.10, 1.00)	0.05	
Left work (51 or older)	55	0.63	(0.35, 1.16)	0.14	
Left work (55 or younger)	36	0.31	(0.12, 0.82)	0.02	*
Left work (56 or older)	49	0.71	(0.38, 1.32)	0.28	
Left work (60 or younger)	57	0.70	(0.36, 1.36)	0.29	
Left work (61 or older)	28	0.55	(0.28, 1.06)	0.07	
Melanoma (51 events)					
Still employed	28	1.00	–		
Not employed	23	0.63	(0.25, 1.60)	0.33	
Left work (50 or younger)	12	0.55	(0.15, 1.97)	0.36	
Left work (51 or older)	11	0.69	(0.23, 2.10)	0.51	
Left work (55 or younger)	13	0.47	(0.14, 1.55)	0.21	
Left work (56 or older)	10	0.87	(0.26, 2.88)	0.82	

Cancer incidence (including SEER data)

Left work (60 or younger)	15	0.46	(0.15, 1.37)	0.16
Left work (61 or older)	8	1.17	(0.33, 4.11)	0.81
Leukemia (59 events)				
Still employed	25	1.00	–	
Not employed	34	0.63	(0.28, 1.41)	0.26
Left work (50 or younger)	15	0.44	(0.12, 1.58)	0.21
Left work (51 or older)	19	0.70	(0.29, 1.69)	0.43
Left work (55 or younger)	20	0.67	(0.25, 1.82)	0.43
Left work (56 or older)	14	0.59	(0.23, 1.52)	0.28
Left work (60 or younger)	26	0.68	(0.29, 1.62)	0.39
Left work (61 or older)	8	0.52	(0.18, 1.52)	0.23
Non-Hodgkin lymphoma (87 events)				
Still employed	25	1.00	–	
Not employed	62	1.26	(0.65, 2.41)	0.49
Left work (50 or younger)	29	0.94	(0.33, 2.66)	0.90
Left work (51 or older)	33	1.38	(0.68, 2.80)	0.37
Left work (55 or younger)	33	0.81	(0.33, 1.98)	0.65
Left work (56 or older)	29	1.70	(0.80, 3.64)	0.17
Left work (60 or younger)	45	1.15	(0.57, 2.33)	0.70
Left work (61 or older)	17	1.53	(0.66, 3.59)	0.32
All cancers (2171 events)				
Still employed	704	1.00	–	
Not employed	1467	0.89	(0.78, 1.01)	0.08
Left work (50 or younger)	632	0.82	(0.66, 1.03)	0.08
Left work (51 or older)	835	0.90	(0.79, 1.04)	0.14
Left work (55 or younger)	768	0.79	(0.66, 0.94)	0.01 ∗
Left work (56 or older)	699	0.95	(0.82, 1.10)	0.47

Cancer incidence (including SEER data)

Left work (60 or younger)	1015	0.87	(0.75, 1.00)	0.05
Left work (61 or older)	452	0.92	(0.79, 1.08)	0.33

Cancer incidence (including SEER data)

Table 3: Adjusted HR estimates for **leaving work**.

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	9948	1.00	–		
	> 0 to 0.36	4205	1.06	(1.02, 1.11)	0.01	*
	> 0.36 to 1.83	4205	1.06	(1.02, 1.11)	< 0.005	*
	> 1.83	4205	1.09	(1.04, 1.13)	< 0.005	*
Cumulative soluble	0 to 0.05	2781	1.00	–		
	> 0.05 to 3.14	6594	1.05	(1.00, 1.10)	0.04	*
	> 3.14 to 11.5	6594	1.09	(1.04, 1.14)	< 0.005	*
	> 11.5	6594	1.20	(1.14, 1.26)	< 0.005	*
Cumulative synthetic	0	15561	1.00	–		
	> 0 to 0.256	2334	1.06	(1.01, 1.12)	0.03	*
	> 0.256 to 1.48	2334	1.06	(1.01, 1.12)	0.02	*
	> 1.48	2334	1.19	(1.13, 1.25)	< 0.005	*
Race	White	12350	1.00	–		
	Black	3628	0.94	(0.91, 0.98)	0.01	*
	Unknown	6585	7.51	(7.22, 7.81)	< 0.005	*
Plant	1	6750	1.00	–		
	2	9257	0.82	(0.79, 0.86)	< 0.005	*
	3	6556	0.82	(0.79, 0.85)	< 0.005	*
Sex	Male	20064	1.00	–		
	Female	2499	1.19	(1.14, 1.25)	< 0.005	*
P-spline of calendar year ($df = 3.06$)			1.01	(1.01, 1.01)	< 0.005	*
			NA	–	< 0.005	*

Table 4: Adjusted HR estimates for incidence of **colon cancer** ($n = 671$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	311	1.00	–		
	> 0 to 0.413	120	1.05	(0.82, 1.34)	0.71	
	> 0.413 to 2.16	120	1.08	(0.85, 1.38)	0.52	
	> 2.16	120	1.05	(0.83, 1.32)	0.70	
Cumulative soluble	0 to 0.05	107	1.00	–		
	> 0.05 to 3.67	188	1.05	(0.81, 1.37)	0.70	
	> 3.67 to 13.6	188	1.01	(0.77, 1.34)	0.92	
	> 13.6	188	1.00	(0.74, 1.35)	0.99	
Cumulative synthetic	0	493	1.00	–		
	> 0 to 0.191	60	1.22	(0.88, 1.68)	0.23	
	> 0.191 to 1.49	59	0.82	(0.60, 1.13)	0.23	
	> 1.49	59	0.95	(0.70, 1.28)	0.72	
Duration of employment	3 to 8	108	1.00	–		
	9 to 16	108	1.07	(0.81, 1.43)	0.62	
	17 to 22	113	1.14	(0.84, 1.55)	0.40	
	23 to 28	114	1.22	(0.89, 1.68)	0.21	
	29 to 31	100	1.30	(0.93, 1.81)	0.13	
	> 31	128	1.51	(1.08, 2.10)	0.02	*
Race	White	405	1.00	–		
	Black	163	1.67	(1.34, 2.06)	< 0.005	*
	Unknown	103	0.91	(0.68, 1.21)	0.51	
Plant	1	226	1.00	–		
	2	244	1.00	(0.78, 1.30)	0.97	
	3	201	1.13	(0.89, 1.44)	0.33	
Sex	Male	593	1.00	–		
	Female	78	0.88	(0.68, 1.14)	0.33	
P-spline of calendar year ($df = 3.07$)			0.99	(0.98, 1.00)	0.06	
			NA	–	< 0.005	*
P-spline of year of hire ($df = 3.03$)			1.01	(0.99, 1.02)	0.30	
			NA	–	0.07	
Employment status	Still employed	47	1.00	–		
	Not employed	142	1.00	(0.63, 1.60)	0.99	
	Still employed	47	1.00	–		
	Left work (50 or younger)	50	1.00	(0.44, 2.25)	1.00	
	Left work (51 or older)	92	1.00	(0.62, 1.61)	0.99	
	Still employed	47	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	59	0.73	(0.37, 1.43)	0.36
Left work (56 or older)	83	1.12	(0.68, 1.86)	0.65
Still employed	47	1.00	–	
Left work (60 or younger)	86	0.91	(0.54, 1.55)	0.73
Left work (61 or older)	56	1.11	(0.65, 1.89)	0.70

Cancer incidence (including SEER data)

Table 5: Adjusted HR estimates for incidence of **rectal cancer** ($n = 318$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	141	1.00	–		
	> 0 to 0.503	59	1.01	(0.71, 1.46)	0.94	
	> 0.503 to 2.07	59	1.22	(0.85, 1.74)	0.29	
	> 2.07	59	1.23	(0.88, 1.72)	0.23	
Cumulative soluble	0 to 0.05	51	1.00	–		
	> 0.05 to 3.72	89	1.07	(0.73, 1.57)	0.73	
	> 3.72 to 11.7	89	1.11	(0.74, 1.66)	0.62	
	> 11.7	89	0.92	(0.60, 1.43)	0.72	
Cumulative synthetic	0	217	1.00	–		
	> 0 to 0.365	34	1.02	(0.66, 1.59)	0.92	
	> 0.365 to 1.79	33	1.13	(0.73, 1.75)	0.59	
	> 1.79	34	1.42	(0.94, 2.13)	0.10	
Duration of employment	3 to 9	53	1.00	–		
	10 to 17	51	1.21	(0.79, 1.85)	0.38	
	18 to 22	51	1.41	(0.90, 2.21)	0.13	
	23 to 28	51	1.23	(0.78, 1.96)	0.38	
	29 to 30	44	2.09	(1.27, 3.43)	< 0.005	*
	> 30	68	1.57	(0.97, 2.54)	0.07	
Race	White	216	1.00	–		
	Black	51	0.81	(0.57, 1.14)	0.23	
	Unknown	51	0.86	(0.57, 1.31)	0.49	
Plant	1	98	1.00	–		
	2	128	0.76	(0.53, 1.09)	0.14	
	3	92	0.76	(0.54, 1.07)	0.12	
Sex	Male	293	1.00	–		
	Female	25	0.60	(0.39, 0.93)	0.02	*
P-spline of calendar year ($df = 3.04$)			0.98	(0.97, 1.00)	0.06	
			NA	–	0.04	*
P-spline of year of hire ($df = 3.01$)			1.02	(1.00, 1.04)	0.02	*
			NA	–	0.04	*
Employment status	Still employed	27	1.00	–		
	Not employed	68	1.18	(0.64, 2.20)	0.60	
	Still employed	27	1.00	–		
	Left work (50 or younger)	32	1.13	(0.41, 3.09)	0.81	
	Left work (51 or older)	36	1.20	(0.62, 2.30)	0.59	
	Still employed	27	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	39	1.16	(0.52, 2.58)	0.71
Left work (56 or older)	29	1.20	(0.59, 2.42)	0.61
Still employed	27	1.00	–	
Left work (60 or younger)	48	1.09	(0.55, 2.18)	0.80
Left work (61 or older)	20	1.35	(0.62, 2.94)	0.45

Cancer incidence (including SEER data)

Table 6: Adjusted HR estimates for incidence of **pancreatic cancer** ($n = 252$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	126	1.00	–		
	> 0 to 0.318	42	1.00	(0.66, 1.52)	0.98	
	> 0.318 to 1.15	42	1.07	(0.71, 1.62)	0.75	
	> 1.15	42	0.75	(0.51, 1.09)	0.13	
Cumulative soluble	0 to 0.05	47	1.00	–		
	> 0.05 to 3.05	69	0.87	(0.58, 1.31)	0.51	
	> 3.05 to 9.59	68	0.82	(0.54, 1.26)	0.37	
	> 9.59	68	0.63	(0.40, 1.00)	0.05	
Cumulative synthetic	0	177	1.00	–		
	> 0 to 0.218	25	1.26	(0.75, 2.11)	0.38	
	> 0.218 to 0.803	25	1.43	(0.86, 2.39)	0.17	
	> 0.803	25	0.94	(0.58, 1.51)	0.79	
Duration of employment	3 to 8	35	1.00	–		
	9 to 17	46	1.60	(0.99, 2.60)	0.05	
	18 to 22	42	1.93	(1.13, 3.29)	0.02	∗
	23 to 27	42	2.33	(1.35, 4.04)	< 0.005	∗
	28 to 30	35	2.33	(1.30, 4.19)	< 0.005	∗
	> 30	52	2.61	(1.46, 4.67)	< 0.005	∗
Race	White	142	1.00	–		
	Black	65	1.45	(1.03, 2.03)	0.03	∗
	Unknown	45	1.40	(0.87, 2.27)	0.17	
Plant	1	85	1.00	–		
	2	99	0.73	(0.49, 1.10)	0.13	
	3	68	0.74	(0.50, 1.09)	0.13	
Sex	Male	221	1.00	–		
	Female	31	0.87	(0.58, 1.31)	0.50	
P-spline of calendar year ($df = 3.09$)			1.01	(0.99, 1.03)	0.50	
			NA	–	0.11	
P-spline of year of hire ($df = 3.02$)			1.01	(0.99, 1.03)	0.32	
			NA	–	0.02	∗
Employment status	Still employed	18	1.00	–		
	Not employed	51	1.26	(0.61, 2.61)	0.53	
	Still employed	18	1.00	–		
	Left work (50 or younger)	21	1.53	(0.47, 4.92)	0.48	
	Left work (51 or older)	30	1.22	(0.58, 2.56)	0.61	
	Still employed	18	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	24	0.95	(0.35, 2.60)	0.92
Left work (56 or older)	27	1.44	(0.65, 3.20)	0.37
Still employed	18	1.00	–	
Left work (60 or younger)	38	1.62	(0.75, 3.51)	0.22
Left work (61 or older)	13	0.85	(0.35, 2.07)	0.72

Cancer incidence (including SEER data)

Table 7: Adjusted HR estimates for incidence of **esophageal cancer** ($n = 174$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	73	1.00	–		
	> 0 to 0.385	34	1.48	(0.92, 2.39)	0.11	
	> 0.385 to 2.15	33	1.26	(0.78, 2.03)	0.34	
	> 2.15	34	1.49	(0.95, 2.33)	0.08	
Cumulative soluble	0 to 0.05	31	1.00	–		
	> 0.05 to 3.31	48	0.79	(0.48, 1.31)	0.37	
	> 3.31 to 10.9	47	0.79	(0.46, 1.33)	0.37	
	> 10.9	48	0.91	(0.52, 1.61)	0.75	
Cumulative synthetic	0	120	1.00	–		
	> 0 to 0.686	27	1.03	(0.60, 1.75)	0.92	
	> 0.686	27	1.39	(0.85, 2.28)	0.19	
Duration of employment	3 to 11	29	1.00	–		
	12 to 17	24	2.00	(1.10, 3.64)	0.02	*
	18 to 21	31	2.56	(1.40, 4.70)	< 0.005	*
	22 to 26	28	1.80	(0.96, 3.37)	0.07	
	27 to 29	22	1.55	(0.78, 3.07)	0.21	
	> 29	40	1.57	(0.81, 3.07)	0.18	
Race	White	106	1.00	–		
	Black	40	1.41	(0.94, 2.14)	0.10	
	Unknown	28	1.32	(0.73, 2.38)	0.36	
Plant	1	54	1.00	–		
	2	55	0.69	(0.41, 1.14)	0.14	
	3	65	0.97	(0.62, 1.52)	0.91	
Sex	Male	169	1.00	–		
	Female	5	0.18	(0.07, 0.45)	< 0.005	*
P-spline of calendar year ($df = 3.06$)			1.01	(0.99, 1.03)	0.49	
			NA	–	0.51	
P-spline of year of hire ($df = 3.00$)			1.03	(1.00, 1.05)	0.08	
			NA	–	0.16	
Employment status	Still employed	20	1.00	–		
	Not employed	27	0.63	(0.27, 1.46)	0.28	
	Still employed	20	1.00	–		
	Left work (50 or younger)	13	0.54	(0.12, 2.44)	0.42	
	Left work (51 or older)	14	0.64	(0.27, 1.51)	0.31	
	Still employed	20	1.00	–		
	Left work (55 or younger)	19	1.11	(0.39, 3.13)	0.85	

Cancer incidence (including SEER data)

Left work (56 or older)	8	0.43	(0.16, 1.15)	0.09
Still employed	20	1.00	–	
Left work (60 or younger)	22	0.77	(0.31, 1.92)	0.57
Left work (61 or older)	5	0.43	(0.13, 1.39)	0.16

Cancer incidence (including SEER data)

Table 8: Adjusted HR estimates for incidence of **stomach cancer** ($n = 214$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	108	1.00	–		
	> 0 to 0.347	36	1.13	(0.72, 1.77)	0.61	
	> 0.347 to 3.28	35	0.73	(0.47, 1.14)	0.16	
	> 3.28	35	1.55	(1.01, 2.37)	0.04	∗
Cumulative soluble	0 to 0.05	50	1.00	–		
	> 0.05 to 4.02	55	0.63	(0.41, 0.97)	0.04	∗
	> 4.02 to 13.4	54	0.74	(0.47, 1.16)	0.19	
	> 13.4	55	0.81	(0.49, 1.33)	0.40	
Cumulative synthetic	0	158	1.00	–		
	> 0 to 0.64	28	0.99	(0.59, 1.64)	0.96	
	> 0.64	28	1.12	(0.70, 1.81)	0.63	
Duration of employment	3 to 6	32	1.00	–		
	7 to 15	37	0.74	(0.45, 1.21)	0.23	
	16 to 20	36	1.07	(0.62, 1.87)	0.80	
	21 to 26	33	0.99	(0.56, 1.76)	0.98	
	27 to 30	38	1.18	(0.65, 2.12)	0.59	
	> 30	38	0.89	(0.48, 1.65)	0.70	
Race	White	116	1.00	–		
	Black	55	1.76	(1.21, 2.56)	< 0.005	∗
	Unknown	43	1.15	(0.71, 1.88)	0.57	
Plant	1	73	1.00	–		
	2	91	1.16	(0.76, 1.77)	0.50	
	3	50	0.81	(0.52, 1.26)	0.35	
Sex	Male	198	1.00	–		
	Female	16	0.49	(0.29, 0.84)	0.01	∗
P-spline of calendar year ($df = 3.08$)			1.00	(0.98, 1.02)	0.97	
			NA	–	0.12	
P-spline of year of hire ($df = 3.01$)			1.01	(0.98, 1.03)	0.59	
			NA	–	0.06	
Employment status	Still employed	21	1.00	–		
	Not employed	44	1.00	(0.47, 2.13)	0.99	
	Still employed	21	1.00	–		
	Left work (50 or younger)	19	0.40	(0.11, 1.48)	0.17	
	Left work (51 or older)	25	1.25	(0.56, 2.82)	0.58	
	Still employed	21	1.00	–		
	Left work (55 or younger)	26	0.94	(0.36, 2.49)	0.91	

Cancer incidence (including SEER data)

Left work (56 or older)	18	1.05	(0.44, 2.47)	0.92
Still employed	21	1.00	–	
Left work (60 or younger)	34	1.11	(0.49, 2.49)	0.80
Left work (61 or older)	10	0.83	(0.31, 2.20)	0.71

Cancer incidence (including SEER data)

Table 9: Adjusted HR estimates for incidence of **laryngeal cancer** ($n = 207$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	100	1.00	–		
	> 0 to 0.475	36	0.82	(0.52, 1.29)	0.38	
	> 0.475 to 2.19	35	0.98	(0.63, 1.54)	0.95	
	> 2.19	36	1.25	(0.83, 1.88)	0.29	
Cumulative soluble	0 to 0.05	28	1.00	–		
	> 0.05 to 3.02	60	1.56	(0.96, 2.54)	0.07	
	> 3.02 to 10.4	59	1.18	(0.71, 1.96)	0.53	
	> 10.4	60	1.08	(0.63, 1.85)	0.78	
Cumulative synthetic	0	148	1.00	–		
	> 0 to 0.656	30	1.00	(0.60, 1.66)	0.99	
	> 0.656	29	1.13	(0.70, 1.82)	0.62	
Duration of employment	3 to 8	32	1.00	–		
	9 to 17	37	1.56	(0.93, 2.62)	0.09	
	18 to 23	29	1.29	(0.71, 2.35)	0.40	
	24 to 28	37	1.75	(0.97, 3.17)	0.06	
	29 to 30	26	1.87	(0.98, 3.57)	0.06	
	> 30	46	1.84	(0.98, 3.43)	0.06	
Race	White	110	1.00	–		
	Black	59	1.67	(1.16, 2.41)	0.01	∗
	Unknown	38	1.18	(0.69, 1.99)	0.55	
Plant	1	80	1.00	–		
	2	81	0.92	(0.60, 1.41)	0.70	
	3	46	0.55	(0.35, 0.84)	0.01	∗
Sex	Male	203	1.00	–		
	Female	4	0.15	(0.06, 0.41)	< 0.005	∗
P-spline of calendar year ($df = 3.08$)			1.01	(0.98, 1.03)	0.59	
			NA	–	0.32	
P-spline of year of hire ($df = 3.01$)			1.00	(0.98, 1.03)	0.76	
			NA	–	0.02	∗
Employment status	Still employed	28	1.00	–		
	Not employed	56	1.30	(0.69, 2.43)	0.42	
	Still employed	28	1.00	–		
	Left work (50 or younger)	23	1.26	(0.43, 3.64)	0.67	
	Left work (51 or older)	33	1.31	(0.68, 2.51)	0.42	
	Still employed	28	1.00	–		
	Left work (55 or younger)	29	1.02	(0.45, 2.34)	0.95	

Cancer incidence (including SEER data)

Left work (56 or older)	27	1.54	(0.74, 3.19)	0.25
Still employed	28	1.00	–	
Left work (60 or younger)	45	1.53	(0.80, 2.94)	0.20
Left work (61 or older)	11	0.83	(0.35, 2.01)	0.69

Cancer incidence (including SEER data)

Table 10: Adjusted HR estimates for incidence of **lung and bronchial cancers** ($n = 1744$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	839	1.00	–		
	> 0 to 0.364	302	1.08	(0.93, 1.26)	0.33	
	> 0.364 to 1.72	301	1.03	(0.88, 1.20)	0.69	
	> 1.72	302	1.01	(0.87, 1.17)	0.90	
Cumulative soluble	0 to 0.05	318	1.00	–		
	> 0.05 to 3.45	476	0.93	(0.79, 1.09)	0.35	
	> 3.45 to 12.1	475	0.90	(0.76, 1.06)	0.21	
	> 12.1	475	0.95	(0.79, 1.14)	0.58	
Cumulative synthetic	0	1253	1.00	–		
	> 0 to 0.269	164	0.96	(0.78, 1.16)	0.65	
	> 0.269 to 1.39	163	1.00	(0.82, 1.21)	1.00	
	> 1.39	164	1.02	(0.85, 1.23)	0.80	
Duration of employment	3 to 7	273	1.00	–		
	8 to 15	275	0.97	(0.81, 1.16)	0.72	
	16 to 21	307	1.16	(0.96, 1.41)	0.13	
	22 to 27	303	1.18	(0.97, 1.45)	0.10	
	28 to 30	227	1.23	(0.99, 1.53)	0.06	
	> 30	359	1.31	(1.06, 1.63)	0.01	*
Race	White	1050	1.00	–		
	Black	350	1.17	(1.02, 1.35)	0.02	*
	Unknown	344	1.06	(0.89, 1.27)	0.49	
Plant	1	549	1.00	–		
	2	711	0.94	(0.81, 1.09)	0.42	
	3	484	0.87	(0.75, 1.01)	0.06	
Sex	Male	1556	1.00	–		
	Female	188	0.81	(0.69, 0.95)	0.01	*
P-spline of calendar year ($df = 3.05$)			0.99	(0.98, 1.00)	0.02	*
			NA	–	< 0.005	*
P-spline of year of hire ($df = 3.01$)			1.02	(1.01, 1.03)	< 0.005	*
			NA	–	< 0.005	*
Employment status	Still employed	165	1.00	–		
	Not employed	400	0.97	(0.75, 1.26)	0.83	
	Still employed	165	1.00	–		
	Left work (50 or younger)	182	1.13	(0.74, 1.73)	0.58	
	Left work (51 or older)	218	0.95	(0.73, 1.23)	0.68	
	Still employed	165	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	219	1.00	(0.71, 1.41)	0.99
Left work (56 or older)	181	0.96	(0.72, 1.27)	0.75
Still employed	165	1.00	–	
Left work (60 or younger)	277	0.95	(0.71, 1.26)	0.71
Left work (61 or older)	123	1.01	(0.74, 1.37)	0.97

Cancer incidence (including SEER data)

Table 11: Adjusted HR estimates for incidence of **breast cancer** ($n = 261$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	143	1.00	–		
	> 0 to 0.189	41	1.31	(0.85, 2.00)	0.22	
	> 0.189 to 0.721	40	1.73	(1.11, 2.71)	0.02	*
	> 0.721	37	1.24	(0.81, 1.91)	0.32	
Cumulative soluble	0 to 0.05	101	1.00	–		
	> 0.05 to 1.22	59	0.90	(0.62, 1.30)	0.58	
	> 1.22 to 3.42	54	0.92	(0.61, 1.40)	0.71	
	> 3.42	47	0.75	(0.47, 1.20)	0.23	
Cumulative synthetic	0	193	1.00	–		
	> 0 to 0.0921	23	1.16	(0.69, 1.95)	0.57	
	> 0.0921 to 0.378	24	0.89	(0.52, 1.51)	0.66	
	> 0.378	21	0.60	(0.36, 1.01)	0.05	
Duration of employment	3 to 9	40	1.00	–		
	10 to 15	43	1.14	(0.72, 1.80)	0.59	
	16 to 18	44	1.07	(0.66, 1.72)	0.78	
	19 to 20	50	1.69	(1.06, 2.68)	0.03	*
	21 to 23	38	1.42	(0.84, 2.40)	0.19	
	> 23	46	2.56	(1.43, 4.60)	< 0.005	*
Race	White	147	1.00	–		
	Black	83	1.20	(0.88, 1.64)	0.25	
	Unknown	31	1.42	(0.78, 2.59)	0.25	
Plant	1	31	1.00	–		
	2	149	1.11	(0.69, 1.79)	0.66	
	3	81	1.13	(0.71, 1.80)	0.61	
P-spline of calendar year ($df = 3.07$)			1.02	(1.00, 1.04)	0.12	
			NA	–	0.01	*
P-spline of year of hire ($df = 3.01$)			1.00	(0.97, 1.03)	0.99	
			NA	–	0.41	
Employment status	Still employed	30	1.00	–		
	Not employed	44	1.51	(0.75, 3.03)	0.24	
	Still employed	30	1.00	–		
	Left work (50 or younger)	22	1.53	(0.62, 3.78)	0.36	
	Left work (51 or older)	22	1.50	(0.67, 3.36)	0.33	
	Still employed	30	1.00	–		
	Left work (55 or younger)	29	1.77	(0.81, 3.85)	0.15	
	Left work (56 or older)	15	1.20	(0.49, 2.93)	0.68	

Cancer incidence (including SEER data)

Still employed	30	1.00	–	
Left work (60 or younger)	36	1.60	(0.78, 3.29)	0.20
Left work (61 or older)	8	1.20	(0.42, 3.43)	0.73

Cancer incidence (including SEER data)

Table 12: Adjusted HR estimates for incidence of **prostate cancer** ($n = 2518$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	1133	1.00	–		
	> 0 to 0.428	463	1.10	(0.97, 1.25)	0.14	
	> 0.428 to 2.17	462	1.06	(0.94, 1.20)	0.36	
	> 2.17	463	1.05	(0.94, 1.18)	0.38	
Cumulative soluble	0 to 0.05	313	1.00	–		
	> 0.05 to 3.82	736	1.06	(0.92, 1.23)	0.38	
	> 3.82 to 13.1	736	1.07	(0.93, 1.24)	0.36	
	> 13.1	736	1.08	(0.92, 1.26)	0.34	
Cumulative synthetic	0	1812	1.00	–		
	> 0 to 0.259	237	1.00	(0.84, 1.18)	0.98	
	> 0.259 to 1.48	236	0.97	(0.82, 1.14)	0.68	
	> 1.48	236	1.09	(0.94, 1.27)	0.27	
Duration of employment	3 to 8	389	1.00	–		
	9 to 17	384	1.10	(0.94, 1.28)	0.23	
	18 to 24	473	1.32	(1.12, 1.56)	< 0.005	∗
	25 to 28	355	1.48	(1.24, 1.76)	< 0.005	∗
	29 to 31	460	1.53	(1.28, 1.82)	< 0.005	∗
	> 31	460	1.60	(1.34, 1.92)	< 0.005	∗
Race	White	1420	1.00	–		
	Black	722	2.14	(1.93, 2.38)	< 0.005	∗
	Unknown	379	1.15	(0.98, 1.34)	0.09	
Plant	1	918	1.00	–		
	2	802	0.89	(0.78, 1.02)	0.10	
	3	801	0.99	(0.88, 1.11)	0.86	
P-spline of calendar year ($df = 3.05$)			1.01	(1.00, 1.01)	0.06	
			NA	–	< 0.005	∗
P-spline of year of hire ($df = 3.01$)			1.02	(1.01, 1.02)	< 0.005	∗
			NA	–	< 0.005	∗
Employment status	Still employed	106	1.00	–		
	Not employed	379	0.73	(0.54, 0.98)	0.04	∗
	Still employed	106	1.00	–		
	Left work (50 or younger)	136	1.00	(0.58, 1.73)	1.00	
	Left work (51 or older)	243	0.73	(0.54, 0.97)	0.03	∗
	Still employed	106	1.00	–		
	Left work (55 or younger)	165	0.66	(0.43, 1.00)	0.05	
	Left work (56 or older)	214	0.75	(0.55, 1.02)	0.06	

Cancer incidence (including SEER data)

Still employed	106	1.00	–		
Left work (60 or younger)	231	0.68	(0.48, 0.95)	0.02	*
Left work (61 or older)	148	0.78	(0.56, 1.08)	0.13	

Cancer incidence (including SEER data)

Table 13: Adjusted HR estimates for incidence of **kidney and renal pelvic cancers** ($n = 256$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	120	1.00	–		
	> 0 to 0.394	46	0.96	(0.64, 1.44)	0.84	
	> 0.394 to 3.4	45	0.87	(0.59, 1.28)	0.48	
	> 3.4	45	1.51	(1.03, 2.20)	0.03	*
Cumulative soluble	0 to 0.05	48	1.00	–		
	> 0.05 to 2.73	70	1.00	(0.67, 1.49)	0.99	
	> 2.73 to 9.27	69	0.89	(0.58, 1.35)	0.58	
	> 9.27	69	0.75	(0.48, 1.19)	0.23	
Cumulative synthetic	0	185	1.00	–		
	> 0 to 0.182	24	1.06	(0.64, 1.77)	0.82	
	> 0.182 to 0.796	23	1.01	(0.60, 1.67)	0.98	
	> 0.796	24	0.75	(0.47, 1.21)	0.24	
Duration of employment	3 to 7	40	1.00	–		
	8 to 16	41	0.92	(0.58, 1.48)	0.74	
	17 to 22	45	0.99	(0.59, 1.65)	0.96	
	23 to 27	43	1.40	(0.82, 2.39)	0.22	
	28 to 30	28	1.01	(0.55, 1.84)	0.98	
	> 30	59	1.75	(0.98, 3.11)	0.06	
Race	White	171	1.00	–		
	Black	41	0.88	(0.60, 1.29)	0.52	
	Unknown	44	1.02	(0.62, 1.67)	0.93	
Plant	1	67	1.00	–		
	2	98	1.03	(0.69, 1.55)	0.88	
	3	91	0.95	(0.65, 1.39)	0.79	
Sex	Male	235	1.00	–		
	Female	21	0.58	(0.36, 0.94)	0.03	*
P-spline of calendar year ($df = 3.09$)			1.02	(1.00, 1.03)	0.11	
			NA	–	0.93	
P-spline of year of hire ($df = 3.01$)			1.02	(1.00, 1.05)	0.04	*
			NA	–	0.23	
Employment status	Still employed	20	1.00	–		
	Not employed	33	0.58	(0.26, 1.31)	0.19	
	Still employed	20	1.00	–		
	Left work (50 or younger)	14	0.28	(0.06, 1.26)	0.10	
	Left work (51 or older)	19	0.66	(0.29, 1.55)	0.34	
	Still employed	20	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	16	0.27	(0.08, 0.98)	0.05
Left work (56 or older)	17	0.81	(0.33, 1.98)	0.64
Still employed	20	1.00	–	
Left work (60 or younger)	24	0.57	(0.23, 1.42)	0.23
Left work (61 or older)	9	0.60	(0.22, 1.63)	0.32

Cancer incidence (including SEER data)

Table 14: Adjusted HR estimates for incidence of **bladder cancer** ($n = 535$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	237	1.00	–		
	> 0 to 0.388	100	1.33	(1.01, 1.75)	0.04	*
	> 0.388 to 2.7	99	1.02	(0.78, 1.34)	0.87	
	> 2.7	99	1.26	(0.98, 1.63)	0.08	
Cumulative soluble	0 to 0.05	88	1.00	–		
	> 0.05 to 3.91	149	0.85	(0.64, 1.14)	0.28	
	> 3.91 to 13.2	149	0.97	(0.72, 1.31)	0.84	
	> 13.2	149	1.06	(0.77, 1.47)	0.71	
Cumulative synthetic	0	395	1.00	–		
	> 0 to 0.255	47	0.82	(0.58, 1.18)	0.30	
	> 0.255 to 1.28	46	0.87	(0.61, 1.24)	0.44	
	> 1.28	47	0.77	(0.55, 1.07)	0.12	
Duration of employment	3 to 7	82	1.00	–		
	8 to 16	88	0.91	(0.66, 1.26)	0.57	
	17 to 22	90	1.14	(0.80, 1.62)	0.48	
	23 to 27	86	1.33	(0.92, 1.93)	0.13	
	28 to 30	85	1.41	(0.95, 2.07)	0.08	
	> 30	104	1.14	(0.77, 1.68)	0.53	
Race	White	381	1.00	–		
	Black	54	0.53	(0.39, 0.72)	< 0.005	*
	Unknown	100	1.01	(0.74, 1.38)	0.95	
Plant	1	144	1.00	–		
	2	187	0.90	(0.68, 1.19)	0.45	
	3	204	1.09	(0.84, 1.41)	0.50	
Sex	Male	512	1.00	–		
	Female	23	0.30	(0.20, 0.46)	< 0.005	*
P-spline of calendar year ($df = 3.06$)			1.00	(0.98, 1.01)	0.48	
			NA	–	< 0.005	*
P-spline of year of hire ($df = 3.02$)			1.03	(1.01, 1.04)	< 0.005	*
			NA	–	0.18	
Employment status	Still employed	33	1.00	–		
	Not employed	85	0.61	(0.34, 1.11)	0.11	
	Still employed	33	1.00	–		
	Left work (50 or younger)	30	0.32	(0.10, 1.00)	0.05	
	Left work (51 or older)	55	0.63	(0.35, 1.16)	0.14	
	Still employed	33	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	36	0.31	(0.12, 0.82)	0.02	*
Left work (56 or older)	49	0.71	(0.38, 1.32)	0.28	
Still employed	33	1.00	–		
Left work (60 or younger)	57	0.70	(0.36, 1.36)	0.29	
Left work (61 or older)	28	0.55	(0.28, 1.06)	0.07	

Table 15: Adjusted HR estimates for incidence of **melanoma** ($n = 266$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	121	1.00	–		
	> 0 to 0.487	49	0.78	(0.52, 1.18)	0.24	
	> 0.487 to 2.05	48	1.11	(0.75, 1.65)	0.60	
	> 2.05	48	1.20	(0.83, 1.76)	0.33	
Cumulative soluble	0 to 0.05	53	1.00	–		
	> 0.05 to 2.92	71	0.97	(0.64, 1.48)	0.90	
	> 2.92 to 8.64	71	1.16	(0.74, 1.80)	0.52	
	> 8.64	71	1.08	(0.66, 1.75)	0.76	
Cumulative synthetic	0	174	1.00	–		
	> 0 to 0.203	31	1.37	(0.85, 2.19)	0.20	
	> 0.203 to 0.949	30	1.21	(0.76, 1.94)	0.42	
	> 0.949	31	1.01	(0.66, 1.57)	0.95	
Duration of employment	3 to 8	42	1.00	–		
	9 to 16	39	1.31	(0.81, 2.12)	0.27	
	17 to 20	49	1.64	(0.97, 2.78)	0.06	
	21 to 26	43	1.96	(1.13, 3.39)	0.02	*
	27 to 30	45	1.80	(1.00, 3.23)	0.05	
	> 30	48	2.06	(1.10, 3.85)	0.02	*
Race	White	216	1.00	–		
	Black	4	0.07	(0.03, 0.20)	< 0.005	*
	Unknown	46	1.43	(0.85, 2.40)	0.17	
Plant	1	44	1.00	–		
	2	115	1.10	(0.71, 1.70)	0.66	
	3	107	1.01	(0.68, 1.51)	0.95	
Sex	Male	247	1.00	–		
	Female	19	0.60	(0.37, 0.98)	0.04	*
P-spline of calendar year ($df = 3.07$)			1.05	(1.03, 1.08)	< 0.005	*
			NA	–	< 0.005	*
P-spline of year of hire ($df = 3.01$)			1.00	(0.97, 1.02)	0.90	
			NA	–	0.46	
Employment status	Still employed	28	1.00	–		
	Not employed	23	0.63	(0.25, 1.60)	0.33	
	Still employed	28	1.00	–		
	Left work (50 or younger)	12	0.55	(0.15, 1.97)	0.36	
	Left work (51 or older)	11	0.69	(0.23, 2.10)	0.51	
	Still employed	28	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	13	0.47	(0.14, 1.55)	0.21
Left work (56 or older)	10	0.87	(0.26, 2.88)	0.82
Still employed	28	1.00	–	
Left work (60 or younger)	15	0.46	(0.15, 1.37)	0.16
Left work (61 or older)	8	1.17	(0.33, 4.11)	0.81

Table 16: Adjusted HR estimates for incidence of **leukemia** ($n = 229$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	109	1.00	–		
	> 0 to 0.329	40	1.10	(0.71, 1.71)	0.67	
	> 0.329 to 2.25	40	0.88	(0.58, 1.35)	0.57	
	> 2.25	40	1.15	(0.77, 1.72)	0.49	
Cumulative soluble	0 to 0.05	45	1.00	–		
	> 0.05 to 3.17	62	0.89	(0.58, 1.38)	0.61	
	> 3.17 to 10.6	61	0.89	(0.56, 1.40)	0.61	
	> 10.6	61	0.76	(0.46, 1.24)	0.27	
Cumulative synthetic	0	162	1.00	–		
	> 0 to 0.18	23	1.49	(0.87, 2.56)	0.15	
	> 0.18 to 1.18	22	1.13	(0.66, 1.92)	0.66	
	> 1.18	22	1.13	(0.68, 1.86)	0.64	
Duration of employment	3 to 7	34	1.00	–		
	8 to 14	40	1.18	(0.73, 1.92)	0.50	
	15 to 21	39	1.00	(0.58, 1.71)	1.00	
	22 to 26	38	1.42	(0.82, 2.48)	0.21	
	27 to 30	37	1.19	(0.66, 2.12)	0.56	
	> 30	41	1.11	(0.61, 2.01)	0.74	
Race	White	145	1.00	–		
	Black	44	1.18	(0.80, 1.73)	0.40	
	Unknown	40	0.93	(0.57, 1.51)	0.77	
Plant	1	69	1.00	–		
	2	85	0.89	(0.57, 1.37)	0.58	
	3	75	1.00	(0.66, 1.49)	0.99	
Sex	Male	210	1.00	–		
	Female	19	0.59	(0.36, 0.97)	0.04	*
P-spline of calendar year ($df = 3.08$)			1.01	(0.99, 1.03)	0.53	
			NA	–	0.01	*
P-spline of year of hire ($df = 3.02$)			1.01	(0.99, 1.03)	0.53	
			NA	–	0.61	
Employment status	Still employed	25	1.00	–		
	Not employed	34	0.63	(0.28, 1.41)	0.26	
	Still employed	25	1.00	–		
	Left work (50 or younger)	15	0.44	(0.12, 1.58)	0.21	
	Left work (51 or older)	19	0.70	(0.29, 1.69)	0.43	
	Still employed	25	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	20	0.67	(0.25, 1.82)	0.43
Left work (56 or older)	14	0.59	(0.23, 1.52)	0.28
Still employed	25	1.00	–	
Left work (60 or younger)	26	0.68	(0.29, 1.62)	0.39
Left work (61 or older)	8	0.52	(0.18, 1.52)	0.23

Table 17: Adjusted HR estimates for incidence of **non-hodgkin lymphoma** ($n = 396$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	173	1.00	–		
	> 0 to 0.342	75	1.21	(0.88, 1.67)	0.24	
	> 0.342 to 2.29	74	0.90	(0.66, 1.24)	0.53	
	> 2.29	74	1.20	(0.89, 1.62)	0.24	
Cumulative soluble	0 to 0.05	54	1.00	–		
	> 0.05 to 3.24	114	1.36	(0.95, 1.95)	0.09	
	> 3.24 to 11.3	114	1.52	(1.04, 2.22)	0.03	∗
	> 11.3	114	1.53	(1.02, 2.32)	0.04	∗
Cumulative synthetic	0	276	1.00	–		
	> 0 to 0.245	40	0.89	(0.60, 1.34)	0.59	
	> 0.245 to 1.46	40	0.96	(0.65, 1.42)	0.84	
	> 1.46	40	1.04	(0.71, 1.50)	0.85	
Duration of employment	3 to 7	64	1.00	–		
	8 to 15	63	0.83	(0.58, 1.21)	0.34	
	16 to 21	59	0.71	(0.47, 1.07)	0.10	
	22 to 26	66	1.03	(0.68, 1.56)	0.89	
	27 to 31	77	0.76	(0.49, 1.16)	0.20	
	> 31	67	0.94	(0.60, 1.49)	0.81	
Race	White	289	1.00	–		
	Black	46	0.59	(0.42, 0.83)	< 0.005	∗
	Unknown	61	0.61	(0.42, 0.90)	0.01	∗
Plant	1	101	1.00	–		
	2	156	1.06	(0.76, 1.49)	0.72	
	3	139	0.95	(0.70, 1.30)	0.76	
Sex	Male	351	1.00	–		
	Female	45	0.97	(0.70, 1.36)	0.87	
P-spline of calendar year ($df = 3.04$)			1.02	(1.00, 1.04)	0.02	∗
			NA	–	< 0.005	∗
P-spline of year of hire ($df = 3.01$)			1.00	(0.99, 1.02)	0.62	
			NA	–	0.48	
Employment status	Still employed	25	1.00	–		
	Not employed	62	1.26	(0.65, 2.41)	0.49	
	Still employed	25	1.00	–		
	Left work (50 or younger)	29	0.94	(0.33, 2.66)	0.90	
	Left work (51 or older)	33	1.38	(0.68, 2.80)	0.37	
	Still employed	25	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	33	0.81	(0.33, 1.98)	0.65
Left work (56 or older)	29	1.70	(0.80, 3.64)	0.17
Still employed	25	1.00	–	
Left work (60 or younger)	45	1.15	(0.57, 2.33)	0.70
Left work (61 or older)	17	1.53	(0.66, 3.59)	0.32

Table 18: Adjusted HR estimates for death due to **all cancers** ($n = 7841$).

Covariate	level	n	HR	(95% CI)	p	
Cumulative straight	0	3750	1.00	–		
	> 0 to 0.37	1364	1.06	(0.99, 1.15)	0.10	
	> 0.37 to 1.99	1363	0.99	(0.92, 1.06)	0.79	
	> 1.99	1364	1.10	(1.03, 1.18)	0.01	*
Cumulative soluble	0 to 0.05	1422	1.00	–		
	> 0.05 to 3.23	2140	1.01	(0.94, 1.09)	0.83	
	> 3.23 to 11.3	2139	1.02	(0.94, 1.10)	0.66	
	> 11.3	2140	1.02	(0.94, 1.12)	0.59	
Cumulative synthetic	0	5648	1.00	–		
	> 0 to 0.224	731	1.05	(0.96, 1.15)	0.32	
	> 0.224 to 1.26	731	0.99	(0.90, 1.08)	0.83	
	> 1.26	731	1.01	(0.93, 1.10)	0.80	
Duration of employment	3 to 8	1301	1.00	–		
	9 to 16	1189	1.10	(1.01, 1.20)	0.03	*
	17 to 21	1274	1.26	(1.15, 1.38)	< 0.005	*
	22 to 27	1420	1.35	(1.23, 1.48)	< 0.005	*
	28 to 30	1088	1.45	(1.31, 1.61)	< 0.005	*
	> 30	1569	1.48	(1.34, 1.64)	< 0.005	*
Race	White	4800	1.00	–		
	Black	1730	1.37	(1.28, 1.45)	< 0.005	*
	Unknown	1311	1.06	(0.97, 1.15)	0.22	
Plant	1	2395	1.00	–		
	2	2976	0.92	(0.85, 0.99)	0.02	*
	3	2470	0.95	(0.88, 1.01)	0.11	
Sex	Male	6944	1.00	–		
	Female	897	0.85	(0.79, 0.91)	< 0.005	*
P-spline of calendar year ($df = 3.05$)			1.00	(1.00, 1.01)	0.01	*
			NA	–	< 0.005	*
P-spline of year of hire ($df = 3.02$)			1.01	(1.01, 1.02)	< 0.005	*
			NA	–	< 0.005	*
Employment status	Still employed	704	1.00	–		
	Not employed	1467	0.89	(0.78, 1.01)	0.08	
	Still employed	704	1.00	–		
	Left work (50 or younger)	632	0.82	(0.66, 1.03)	0.08	
	Left work (51 or older)	835	0.90	(0.79, 1.04)	0.14	
	Still employed	704	1.00	–		

Cancer incidence (including SEER data)

Left work (55 or younger)	768	0.79	(0.66, 0.94)	0.01	*
Left work (56 or older)	699	0.95	(0.82, 1.10)	0.47	
Still employed	704	1.00	–		
Left work (60 or younger)	1015	0.87	(0.75, 1.00)	0.05	
Left work (61 or older)	452	0.92	(0.79, 1.08)	0.33	

Cancer incidence (including SEER data)

Table 19: Adjusted HR estimates for incidence of the indicated outcome, associated with race. Caution: these estimates are simply the conditional estimates from the previous tables.

Outcome	level	n	HR	(95% CI)	p	
Colon cancer	White	405	1.00	–		
	Black	163	1.67	(1.34, 2.06)	< 0.005	∗
	Unknown	103	0.91	(0.68, 1.21)	0.51	
Rectal cancer	White	216	1.00	–		
	Black	51	0.81	(0.57, 1.14)	0.23	
	Unknown	51	0.86	(0.57, 1.31)	0.49	
Pancreatic cancer	White	142	1.00	–		
	Black	65	1.45	(1.03, 2.03)	0.03	∗
	Unknown	45	1.40	(0.87, 2.27)	0.17	
Esophageal cancer	White	106	1.00	–		
	Black	40	1.41	(0.94, 2.14)	0.10	
	Unknown	28	1.32	(0.73, 2.38)	0.36	
Stomach cancer	White	116	1.00	–		
	Black	55	1.76	(1.21, 2.56)	< 0.005	∗
	Unknown	43	1.15	(0.71, 1.88)	0.57	
Laryngeal cancer	White	110	1.00	–		
	Black	59	1.67	(1.16, 2.41)	0.01	∗
	Unknown	38	1.18	(0.69, 1.99)	0.55	
Lung and bronchial cancers	White	1050	1.00	–		
	Black	350	1.17	(1.02, 1.35)	0.02	∗
	Unknown	344	1.06	(0.89, 1.27)	0.49	
Breast cancer	White	147	1.00	–		
	Black	83	1.20	(0.88, 1.64)	0.25	
	Unknown	31	1.42	(0.78, 2.59)	0.25	
Prostate cancer	White	1420	1.00	–		
	Black	722	2.14	(1.93, 2.38)	< 0.005	∗
	Unknown	379	1.15	(0.98, 1.34)	0.09	
Kidney and renal pelvic cancers	White	171	1.00	–		
	Black	41	0.88	(0.60, 1.29)	0.52	
	Unknown	44	1.02	(0.62, 1.67)	0.93	
Bladder cancer	White	381	1.00	–		
	Black	54	0.53	(0.39, 0.72)	< 0.005	∗
	Unknown	100	1.01	(0.74, 1.38)	0.95	
Melanoma	White	216	1.00	–		
	Black	4	0.07	(0.03, 0.20)	< 0.005	∗

Cancer incidence (including SEER data)

	Unknown	46	1.43	(0.85, 2.40)	0.17	
Leukemia	White	145	1.00	–		
	Black	44	1.18	(0.80, 1.73)	0.40	
	Unknown	40	0.93	(0.57, 1.51)	0.77	
Non-Hodgkin lymphoma	White	289	1.00	–		
	Black	46	0.59	(0.42, 0.83)	< 0.005	*
	Unknown	61	0.61	(0.42, 0.90)	0.01	*
All cancers	White	4800	1.00	–		
	Black	1730	1.37	(1.28, 1.45)	< 0.005	*
	Unknown	1311	1.06	(0.97, 1.15)	0.22	

Cancer incidence (including SEER data)

Citations

1. Garcia E, Picciotto S, Costello S, Bradshaw PT, Eisen EA. Assessment of the healthy worker survivor effect in cancer studies of the united autoworkers-general motors cohort. *Occupational and environmental medicine.* 2017;74(4):294-300.