HWSE path analysis

Replicating (?) the analysis in Garcia et al. (2017)

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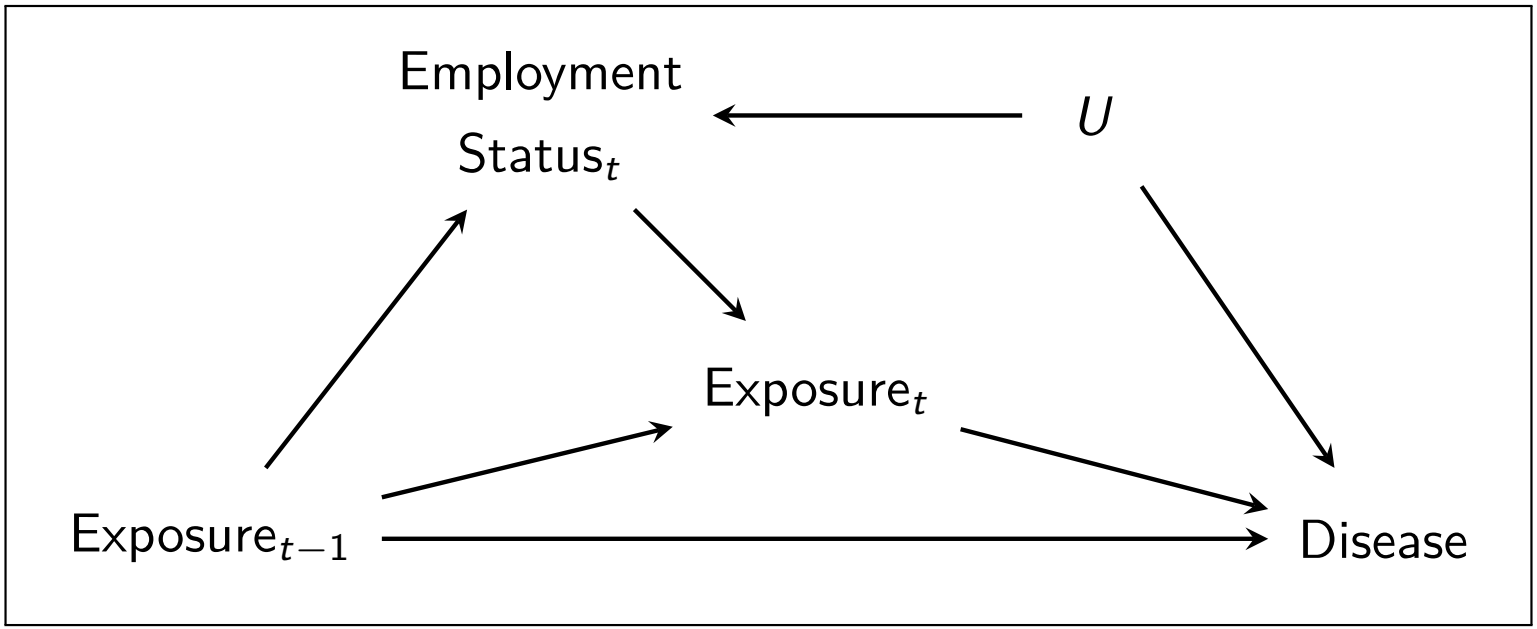
From Erika Garcia's paper[1]



The presence of the healthy worker survivor effect (HWSE) implies the presence of the following three conditions:

1. Leaving work predicts (future) exposure
2. Leaving work is associated with the disease
3. Prior exposure predicts predicts leaving work

Analytic population

- Restricted to
  - Those alive and under age 75 on January 1, 1985
  - Missing no more than half of their work history
  - No discrepancy identified
  - No job history pattern with 1977
  - Record has reliable job history data (not an odd end)
  - Eligible for cancer follow-up (2004, 2009, and 2015)
- Leaving work and cancer incidence
  - FU spans 1985–1994
- MWF exposure and leaving work
  - FU spans 3 years after hire throuh 1994, death, or leaving work

Characteristics

	Cancer follow-up		Employment follow-up	
Study population size (person-years)	31,758	(290,757)	31,758	(954,672)
Race				
White	20,960	(66%)	20,960	(66%)
Black	5,929	(19%)	5,929	(19%)
Unknown	4,869	(15%)	4,869	(15%)
Sex				
Male	27,581	(87%)	27,581	(87%)
Female	4,177	(13%)	4,177	(13%)
Plant[♮]				
Plant 1	7,265	(23%)	7,264	(23%)
Plant 2	13,246	(42%)	13,246	(42%)
Plant 3	11,247	(35%)	11,248	(35%)
Ever exposed to MWFs				
Straight	18,517	(58%)	18,517	(58%)
Soluble	28,517	(90%)	28,517	(90%)
Synthetic	11,757	(37%)	11,757	(37%)
Left work by 1995	20,822	(66%)	20,822	(66%)
Deceased by end of follow-up	3,132	(10%)	3,132	(10%)

Cancers in men

	All cancers		Prostate	
Study population size (person-years)	1,388	(11,002)	385	(3,428)
Year of birth	1926	(1920, 1933)	1923	(1919, 1929)
Year of hire	1953	(1949, 1966)	1953	(1948, 1963)
Race				
White	833	(60%)	218	(57%)
Black	304	(22%)	113	(29%)
Unknown	251	(18%)	54	(14%)
Deceased by end of follow-up	655	(47%)	64	(17%)
Left work by 1995	1,294	(93%)	365	(95%)
Age at leaving work (years)*	55	(40, 61)	58	(44, 62)

Cancers in men

		Lung		Colorectal
Study population size (person-years)	338	(2,272)	181	(1,472)
Year of birth	1925	(1920, 1932)	1925	(1919, 1932)
Year of hire	1953	(1949, 1965)	1953	(1948, 1966)
Race				
White	186	(55%)	113	(62%)
Black	74	(22%)	37	(20%)
Unknown	78	(23%)	31	(17%)
Deceased by end of follow-up	277	(82%)	70	(39%)
Left work by 1995	334	(99%)	171	(94%)
Age at leaving work (years)*	53	(38, 60)	56	(39, 62)

Cancers in women

	All cancers	
Study population size (person-years)	208	(1,698)
Year of birth	1929	(1921, 1943)
Year of hire	1968	(1953, 1976)
Race		
White	126	(61%)
Black	41	(20%)
Unknown	41	(20%)
Deceased by end of follow-up	83	(40%)
Left work by 1995	166	(80%)
Age at leaving work (years)*	51	(41, 59)

2. Leaving work and cancer incidence

- Exposure: Employment status (binary)
- Conditioning set:
  - Age
    (index time for Cox model)
  - Cumulative MWF exposure
    (lagged 1 year)
  - Year of hire
    (P-spline, $df = 3$)
  - Calendar year
    (P-spline, $df = 3$)
  - Duration of employment
  - Race
    (unknown as white)
  - Plant
  - Sex
- If cancer incidence date was the same as the date of leaving work, it was considered to have occurred after leaving work
- If cancer incidence date was after date of death, it was assumed to have been on the day of death

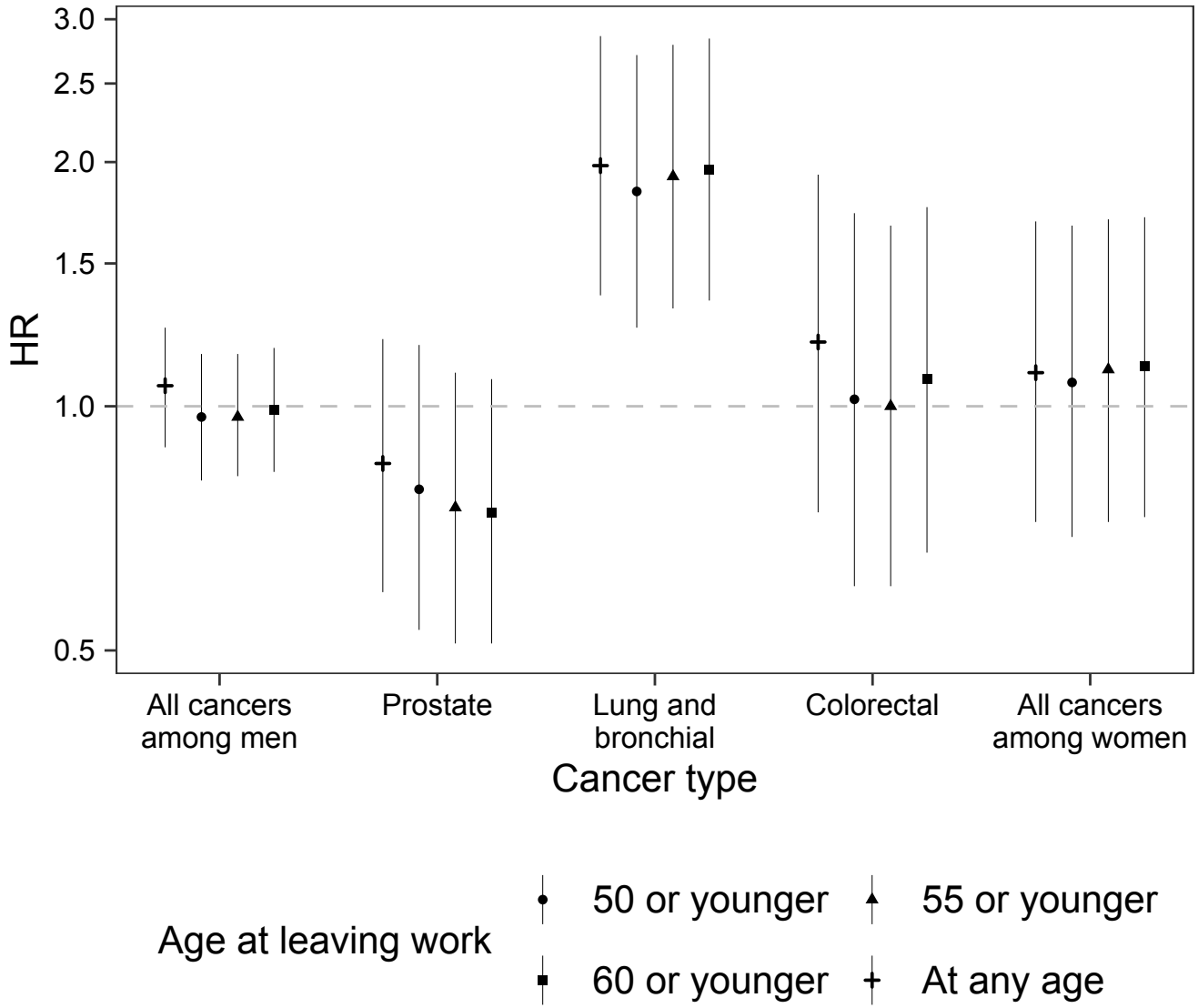
2. Leaving work by age 50 and cancer incidence

$$\begin{aligned}\log h(t \mid a,\ x) = \log h_0(t) & \\ & + a \cdot \mathbb{1}\left[t < 51\right] \cdot \beta_1 + a \cdot \mathbb{1}\left[t \geq 51\right] \cdot \beta_2 \\ & + x \begin{pmatrix} \beta_3 & \cdots & \beta_p \end{pmatrix}^\top\end{aligned}$$

where a is the indicator of having left work, t is age, and x is a vector of covariates

- Coefficients β_1 and β_2 may be thought of as interaction effects of employment status and age

2. Leaving work and cancer incidence



3. Prior exposure and leaving work

- Exposure: Cumulative exposure lagged 1 year
- Conditioning set:
  - Age
    (index time for Cox model)
  - Calendar year
    (P-spline $df = 3$)
  - Race
    (unknown as white)
  - Plant

3. Prior exposure and leaving work (men)

MWF exposure	n	Adjusted HR	(95% CI)
Cumulative straight			
0	8132	1.00	
$>$ 0 to 0.393	3419	1.15	(1.1, 1.21)
$>$ 0.393 to 2.06	3419	1.09	(1.05, 1.14)
$>$ 2.06	3419	1.11	(1.06, 1.16)
Cumulative soluble			
0 to 1.27	4386	1.00	
$>$ 1.27 to 4.81	4668	1.13	(1.08, 1.18)
$>$ 4.81 to 15.1	4667	1.11	(1.06, 1.16)
$>$ 15.1	4668	1.21	(1.16, 1.27)
Cumulative synthetic			
0	12795	1.00	
$>$ 0 to 0.266	1865	0.86	(0.81, 0.91)
$>$ 0.266 to 1.53	1864	0.90	(0.84, 0.95)
$>$ 1.53	1865	1.07	(1.02, 1.13)

3. Prior exposure and leaving work (women)

MWF exposure	n	Adjusted HR	(95% CI)
Cumulative straight			
0	1085	1.00	
$>$ 0 to 0.185	448	1.07	(0.95, 1.21)
$>$ 0.185 to 0.972	447	1.02	(0.89, 1.16)
$>$ 0.972	448	1.21	(1.07, 1.37)
Cumulative soluble			
0 to 0.11	582	1.00	
$>$ 0.11 to 1.55	616	1.05	(0.93, 1.19)
$>$ 1.55 to 4.2	615	1.18	(1.03, 1.34)
$>$ 4.2	615	1.22	(1.06, 1.39)
Cumulative synthetic			
0	1547	1.00	
$>$ 0 to 0.172	294	1.10	(0.95, 1.28)
$>$ 0.172 to 0.844	293	1.04	(0.89, 1.21)
$>$ 0.844	294	1.15	(0.99, 1.33)

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.