

Epidemiology of Occupational Cancers

Lesley Rushton
MRC-PHE Centre for Environment and Health

Estimating the Burden of Occupational Cancer in Britain

Aims

- Establish baseline risk
- Identification of major risk factors
 - Carcinogens (42)
 - Cancer sites (23)
 - Industries and occupations (60+)
- Support decisions on priority actions for risk reduction
- Facilitate planning for future needs
- Identify knowledge gaps

What did we estimate?

- **Current Burden of Occupational Cancer:**
 - Estimate size of current burden based on past exposures at work
 - Estimation carried out for all substances and circumstances (e.g. work as a painter or welder) in the workplace defined by International Agency for Research on Cancer (IARC) as:
 - » **definite** (group 1) human carcinogen
 - » **probable** (group 2A) human carcinogen
- **Prediction of Future Burden of Occupational Cancer**
 - Estimate size of future burden based on current and past exposures
 - Demonstrate effect of measures to reduce exposure

How did we measure burden?

- **Measured burden using:**
 - » **Attributable Fraction:** proportion of cases attributable to exposure
 - » **Attributable Deaths**
 - » **Attributable Cancer Registrations** (Newly occurring cancers)
 - » **DALYs (YLL + YLD):** (Disability-adjusted life-years = Years of life lost + Years of life lived with a disability)
- **Used data from:**
 - Published literature on occupational risks
 - National data sources
 - » Carcinogen exposure database (CAREX)
 - » Labour Force Survey (LFS)
 - » Employment data

Attributable fraction

Cancer site:	Attributable Fraction(%)		
	Male	Female	Total
Bladder	7.1	1.9	5.3
Breast	4.6	4.6	4.6
Larynx	2.9	1.6	2.6
Leukaemia	0.9	0.5	0.7
Lung	21.1	5.3	14.5
Mesothelioma	97.0	82.5	94.9
Non-Hodgkin's Lymphoma	2.1	1.1	1.7
Non-melanoma Skin Cancer	6.9	1.1	4.5
Oesophagus	3.3	1.1	2.5
Sinonasal	43.3	19.8	32.7
Soft Tissue Sarcoma	3.4	1.1	2.4
Stomach	3.0	0.3	1.9
Total	8.2	2.3	5.3
Total GB cancers 15+yrs			

Attributable fraction, deaths

Cancer site:	Attributable Fraction(%)			Attributable Deaths (2005)		
	Male	Female	Total	Male	Female	Total
Bladder	7.1	1.9	5.3	215	30	245
Breast	4.6	4.6	4.6		555	555
Larynx	2.9	1.6	2.6	17	3	20
Leukaemia	0.9	0.5	0.7	18	5	23
Lung	21.1	5.3	14.5	4,020	725	4,745
Mesothelioma	97.0	82.5	94.9	1,699	238	1,937
Non-Hodgkin's Lymphoma	2.1	1.1	1.7	43	14	57
Non-melanoma Skin Cancer	6.9	1.1	4.5	20	2	23
Oesophagus	3.3	1.1	2.5	156	28	184
Sinonasal	43.3	19.8	32.7	27	10	38
Soft Tissue Sarcoma	3.4	1.1	2.4	11	3	13
Stomach	3.0	0.3	1.9	101	6	108
Total	8.2	2.3	5.3	6,355	1,655	8,010
Total GB cancers 15+yrs				77,912	72,212	150,124

Attributable fraction, deaths and new cancers

Cancer site:	Attributable Fraction(%)			Attributable Deaths (2005)			Attributable Registrations (2004)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Bladder	7.1	1.9	5.3	215	30	245	496	54	550
Breast		4.6	4.6		555	555		1,969	1,969
Larynx	2.9	1.6	2.6	17	3	20	50	6	56
Leukaemia	0.9	0.5	0.7	18	5	23	30	9	38
Lung	21.1	5.3	14.5	4,020	725	4,745	4,627	815	5,442
Mesothelioma	97.0	82.5	94.9	1,699	238	1,937	1,699	238	1,937
Non-Hodgkin's Lymphoma	2.1	1.1	1.7	43	14	57	102	39	140
Non-melanoma Skin Cancer	6.9	1.1	4.5	20	2	23	2,513	349	2,862
Oesophagus	3.3	1.1	2.5	156	28	184	159	29	188
Sinonasal	43.3	19.8	32.7	27	10	38	95	31	126
Soft Tissue Sarcoma	3.4	1.1	2.4	11	3	13	22	4	27
Stomach	3.0	0.3	1.9	101	6	108	149	9	157
Total	8.2	2.3	5.3	6,355	1,655	8,010	9,988	3,611	13,598
Total GB cancers 15+yrs				77,912	72,212	150,124	175,399	168,184	343,583

Rankings by different burden measures

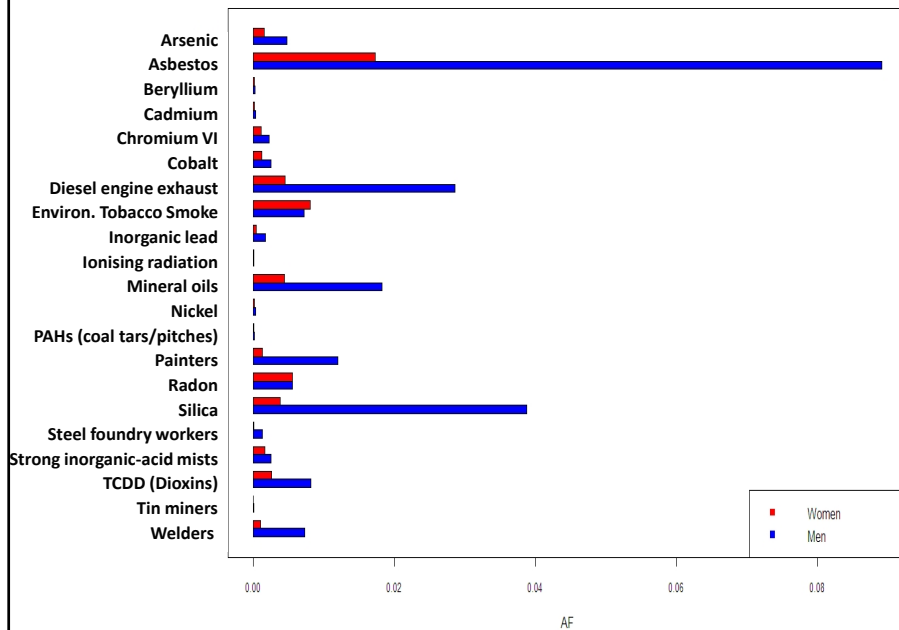
AFs (%)	Deaths	Registrations	Typical mean YLL (years)
Mesothelioma (95)	Lung (4745)	Lung (5442)	Breast (17.3)
Sinonasal (33)	Mesothelioma (1937)	NMSC (2862)	NHL (16.9)
Lung (14.5)	Breast (555)	Breast (1969)	Sinonasal (16.4)
Bladder (5.3)	Bladder (245)	Mesothelioma (1937)	Mesothelioma (13.9)
Breast (4.6)	Oesophagus (184)	Bladder (550)	Oesophagus (13.7)
NMSC (4.5)	Stomach (108)	Oesophagus (188)	Lung (13.2)
Larynx (2.6)	NHL (57)	Stomach (157)	Stomach (12.3)
Oesophagus (2.5)	Sinonasal (38)	NHL (140)	Bladder (9.6)

AF: attributable fraction; NMSC: non-melanoma skin cancer; NHL: non-Hodgkin lymphoma; YLL: years of life lost

Major occupational carcinogens

Cancer Site	Asbestos	Shift work	Mineral oils	Solar radiation	Silica	Diesel Engine Exhaust	Polycyclic Aromatic Hydrocarbons (Tars)	Painters	Dioxins	Environmental Tobacco Smoke	Radon	Welders	All
Bladder			296			106		71					550
Breast		1,957											1,969
Larynx	8												56
Leukaemia													38
Lung	2,223		470		907	695		282	215	284	209	175	5,442
Mesothelioma	1,937												1,937
Non-Hodgkins Lymphoma									74				140
Non-Melanoma Skin Cancer			902	1,541			475						2,862
Oesophagus													188
Sinonasal			55										126
Soft Tissue Sarcoma									27				27
Stomach	47							83					157
Total Registrations	4,216	1,957	1,722	1,541	907	801	475	437	316	284	209	175	13,598

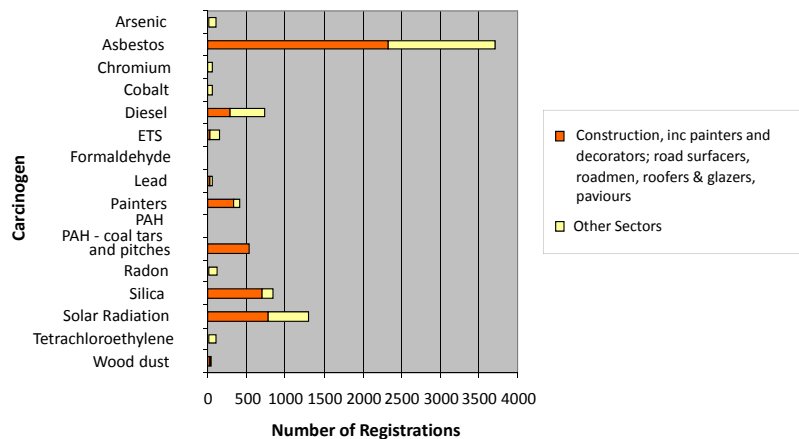
Lung cancer by carcinogen/occupation



Major industry sectors

Industry Sector	Asbestos	Shift work	Mineral oils	Solar radiation	Silica	DEE	PAHs (Tars)	Painters	Dioxins	ETS	All
Total Agriculture and Farming				135					55		263
Iron/steel industries			0	0		0	4		75		135
Manufacture industrial chemicals	64				1	1			11		121
Metal workers			1,252								1,252
Mining	197			31	29	43					302
Non-ferrous metal industries				9	4	2			50		159
Total Manufacturing	535		1,722	163	200	80	4	102	254		3,944
Total Construction	2,773			841	707	290	471	334		36	5439
Land transport	133			6		350				3	505
Personal/household services	361		7	14		29				22	804
Public admin./defence				240						20	273
Total Service Industry	573	1,957	7	402		431			7	248	4,177
Total Registrations	4,216	1,957	1,722	1,541	907	801	475	437	316	284	13,598

Cancer Registrations Attributable to Work in the Construction Industry - Men



Key results on the current burden of occupational cancer in Britain

- **Overall burden**
 - » 5.3% (8.2% men, 2.3% women) of all cancers are due to occupational carcinogens
 - » Gives 8010 deaths and 13598 new cancers
- **Key cancer sites**
 - » Mesothelioma, Lung, Bladder, Breast, Non-melanoma skin, sinonasal
- **Key carcinogens (100+ new cancers)**
 - » Asbestos, shift/night work, mineral oils, solar radiation, silica, diesel engine exhaust, coal tars/pitches, occupation as a painter or welder, dioxins, environmental tobacco smoke, radon, tetrachloroethylene, arsenic and strong inorganic mists
- **Key industries**
 - » construction, metal working, personal and household services, mining, land transport, printing/publishing, retail/hotels/restaurants, public administration/defence, farming and several manufacturing sectors.

Predicting Future Burden

- Attributable Fractions and Attributable Numbers of deaths and cancer registrations estimated for a series of forecast years, e.g. 2010, 2020 ... 2060
- Changing balance between past and future exposure
- Method provides a tool for comparing 'doing nothing' with various interventions
- Methods applied to top 14 carcinogens/occupations identified as accounting for 85.7% of total current (2004) cancer registrations

Change in future exposure: Intervention Scenarios

Baseline scenario - based on pattern of past exposure, but no future change in exposed numbers or exposure levels

Interventions - can test:

- Introduction of a range of possible **exposure standards** or reduction of a current exposure limit
- **Improved compliance** to an existing exposure standard
- **Planned intervention** such as engineering controls or introduction of personal protective equipment
- **Timing** of introduction (2010, 2020 etc)
- Compliance levels e.g. according to **workplace size** (self-employed, 1-49, 50-249, 250+ employees)

Compare predicted numbers from baseline 'no change' with interventions

Example of silica

Silica: current limit 0.1 mg/m³, 33% compliance

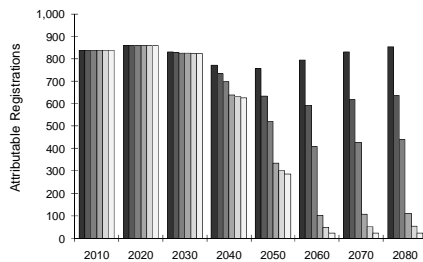
- Reduce exposure limit in all workplaces to:
 - 0.05 mg/m³ in 2010
 - 0.025 mg/m³ in 2010
- Improve compliance from 33% to 90% in all workplaces
- Do both for all workplaces
- Successively enforce a new limit and improve compliance in workplaces of different sizes

Reduce exposure standard and then improve compliance

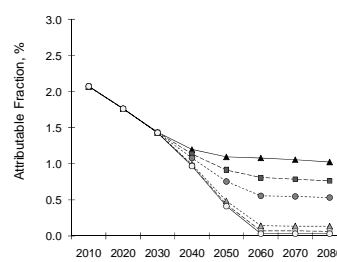
Lung cancers from respirable crystalline silica			
2010			
	Attributable Fraction	Attributable cancers	Avoided cancers
	3.3	803	
Test scenarios			
2060			
Base-line: exposure limit 0.1mg/m ³ , compliance 33%	1.08	794	
Exposure limit 0.05mg/m ³ , compliance 33%	0.80	592	202
Exposure limit 0.025mg/m ³ , compliance 33%	0.56	409	385
Exposure limit 0.1mg/m ³ , compliance 90%	0.14	102	693
Exposure limit 0.05mg/m ³ , compliance 90%	0.07	49	745
Exposure limit 0.025mg/m ³ , compliance 90%	0.03	21	773

Reduce exposure standard and then improve compliance

A) Attributable registrations



B) Attributable Fractions



- Baseline: exposure limit 0.1mg/m³ maintained, compliance 33%
- Exposure limit 0.05mg/m³ from 2010, compliance 33%
- Exposure limit 0.025mg/m³ from 2010, compliance 33%
- Exposure limit 0.1mg/m³ maintained, compliance 90%
- Exposure limit 0.05mg/m³ from 2010, compliance 90%
- Exposure limit 0.025mg/m³ from 2010, compliance 90%

Test improvement in compliance by workplace size

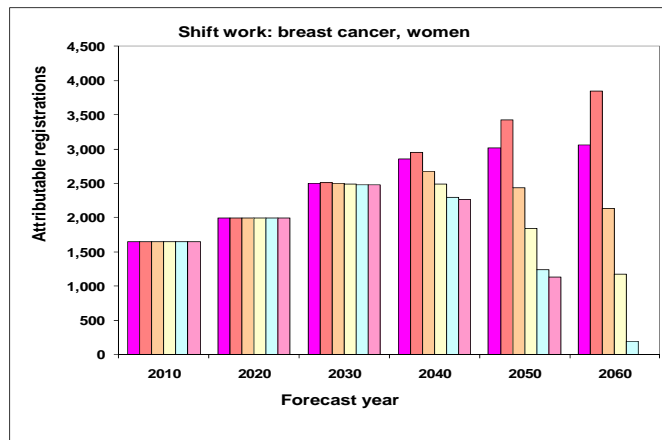
Lung cancers from respirable crystalline silica			
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	Attributable Fraction %	Attributable cancers	Avoided cancers
	3.3	803	
2060			
Test scenarios			
Exposure limit 0.1mg/m ³ , compliance 33%	1.08	794	
Exposure limit 0.05mg/m ³ , compliance 33%	0.80	592	202
Exposure limit 0.05mg/m ³ , change compliance by workplace size/self employed			
90% 250+; 33% <250, self employed	0.68	499	295
90% 50+; 33% <50, self employed	0.61	451	344
90% all sizes employed; 33% self employed	0.35	261	533
90% all workplaces	0.07	49	745

Occupational Circumstances no 'exposure data' Example: Shift Work (Night work)

- Breast cancer: important contribution to the total current occupational cancer burden
- Exposure defined by nature of occupation – unknown agent, no exposure data
- Evidence of dose response with duration of night work (Lie et al 2006)

Duration	Relative Risk	Proportion 'exposed'
<5 years:	0.95	30%
5-14 years:	1.29	40%
15+ years:	2.21	30%

- Intervention scenarios expressed as limiting proportions in night work for durations of 15+ and 5+ years



- (1) Current employment levels maintained, 30% <5, 40% 5-14, 30% 15+ years night shift work
- (2) Linear employment trends to 2021-30
- (3) 50%<5, 30% 5-14, 20% 15+ years night shift work
- (4) 70%<5, 20% 5-14, 10% 15+
- (5) 90%<5, 10% 5-14, 0% 15+
- (6) 100% <5 years

Summary of Future Burden Results

- 14 agents account for 85.7% current occupation attributable cancer giving 12,000 cancers in 2010
- Will rise to nearly 13,000 by 2060 given current trends in employment and exposure levels.
- No impact seen until 2030 because of general increase in cancers due to aging population
- With modest intervention over 2,000 cancers can be avoided by 2060 (including 376 lung, 928 breast cancers, 432 NMSC)
- With stronger interventions nearly 8,500 can be avoided by 2060 (including 1,732 lung, 3,062 breast and 3,287 NMSC)
- Methods enables effective interventions to be identified
- Need to monitor exposure levels in future to assess whether interventions have been successful

Prevention

- Our study has showed that workplace cancers are a concern
- The current occupational cancer burden is mostly caused by a small number of agents
- Without any additional actions burden in the future will stay approximately the same
- Exposures have been decreasing steadily over time
- Focused effort could ensure the occupational cancer burden becomes much less:
 - Small and medium sized companies, self employed workers
 - Dusts, fibres, fumes, gases through inhalation e.g. asbestos, silica, wood dust, diesel exhaust, welding fumes
 - Solar radiation – encourage use of sunscreens and appropriate clothing
 - Shift (night) work

Publications

- Current burden results
 - Overview Paper: [Br J Cancer 2010, 102: 1428-1437](#)
 - Supplement (13 papers) of current burden detailed results
 - » [Br J Cancer 2012;107\(S1\):S1-S108](#)
 - » 23 technical reports available at <http://www.hse.gov.uk/cancer/>
- Future burden
 - Methodology paper: [Am J Epidem 2011, 173, 1069-1077](#)+ technical report on HSE website
 - Future burden results: [Cancer Prevention Research, 2012, online](#)