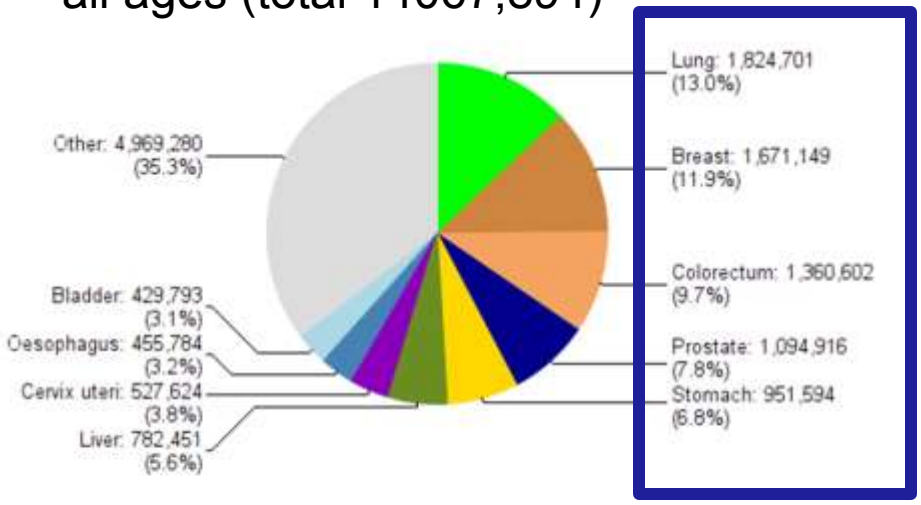
Occupational Risk Factors for Lung Cancer

Dr Ann Olsson
International Agency for Research on Cancer
Lyon, France

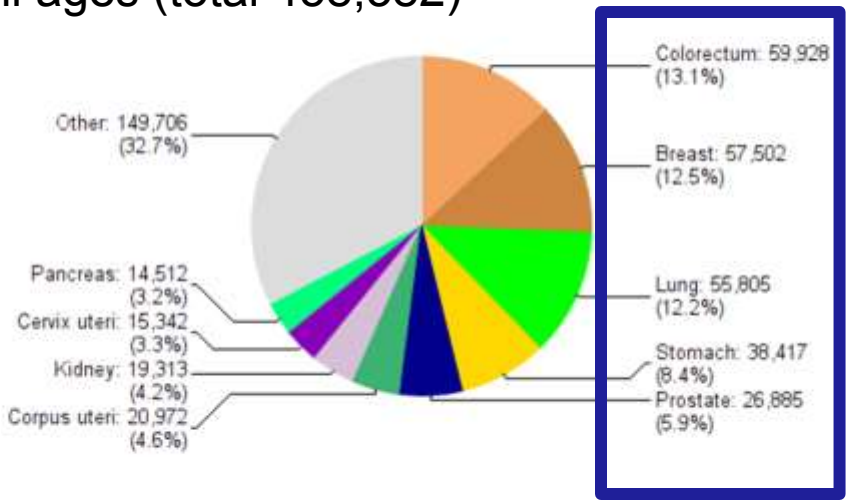
Lung cancer…

is the most common cancer in the world

World population, both sexes
Estimated number of cancer cases
all ages (total 14067,894)



Russian Federation, both sexes
Estimated number of cancer cases
all ages (total 458,382)



International Agency for Research on Cancer

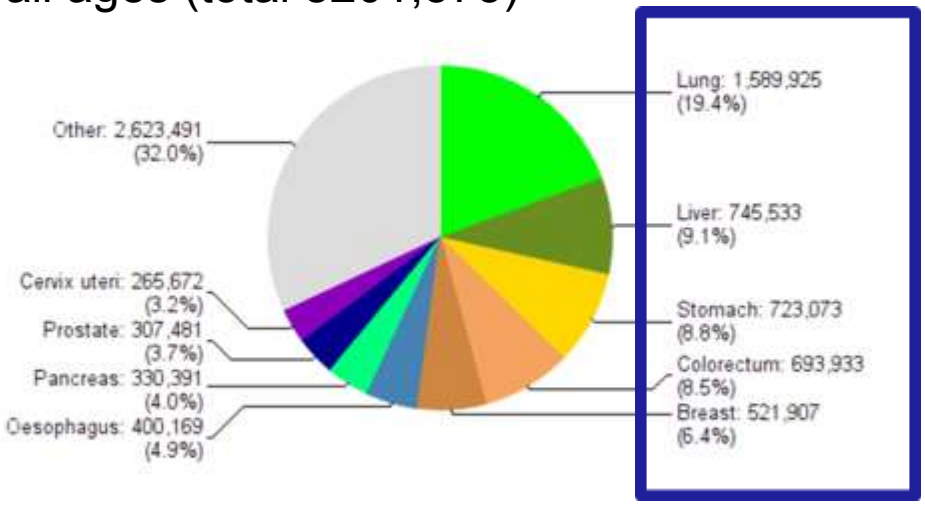
World Health Organization

GLOBOCAN 2012 (IARC) – 2.9.2015

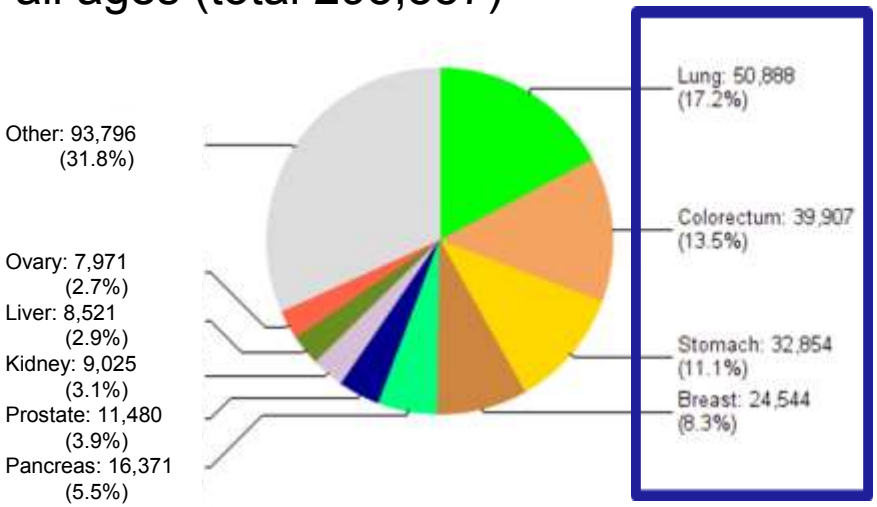
Lung cancer…

is the most common death from cancer in the world

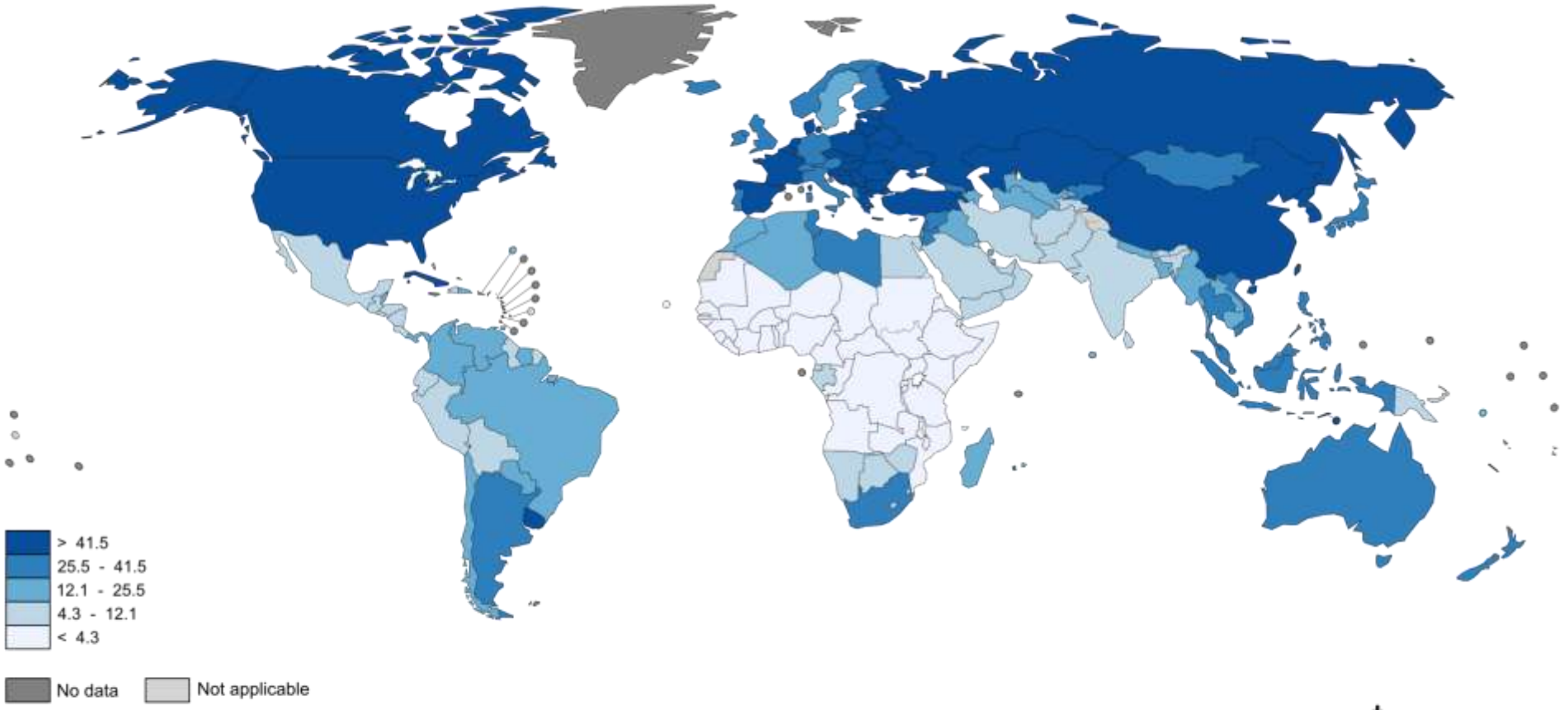
World population, both sexes
Estimated number of cancer deaths, all ages (total 8201,575)



Russian Federation, both sexes
Estimated number of cancer deaths, all ages (total 295,357)



Estimated Lung Cancer Incidence Worldwide in 2012: Men



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data source: GLOBOCAN 2012
Map production: IARC
World Health Organization

World Health Organization

Risk factors for lung cancer

- Tobacco smoking
- Second-hand smoke
- Radon gas, residential
- Occupational exposures (asbestos, silica, diesel exhaust etc.)
- Outdoor air pollution
- Indoor air pollution
- Family history
- Previous cancer
- Previous lung disease (pneumonia, silicosis, COPD)
- Autoimmune conditions, organ transplant, diabetes
- Beta-carotene supplements

Agents (n=982) classified by the IARC Monographs since 1971

Group	Definition	Number
1	Carcinogenic to humans	117
2A	Probably carcinogenic to humans	74
2B	Possibly carcinogenic to humans	287
3	Not classifiable as to its carcinogenicity to humans	503
4	Probably not carcinogenic to humans	1

http://monographs.iarc.fr/

IARC Group 1 carcinogens by main source of exposure

Exposure	Number
Occupation	57
Lifestyle	10
Radiation	17
Pharmaceuticals	22
Biological agents	11

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Vol. 1-113 (http://monographs.iarc.fr/ENG/Monographs/)

Occupational risk factors for lung cancer

Asbestos

Arsenic

Iron and steel founding

Silica

Chromium VI

Soot

Diesel engine exhaust

Aluminium production

Coal tar pitch

Rubber production industry

Cadmium

Nickel

Beryllium

Hematite mining (underground)

Coke production

Coal gasification

Bis(chloromethyl)ether

Painting

X-radiation, gamma radiation

…

International Agency for Research on Cancer

World Health Organization

How much of the lung cancer burden is due to occupational exposures?

Authors	When	Where	Who	Attributable fraction %
Doll & Peto	1981	US	Men	15
Autier et al.	2000	France	Men Women	11 4
Olsson et al.	1998-2002	IARC multi-centre study in Central & Eastern Europe	Men Gr 1 Men Gr 1+2A Women Gr 1 Women Gr 1+2A	8 16 1 5
Rushton et al.	2005	UK	Men Gr 1 Men Gr 1+2A Women Gr 1 Women Gr 1+2A	18 21 4 5

Agents with limited evidence for lung cancer

- Acid mists, strong inorganic
- Art glass manufacturing
- Biomass fuel (primarily wood)
- Bitumens (oxidized, hard), exposure their emissions during roofing and mastic asphalt work
- Carbon electrode manufacture
- alpha-Chlorinated toluenes and benzoyl chloride (combined exposures)
- Cobalt metal with tungsten carbide
- Creosotes
- Diazinon
- Fibrous silicon carbide
- Frying, emissions from high-temperature
- Insecticides, non-arsenical, occupational exposures in spraying and application
- Printing processes
- 2,3,7,8-Tetrachlorodibenzo para-dioxin
- Welding fumes
- Plus > 500 agents in Group 3

Asbestos

Exposure occurs mainly in:

- Construction
- Service industries
- Manufacturing
- Mining
- Quarrying
- Electricity
- Gas
- Water

Asbestos insulation around a pipe

International Agency for Research on Cancer

World Health Organization

Silica

Exposure occurs mainly in:

- Construction
- Manufacturing
- Mining

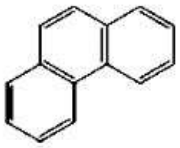
Metals

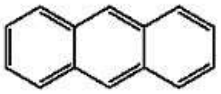
Exposure occurs mainly in:

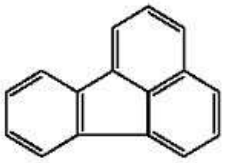
- Metal smelting
- Metal plating
- Foundries
- Manufacturing, processing, and application of metals and metal-containing products

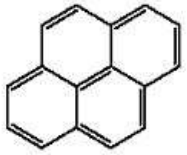
Polycyclic aromatic hydrocarbons

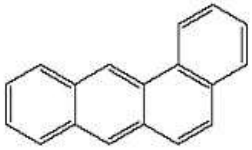
Group 1 carcinogenic to humans

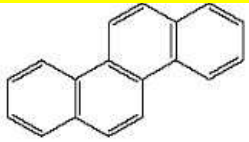

phenanthrene

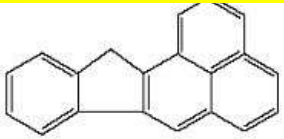

anthracene

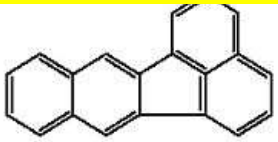

fluoranthene

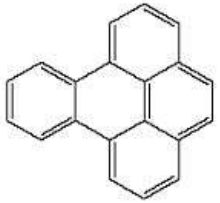

pyrene

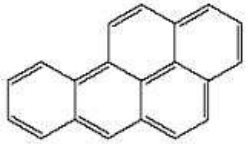

benzo[a]anthracene

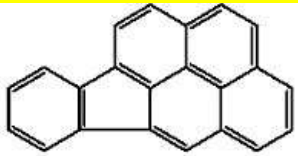

chrysene

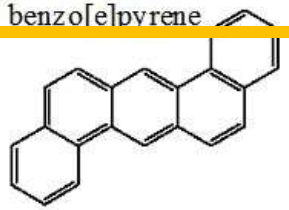

benzo[b]fluoranthene

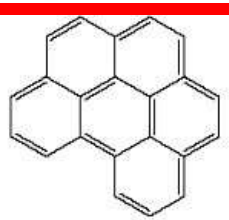

benzo[k]fluoranthene


benzo[e]pyrene


benzo[a]pyrene


indeno[1,2,3-cd]pyrene


Dibenz [a,h]anthracene


benzo[ghi]perylene

Occupational exposure during:

- Coal gasification
- Coke production
- Coal-tar distillation
- Chimney sweep
- Paving and roofing with coal tar pitch
- Aluminium production

Group 2A probably carcinogenic

Occupational exposure during:

- Carbon electrode manufacture

Group 2B possibly carcinogenic

International Agency for Research on Cancer

World Health Organization

Diesel engine exhaust

Exposure occurs mainly in:

- Construction
- Manufacturing
- Mining
- Transport

International Agency for Research on Cancer

World Health Organization

The SYNERGY project

- Started in 2007 to study joint effects of occupational exposures and smoking on lung cancer
- 16 case-control studies from Europe, North America, China (Hong Kong), New Zealand conducted 1985-2010
- ~19,300 lung cancer cases, ~23,600 controls
- Complete occupational and tobacco history, start and stop
- Occupational data coded according to International Standard Classification of Occupations (ISCO -68) and the International Standard Industrial Classification of all Economic Activities (ISIC Rev. 2)

Objectives

- Estimate joint effects of selected occupational exposures and smoking
- Estimate risks in important sub populations
- Address additional open research questions:
  - organic dust, diesel motor exhaust, smoking by histology etc.
  - hairdresser, cooks, welders, bricklayer, and miners

Diesel Motor Exhaust in SYNERGY

Cumulative DME exposure	OR 1 (95% CI)	OR 2 (95% CI)
1st Quartile	1.04 (0.96-1.13)	0.98 (0.89-1.08)
2nd Quartile	**1.13 (1.04-1.23)**	1.04 (0.95-1.14)
3rd Quartile	**1.23 (1.13-1.33)**	1.06 (0.97-1.16)
4th Quartile	**1.42 (1.31-1.54)**	**1.31 (1.19-1.43)**

OR 1 is adjusted for age, sex, study, and ever employment in a “List A” job
OR 2 is in addition adjusted for cigarette pack-years and time-since-quitting-smoking

Olsson et al. Am J Resp Crit Care Med, 2011

Diesel Motor Exhaust in SYNERGY

Duration among workers exposed to only low DME levels	OR 1 (95% CI)	OR 2 (95% CI)
1-10 years	1.05 (0.97-1.13)	1.00 (0.92-1.09)
11-20 years	1.08 (0.98-1.20)	0.98 (0.88-1.10)
21-30 years	**1.18 (1.06-1.33)**	1.03 (0.91-1.17)
>30 years	**1.28 (1.18-1.40)**	**1.17 (1.07-1.29)**
Duration among workers ever exposed to high DME levels	**OR 1 (95% CI)**	**OR 2 (95% CI)**
1-10 years	**1.48 (1.33-1.65)**	**1.28 (1.14-1.45)**
11-20 years	**1.34 (1.10-1.62)**	1.21 (0.98-1.51)
21-30 years	**1.75 (1.36-2.26)**	**1.52 (1.15-2.02)**
>30 years	**1.59 (1.22-2.08)**	**1.45 (1.07-1.96)**

International Agency for Research on Cancer

World Health Organization

OR 1 is adjusted for age, sex, study, and ever employment in a “List A” job

OR 2 is in addition adjusted for cigarette pack-years and time-since-quitting-smoking

Hairdressers & Cooks in SYNERGY

Female hairdressers	OR 1 (95% CI)	OR 2 (95% CI)
Ever	**1.65 (1.16-2.35)**	1.12 (0.75-1.68)
<8 years	**2.07 (1.25-3.46)**	1.28 (0.72-2.29)
8-26 years	1.00 (0.51-1.97)	0.93 (0.42-2.02)
>26 years	1.96 (0.95-4.03)	1.10 (0.48-2.51)

Olsson et al. Am J Epi, 2013

Male cooks	OR 1 (95% CI)	OR 2 (95% CI)
Ever	**1.27 (1.09-1.49)**	0.98 (0.83-1.17)
< 4 years	1.11 (0.81-1.52)	0.87 (0.61-1.22)
4-8 years	**1.61 (1.14-2.27)**	1.23 (0.83-1.81)
9-22 years	1.34 (0.97-1.85)	0.97 (0.68-1.40)
> 22 years	1.17 (0.89-1.53)	0.93 (0.68-1.28)

Bigert et al. JOEM, 2015

International Agency for Research on Cancer

World Health Organization

OR 1 is adjusted for age, sex, study, and ever employment in a “List A” job

OR 2 is in addition adjusted for cigarette pack-years and time-since-quitting-smoking

Bricklayers in SYNERGY

Bricklayers	OR 1 (95% CI)	OR 2 (95% CI)
Ever	**1.47 (1.28-1.68)**	**1.32 (1.14-1.52)**
< 10 years	1.20 (0.98-1.47)	1.10 (0.90-1.36)
10-19 years	**1.55 (1.09-2.20)**	1.37 (0.96-1.94)
20-29 years	**1.73 (1.17-2.56)**	**1.53 (1.03-2.26)**
30-39 years	**2.43 (1.61-3.66)**	**2.12 (1.40-3.20)**
≥ 40 years	**1.81 (1.22-2.69)**	**1.58 (1.06-2.35)**

Consonni et al. IJC, 2015

International Agency for Research on Cancer

World Health Organization

OR 1 is adjusted for age, sex, study, “List A/B” jobs, and education
OR 2 is in addition adjusted for smoking

Welding in SYNERGY

Years as welder	Among all OR (95% CI)	Among workers who had smoked 0-10 pack-years OR (95% CI)
1-2 years	1.14 (0.80-1.61)	1.27 (0.52-3.09)
3-9 years	**1.46 (1.26-1.91)**	1.78 (0.96-3.31)
10-25 years	**1.38 (1.06-1.79)**	1.84 (0.95-3.56)
>25 years	**1.77 (1.31-2.39)**	**3.72 (1.93-7.19)**
Years in occasional welding occupations	**Among all OR (95% CI)**	**Among workers who had smoked 0-10 pack-years OR (95% CI)**
1-2 years	1.13 (0.94-1.34)	0.93 (0.58-1.49)
3-9 years	**1.11 (1.00-1.24)**	1.24 (0.86-1.78)
10-25 years	**1.16 (1.00-1.34)**	**1.39 (1.03-1.88)**
>25 years	**1.40 (1.21-1.62)**	1.31 (0.94-1.81)

OR adjusted for age, study, cigarette pack-years and time-since-quitting-smoking, List A (excl. welding related occupations)

Kendzia et al. Am J Epi, 2013

Miners in SYNERGY

Ore miners	OR 1 (95% CI)	OR 2 (95% CI)
Ever	**2.32 (1.43-3.78)**	**2.34 (1.36-4.03)**
1-9 years	-	**2.21 (1.21-4.02)**
10-19 years	-	2.26 (0.58-8.85)
≥20 years	-	-

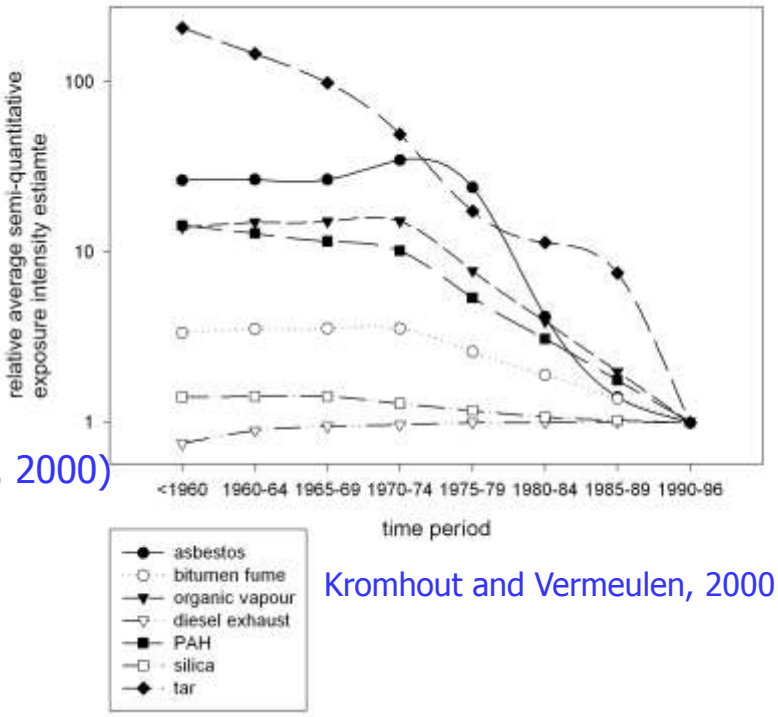
Cole miners	OR 1 (95% CI)	OR 2 (95% CI)
Ever	**1.57 (1.34-1.83)**	**1.40 (1.18-1.67)**
1-9 years	-	**1.46 (1.18-1.80)**
10-19 years	-	0.99 (0.67-1.47)
≥20 years	-	**1.73 (1.14-2.65)**

Taeger et al. SJWEH, 2015

OR 1 is adjusted for age, sex, study, "List A" except mining and quarrying
OR 2 is in addition adjusted for cigarette pack-years and time-since-quitting-smoking

Long-term trends in Europe "It's getting better all the time"

- Asphalt paving (Burstyn et al. 2000)
  - 6% for bitumen fume
  -14% for bitumen vapor
  -11% for PAH
- Carbon black (van Tongeren et al. 2000)
  -7% to -13% for inhalable dust
  -6% to -10% for respirable dust
- Rubber manufacturing (Vermeulen et al. 2000)
  -6% for inhalable dust
  -7% for dermal exposure
- Wood dust (Teschke et al. 1999)
  -7% (1979-1997)
- Solvents among painters (Burstyn and Kromhout 2002)
  -12% (1980-1999)



Kromhout and Vermeulen, 2000

Decreasing exposure trends are mainly due to

- Long-term investments in occupational health and safety, notably in…
  - Training
  - Surveillance
  - Research
  - Improved technology

What will happen in times of economic crisis…

- Reduction of staff?
- Reduction of training?
- Reduction of exposure monitoring?
- Reduction of occupational health services?
- Reduction of…?
- Results in…???

Acknowledgement

The SYNERGY project was funded by:
German Social Accident Insurance (DGUV)

Thanks for your attention !

olssona@iarc.fr

International Agency for Research on Cancer
World Health Organization