Well-being through work

Finnish Institute of Occupational Health

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Nordic Job Exposure Matrices

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Outline of the presentation

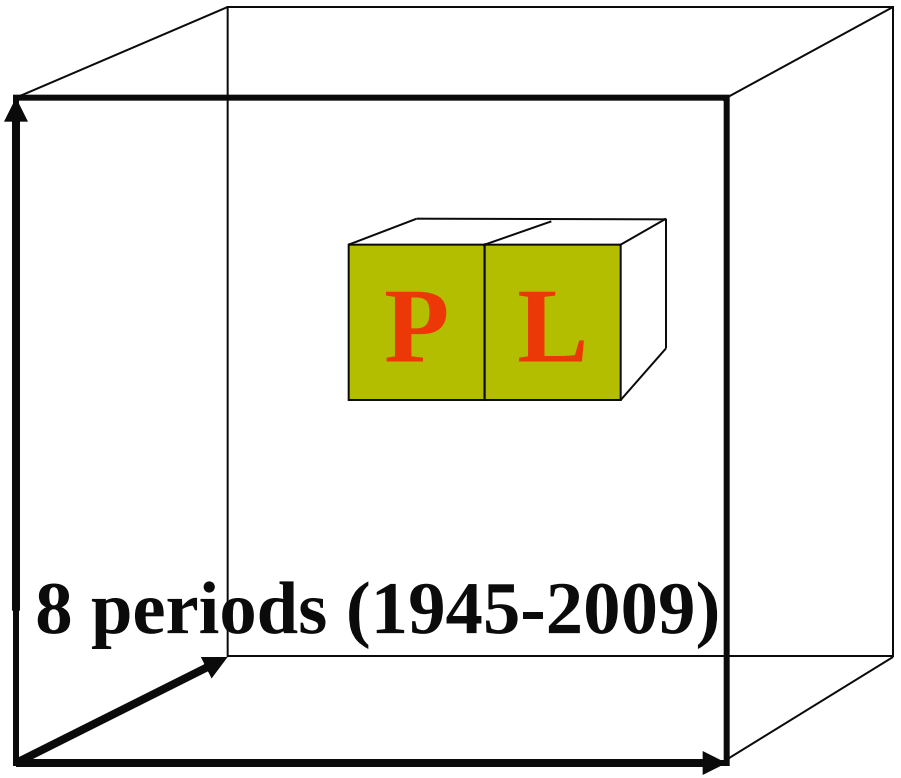
- **Some basics**: What is a job-exposure matrix (JEM)? Uses of JEMs? Advantages and disadvantages of using JEMs?
- **NOCCA-JEMs**: Why to construct? The base matrix (FINJEM)? The structure and contents of NOCCA-JEMs? Intercountry differences in occupational exposure? The construction process?
- **Use of NOCCA-JEMs in epidemiology**: Incorporation of JEMs in NOCCA cancer data? Validity issues, experiences on FINJEM use? Misclassification?

Job-exposure matrix (JEM)?

- **JEM** = cross-tabulation of occupations and exposure agents/factors, in which a matrix element ('cell') describes exposure
- **'Job'** = occupation, industry, occup.-industry, work task, work department, work area…
- **'Exposure'** = chemical, physical, physiological, psychosocial agent/factor; lifestyle factor…
- **Cross-tabulation** = 2-dimensional matrix, additional dimentions/axises (time, gender…)
- **Element** = usually exposure prevalence (P) and level (L) as classified or continuous variable

FINJEM

84 exposures: (chem, phys, ergo, psycho, lifestyle)



P, prevalence of exposure (%)

L, level of exposure (ppm, etc.)

311 occupations (Finnish classification)

Types of JEMs

- **GENERAL (GENERIC)** = covers the whole occupational classification (all occupations, eg FINJEM, NOCCA-JEMs)
  - Use in occupational epidemiology: general population-based register linkage studies (ie, usually cohort studies), large case-control studies
- **SPECIFIC** = covers only one or several industries, occupations, workplaces etc.
  - Use in occupational epidemiology: industry-based cohort studies

History of general JEMs

- **early 1980s**: need for exposure assessment of large register-based studies in occupational epidemiology: NCI-JEM (USA)
- **1980s**: MRC-JEM (Southampton, UK) etc.
- **1990s**: FINJEM (FIOH, Finland), documented multipurpose databank, exposure as continuous variable, update every 3 years
- **1990s-2000s**: SUMEX (INRS, France), Canada (Montreal), the Netherlands, NOCCA-JEMs etc

Uses of general JEMs

- **exposure assessment in large epidemiologic studies**: the most frequent use
- **national surveillance of occupational exposures**: exposure trends, numbers of exposed persons, exposure profiles
- **prevention of high risks**: identification of heavily exposed occupations
- **assesment of risks and burden of work-related diseases:** provides exposure data for quantitative risk and burden assessment
- **as general databank for various other purposes**: construction of JEMs for other countries, training, project planning etc.

Advantages of using a JEM in occupational epidemiology

- possibility to study **causal factors** (exposures) instead of surrogates (occupation) for risk assessment and prevention
- rather **easy to use**
- in large studies much **cheaper** than other methods of exposure assessment (eg, expert judgment)
- **independent** of case-control status
- often the **only feasible method** in very large studies

Disadvantages of using a JEM in occupational epidemiology

- exposure estimates are **subjective** (validity difficult to test)
- **laborious** to construct (expert time)
- requires coding of occupations according to a certain classification, or inaccurate **conversions**
- inherent **misclassification** of exposure and 'dilution' of exposure may produce unreliable results (within-occupation variability)

Construction of job-exposure matrices for the Nordic Occupational Cancer Study (NOCCA)

Acta Oncologica 2009;48:791-800
Downloadable freely from NOCCA web-site (http://astra.cancer.fi/NOCCA)

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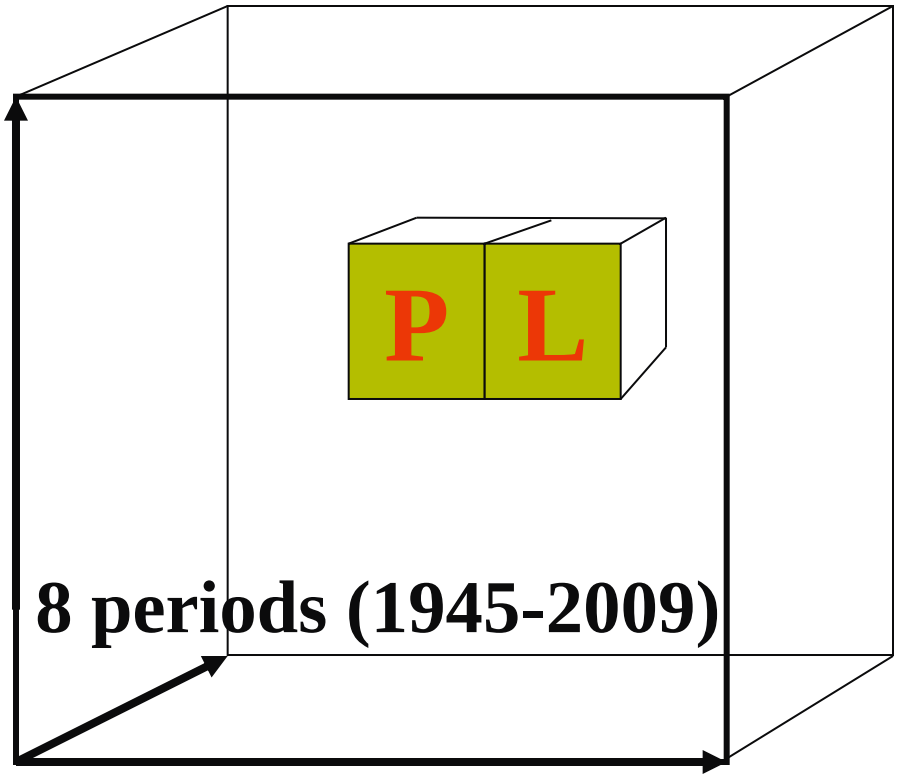
Why to construct NOCCA-JEMs?

- possibility to study **causal factors** (exposures) of many cancers instead of surrogates (occupation) in a very large Nordic census population
- the **only feasible method** of exposure assessment in NOCCA
- **availability of a base JEM (FINJEM)** which could be modified for use in other 4 Nordic countries with reasonable effort
- **good experiences on FINJEM use** in occupational cancer epidemiology in Finland

FINJEM (the base of NOCCA-JEMs)

84 expo-sures: (chem, phys, ergo, psycho, lifestyle)



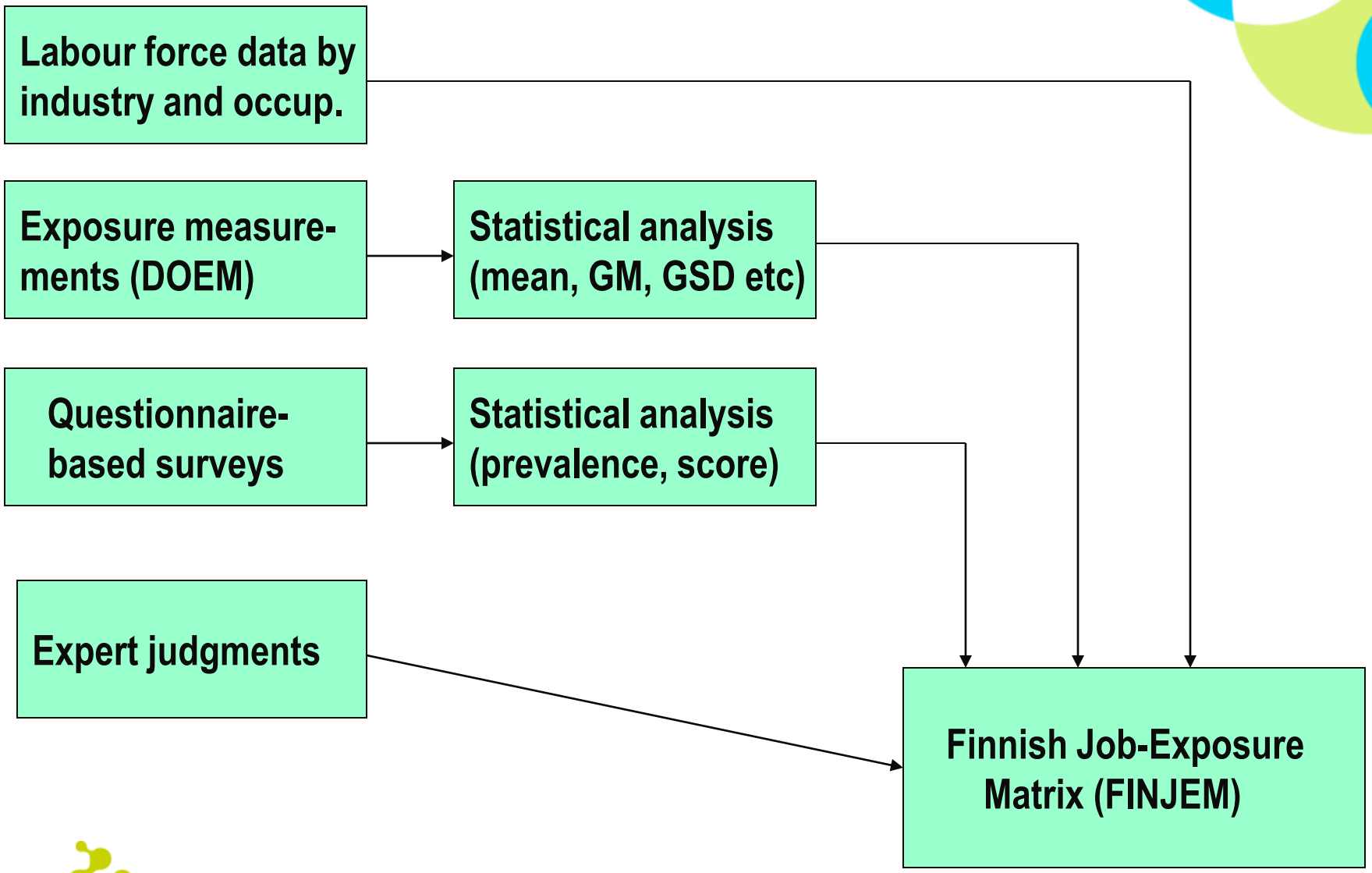
P, preva-lence of exposure (%)

L, level of exposure (ppm, etc.)

311 occupations (Finnish classification)

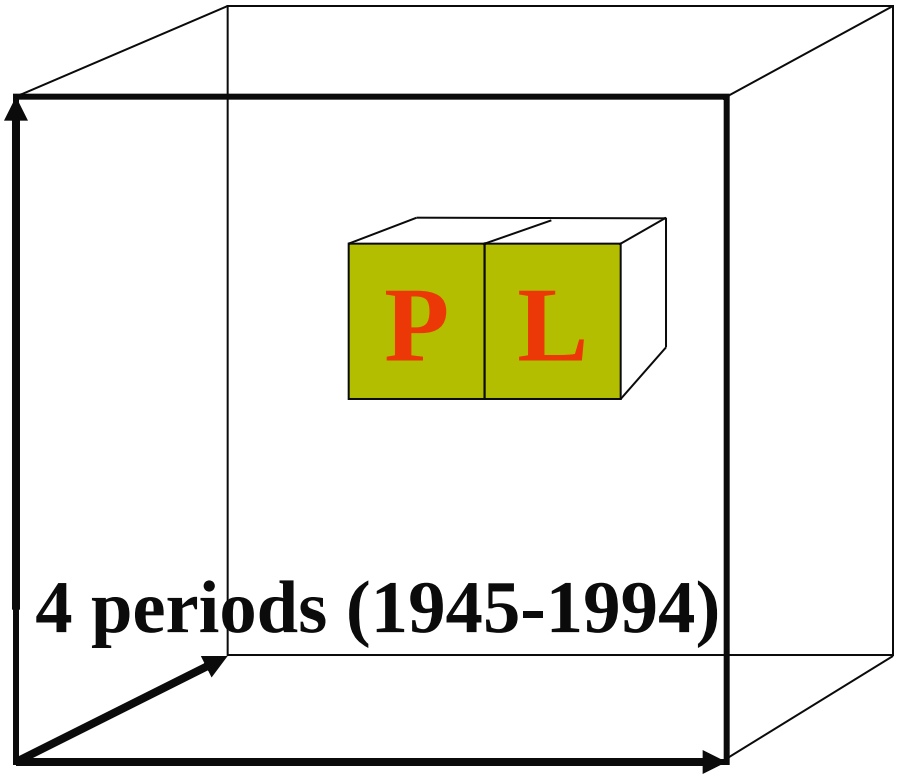
+ comprehensive documentation

FINJEM: Sources of information



Five NOCCA-JEMs

28 exposures: (chem, phys, ergo, psycho)



P, prevalence of exposure (%)

L, level of exposure (ppm, etc.)

N occupations (national classification, conversion from Finnish class., N varies by country, in Denmark not feasible)

NOCCA-JEMs: chemical agents

(new agents, not originally in FINJEM, in red)

- ASBESTOS
- SILICA
- NICKEL
- LEAD
- DIESEL EXHAUST
- WOOD DUST
- BENZO(A)PYRENE (PAH)
- WELDING FUMES
- FORMALDEHYDE
- ANIMAL DUST
- BITUMEN FUMES
- ALIPHATIC, AROMATIC, CHLORINATED AND OTHER SOLVENTS
- benzene, toluene, methylene chloride, perchloroethylene, trichloroethylene and 1,1,1-trichloroethane
- GASOLINE
- CHROMIUM
- IRON
- SULPHUR DIOXIDE

NOCCA-JEMs: non-chemicals

- **ULRAVIOLET RADIATION**
- **IONISING RADIATION**
- **PHYSICAL WORKLOAD**
- **NIGHTWORK**

- **Estimates only for the period 1985-1994, directly from FINJEM (no re-evaluation)**

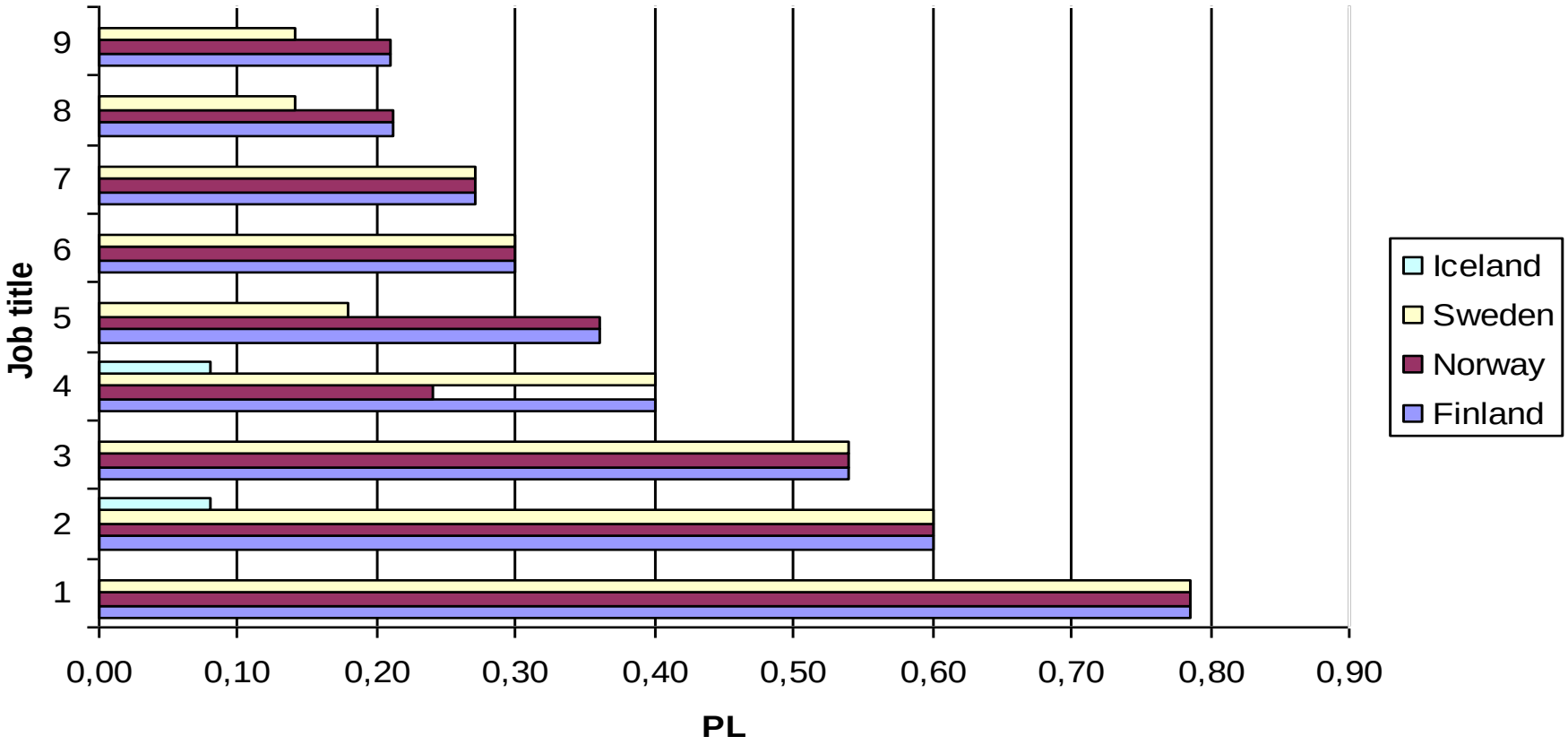
NOCCA-changes made to FINJEM

- **8 new agents** assessed and added (101 exposed and 2378 unexposed agent-occupation combinations)
- **FINJEM-period 1960-84 split** to 1960-74 and 1975-84, other periods in NOCCA-JEMs: 1945-59 and 1985-94
- 140 of 6220 agent-occupation combinations changed in FINJEM **(re-evaluation)**
  - 118 estimates of 282 'exposed' combinations improved
  - 22 of 5938 'unexposed' combinations shifted from 'no exposure' to 'exposure'
  - Swedish and Norwegian measurement data used to modify exposure estimaes

Some examples of exposure differences between countries

- **ASBESTOS**: Mining of asbestos only in Finland, levels probably rather similar in other occupations in all 5 countries (based on asbestos use and mesothelioma statistics), asbestos prohibition year recorded and may be used as cutpoint between periods
- **SILICA**: Silica in Iceland only in Kieselguhr and ferrosilicon plants, Norwegian levels maybe higher than elsewhere
- **Major exposure differences** tabulated in the article in Acta Oncologica

Exposure to silica by occupation (eg 4=smelter workers) and country in 1960-74

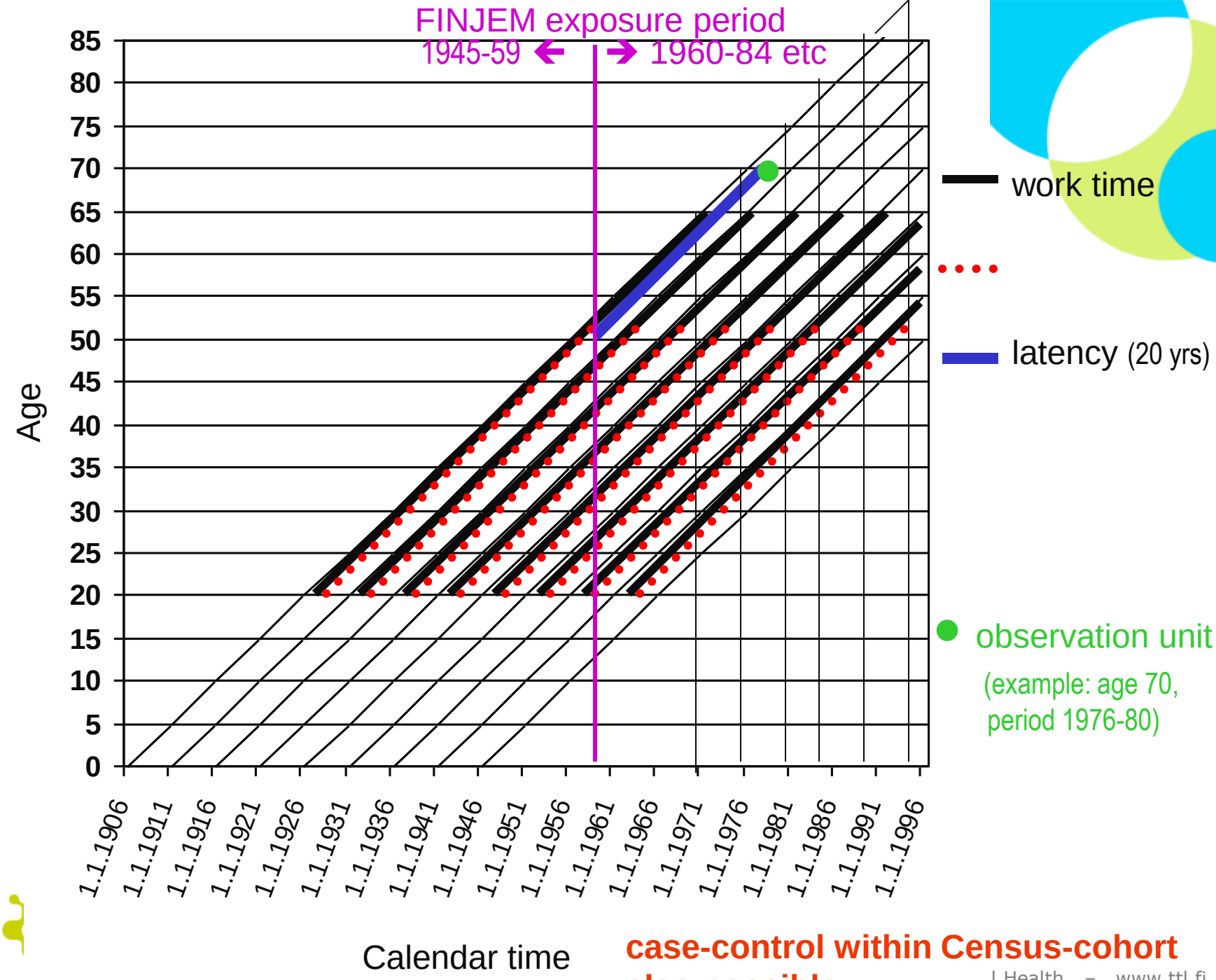


The construction process

- **Challenge**: the high number of estimates to be evaluated (over 50,000/country)
- **Priority agent-occupation combinations** were selected based on $N_{exposed}$, and P*L
- **General principles** were adopted in the beginning of the work
- **Inter-country differences** assessed first, then the conversions to national classifications (consistency emphasised)
- **In practise**: Finnish estimates copied for other countries, priority agent-occupations identified, checked and modified, occupations converted
- **JEM-team**: 7 persons, 4 meetings, 2.5 person-years

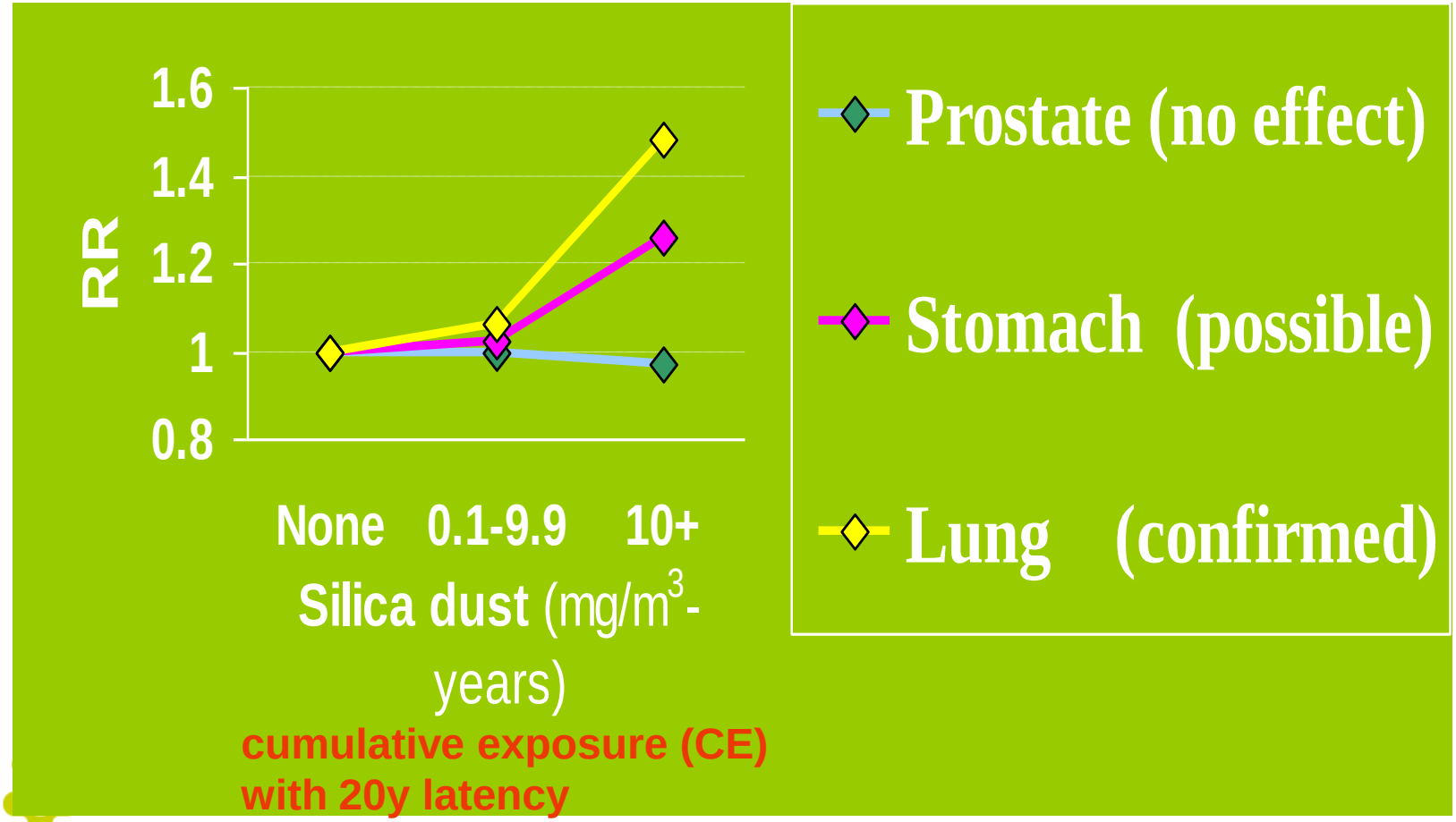
Nordic JEM: Exposure metric

- The NOCCA analyses: recommended to be based on **P*L** as exposure metric (=best guess of average exposure level in an occupation).
- It is possible to estimate crudely also the duration and period of exposure from the birth year of the subject which allows the use of (potential) cumulative exposure (**CE**) as the final metric.
- **Latency** period can be incorporated in the metric
- The methodology has been tested in Finland with FINJEM: see Pukkala E et al. National job-exposure matrix in analyses of census-based estimates of occupational cancer risk. Scand J Work Environ Health 2005;31:97-107)



case-control within Census-cohort also possible

Example results of a Census-based FINJEM study on cancer (Pukkala et al 2005)



Misclassification of exposure
No misclassification ('the truth')

sensitivity (Se)= probability of classifying correctly the exposed workers
specificity (Sp)= probability of classifying correctly the unexposed workers

	Exp +	Exp -
Case	10	90
Cont	20	480

Se = 100%

Sp = 100%

Pr(cont)= 4%

OR = 2,66

No error (true OR)

100 cases, 500 controls

Misclassification of exposure
Sensitivity decreased by 50%

	Exp +	Exp -
Case	5	95
Cont	10	490

Se = 50%

Sp = 100%

Pr(cont)= 2%

OR = 2,57

Low Se, Small error

Misclassification of exposure
Specificity decreased by 10%

	Exp +	Exp -
Case	19	81
Cont	68	432

Se = 100%

Sp = 90%

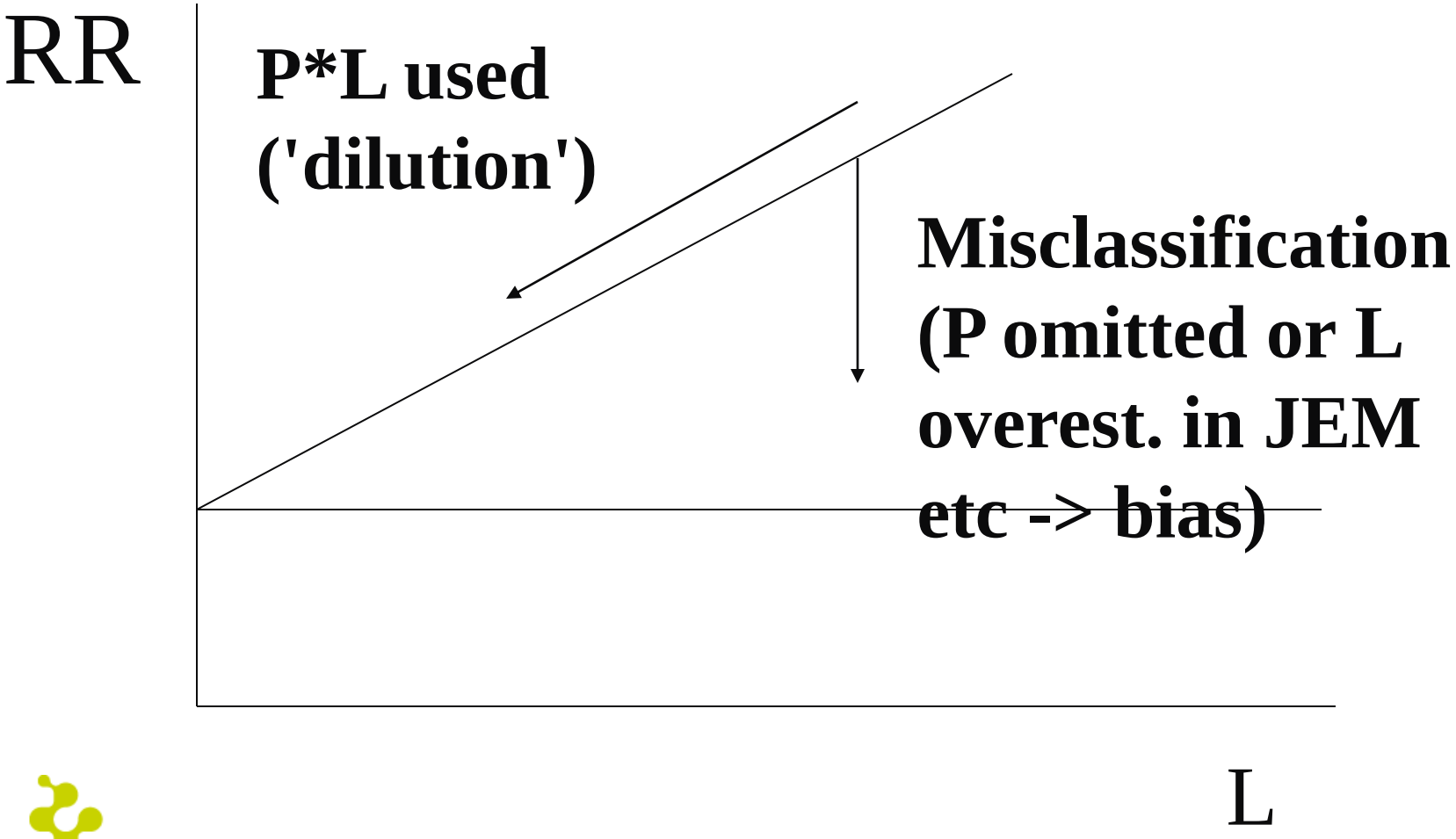
Pr(cont)=14%

OR = 1,49

Low Sp,

Large error (underestim. of OR)

Influence of misclassification on exposure-response relationship



How does the mislassification of exposure influence on the validity of the results in NOCCA?

- NOCCA-JEMs have very high specificity at the group level (i.e., totally unexposed occupations are not classified as exposed), sensitivity may be lower
- Whenever P<100%, there are unexposed individuals which are classified as exposed (misclassification at individual level)
- Estimates of P*L and CE are on average unbiassed, provided that P, L and duration of exposure are correctly estimated; **quantitative exposure metrics** therefore recommended
- Qualitative metric (exposed/not exposed) is not recommended because the average exposure level of the 'exposed' may be very low due to the inclusion of unexposed individuals