

# Writing a Cochrane systematic review on preventive interventions to improve safety - the case of the construction industry -

**Henk F. van der Molen**

email: [h.f.vandermolen@amc.nl](mailto:h.f.vandermolen@amc.nl)  
[vandermolen@arbouw.nl](mailto:vandermolen@arbouw.nl)

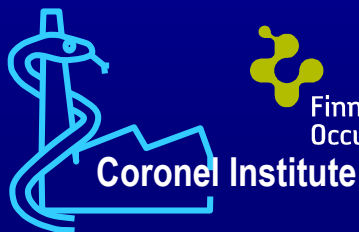
Coronel Institute of Occupational Health, Academic Medical Center, Amsterdam, the Netherlands

Arbouw, Health & Safety Institute in the Construction Industry, Amsterdam, the Netherlands



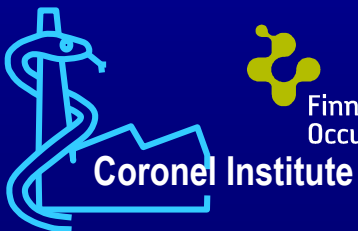
# Coronel Institute of Occupational Health

- Department of the Academic Medical Center (AMC)
- Samuel Coronel (Sr) (1827-1892):
  - one of the first to relate living conditions with health
- Coronel Institute:
  - Largest University-based center on Occupational Health in the Netherlands ( $\pm$  65 colleagues)
  - Netherlands Center for Occupational Diseases
  - Research Center for Insurance Medicine
  - Polyclinic Men and Work



# Arbouw

- Knowledge & Service institute for Dutch industry sector
- Working circumstances ↑ & disability for work ↓
- Board of employers & employee organisations
- Collectively financed
- Organisation:
  - Research & Development
  - Contract with Occupational Health & Safety Services
  - Facilitative towards sector, e.g. brochures, instruments



# Thanks to the Cochrane review group

Marika Lehtola, Cochrane Occupational Health Field (FIOH)

Jorma Lappalainen, Occupational safety Team (FIOH)

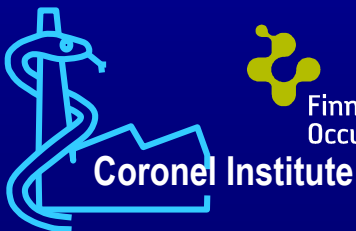
Peter Hoonakker, CQPI, University of Wisconsin

Hongwei Hsiao, Protective Technology Branch (NIOSH)

Roger Haslam, Department of Human Sciences, Loughborough University

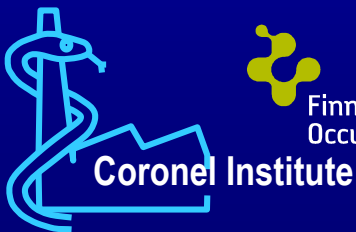
Andrew Hale, Safety Science Group, Delft University of Technology

Jos Verbeek, Cochrane Occupational Health Field (FIOH) & Coronel Institute,  
University of Amsterdam



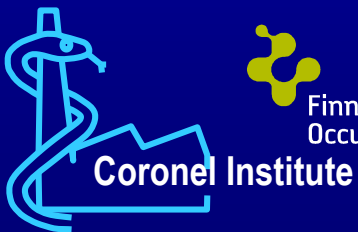
# Background

- **Poor construction safety worldwide**
  - Fatal injuries: e.g., 4 in UK (Haslam et al. 2005) to 11.7 in USA (Dong et al. 2004) per 100,000 workers in 2003
  - Non fatal injuries: e.g., 0.4% for major injuries in UK (Haslam 2005) to 10% for any injuries in NL (Lourens 2005) in 2003 / 2004
  - Disability for work: e.g., SIR of 2.5 for disability pension compared with general workforce in Germany (Arndt et al. 2004)
  - Costs: e.g., 4.3% of \$100 payroll costs in large USA construction project (Lipscomb et al. 2006)
- **No, outdated or restricted (systematic) reviews about effects of interventions on these measures**

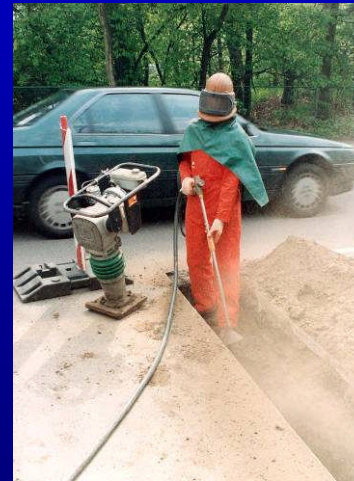
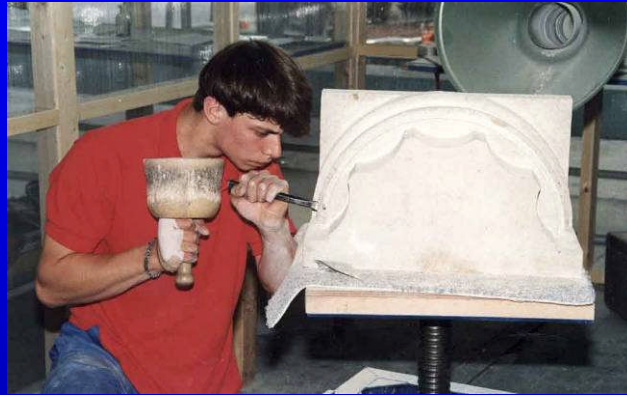


# Injury

- Occupational fatal injuries
- Non-fatal occupational injury (Peden et al., WHO 2002)
  - Body lesion at the organic level
  - Resulting from acute exposure to energy (e.g., mechanical, electrical)
  - In a work environment
  - In amounts that exceed physiological tolerance
  - Or through insufficiency of a vital element (e.g. drowning, strangulation)

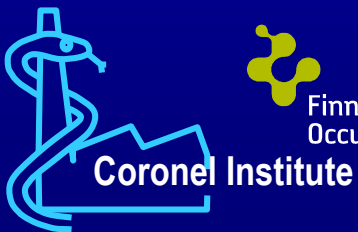


# Construction industry (1)



# Construction industry (2)

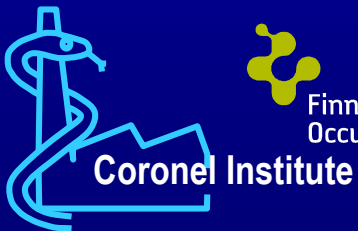
- Limited to construction workers, characterized by (NAICS 2002):
  - Being employees or self employed
  - Engaged in construction, refurbishment, demolition of buildings or engineering projects
  - Managed from a fixed place of business
  - Performing activities at (multiple) project site(s)





# Objectives (1)

- To evaluate the effectiveness of interventions to prevent occupational injuries among workers at construction sites



# Objectives (2)

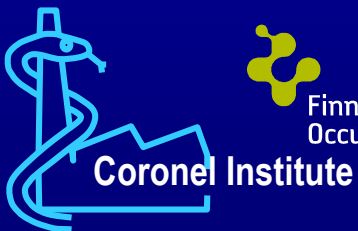
**P** : Persons working at construction sites

**I** : Interventions aimed to decrease the rate or severity of injuries

**C** : No or other intervention

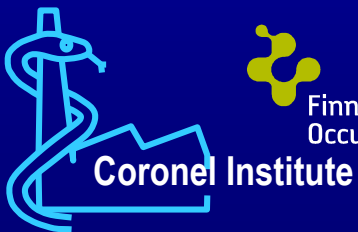
**O** : Fatal and non-fatal injuries (primary),

: Number of lost working days, behavioral changes (secondary)

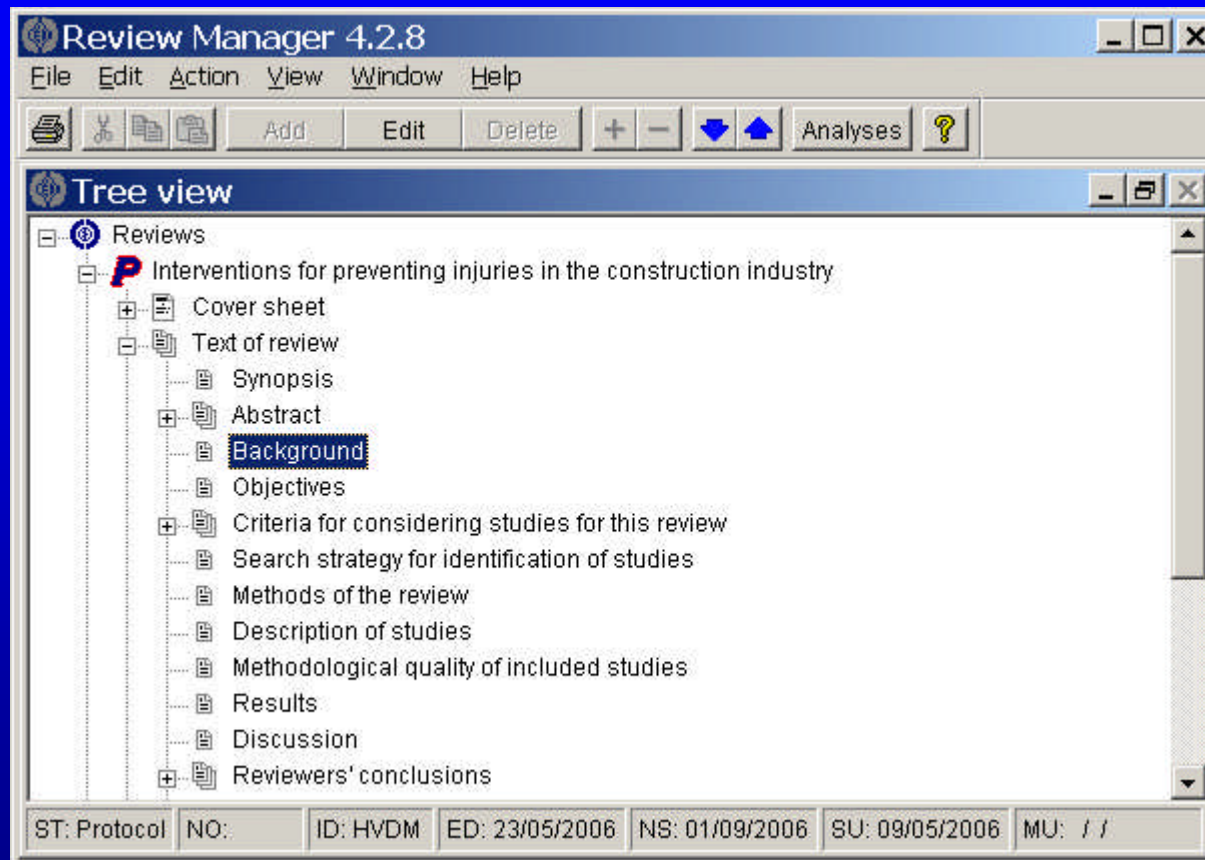


# Methods: Cochrane procedure (1)

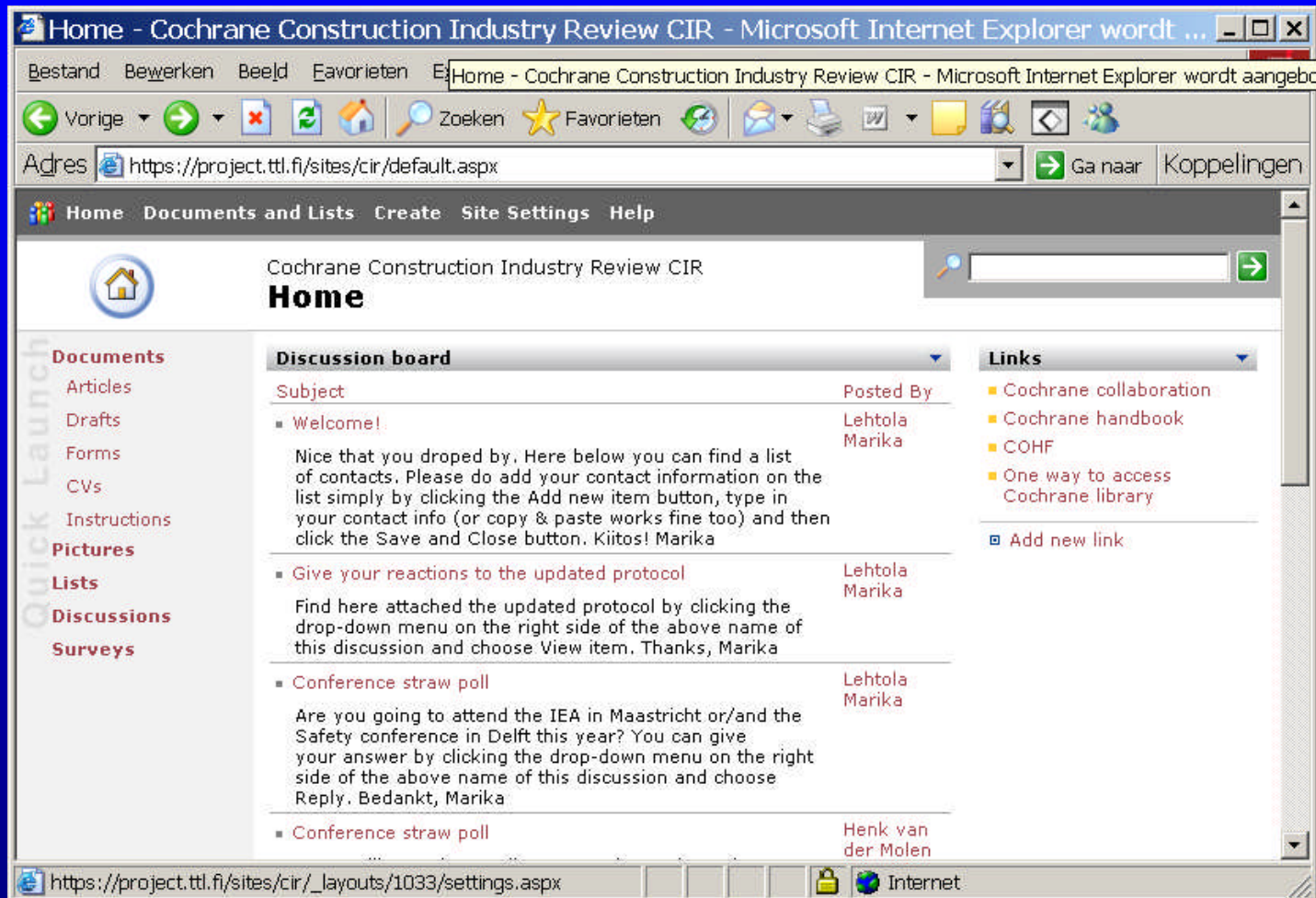
- Joining injury review group
- Register title
- Formation of review group
- Writing protocol (peer-reviewed)
- Executing protocol
- Writing and submitting review (peer-reviewed)
- Cochrane review (and Journal article)
- Actualizing review



# Methods: Cochrane procedure (2)

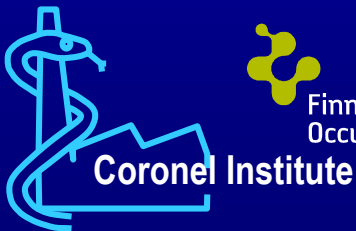


# Methods: Project site



# Methods: Inclusion criteria

- Study participants are working at construction site for buildings, roads or industrial installation
- Occupational injuries are used as outcome measure
- Intervention aimed to decrease rate or severity of injuries
- Study design is (cluster) RCT, prospective controlled trial or time series
  - before after studies, case reference studies are only included in discussion section



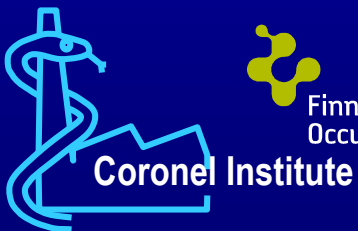
# Methods: Search strategy (1)

Electronic in the following databases:

- Medline (1966 to June 2006)
- Embase (1988 to June 2006)
- PsychINFO (1983 to June 2006)
- OSH-ROM (including NIOSHTIC and HSELINE)
- EI Compendex (1990 to June 2006)

Handsearching:

- Snowballing references of eligible studies



# Methods: Search strategy (2)

## Construction Journals (1995 to present)

- Journal of Construction Engineering and Management
- Journal of Management in Engineering
- International Journal of Reliability, Quality and Safety Engineering
- Safety Science Monitor

## Websites:

- <http://www.cdc.gov/elcosh/index.html>
- <http://www.pubs.asce.org/journals/jrns.html>
- <http://www.hse.gov.uk/research/rrhtm/index.htm>
- <http://www.inrs.fr>
- <http://www.arbetslivsinstitutet.se/biblioteket/default.asp>
- <http://www.hvbg.de/d/bia/pub/ueb/index.html>





# Methods: Search strategy (3)

Working at construction sites

AND

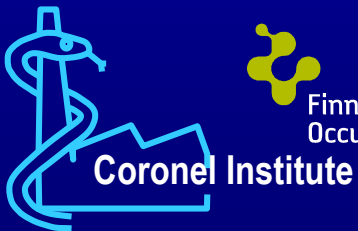
Intervention

AND

Injury

AND

Study design



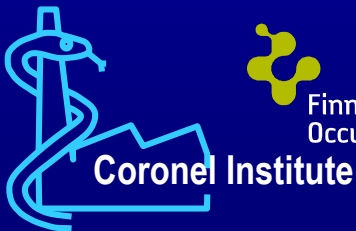
# Methods: Search strategy (4)

construction\*[tiab] OR building\*[tw] OR builder\*[tiab]OR laborer\* [tw] OR labourer\* [tw]  
OR contractor\* [tw] OR supervisor\*[tw] OR "machine driver"[tw] OR "machine drivers"[tw]  
OR "machine operator"[tw] OR "brick mason"[tw] OR "pile driver"[tw] OR "pile drivers"[tw]  
OR "concrete worker"[tw] OR "concrete workers"[tw] OR "metal worker"[tw] OR "metal workers"[tw]  
OR "road builder"[tw] OR "road builders"[tw] OR "pipe driver"[tw] OR "pipe drivers"[tw]  
OR "tower crane"[tw] OR fitter\*[tw] OR carpenter\* [tw] OR rammer\* [tw] OR scaffolder\* [tw]  
OR bricklayer\* [tw] OR pointer\* [tw] OR plasterer\* [tw] OR plasterpainter\* [tw] OR roofer\* [tw]  
OR plumber\* [tw] OR glazier\* [tw] OR screeder\* [tw] OR electrician\* [tw] OR tiler\* [tw]  
OR painter\* [tw] OR paviour\* [tw] OR pavier\*[tw] OR ironwork\*[tw] OR metalwork\*[tw]  
OR asphalt\*[tw] OR roofing[tw] OR painting[tw] OR "construction materials"[MeSH]  
OR "facility design and construction"[MeSH]

AND

Safety[MeSH] OR "Safety Management"[MeSH] OR "prevention and control"[MeSH Subheading]  
OR safet\*[tw] OR prevent\*[tw] OR control\*[tw] OR risk[tiab] OR "risk"[MeSH Term]  
OR "risk management"[MeSH Terms] OR "accident prevention"[MeSH Terms]

AND



Finnish Institute of  
Occupational Health

Coronel Institute



# Methods 9: Search strategy (5)

injur\*[tw] OR accident\*[tw] OR "accidents, occupational"[MeSH] OR "wounds and injuries"[MeSH]  
OR harm\*[tw] OR wound\*[tw] OR fall[tw] OR falling\*[tw] OR burn\*[tw] OR slipper\*[tw] OR poison\*[tw]  
OR fatal\*[tw] OR "injuries"[MeSH Subheading]

AND

(randomized controlled trial[pt] OR controlled clinical trial[pt]  
OR randomized controlled trials[mh] OR random allocation[mh]  
OR double-blind method[mh] OR single-blind method[mh]  
OR clinical trial[pt] OR clinical trials[mh]  
OR "clinical trial"[tw] OR ((singl\*[tw] OR doubl\*[tw]  
OR trebl\*[tw] OR tripl\*[tw]) AND (mask\*[tw] OR blind\*[tw]))  
OR "latin square"[tw] OR placebos[mh] OR placebo\*[tw]  
OR random\*[tw] OR research design[mh:noexp] OR comparative  
study[mh] OR evaluation studies[mh] OR follow-up studies[mh]  
OR prospective studies[mh] OR cross-over studies[mh]  
OR control\*[tw] OR prospectiv\*[tw] OR volunteer\*[tw])  
NOT (animal[mh] NOT human[mh])

OR

(effect\* [tw] OR control\* [tw]  
OR evaluation\* [tw]  
OR program\* [tw])  
NOT (animal[mh]  
NOT human[mh])



# Methods: Selection of studies

Inclusion of studies according inclusion criteria:

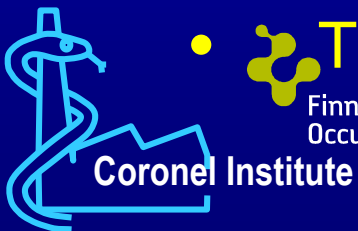
- Title and abstract by two reviewers independently
- Third reviewer if no agreement
- Full articles by two reviewers independently

Quality assessment (Downs & Black 1998; EPOC 2004 for time series)

- Two reviewers independently
- Third reviewer if no agreement

Data extraction

- Two reviewers independently



# Methods: Data synthesis (1)

## Meta analysis

- If available studies are sufficiently similar with respect to participants, setting, interventions and outcomes

## Strength of evidence (adapted from Van Tulder & Koes 2003)

- Strong : Consistent\* findings in multiple high quality RCTs or CTs
- Moderate : Consistent\* findings in multiple low RCTs, CTs, Time series and/or one high quality RCT
- Limited : One low quality RCT or CT or Time series
- Conflicting : Inconsistent findings in multiple trials
- No evidence

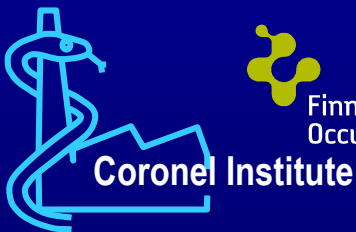
\* Consistent if at least 75% of the trials or time series report statistical significant results in same direction



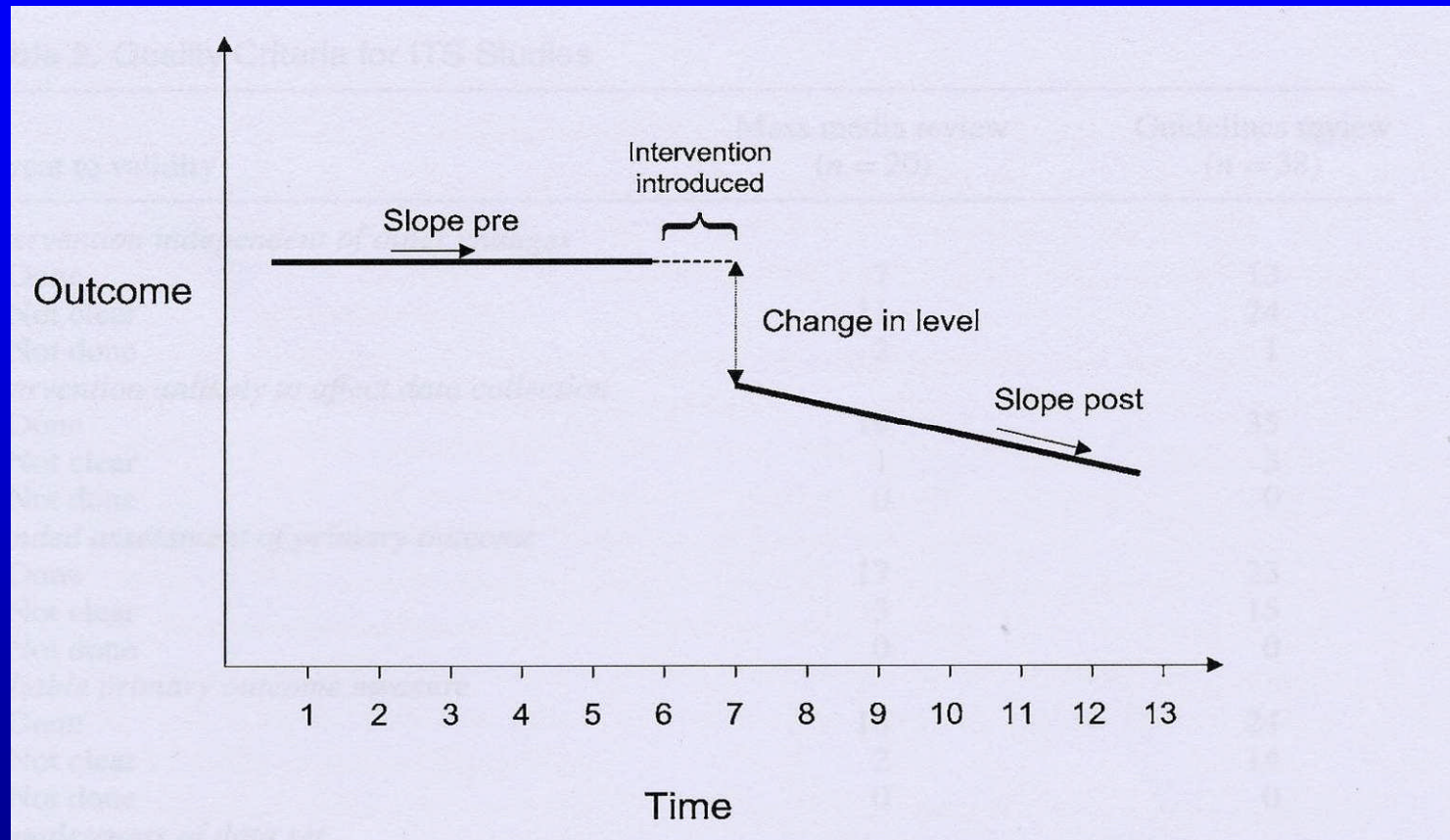
# Methods: Data synthesis (2)

## Effect sizes

- Data from original papers were extracted and standardized
- Reanalyzed using segmented time series regression analysis to estimate the effect of an intervention while taking into account secular time trends and any autocorrelation between individual observations (Ramsay et al. 2003)
- $Y = \beta_0 + \beta_1 \text{time} + \beta_2 (\text{time} - p) I(\text{time} > p) + \beta_3 I(\text{time} > p) + E, E \sim N(0, s^2)$
- Stata 9.2; Prais-Winsten first order autocorrelation version of GLS
- Two standardized effect sizes for each study:
  - i) change in level of the regression lines before and after the intervention
  - ii) change in slope of the regression lines before and after the intervention
- Standardized by dividing the outcome and SE by the pre-intervention SD

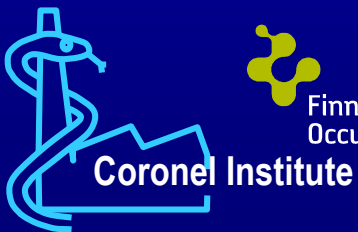


# Methods: Data synthesis (3) (Ramsay 2003)



# Results: Included studies

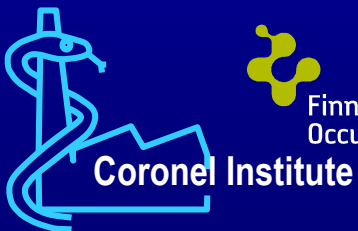
- Electronic databases : 7484
  - Snowballing : 3
  - Websites : 35
- 
- Full articles: 55
  - Inclusion: 5 ITS studies



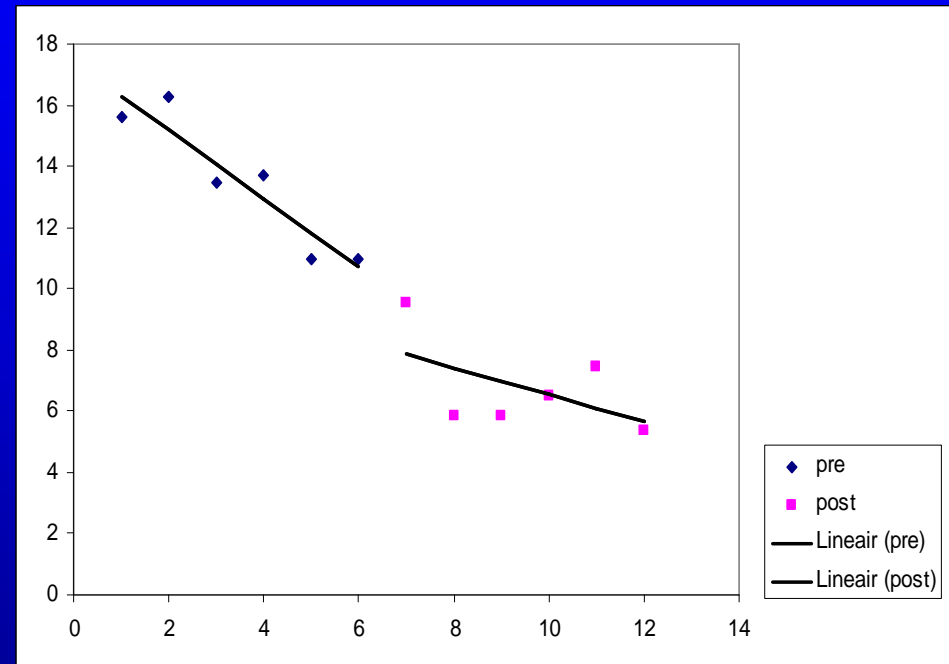
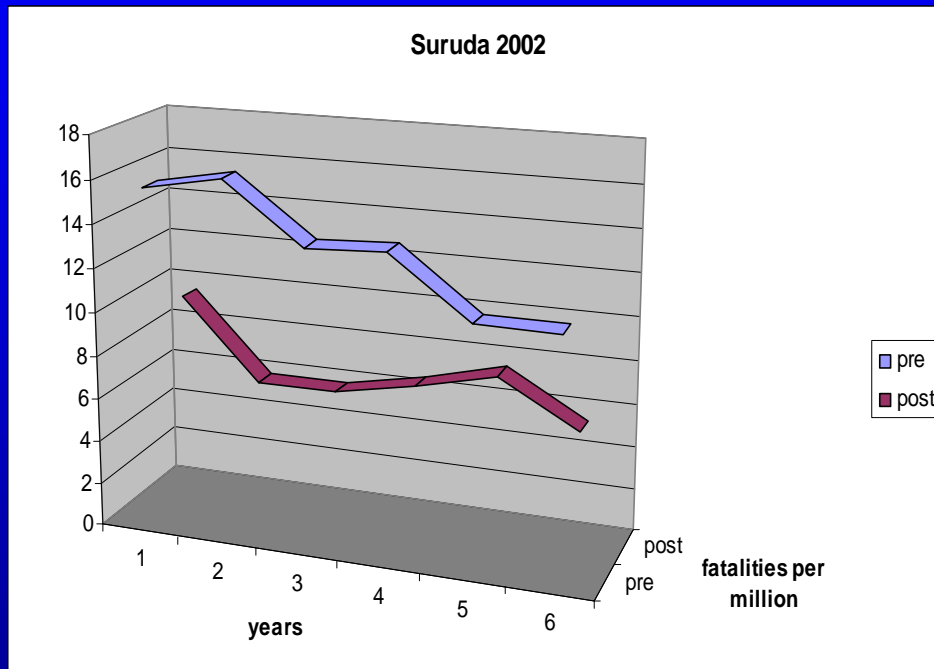


# Results: Summary included legislative studies

Intervention	Participants	Setting	Outcome	Quality
Legislation (Derr 2001) Fall standard	Construction workers (n: not clearly reported)	USA	Fatal injuries	3/6 (50%)
Legislation (Suruda 2002) Trench & excavation standard	Trench & excavation workers n= about 5 million	USA	Fatal injuries	3/6 (50%)
Legislation (Lipscomb 2003) Fall standard	Carpenters n=16,215	USA	Non-fatal injuries	4/6 (67%)



# Example: time series of Suruda (2002)

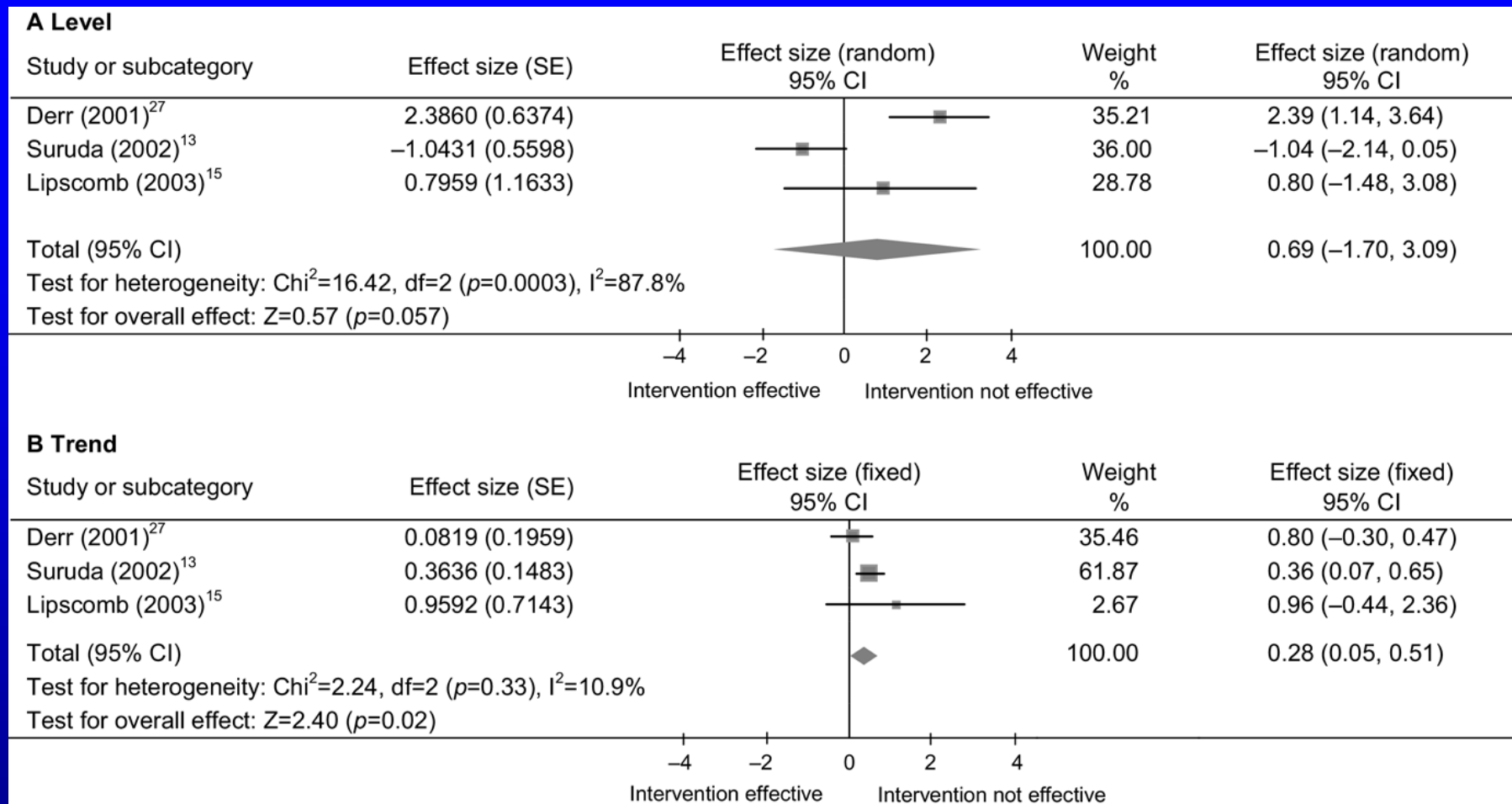


# Results: Meta analysis legislation interventions (1)

Legislation	level	95% CI	slope	95% CI
Pooling	0.69	-1.70 to 3.09	0.28	0.05 to 0.51

No evidence that legislation alone is effective in preventing non-fatal and fatal injuries, based on 3 low quality studies

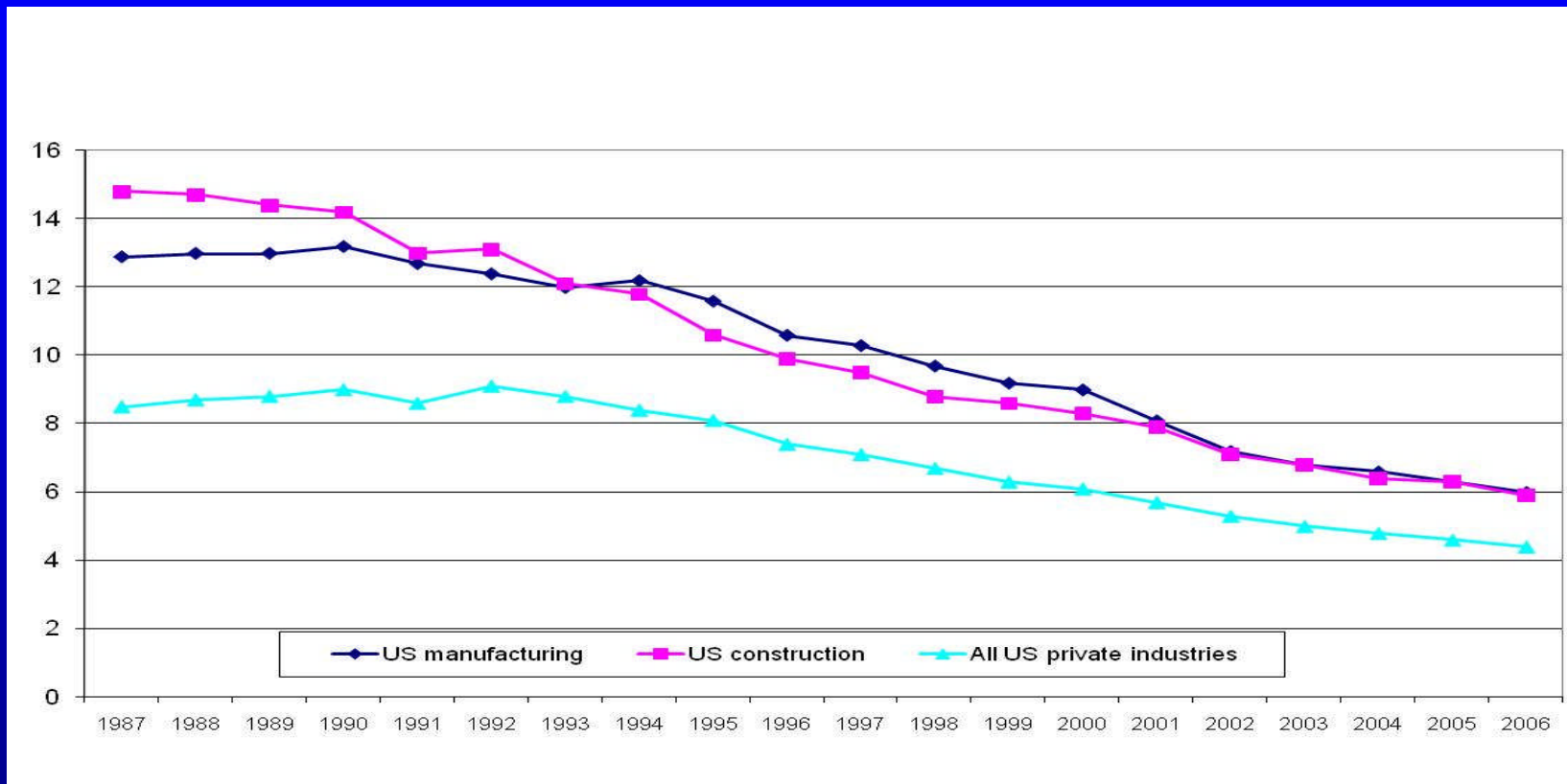
# Results: Meta analysis legislative interventions (2)



Adapted from Am. J. Ind. Med. 2008



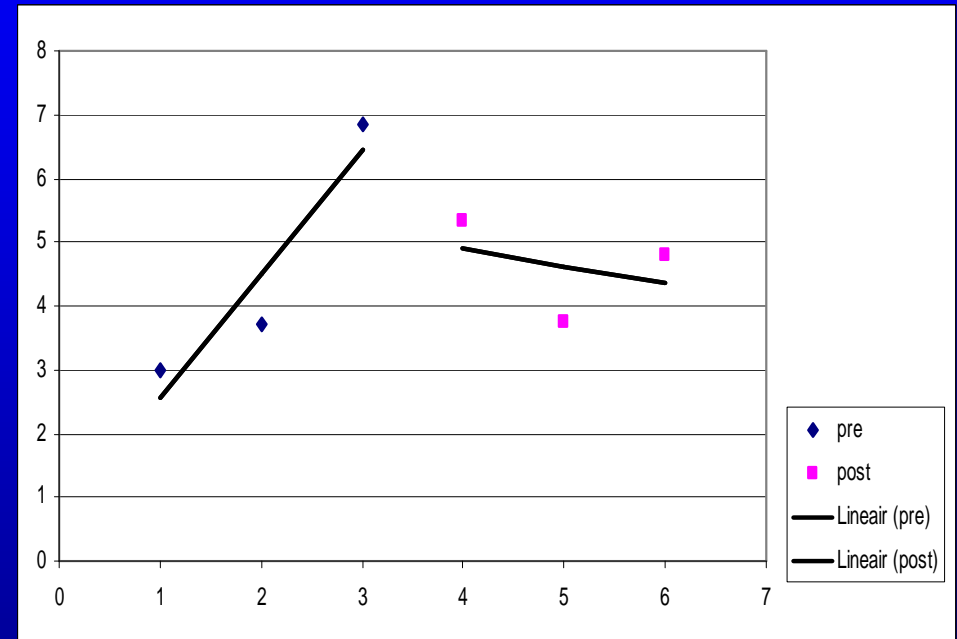
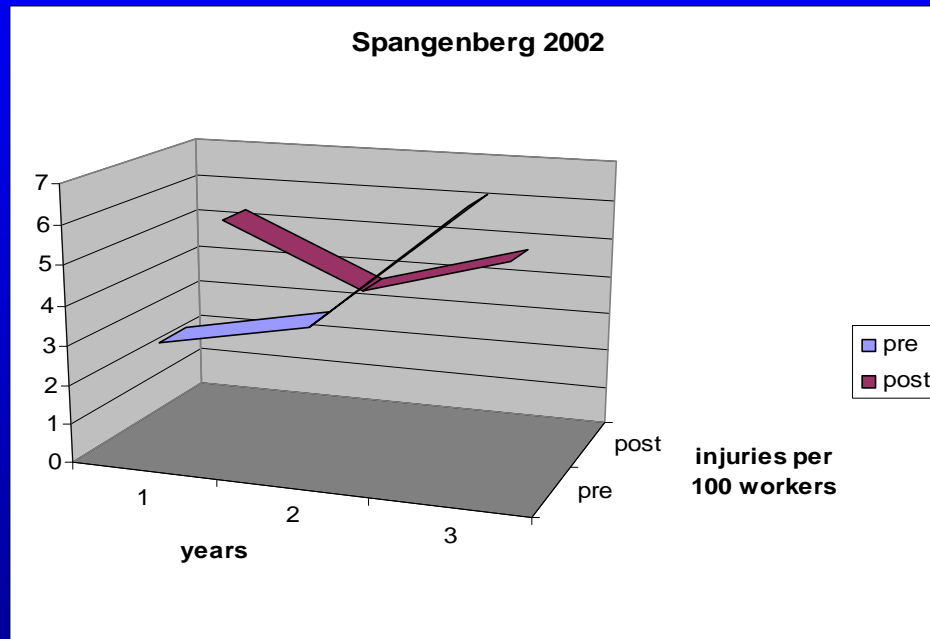
# Time trend injury rates per 100 FTE (BLS 2008)



# Results: Summary included multifaceted studies

Intervention	Participants	Setting	Outcome	Quality
<b>Safety campaign</b> (Spangenberg 2002) information, feedback, inspection	Construction workers (tunnel / bridge) n=4,250 man-years	Denmark	Non-fatal injuries	2/6 (33%)
<b>Drug-free workplace program</b> (Wickizer 2004) information, education, financial award, drug-testing	Construction workers I: n=3,305 C: n=65,720 person-years	USA	Non-fatal injuries	4/6 (67%)

# Example: time series of Spangenberg (2002)



# Results: Safety campaign

Effect sizes	level	95% CI	slope	95% CI
Spangenberg 2002	-1.82	-2.90 to -0.75	-1.30	-1.79 to -0.80

Limited evidence that a multifaceted safety campaign had an initial and sustained reducing effect on non-fatal injuries, based on 1 low quality study.



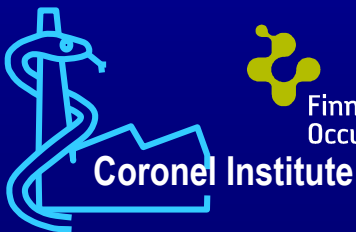
# Results: Drug-free workplace program

Effect sizes	level	95% CI	slope	95% CI
Wickizer 2004	-6.78	-10.02 to -3.54	-1.76	-3.11 to -0.41

Limited evidence that a multifaceted drug-free workplace program had an initial and sustained reducing effect on non-fatal injuries, based on 1 low quality study.

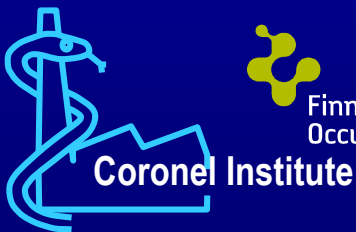
# Implications for practice

- No evidence that legislation alone is effective for reducing injuries
- Additional strategies necessary to increase compliance employers and workers to measures prescribed by legislation
- Multifaceted and continuing interventions seem effective for reducing injuries (like safety campaign and drug-free workplace program)
- Influencing safety culture and enforcement / feedback important elements of these interventions



# Implications for research

- Evaluate interventions recommended by text books, courses or consultants
- Measure implementation level and strategy
- Measure behavioural change and injuries
- ITS is a feasible option to evaluate interventions with injuries as outcome



# Discussion (1)

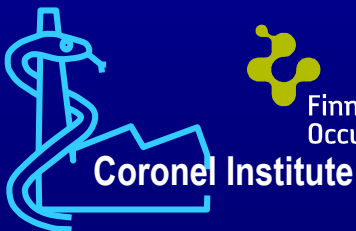
## Not finding effects for legislation interventions due to:

- Intervention
  - Information and education should accompany legislation (Lipscomb et al. 2003)
  - Legislation alone is not powerful enough to change behaviour (Ilmarinen 2006)
  - Better reporting due to intervention (Hale 2008)
- ITS analysis
  - Sensitivity of ITS study design (Lehtola et al. 2008)
  - Gradual diffusion or delayed causation (Shadish et al. 2002)
  - Anticipation on legislation
- Systematic review
  - Retrospective study design (Shea 2008)
  - Publication bias
  - Strict Cochrane criteria

# Discussion (2)

Cochrane reviews highest level of evidence base, but:

- Not only RCT as eligible study design
  - Cluster RCT
  - Controlled pre-post
  - Interrupted time series
- Also pre-post studies & qualitative studies
  - Specifying active ingredients of intervention
  - Measuring behavioural change
  - Determining of feasibility
- Also expert and practice base
  - Involvement of stakeholders like employers and employees
  - Ethical and juristical aspects
  - Economic , organisational and technical aspects



# Discussion (3)

Always be aware of new preventive interventions!



Michelangelo's David returns to Italy this week after a successful 12 week, 20 city, US tour.....

Grazie Mille!!!

Thanks for the invitation and your attention

Questions?  
Remarks?

