What do we know about wood dust exposure and non-malignant diseases – an epidemiological approach

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A very old story!

"... rainwater that runs off cypress bark contains poison. It has been said that men lumbering in cypress forests have many sores on their feet."

(From “Sakuteiki” by Tachibana, 1028 – 1094)
Wood dust exposure

- 2 mio. in EU employed in the wood industry (Kauppinen 2000)
- Inhabitants DK: 5,00,0000
- Labour force DK: 2,200,000 workers
- DK: 76,000 employed in industries with wood dust exposure; 3.4 % of the workforce (Statistics Denmark 2001)
- Several thousand wood types, more than 1000 in production
Concurrent exposures

- Terpene exposure: well documented in saw mills (Eriksson 1996; Teschke 1999; Rosenberg 2002), but also seen in the "dry" wood industry (Eriksson 1997, Mikkelsen 1998)


- Glue, formaldehyde, surface treatment (Holmström 1989, 1995; Grandstrand 1998)
Possible non-malignant health effects of wood dust

- Asthma
- Chronic bronchitis
- Impairment of lung function
- Rhino-conjunctivitis
- Skin problems
- Allergic alveolitis
- Pulmonary fibrosis
Mortality of obstructive lung diseases in the wood industry

- Increased asthma mortality among woodworkers SMR 226 (108 - 334) (Torén 1991)

- Marginal increased mortality of obstructive lung diseases among woodworkers RR 1,5 (1,1 - 1,9) (Demers 1998)
Western red cedar asthma


- Dose-response relation between exposure and prevalence of Western red cedar asthma (Brooks 1981)

- The diagnosis confirmed in clinical investigations

- Aetiological agent: plicatic acid (Chan-Yeung 1973)

- Immunological mechanism other than IgE mediated sensitisation most important (Chan-Yeung 1994)

- The majority of studies on saw mill workers
Asthma and other wood species

- Casuistically asthma caused by e.g. oak, beech, pine, ash, iroko, abachi, mahogany
- Self-reported asthma 4 - 11% (OR 1.0 - 3.7)
- Wheezing 10 - 28% (OR 0.7 - 4.1)
- Chest tightness 27 - 41% (OR 1.7 - 1.8)
- Few studies included objective measures for asthma
- The Immunological mechanism?
OR for asthma symptoms from cross-sectional studies in the wood industry

- Hessel 1995
- Åhman 1995
- Herbert 1995
- Talini 1998
- Mandryk 1999
- Bohadana 2000
- Schlünssen 2001
- Douwes 2001
- Rongo 2002
- Born 2002
- Fransman 2003

Legend:
- Self. rep. asthma
- Wheezing
Study in the Danish furniture industry 1997 – 99

54 furniture factories, 2,303 WW
3 control factories, 576 C

Lung function
1,977 WW
507 C

Personal dust measurements, hygienic variables,
1,779 WW

Questionnaires,
2,033 WW 474 C

Clinical investigations,
\( n = 453 \)

WW = woodworkers
C = controls
Asthma symptoms + BHR and wood dust exposure, stratified by atopy. 
N = 118

![Graph showing the relationship between inhalable dust levels and asthma symptoms stratified by atopy.](image)

*: p < 0.05

Schlünssen et al, in press
Rhino-conjunctivitis

- Nasal symptoms *(itching, blocking, sneezing, and dripping nose)* 7 - 77% (OR 0.8 - 12.1)

- Eye symptoms *(itching, burning, tearing, and swelling eyes)* 20 - 46 % (OR 1.4 - 5.9)

- Decreased mucociliary clearance *(Wilhelmsson 1984)*

Mucosal swelling (vol2 - 5cm) before and at 4 and 7 hours of work for four exposure groups. N = 175

*: p < 0.05

Schlünssen 2002
IgE mediated sensitisation to wood dust

- Case reports (*i.e.* beech, oak, pine, mahogany, iroko)
- Clinical investigations for occupational asthma or rhinitis (*Oertmann 1993, Kanerva 1993*)
Chronic bronchitis

- Chronic bronchitis 8 - 30% (OR 1.0 - 14)
- Coughing 27 - 50% (OR 0.8 - 8)
- Expectoration 10 - 61% (OR 1.2 - 8)
OR for coughing from cross-sectional studies in the wood industry

- Pisanello 1991
- Shamssain 1992
- Norrish 1992
- Åhman 1995
- Herbert 1995
- Talini 1998
- Mandryk 1999
- Bohadana 2000
- Schlünssen 2001
- Rongo 2002
- Borm 2002
- Douwes 2001

OR
Acute decline in lung function

Dose-response relations between wood dust exposure and acute decline in lung function \((FEV_1, FVC)\) during a work day
(Mandryk 1999; Beritic-Stahuljak 1988; Schlünssen et al, submitted)
### Linear regression on cross-shift $\text{fev}_1$
and dust exposure. $N = 639$

<table>
<thead>
<tr>
<th>Exposure estimates</th>
<th>Coef.</th>
<th>SE</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual, all measurement</td>
<td>0.792</td>
<td>0.34</td>
<td>0.02</td>
</tr>
<tr>
<td>Grouping, 12 categories</td>
<td>1.636</td>
<td>0.77</td>
<td>0.03</td>
</tr>
<tr>
<td>Weighted estimate</td>
<td>1.336</td>
<td>0.53</td>
<td>0.01</td>
</tr>
<tr>
<td>Mixed Model</td>
<td>1.248</td>
<td>0.56</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**GM (GSD):** $1.0 (2.1) \text{ mg/m}^3$ inhalable dust

_Schlünssen et al, submitted_
Chronic impairment in lung function

- Annual dose-response related decline in FEV$_1$ and FVC among Western red cedar workers.
  Exposure level: $< 0.2, 0.2-0.4, > 0.4$ mg/m$^3$ total dust (Noertjojo 1996)

- Annual increased decline in FEV$_1$ in wood dust exposed western red cedar asthma patients (Fung 1996)

- Other wood species: conflicting results, no follow up studies (Mandryk 1999; Schlünssen 2002)
Skin problems

- Allergic and toxic dermatitis to different types of wood and wood components, e.g. pao ferro, mahogany, Brazilian rosewood, teak, abachi, pine, oak, beech, colophonium, and terpenes
- Direct and air born exposure to wood dust
- Epidemiological studies: skin problems between 4% and 60% (Gan 1997; Meding 1996; Oleffe 1975)
- Urticaria has been described using abachi, mukali, or mahogany
Allergic alveolitis

- Several case reports of extrinsic allergic alveolitis among saw mill workers
- Precipitating antibodies against moulds and wood have been found (Eduard 1994; Halpin 1994)
- At least two cases of allergic alveolitis reported among workers in the dry wood industry (Baur 2000; Malmström 1999)
Pulmonary fibrosis

- Increased OR (1.7 - 2.9) among woodworkers in case-control studies
  
  (Gustavson 2003, Scott 1990; Hubbard 1996)

- Decrease in lung diffusion capacity in wood dust exposed workers; dose-response relation between decrease in diffusion capacity and time of employment
  
  (Carosso 1987)
Exposure level

- No simple relation between exposure and health effects
- Different exposure levels across trades, studies, countries etc.
- Different measuring strategies and equipment
- Increasing evidence for dose-response relations between wood dust exposure below 1 mg/m$^3$ and respiratory health effects (Noertjojo 1996; Schlünssen 2001, 2002)
Prevention

• Several preventable determinants for dust exposure (*Sheeper 1995; Teschke 1999; Hall 2002; Mikkelsen 2002*)

• Studies to explore the effect of intervention (*Lazovich 2002*)

• Early recognition and effective treatment of workers with Western red cedar asthma improve the prognosis (*Chan-Yeung 1987; Marabine 1993*)
What do we know?
We know -

- Many subjects are exposed to wood dust
- Western red cedar asthma and rhinitis is well characterised and not uncommon among exposed subjects
- Western red cedar dust can cause an accelerated decline in lung function
- Other types of wood dust can cause asthma, rhino-conjunctivitis, chronic bronchitis, skin affection and acute decline in lung function
We know -

- Wood dust exposure may cause chronic obstructive lung disease, allergic alveolitis and pulmonary fibrosis
  - Increasing evidence for dose-response relations between wood dust exposure below 1 mg/m$^3$ and respiratory health effects
- Prevention is possible
What do we need to know?
We need to know -

- The temporal relation between wood dust exposure and diseases with latency time (e.g. asthma, chronic obstructive lung diseases)
- Dose-response relations between wood dust exposure and health effects
- The impact of concurrent exposures, e.g. biohazards, terpenes
We need to know -

• The impact of different wood species
• The disease mechanisms
• The impact of preventive measures - does it help?
Thank you for your attention!

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