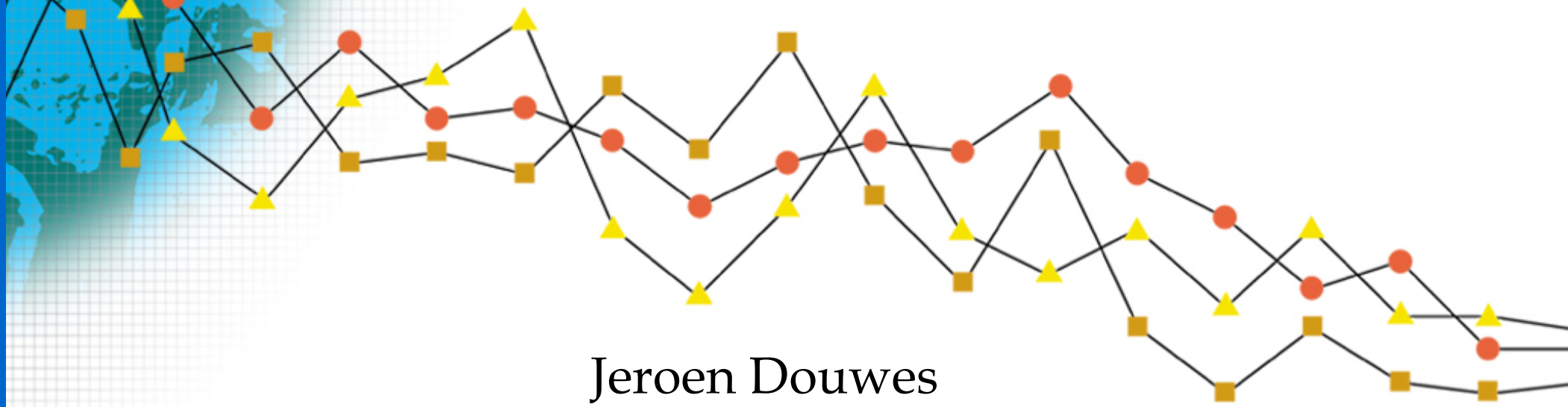
Environmental Health Risks: The Great Indoors



Jeroen Douwes
Centre for Public Health Research
Massey University
New Zealand

Priorities in environmental health, Nelson 2006

The built or indoor environment

- We spend most of our time indoors (often >90%)
- Residential and office buildings
- Concentration of pollutants, particularly when ventilation is poor
- Sick building syndrome (late 1970s)
- Susceptible populations including babies, pregnant women, elderly, sick people, etc

Indoor exposures with potential adverse health effects

- Pets
- Pests
  - mice, rats, cockroaches
- Dust mites
- Radon
  - Natural and building materials
- Formaldehyde
  - Building materials
- NO_2
  - Gas cooking and heating
- CO
  - heating
- Damp/mould
  - Water damage, poor ventilation, poor insulation
- Human/crowding
  - Infectious diseases such as flu, tb, etc

Indoor related health effects

- Respiratory symptoms and disease
  - Asthma, COPD, rhinitis, rhinoconjunctivitis
  - Airway irritations, allergies
  - *Dust mite, cockroaches, mould, VOCs such as formaldehyde, NO_2, tobacco smoke, etc*
- Cancer
  - Lung cancer
  - *tobacco smoke, radon, coal burning, mycotoxins?*
- Infections
  - TB, flu, etc
  - *Crowding, pests*
- Sick building syndrome (SBS)
  - *Microbes? Climate? VOCs? Psychology?*
- Death
  - *Coal burning, mould? mycotoxins?*

Burning of biomass in developing countries

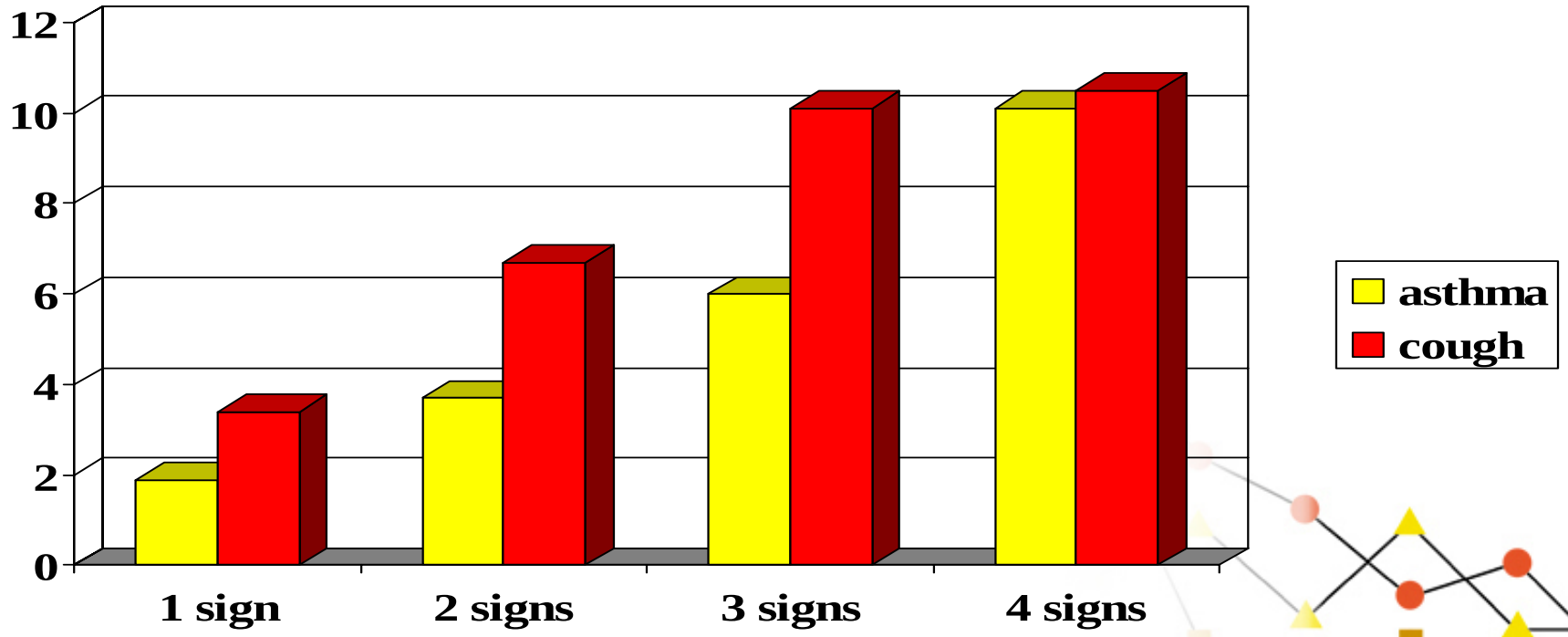
- "Women who cook on biomass are up to four times more likely to suffer from **COPD**, such as chronic bronchitis.
- "**Lung cancer** in women in China has been directly linked to use of coal burning stoves.
- "In addition there is evidence to link the pollution to **asthma, tuberculosis, low birth weight and infant mortality and cataracts**."
- More than half the people who cook on biomass live in India and China, but in many sub-Saharan African countries more than 90% of people do so.
- More than 2,000,000 **deaths** (mainly women and children) because of indoor air pollution yearly

WHO ‘Concern for Europe’s Tomorrow’ (1996)

- Identified exposure to ‘home dampness’ as the single most frequent adverse environmental exposure in the European population

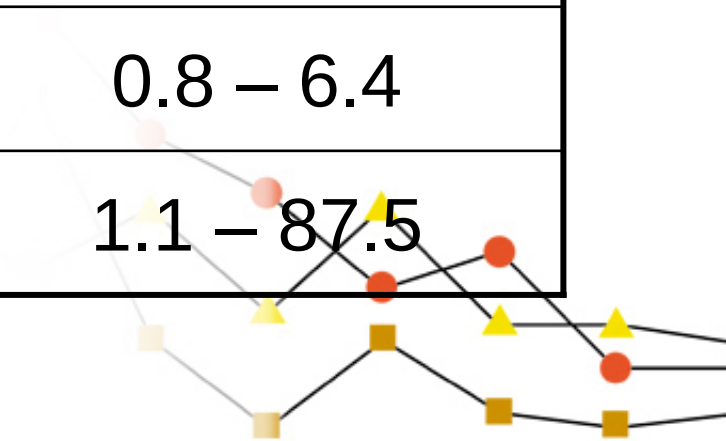
Engvall *Int J Tub Lung Dis 2001;5:468-77*

Relationship of asthma and cough to one or more signs of dampness: condensation, bathroom humidity, odours, water leakage

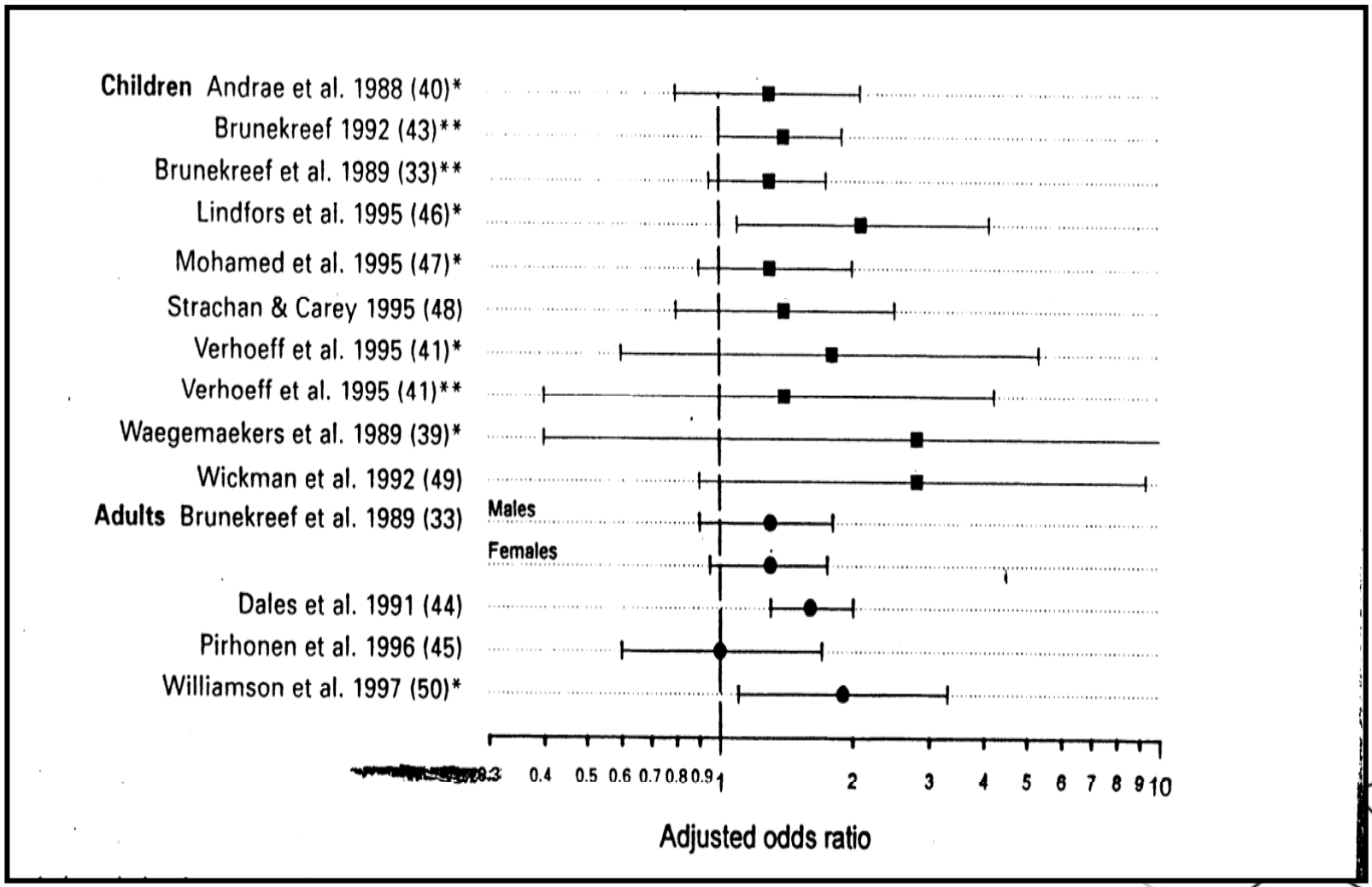


Nafstad, AJRCCM 1998;157;410-4
Oie, Epidemiology 1999;10;294-9

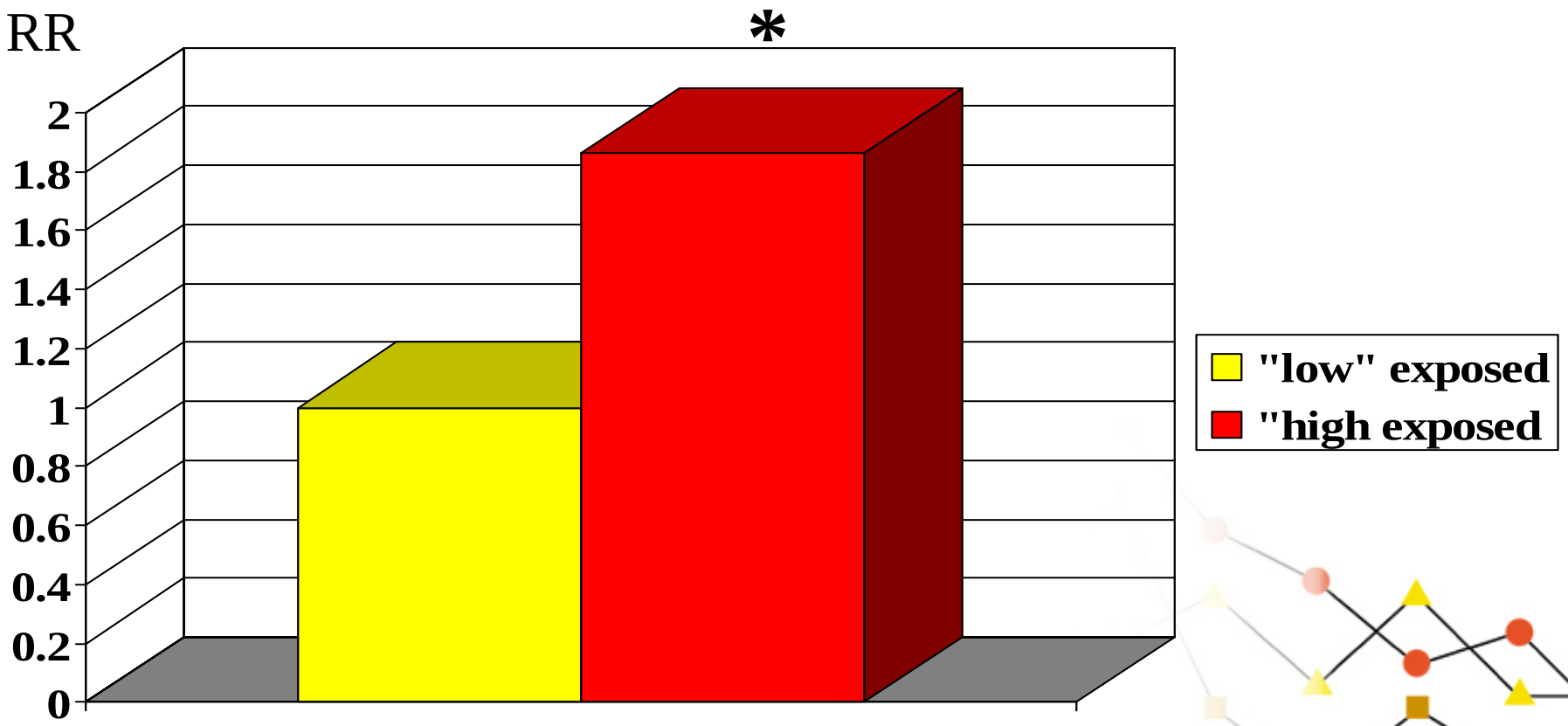
Bronchial obstruction in 0-2 yr olds		
	Adjusted OR	95% c.i.
Reported damp	2.5	1.1 – 5.5
Observed damp	3.8	2.0 – 7.2
at high ventilation	2.3	0.8 – 6.4
at low ventilation	9.6	1.1 – 87.5



Association between asthma and damp or mould in the home (Peat et al., 1998)

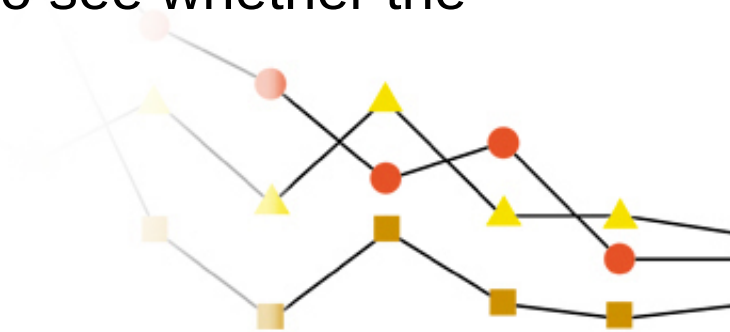


Measured fungal exposure and lower respiratory tract illnesses at 12 months, n=499 (stark et al., AJRCCM 2004)



Indoor mould is not a new problem

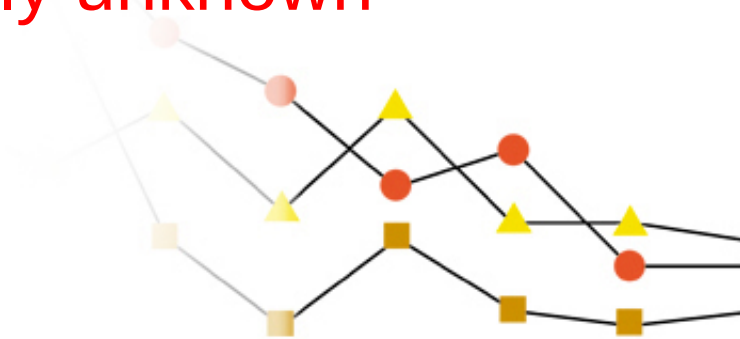
- One of the first mentions of mould and mould cleanup is in the Bible:
  - Leviticus, Ch. 13, verses 47-59: mouldy clothing must be burned;
  - and Ch. 14, verses 33-48: mouldy "with greenish or reddish depressions" on the inside wall of a house must be remedied
  - The rabbi did inspections and acted as the public health officer.
  - Remedy involved tearing out the contaminated stones and throwing them into "an unclean place outside the town," then scraping the remaining inside walls and throwing the scrapings in an unclean place. The old stones are replaced with new, the house is replastered and then monitored to see whether the trouble recurs.



What can be concluded from these studies?

Bornehag, Indoor Air 2001;Douwes, Am J Epidemiol 2003; IOM 2004

- dampness is associated with cough and wheeze, and to a lesser degree asthma in both children and adults
- A role for indoor fungal exposure is plausible but the evidence is weak
- The disease mechanisms are largely unknown



Most important weaknesses

Bornehag, Indoor Air 2001;Douwes, Am J Epidemiol 2003; IOM 2004

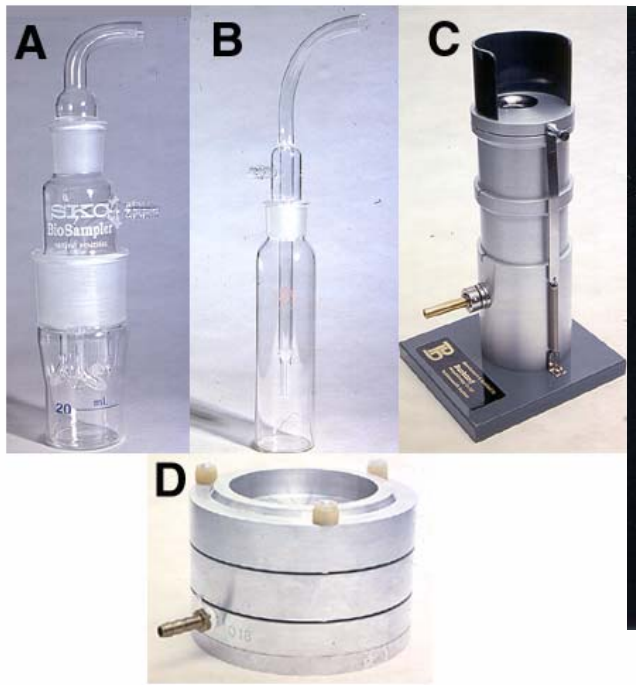
- Most studies have been cross-sectional
- Few studies have employed objective measures of exposure or disease
- Exposure assessment mostly by questionnaire

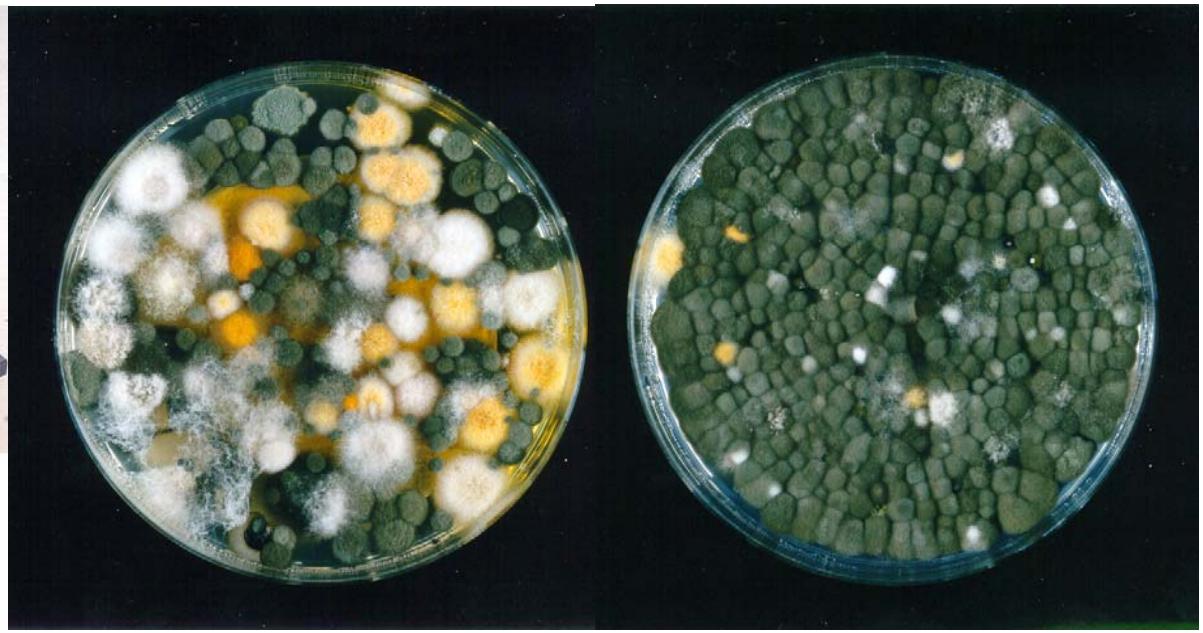
How biased are parents of symptomatic children?
Verhoeff, AJE 1995;141:103-10

Mold reported		Mold observed	
		No	Yes
Cases	No	134 (53.6%)	27 (10.8%)
	Yes	9 (3.6%)	80 (30.3%)
Controls	No	144 (58.5)	26 (10.6%)
	Yes	11 (4.5%)	65 (26.4%)


How problematic is exposure assessment?

Exposure assessment

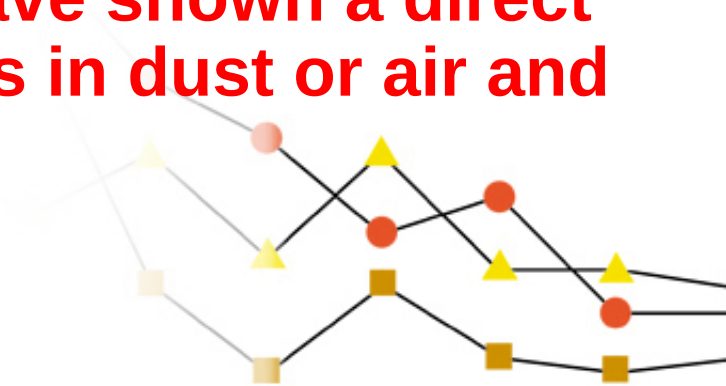




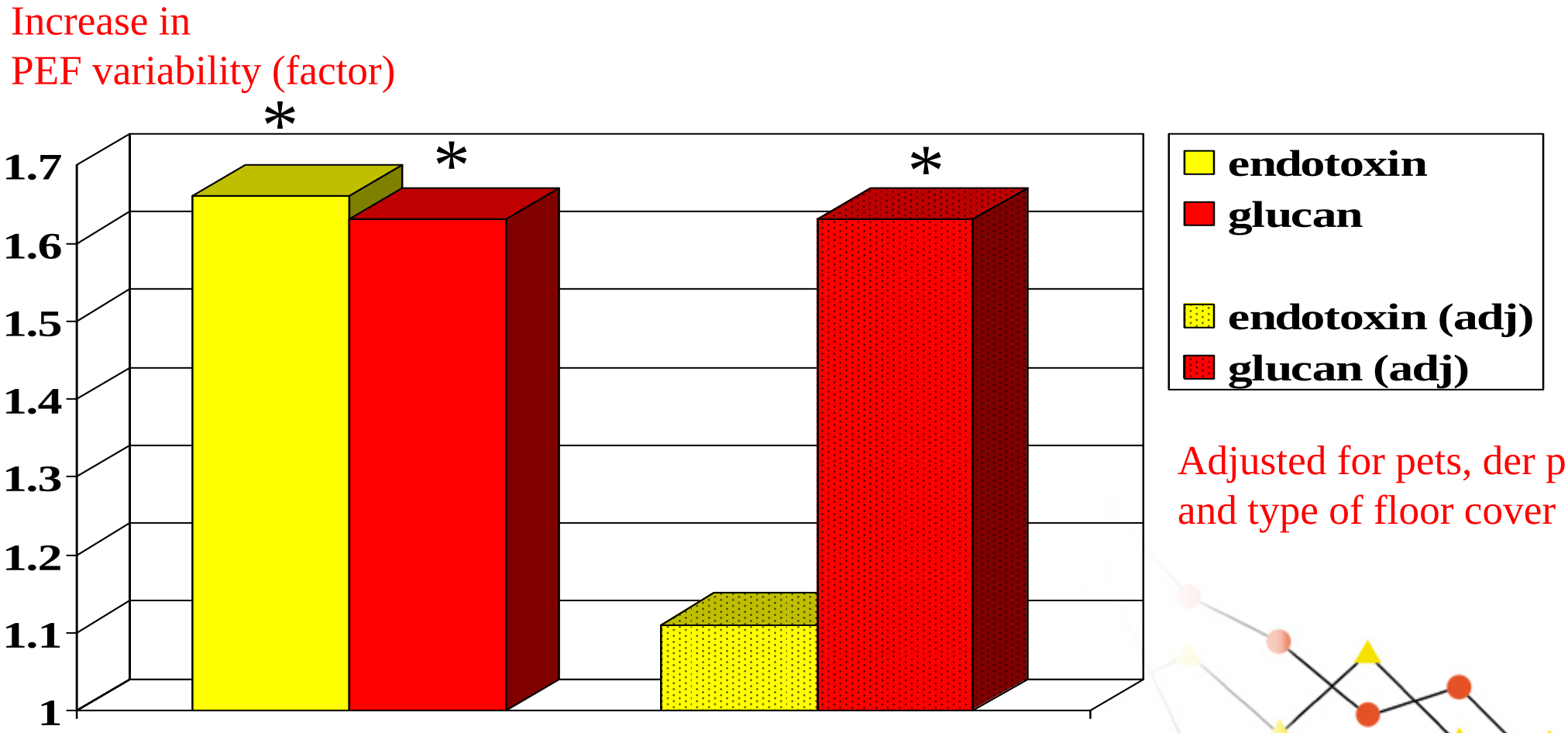
- Culture based methods
- Non-culture based methods
- Methods to assess specific constituents

Problems with culture methods

- Selection of media and culture conditions affects colony growth (selection of certain genera)
- Viability may be irrelevant to the toxicity (e.g. allergens, ß(1,3)-glucans)
- **Large variability in exposure assessment (poor reproducibility)**
- Personal exposures are difficult/impossible to measure
- Labour intensive and tedious (particularly speciation)
- **Very few epidemiological studies have shown a direct association with CFU measurements in dust or air and adverse health effects**



Endotoxin and ß(1,3)-glucan in relation to PEF variability in children with asthma symptoms

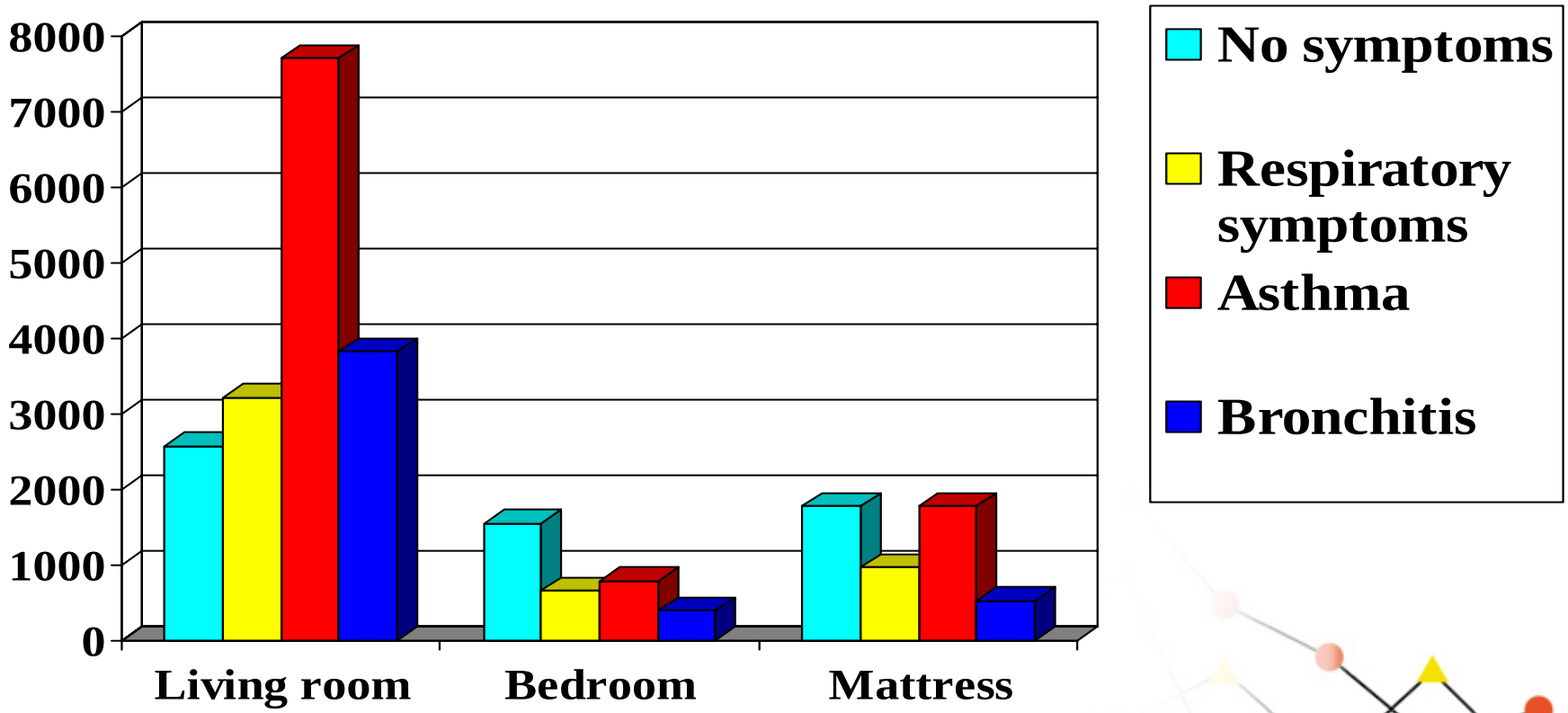


Adjusted for pets, der p1 and type of floor cover

(Douwes et al., Am J Respir Crit Care Med 2000)

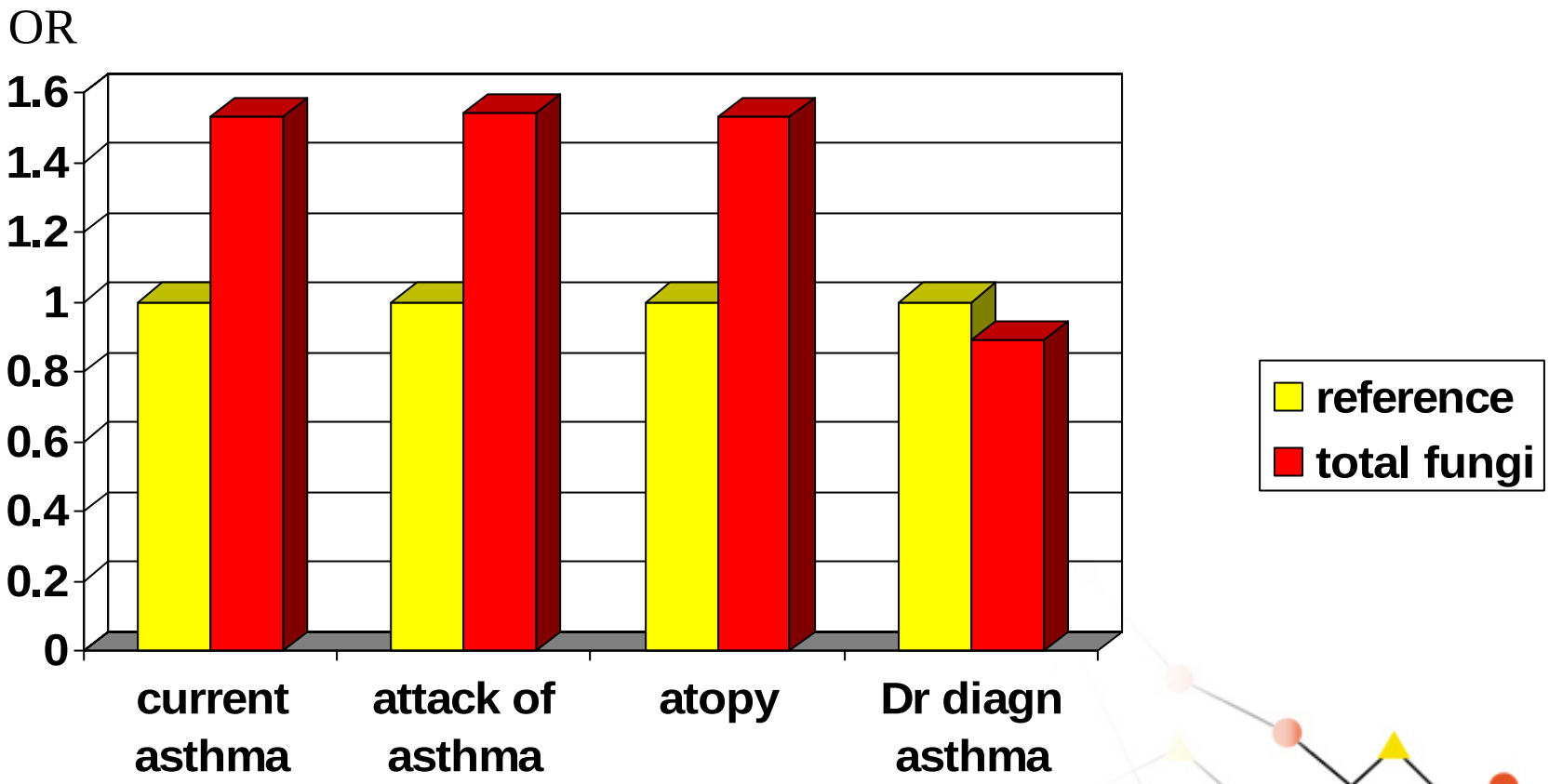
Fungal EPS and respiratory symptoms

Douwes et al., , J Allergy Clin Immunol 1999



New onset symptoms associated with a doubling in indoor fungal levels over a 2-year period

Matheson et al., 2005



Environmental Risk Factors Associated With Pediatric Idiopathic Pulmonary Hemorrhage and Hemosiderosis in a Cleveland Community

Eduardo Montaña, MD, MPH*; Ruth A. Etzel, MD, PhD*; Terrance Allan, RS, MPH‡; Timothy E. Horgan, MPH‡; and Dorr G. Dearborn, PhD, MD§

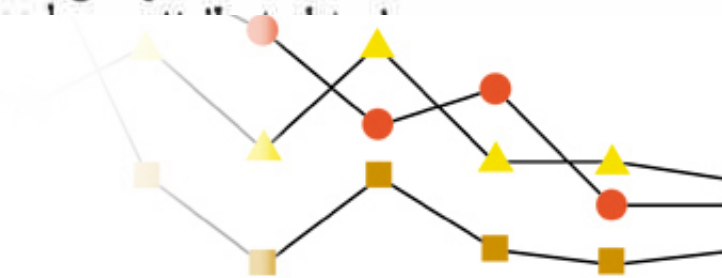
ABSTRACT. *Background.* Unexplained pulmonary hemorrhage and hemosiderosis are rarely seen in infancy. A geographic cluster of 10 infants with this illness was identified in a large pediatric referral hospital in Cleveland, Ohio, during the period of January 1993 through December 1994. One infant died of severe respiratory failure.

Methods. A case-control study was conducted. Three control infants were matched by age with each case infant. All study infants' guardians were interviewed. Questions were asked about child care practices and home conditions for the period before case infants' illnesses. All infants' records were reviewed, their homes were visited, and a structural and environmental survey was conducted.

Results. All 10 case infants were black, and 9 were

A cluster of 10 infants with idiopathic pulmonary hemosiderosis (IPH) was identified at a major pediatric referral hospital in Cleveland, Ohio, during the 24-month period from January 1993 through December 1994. One of the infants had died after severe respiratory failure. Pediatric pulmonologists at this hospital had seen only three cases of IPH among children in the preceding 10 years. A case-control study was initiated to identify environmental risk factors for pulmonary hemorrhage among infants.

Spontaneous pulmonary hemorrhage in infants is a rare and dramatic event. In older patients, the pulmonary hemorrhage syndromes, such as Good-



Update: Pulmonary Hemorrhage/Hemosiderosis Among Infants — Cleveland, Ohio, 1993–1996

A review within CDC and by outside experts of an investigation of acute pulmonary hemorrhage/hemosiderosis in infants has identified shortcomings in the implementation and reporting of the investigation described in *MMWR* (*1,2*) and detailed in other scientific publications authored, in part, by CDC personnel (*3–5*). The reviews led CDC to conclude that a possible association between acute pulmonary hemorrhage/hemosiderosis in infants and exposure to molds, specifically *Stachybotrys chartarum*, commonly referred to by its synonym *Stachybotrys atra*, was not proven. This report describes the specific findings of these internal and external reviews.

Background

In December 1994 and January 1997, articles in *MMWR* described a cluster of 10* infants from Cleveland, Ohio, with acute idiopathic pulmonary hemorrhage, also referred to as pulmonary hemosiderosis (*1,2*). The children resided in seven contiguous postal tracts and had had one or more hemorrhagic episodes, resulting in one death, during January 1993–December 1994. Preliminary results of a CDC case-control study

USA WEEKEND

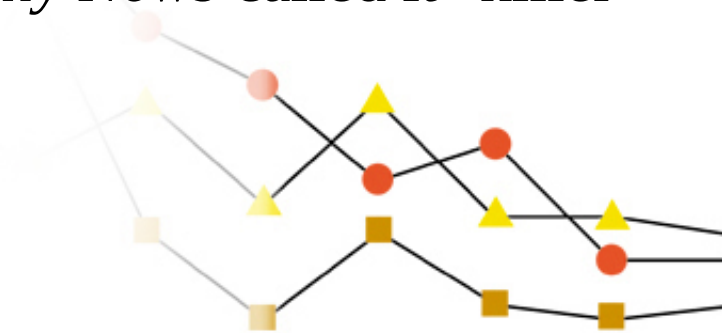
THE MOLD IN YOUR HOME MAY BE DEADLY

Toxic intruder: Black mold panic has families fleeing their homes. ABC News, 2002

In Oregon, the O'Hara family asked their local fire department to burn their $450,000 home to the ground after black mold was found inside. "It's basically just a house that poisoned my family," Mark O'Hara said.

In Hawaii, a $95 million Hilton Hotel tower has been closed since July because black mold was found in some of the rooms.

In a July 2001 story *Time* magazine said toxic mold is spreading "like some sort of biblical plague." The New York *Daily News* called it "killer mold."



America's Secret Enemy - Mold

Amanda Carver, News Blaze

“Then the "black mold" craze hit the insurance industry a few years ago, everything changed. Someone had mold, bad mold, and decided that their insurance company should pay for the damages”

“The case ultimately went to court and the judge sided with the insured. It was mind boggling to see how many "Mold Restoration Specialists" popped up over night. Attorneys, specialists, and new claimants flooded the insurance industry demanding, yup, money”

“Money was pouring into "mold claims" like wine at Caligula's pad on a Friday night”

“House's were remediated at 3 times their cost”

public health relevance

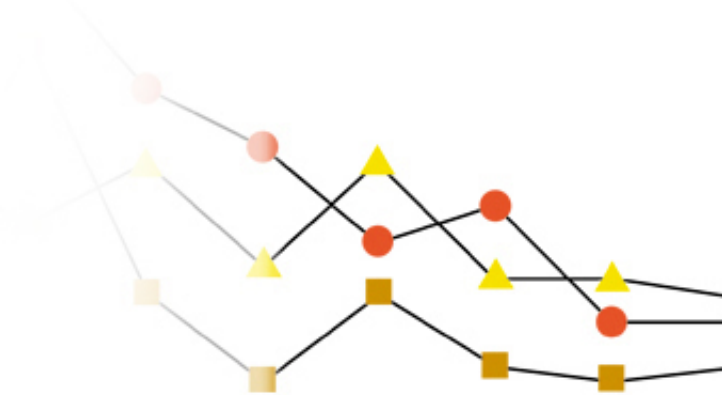
- “black mould” and infant pulmonary hemorrhage
- Severe, life threatening
- Rare: very few individuals world wide
- Receives too much attention
- Public awareness is great (at least in the US)

- **Dampness/mould and asthma, airway irritations, allergies**
- **Mild, moderate and severe**
- **Common: potentially tens of millions of people world wide**
- **Receives too little attention**
- **Public awareness is minor**
- **Interventions are needed**
- **More research is needed**

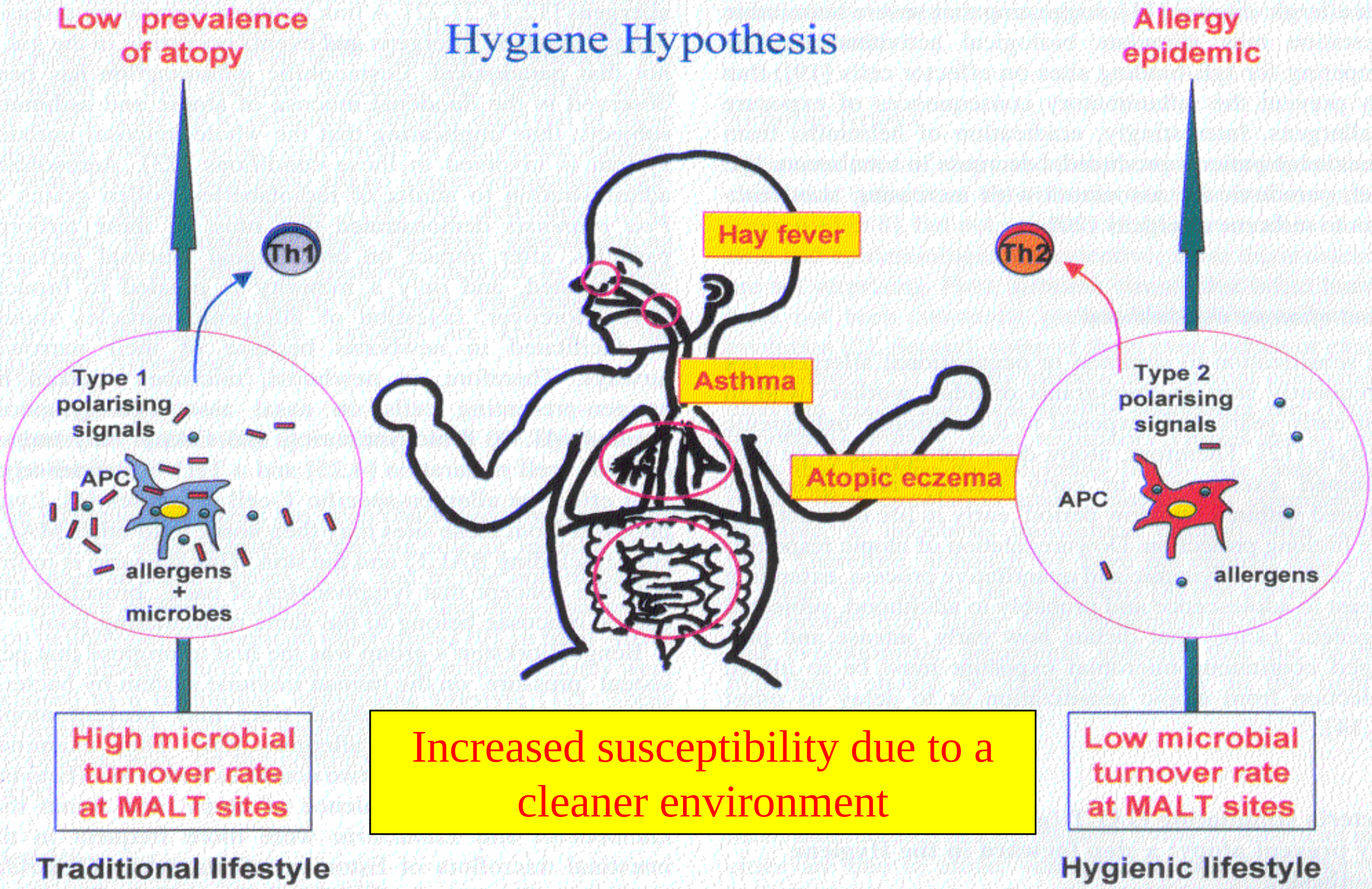
Relevance for New Zealand

- New Zealand homes generally do not have central heating,
- New Zealand homes are poorly insulated
- Dampness/water damage problems are relatively common

- National telephone survey in 613 households
  - Howden-Chapman et al., Indoor Air 2005
  - More or less representative for the whole NZ population
  - 35.1% reported mould in one or more rooms.
- Community-based intervention study in 1310 households
  - Howden-Chapman et al., Social Science and Medicine 2005
  - At least one person with respiratory symptoms
  - Low income communities
  - 66% reported non-condensation dampness at baseline
  - 75% reported indoor mould at baseline



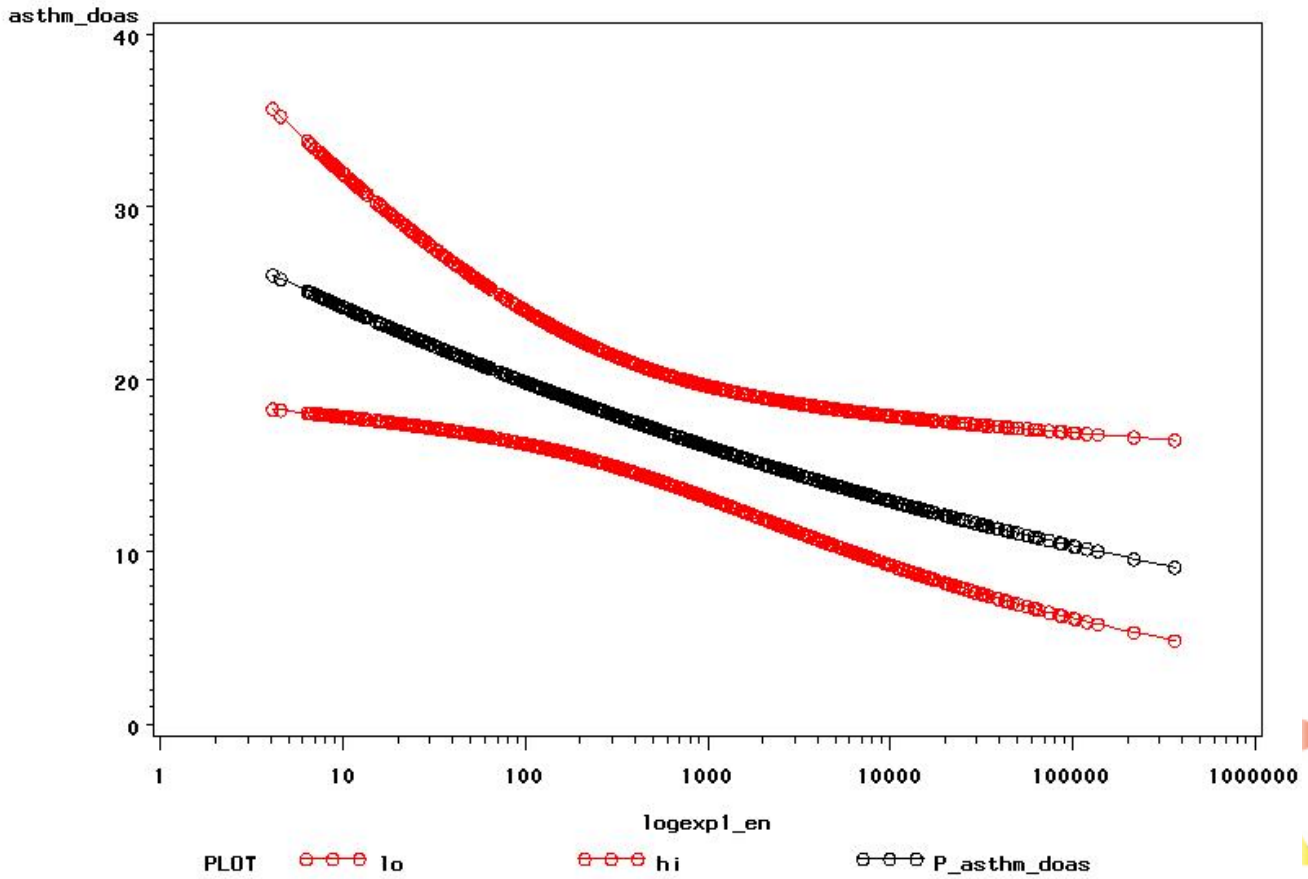
Hygiene Hypothesis



Increased susceptibility due to a cleaner environment

The association between endotoxin and doctor's diagnosed asthma at 48 months using generalized additive modeling (smoothing)

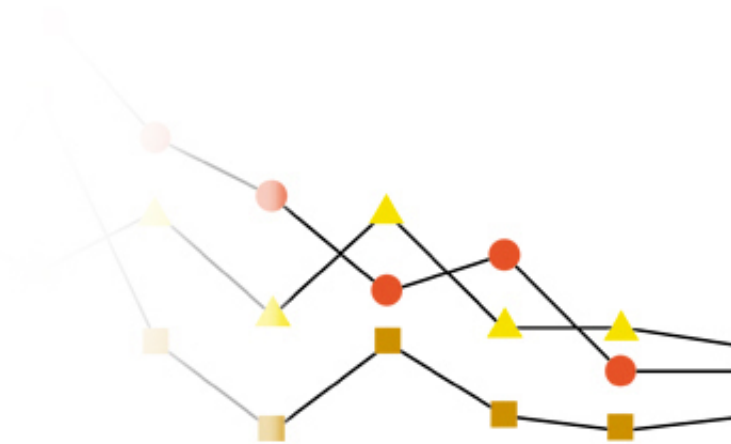
Douwes et al., J Allergy Clin Immunol 2006



Log endotoxin concentration

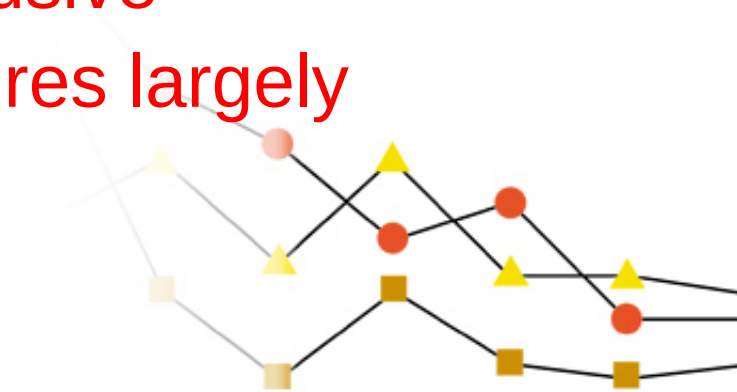
Indoor microbial exposure and health: adverse versus potential protective effects

- Dose/balance
- Timing of exposure
- Type of microbial agents



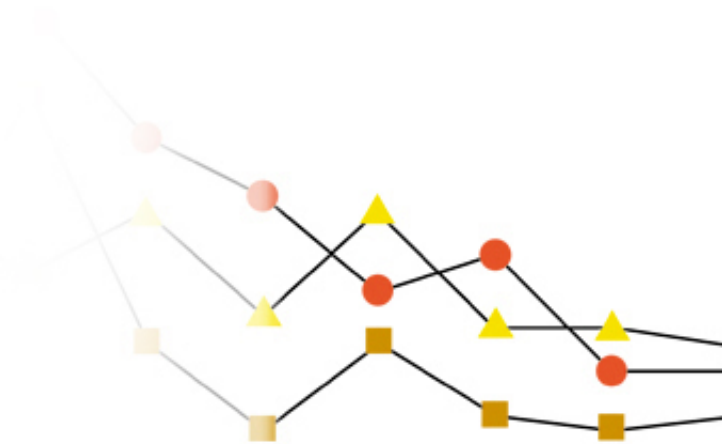
In conclusion

- Questionnaire studies continue to find associations between living in a damp home and respiratory symptoms & disease
- Information bias seems unlikely
- Mite allergy may be important in some places but does not explain the associations in many others
- Studies using measurements of mold exposure have been small-scale and largely inconclusive
- Interactions with other indoor exposures largely unexplored



In conclusion II

- Mould may be related to the infant pulmonary hemorrhage “epidemic” in Cleveland, but the evidence is weak
- High exposures to indoor microbial exposures is likely to cause adverse health effects; some exposure may, however, be beneficial (hygiene hypothesis)



What more is needed?

- Prospective studies in open populations; ongoing and planned birth cohort studies have good potential
- Intervention trials in institutional buildings such as schools and offices


Thank you!!