Health and the Domestic Environment

- Accidents
- Mental health
- Respiratory health
- Cardiovascular health
  - Xcess winter mortality

Lung Health and the Domestic Environment

- Indoor environment health effects:
  - Asthma
    - Infants, children, elderly
  - COPD
    - Elderly
  - Rare – fibrosing lung disease
    - indoor birds
    - hobbies

Lung Health and the Domestic Environment

- Indoor environment health effects:
  - Asthma
    - Infants, children, elderly
  - COPD
    - Elderly
  - Rare – fibrosing lung disease
    - indoor birds
    - hobbies

Lung Health and the Domestic Environment

- What is asthma (and allergy)
- Domestic environment
  - Allergies
  - Remedies
  - Damp and mould
  - Irritants - Nitrogen oxides (gas)
  - Viral infection

What is Asthma ??

….widespread narrowing of the bronchial airways, which changes its severity over short periods of time either spontaneously or under treatment, and is not due to cardiovascular disease. WHEEZING

+ bronchial hyperresponsiveness *physiology*

+ airway inflammation *pathology*

CIBA Symposium 1959

Descriptions of Asthma

Asthma  Non-Asthma

wheezy bronchitis

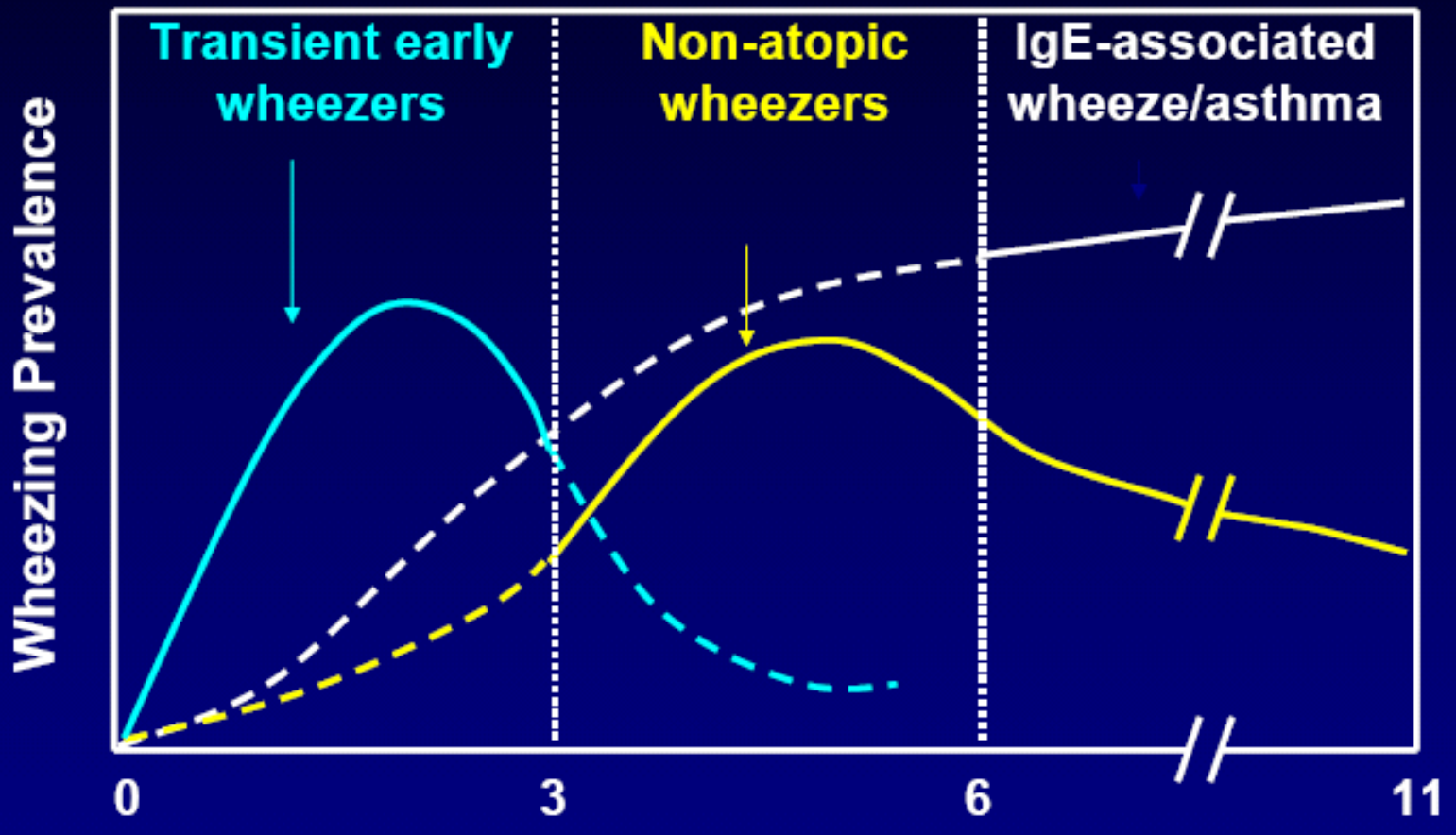
occupational asthma *cough variant asthma*

post viral wheeze

Allergic – Eosinophil

Non allergic – Neutrophil

Natural History of Childhood Wheezing



Martinez, JACI 1999

Asthma Epidemiology

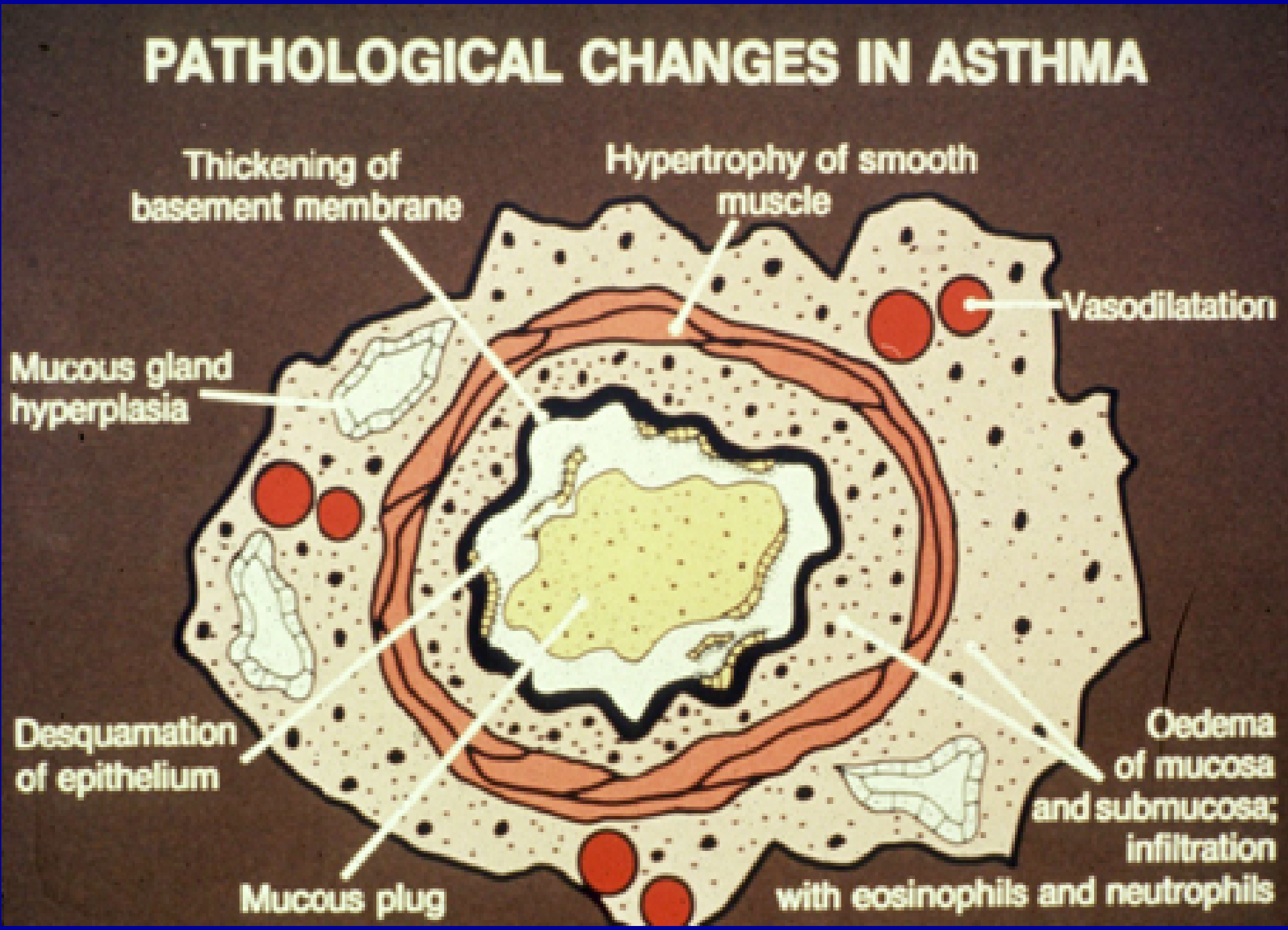
Wheeze = Asthma

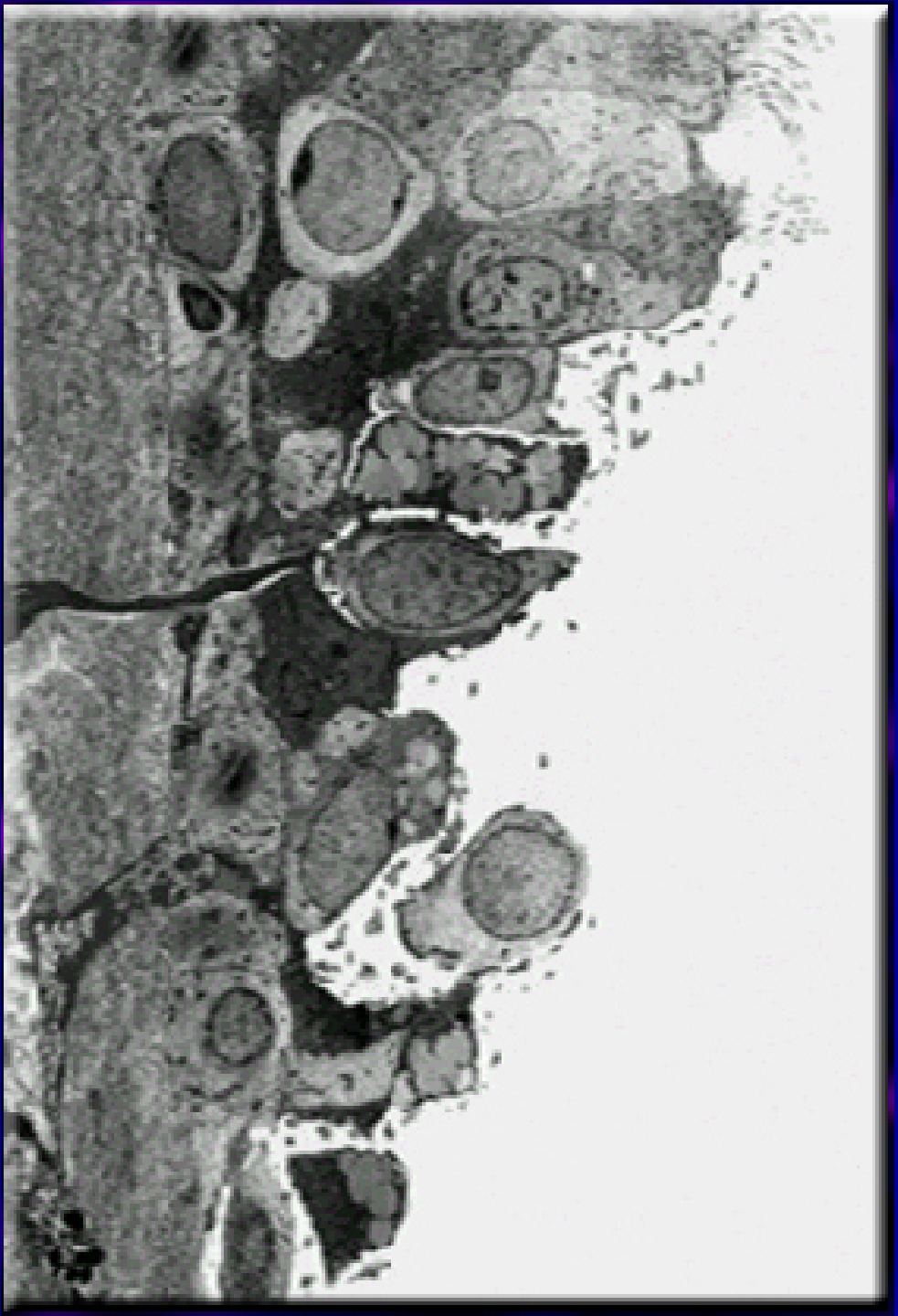
Melbourne children prevalence Wheeze = 54%

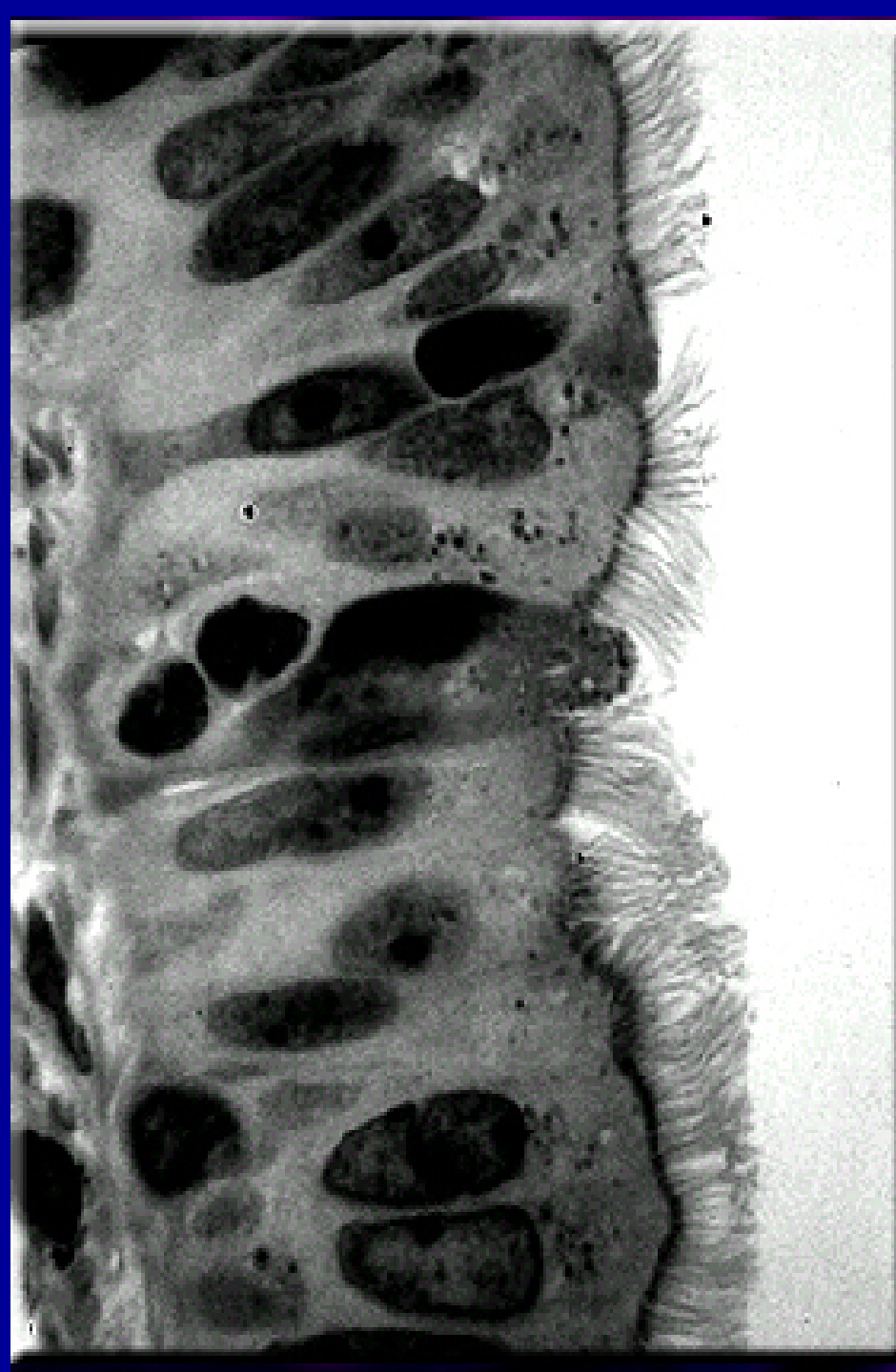
Dunedin Cohort age 26 years – 70% 1 report wheeze
50% 2 or more

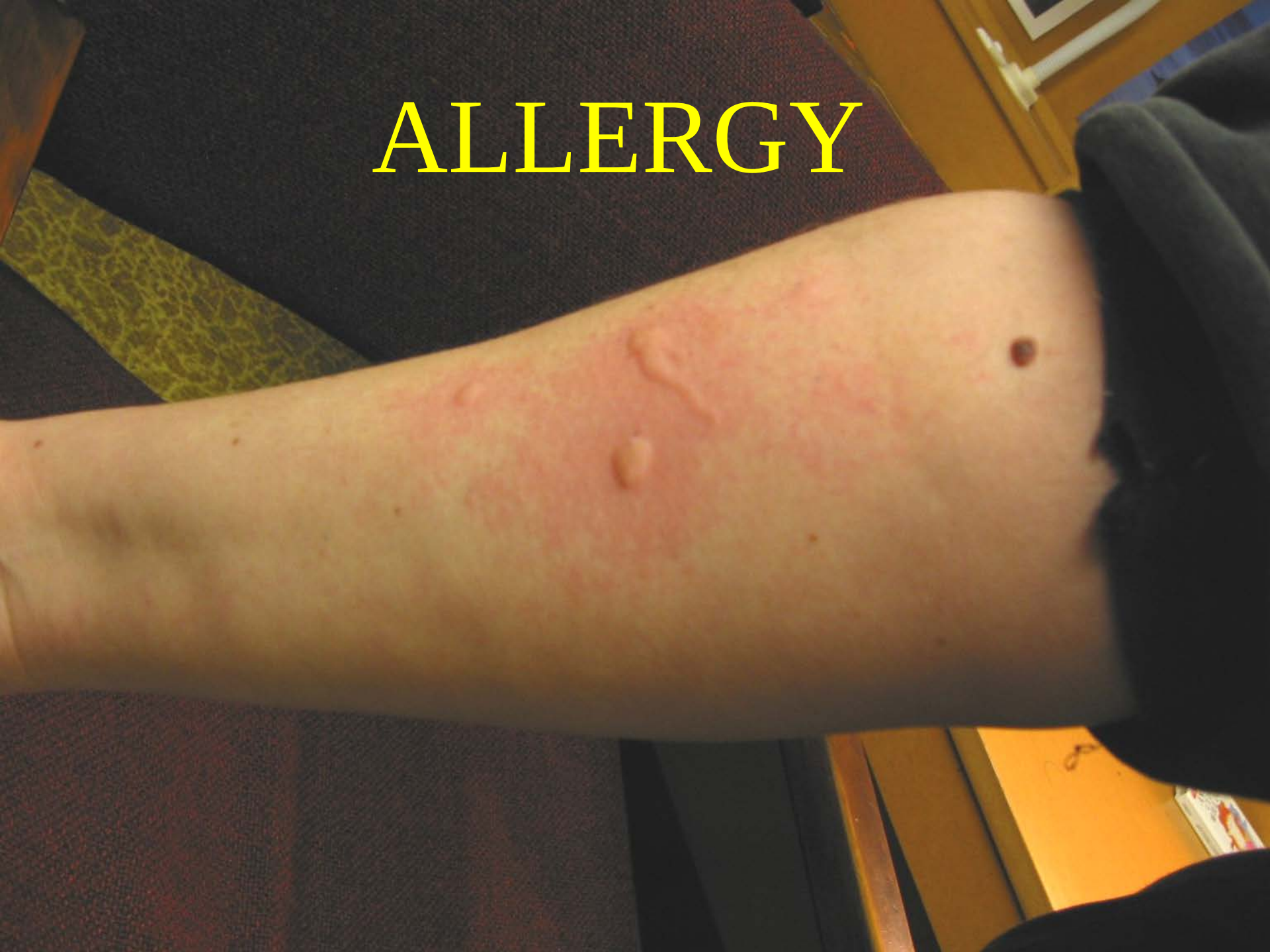
Perfect ‘data’ wheeze = 100% by 20 years age

PATHOLOGICAL CHANGES IN ASTHMA

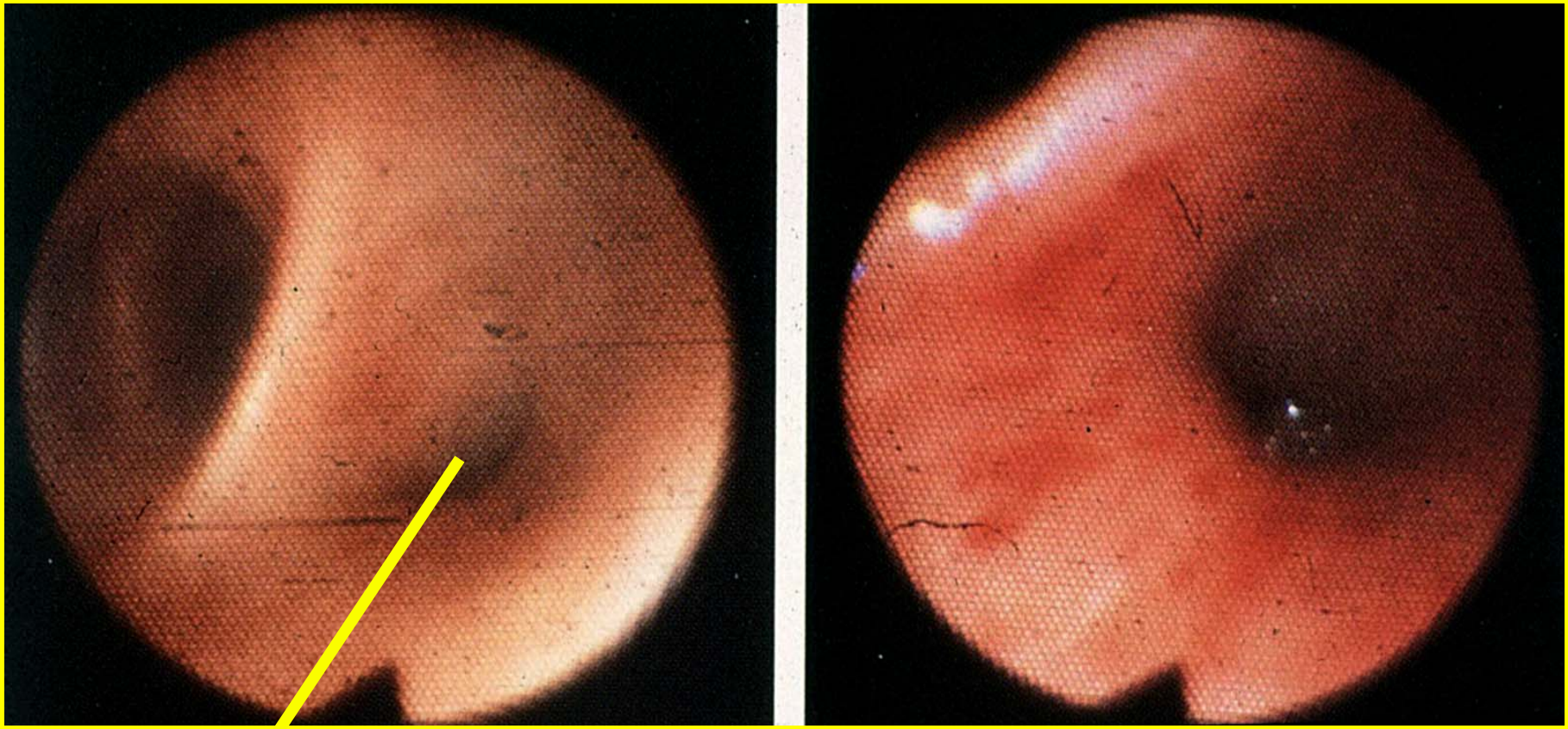






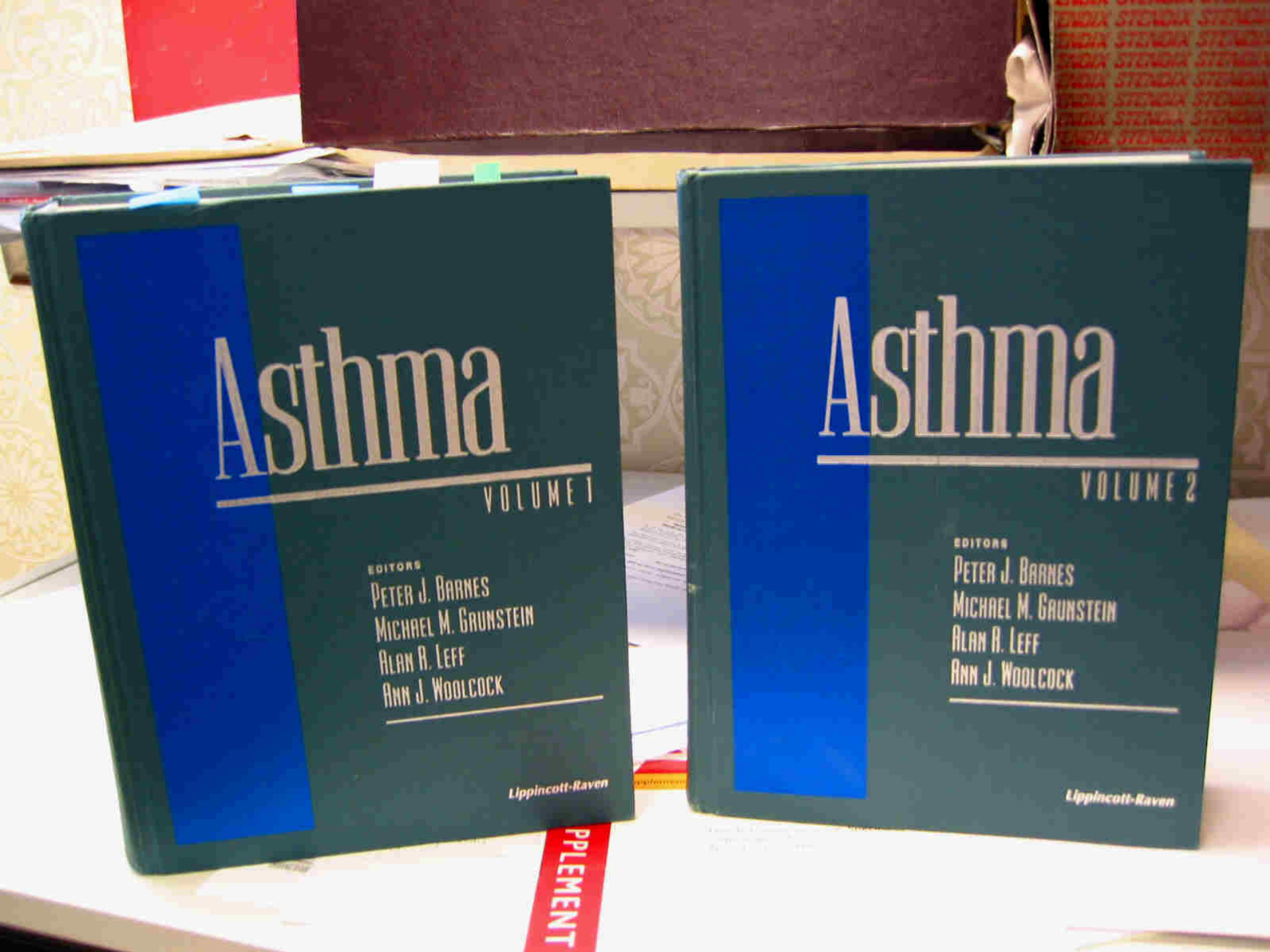

ALLERGY

Allergen in the airway



Constriction

Inflammation


Asthma
VOLUME 1
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Asthma
VOLUME 2
EDITORS
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Lippincott-Raven

Asthma - Overview

- What is asthma?

  "Despite the immense amount of material presented here (2200 pages) we do not know the answer to this question…"
- How should we classify asthma?

  "The classification of asthma will remain a problem until more is known about the disease"

Asthma - Overview

- Why does asthma differ in severity between patients?

  "We have little understanding of why the disease differs in severity between patients…."
- How should asthma be managed?

  "The whole area of management remains controversial and has led to a mania in the production of management guidelines…"

Asthma at the Clinic

History
Wheeze

+

reversible airflow obstruction

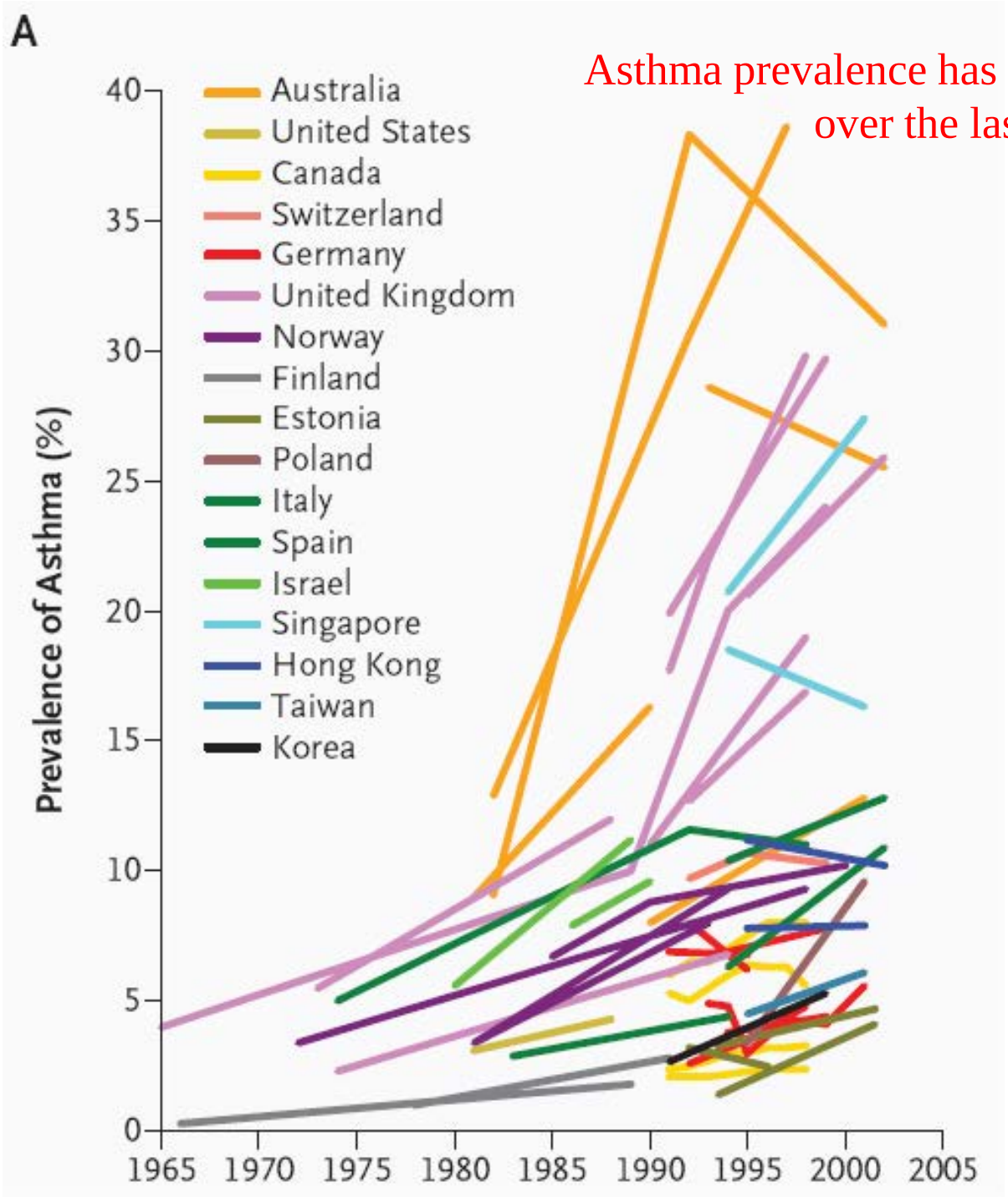
+

Response to Rx

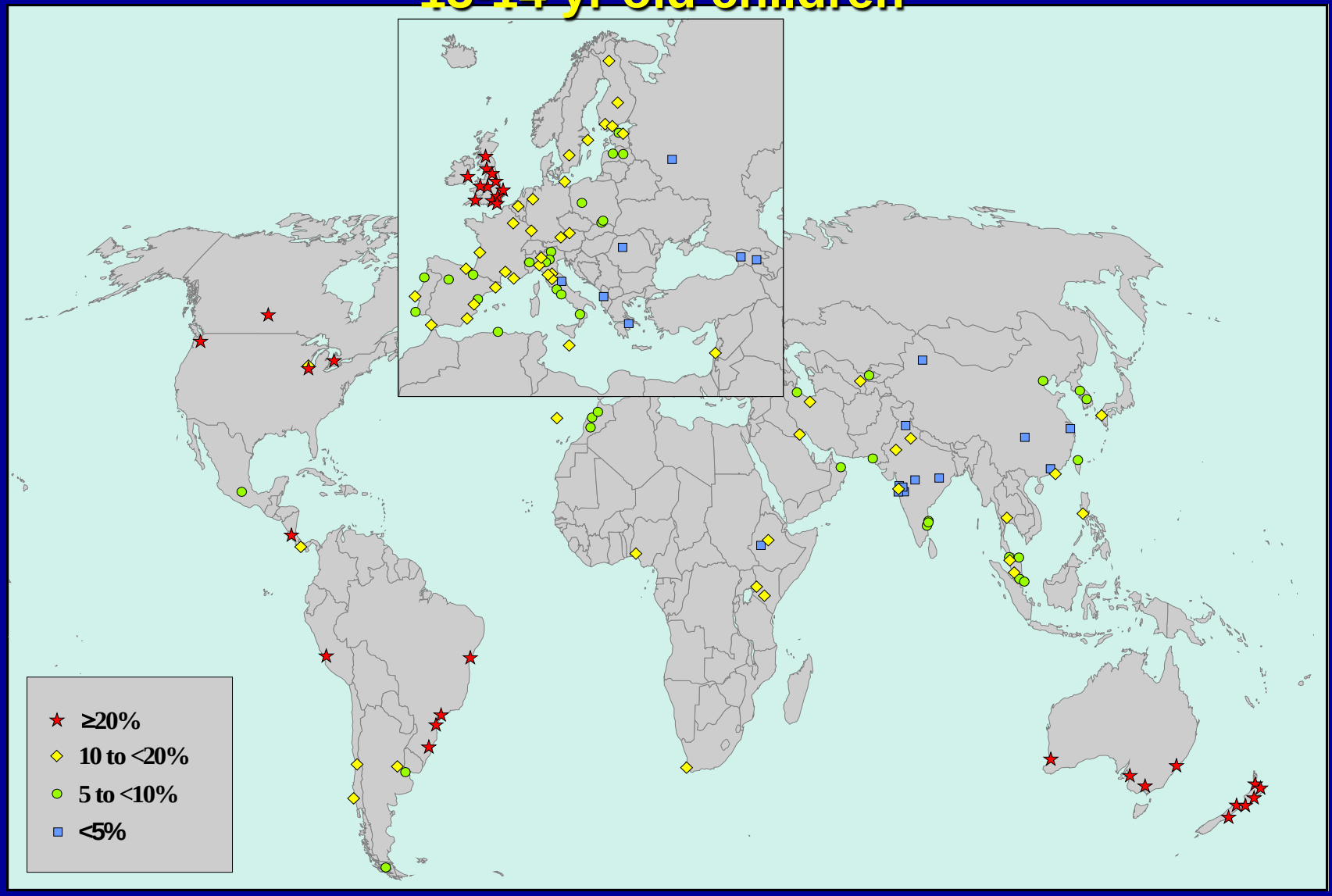
Family history
Allergies
IgE
Hay fever
Eczema
TRIGGERS

OCCUPATION

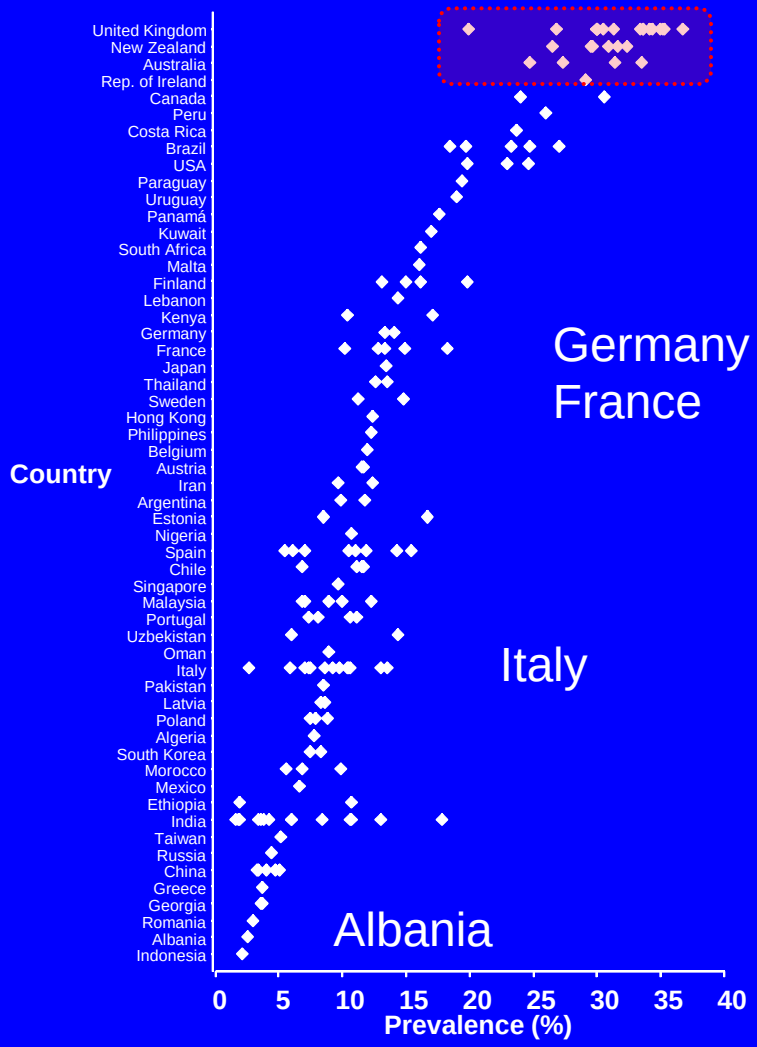
Asthma prevalence has increased substantially over the last 50 years



12 month period prevalence of asthma symptoms in 13-14 yr old children

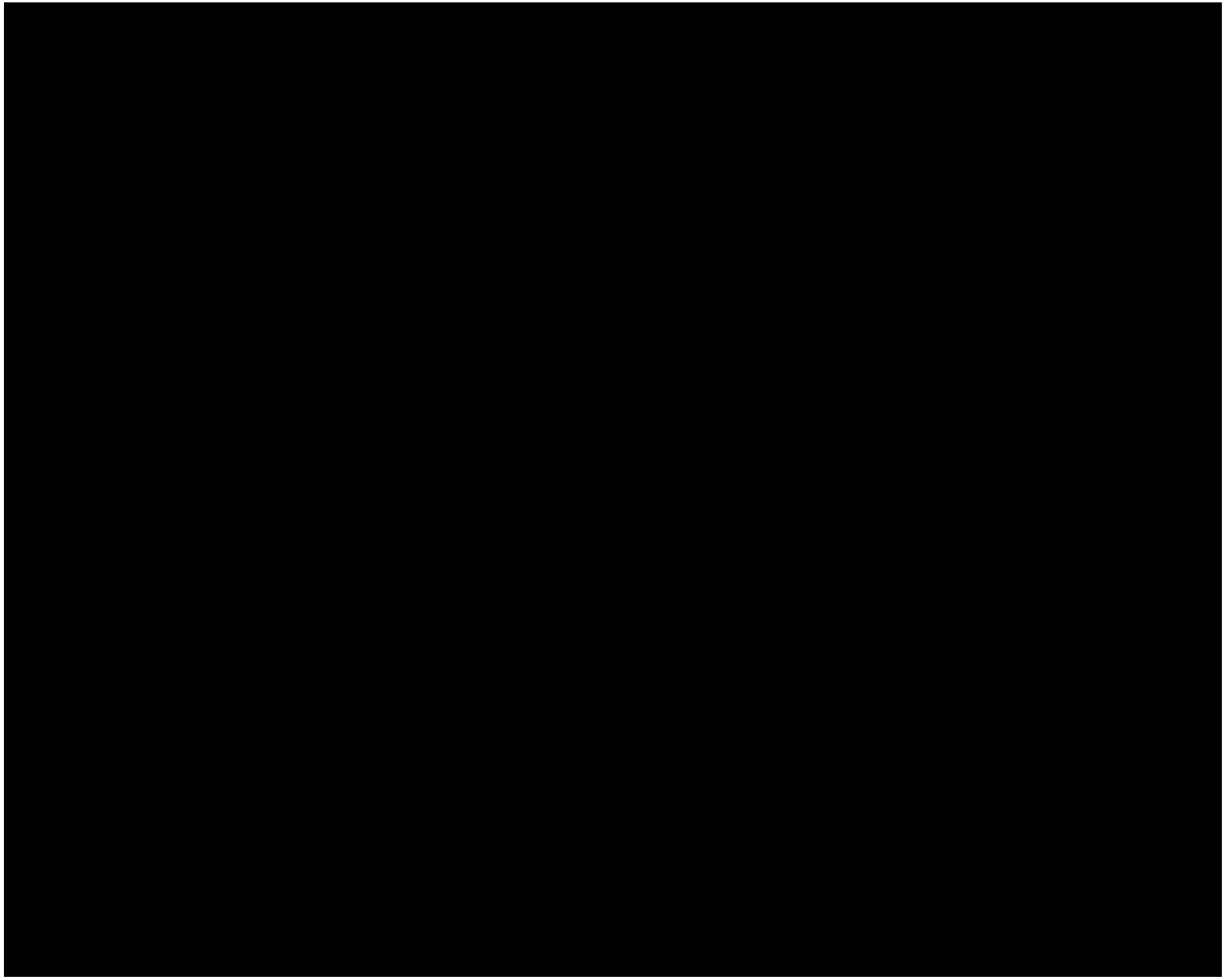


Phase One Prevalence of Current Wheeze, 13-14 Year Age Group

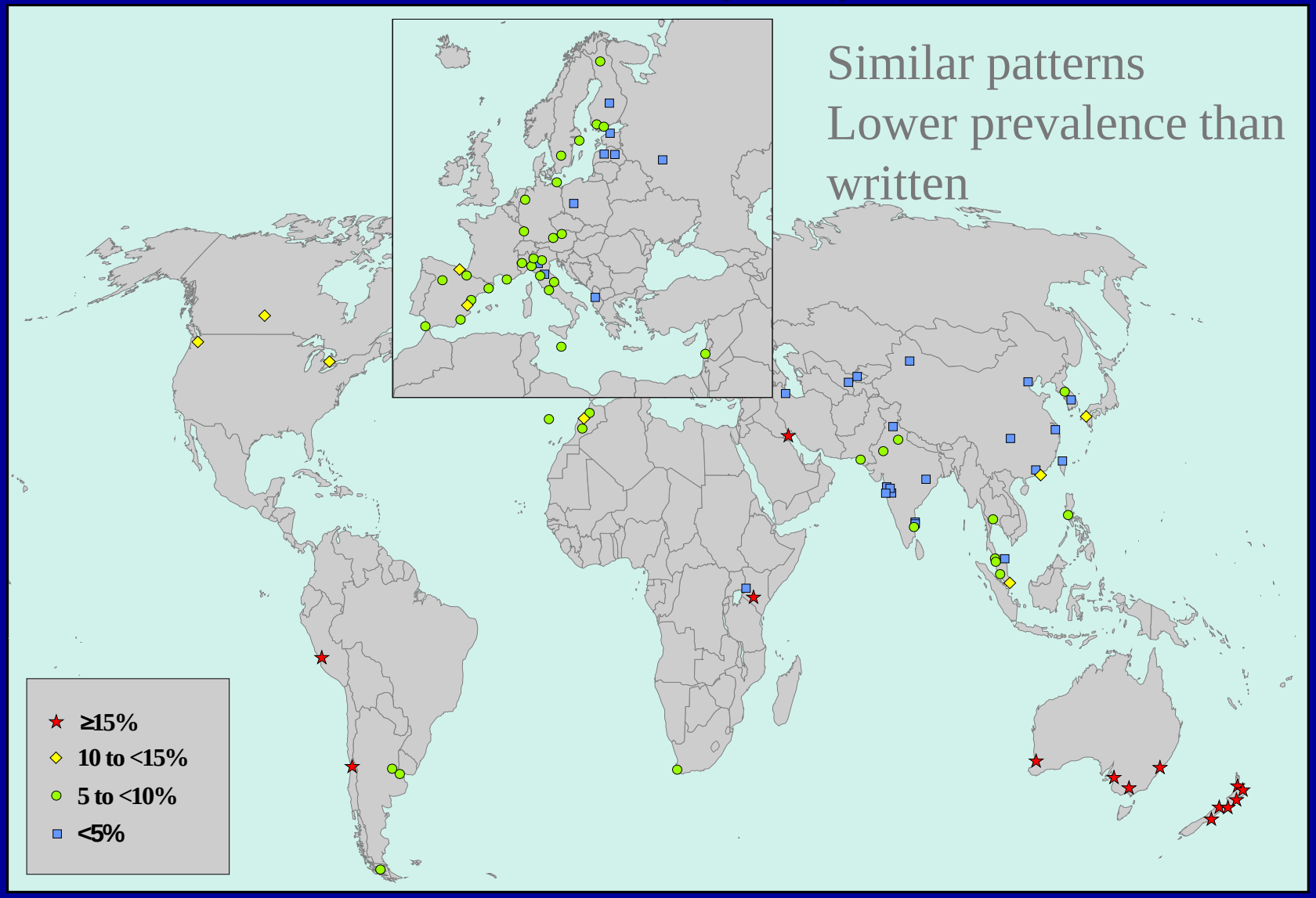


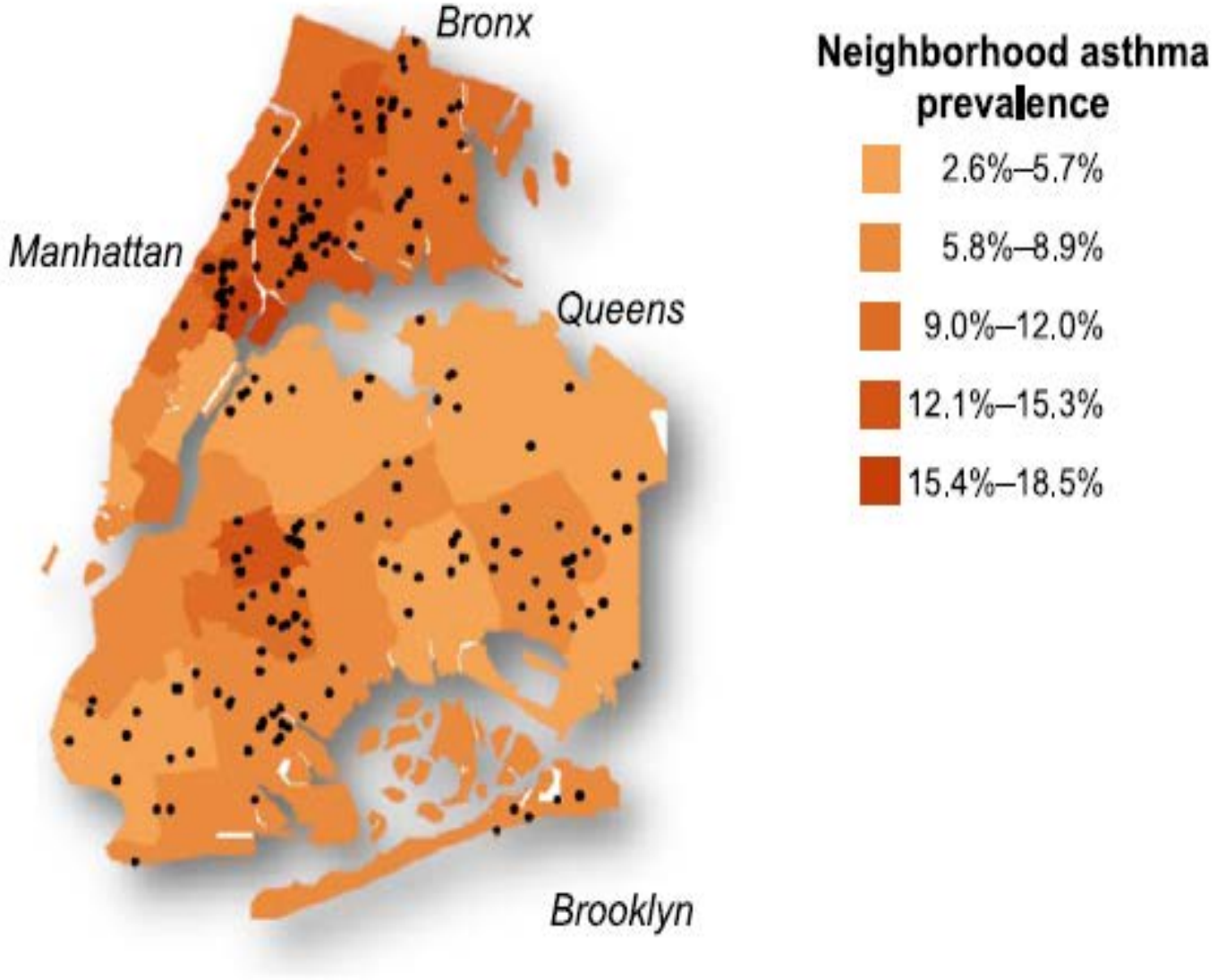
Source: ISAAC Steering Committee. Lancet 1998;351:1225-32.

Video clip



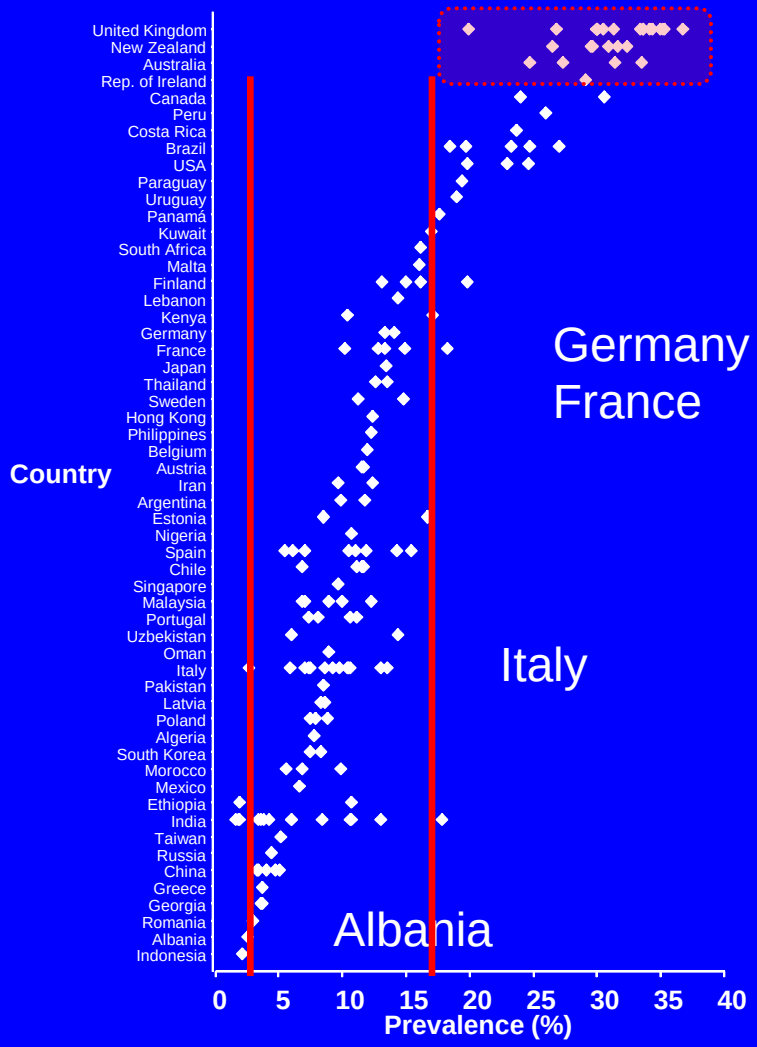
12 month period prevalence of asthma symptoms in 13-14 year old children (video)





Mainardi, T. Pediatrics 2013;131;1

Phase One Prevalence of Current Wheeze, 13-14 Year Age Group



Source: ISAAC Steering Committee. Lancet 1998;351:1225-32.

Phase One Prevalence of Current Wheeze, 13-14 Year Age Group

UK
NZ
OZ
Ireland
Canada

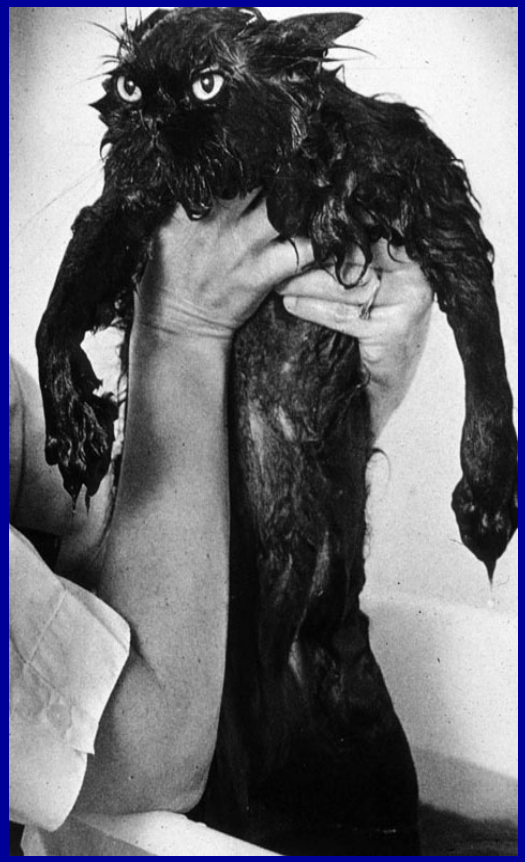
Germany
France

Albania

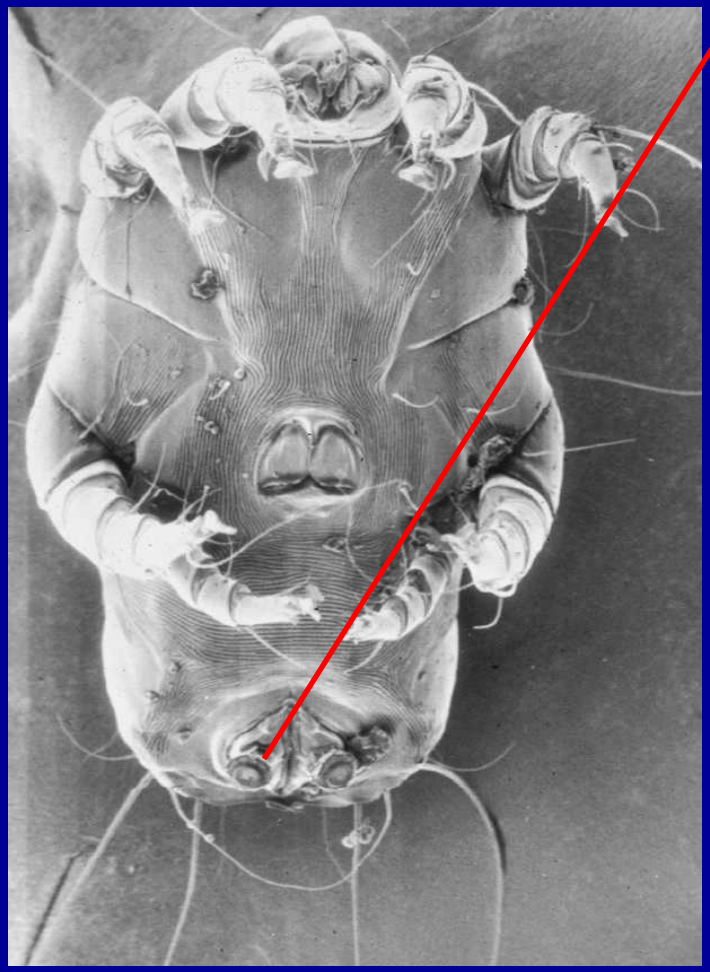
NYC Emergency ER visits for asthma
In children vary 20 fold by district

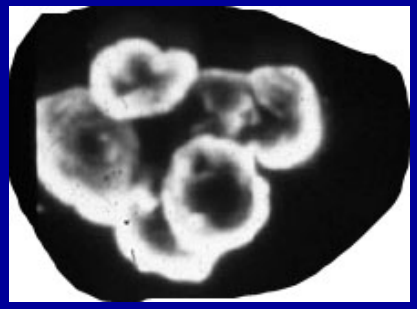
Source: ISAAC Steering Committee. Lancet 1998;351:1225-32.

Domestic Environmental Allergens



NZ highest levels domestic HDM allergen in world

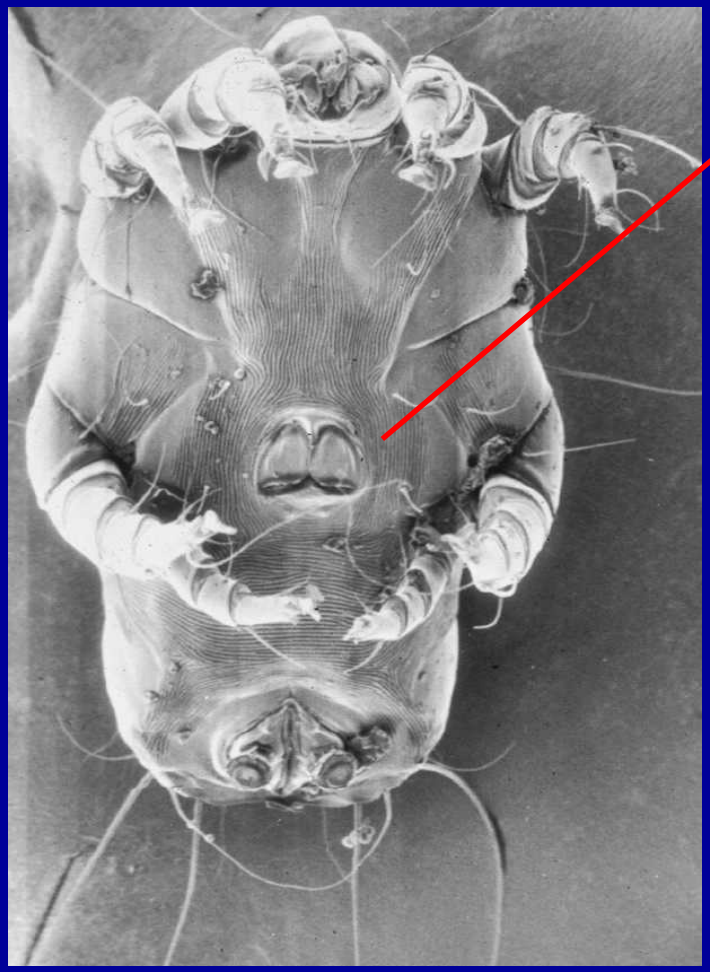




Measure the chemical causing allergy in dust

>2mcg/g - sensitisation
>10mcg/g - asthma attacks

NZ amongst highest in the world
Floors ~40mcg/gm
Bedding ~20mcg/gm



‘valve’ to control the mite’s water supply from the surrounding air

Cannot survive in dry climates
Requires RH >50%
Desert
Mountains
- prevention strategy


Children with mite allergic asthma achieve
complete remission of symptoms and normal lung function
in ~ 3months

Asthma

- Common in NZ and English speaking countries
- Allergic and non allergic
- Prevalence has increased substantially in last 50 years
- Prevalence varies considerable by country
- Prevalence can vary considerable within cities
- HDM allergen high levels in NZ homes

Managing allergies

- Complete mite avoidance only at altitude
- Heat recovery ventilation
- Bedding covers – pillows, duvets, mattresses
- Miticides, chemicals to denature allergen
- Humidity control
  - Problem – mites can survive 23/24 hrs 0RH%
- Low allergen pets, washing ??

Many studies show reduction in allergen and mites but fail to show improvement in asthma

Allergy 1998: 53: 755–762
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ALLERGY
ISSN 0105-4538

A pilot study of the effect of mechanical ventilation and heat exchange on house-dust mites and Der p 1 in New Zealand homes

Crane J, Ellis I, Siebers R, Grimmet D, Lewis S, Fitzharris P. A pilot study of the effect of mechanical ventilation and heat exchange on house-dust mites and Der p 1 in New Zealand homes.
Allergy 1998: 53: 755–762. © Munksgaard 1998.

J. Crane, I. Ellis, R. Siebers, D. Grimmet, S. Lewis, P. Fitzharris

Wellington Asthma Research Group, Department of Medicine, School of Medicine, Wellington, New Zealand

We have examined the effect of reducing relative humidity (RH), with inbuilt mechanical ventilation and heat-exchange (MVHE) units, on house-dust-mite (HDM) counts and allergen levels, in a pilot study of 10 Wellington dwellings. Recent international prevalence studies in adults and children have confirmed a high prevalence of asthma in New Zealand. Sensitivity to HDM is common among the general population, and HDM is the major allergen associated with asthma. Recent studies of allergen levels have confirmed high concentrations of Der p 1 in the domestic environment. While humidity was significantly reduced in those dwellings fitted with ventilation units, no systematic effect on mites or Der p 1 was observed during the study period. When the reductions in humidity were examined in the context of the time spent below the critical equilibrium humidity (CEH), the intervention led to RH values below the CEH for only 39% of the total of 24-h periods for which measurements were made. Reducing RH by means of MVHE in New Zealand domestic dwellings does not have

Key words: allergen avoidance; domestic environment; house-dust mites; humidity control.

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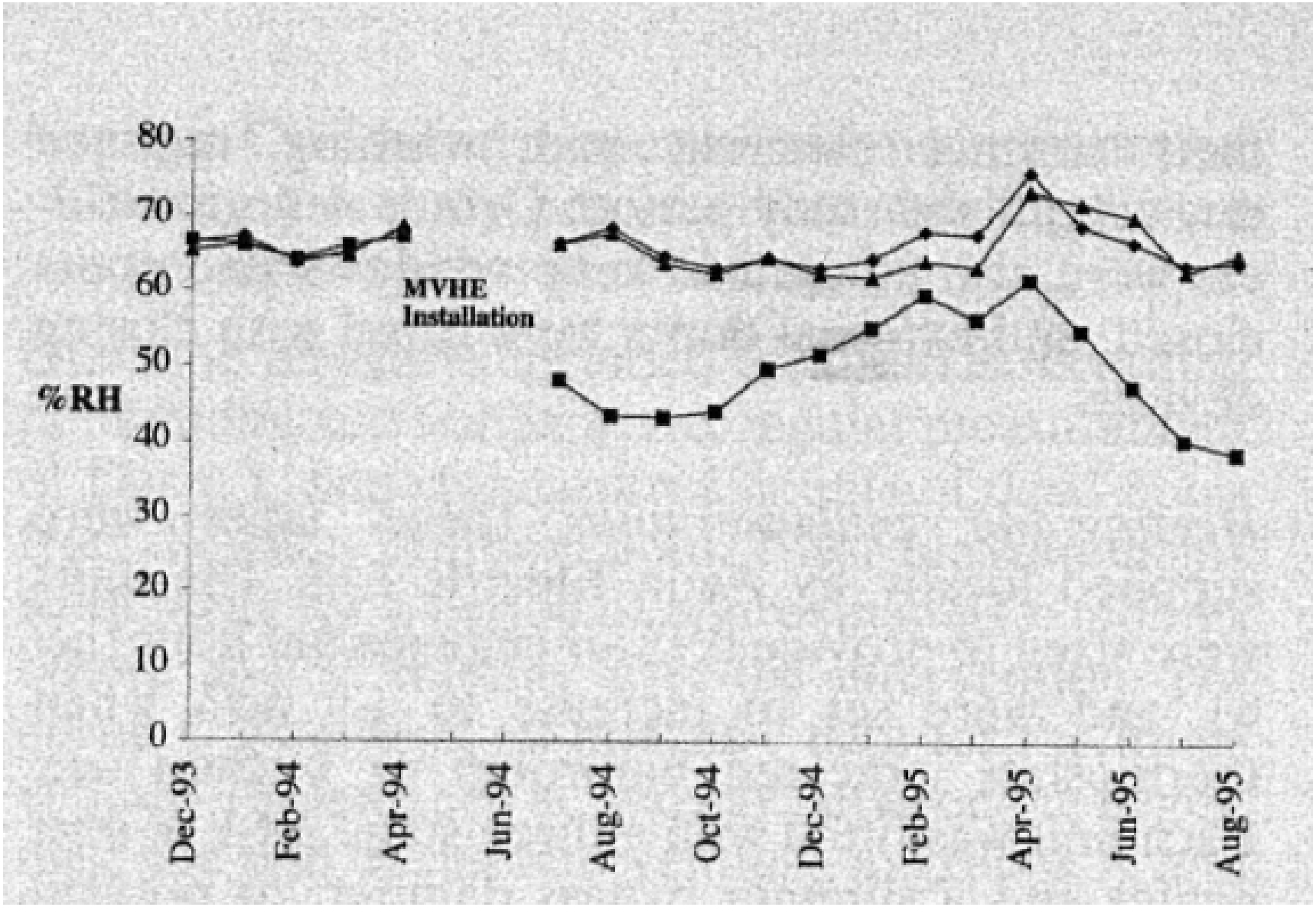
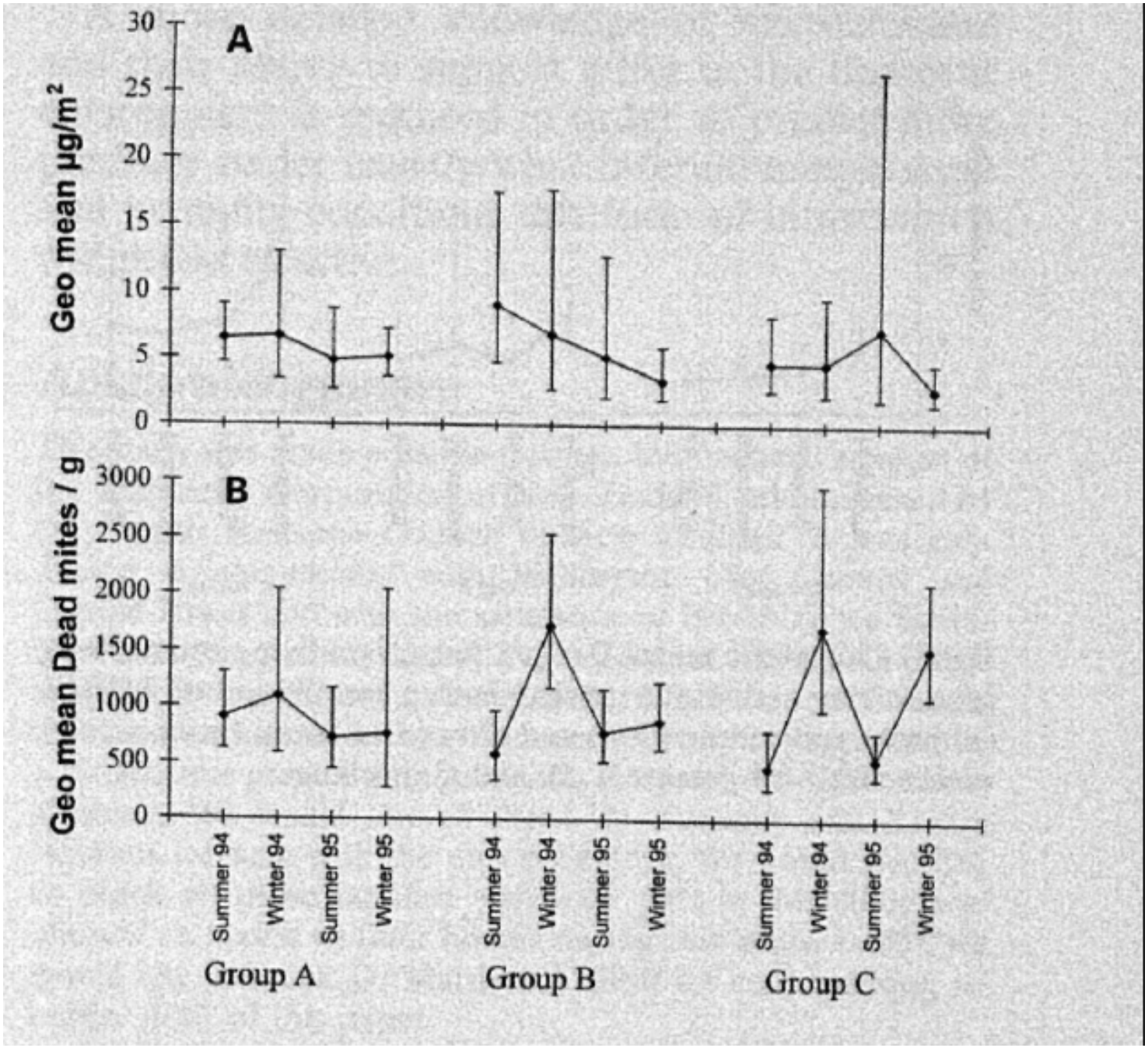

80
70
60
50
40
30
20
10
0
%RH
MVHE
Installation
Dec-93
Feb-94
Apr-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Apr-95
Jun-95
Aug-95


A
B
Geo mean µg/m²
Geo mean Dead mites / g
30
25
20
15
10
5
0
3000
2500
2000
1500
1000
500
0
Summer 94
Winter 94
Summer 95
Winter 95
Group A
Group B
Group C

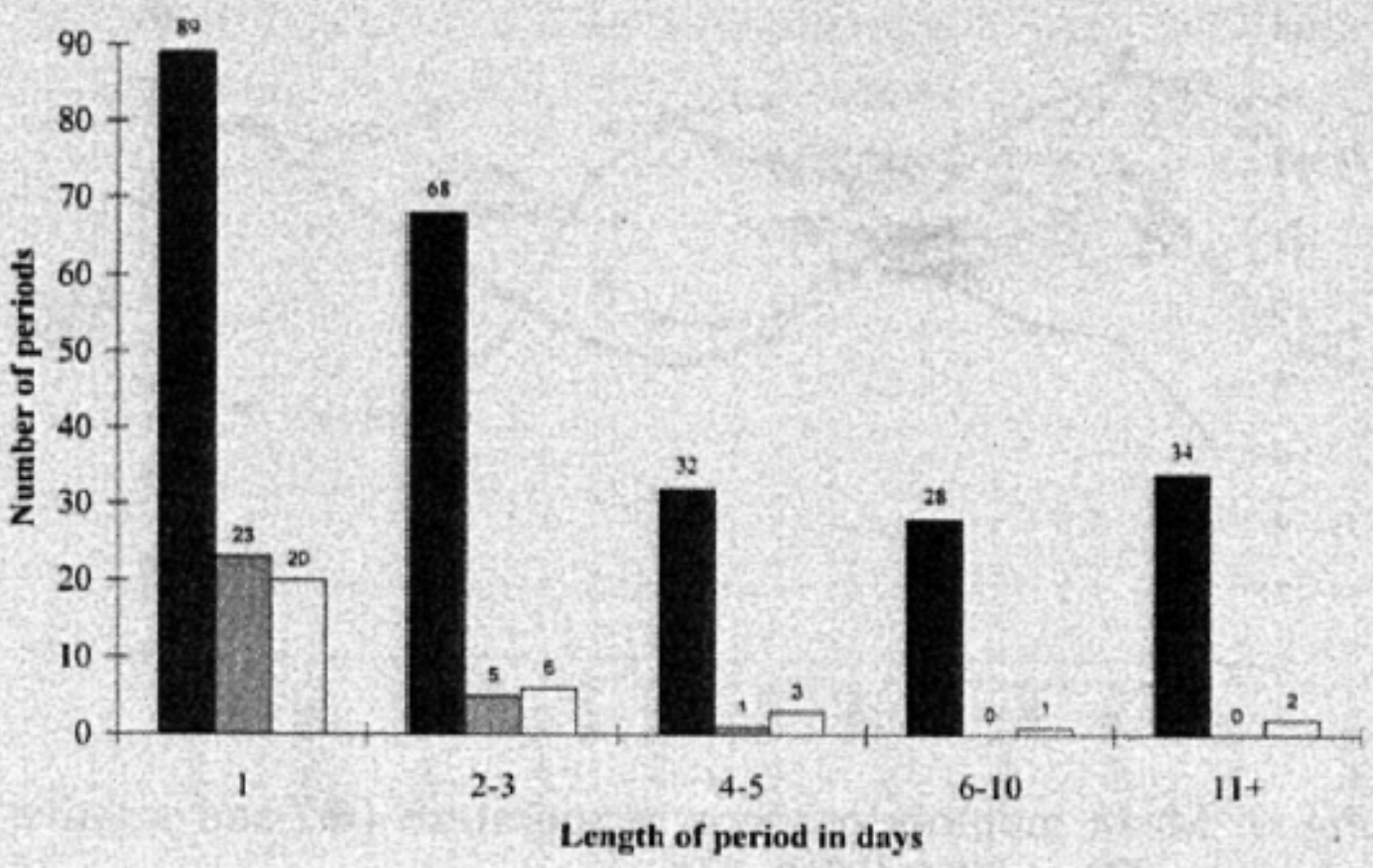


Fig. 7. Number of periods below critical equilibrium humidity in groups A, B, and C dwellings.

Outcomes

- Substantial increase in temperature and reduction in RH%
- No effect on mite numbers or mite allergen

- Reduced humidity not sufficiently sustained
- 1 hour @ 70% RH in 24hrs 5% RH sufficient for mite survival and reproduction

Asthma and domestic environment

- Damp, cold and mould
  - Moulds - allergic and non-allergic
    - Make existing asthma worse
    - May ‘cause’ asthma
  - Non specific effect of fungal wall material
    - ? Primary and secondary
  - Increased risk URTI - ?? Viral
  - Other?

- VOC’s – carpets, synthetic bedding, flooring
- NOx – unflued gas
- Particulates from wood/coal burning
- ETS – only modifiable asthma risk factor

Moulds and Asthma Severity

- Asthmatics allergic to moulds have more severe asthma (but mould allergy uncommon 2-5%)
  - Studies asthma clinic and specialist referrals
  - Hospital and ICU admissions
  - Life threatening asthma and deaths
  - A/E, hospital admissions - spore counts

Allergy 2000: 55: 501–504
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ALLERGY
ISSN 0105-4538

Short communication

Sensitivity to fungal allergens is a risk factor for life-threatening asthma

Background: Previous studies have suggested that sensitivity to *Alternaria* and *Cladosporium* may be risk factors for life-threatening asthma. We have investigated this by studying the relationship between skin tests for fungal spores and admission to an intensive care unit (ICU) for asthma.
Methods: Skin prick tests for fungal spores (*Alternaria tenuis*, *Cladosporium cladosporoides*, *Helminthosporium maydis*, and *Epicoccum nigrum*), cat dander, house-dust mite (*Dermatophagoides pteronyssinus*), and a seven-grass mix were performed in three groups of patients: patients admitted to an ICU with an attack of asthma; those who had received emergency treatment for asthma but had not been admitted to an ICU, and those who had never required emergency treatment for their asthma.
Results: Twenty of 37 patients (54%) admitted to the ICU had a positive skin test for one or more fungal allergens compared with 15/50 patients (30%) in each of the other groups ($P = 0.005$). The ICU patients were no more likely to have positive skin tests for the grass mix, cat dander, or house-dust mite than the other patients.
Conclusions: A positive skin test for fungal allergens is a risk factor for admission to an ICU with an acute attack of asthma.

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Department of Medicine, University of Auckland, Auckland, New Zealand

Key words: asthma; fungal allergens.

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Accepted for publication 20 December 1999

Table 1. Baseline characteristics of subjects

	No. of subjects	Mean age (years)[3]	Male:female
ICU	37	36.0 ± 9.8	13/24
Hospital[1]	50	32.5 ± 8.5	10/40
Community[2]	50	35.9 ± 9.8	20/30

Table 2. Percentage of positive skin tests for different allergens

	Hospital	Community	ICU
Alternaria	26.0%	24.0%	40.5%
Cladosporium	14.0%	14.0%	24.3%
Epicoccum	20.0%	2.0%	21.6%
Helminthosporium	14.0%	8.0%	21.6%
All fungi	30.0%	30.0%	54.1%
Grass mix	76.0%	72.0%	59.5%
Cat dander	62.0%	62.0%	51.4%
D. pteronyssinus	90.0%	84.0%	89.2%

Sensitisation to airborne moulds and severity of asthma: cross sectional study from European Community respiratory health survey

Mahmoud Zureik, Catherine Neukirch, Bénédicte Leynaert, Renata Liard, Jean Bousquet, Françoise Neukirch, on behalf of the European Community Respiratory Health Survey

Abstract

Objective To assess whether the severity of asthma is associated with sensitisation to airborne moulds rather than to other seasonal or perennial allergens.

Design Multicentre epidemiological survey in 30 centres.

Setting European Community respiratory health survey.

Participants 1132 adults aged 20-44 years with current asthma and with skin prick test results.

Main outcome measure Severity of asthma according to score based on forced expiratory volume in one second, number of asthma attacks, hospital admissions for breathing problems, and use of corticosteroids in past 12 months.

Results The frequency of sensitisation to moulds (*Alternaria alternata* or *Cladosporium herbarum*, or both) increased significantly with increasing asthma severity (odds ratio 2.34 (95% confidence interval 1.56 to 3.52) for either for severe *v* mild asthma). This association existed in all of the study areas (gathered into regions), although there were differences in the frequency of sensitisation. There was no association

ity, but the identification of such factors is necessary for management and prevention.

Sensitisation to airborne allergens might be involved in the underlying mechanisms of severity. The associations between exposure, sensitisation, and asthma have suggested that house dust mite,[1 2] animal dander,[3 4] cockroaches,[5] pollens,[6] and mould spores[7] have a causal role in development. However, the associations between sensitisation to different allergens and the severity of asthma have been poorly explored.

Sensitisation to moulds has been suggested as a risk factor for life threatening asthma. In a study of 11 patients with episodes of respiratory arrest, 10 had positive results on skin prick testing for *Alternaria alternata* compared with only 31 of the 99 matched controls with asthma and no history of respiratory arrest.[8] It was recently reported that 20 of 37 (54%) patients admitted to an intensive care unit for asthma had a positive result on skin testing for one or more fungal allergens (*Alternaria tenuis*, *Cladosporium cladosporoides*, *Helminthosporium maydis*, or *Epicoccum nigrum*) compared with 30% in patients not admitted to intensive care units. The patients admitted to inten-

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Catherine Neukirch *senior physician in allergology*
Bénédicte Leynaert *epidemiological researcher*
Renata Liard *epidemiologist*
Françoise Neukirch *senior epidemiological researcher*

National Institute of Health and Medical Research (INSERM), Unit U454 Hôpital Arnaud de

Table 3 Associations between sensitisation to moulds and severity of asthma (% of sensitised participants by severity and odds ratios (95% confidence interval) for moderate versus mild asthma and severe versus mild asthma)

	Current asthma			
	Mild (n=564)	Moderate (n=333)	Severe (n=235)	P value for trend
Alternaria alternata				
% sensitised	8.9	13.8	16.6	<0.001
Unadjusted odds ratio	1	1.64 (1.08 to 2.52)	2.05 (1.31 to 3.21)	<0.001
Multivariate adjusted odds ratio*	1	1.61 (1.04 to 2.50)	2.03 (1.26 to 3.27)	<0.001
Cladosporium herbarum				
% sensitised	3.9	5.4	11.1	<0.001
Unadjusted odds ratio	1	1.41 (0.74 to 2.66)	3.07 (1.70 to 5.50)	<0.001
Multivariate adjusted odds ratio*	1	1.21 (0.62 to 2.36)	3.20 (1.72 to 5.94)	<0.001
Either mould				
% sensitised	10.8	15.9	22.1	<0.001
Unadjusted odds ratio	1	1.56 (1.05 to 2.32)	2.34 (1.56 to 3.52)	<0.001
Multivariate adjusted odds ratio*	1	1.48 (0.98 to 2.24)	2.34 (1.52 to 3.60)	<0.001

*Adjusted for age, sex, smoking, passive smoking, parental history of asthma, and region.

Severity classified by score

Severe asthma 2-3 x sensitised

Health outcome category	Total number of studies	Odds Ratios (OR) Range	Number of estimates showing any increased risk with D/M [a, b]	Number of total estimates	Proportion of total estimates showing any increased risk with D/M [a, b]
Intervention total	6	---[c]	36	38	95%
Prospective total	36	0.4-7.6	88	105	84%
Retrospective total	17	0.6-4.9	50	60	83%
Cross-sectional total	211	0.3-9.4	570	628	91%

[a] qualitatively assessed dampness or mold

[b] proportion of findings with ORs, risk ratios (RRs), or incidence rate ratios (IRRs) >1.0 (or, for removal of dampness/mold, <1.0), or other types of regression coefficients greater/less than 0 or 1 as appropriate

[c] reported coefficients from linear regression models, not ORs from logistic egression

Unknown how this effect is mediated

- Irritation fungal products
- Immune – beta glucans
- Mould just marker – increased viral exposure

Mendell MJ. Indoor dampness and mold as indicators of respiratory health risks: epidemiologic evidence. 2014

Eur Respir J 2007, 29. 509–515
DOI. 10.1183/09031936.00040806

2-4 fold increased risk for mould damage or visible mould

Moisture damage and childhood asthma: a population-based incident case–control study

J. Pekkanen*,#, A. Hyvärinen*, U. Haverinen-Shaughnessy*, M. Korppi¶, T. Putus* and A. Nevalainen*

ABSTRACT: Most previous studies on the association between moisture damage and asthma have been cross-sectional and relied on self-reported exposure and health. The present authors studied the association by carrying out careful home inspections among new, clinically determined cases of asthma and controls.

New cases of asthma aged 12–84 months (n=121) were recruited prospectively and matched for year of birth, sex and living area with two randomly selected population controls (n=241). Trained engineers visited all homes. Both cases and controls had lived ⩾75% of their lifetime or the past 2 yrs in their current home.

Risk of asthma increased with severity of moisture damage and presence of visible mould in the main living quarters but not in other areas of the house. Cases more often had damage in their bedroom. Associations were comparable for atopic and nonatopic asthma and for children aged >30 months or ⩽30 months.

The present results, using standardised assessment of exposure and asthma, suggest that moisture damage and mould growth in the main living quarters are associated with the development of asthma in early childhood.

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¶Dept of Paediatrics, Kuopio University Hospital, Kuopio, Finland.

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Received.

HOME Study

- Is visible mould associated with the **onset** of wheezing?
- 450 children between 1 and 6 years old,
- Living in Wellington/Hutt Valley/ Porirua/Kapiti region
- Cases:
  - recently prescribed and used their 1st treatment for wheezing = in the last 12 months
  - Lived in their homes for 6 months prior to 1st treatment
- Controls:
  - No history of wheezing, 2 controls per case, matched on gender, age, area
- Recruitment via 54 medical centres
  - via medtech query, sent letter from GP practice
- Independent building inspection + mould assessment by researchers

Mould/dampness factor	Prevalence CASE	CONTROL	Odds ratios (95% confidence intervals)
Visible mould house			
- Parent identified	96%	82%	5.19 (2.16 – 12.5)*
- Inspector identified	47%	37%	1.57 (1.03 – 2.34)*
Visible mouldscore bedroom	Mean	Mean	
- Researcher identified	2.2	1.2	1.33 (1.18 – 1.50)*
- Parent identified	2.0	0.9	1.30 (1.16 – 1.46)*
Mould odour			
- Researcher identified (bedroom)	21%	10%	2.57 (1.47 – 4.51)*
- Parent identified (bedroom)	25%	10%	2.23 (1.24 – 4.04)*
- Inspector identified (house)	22%	15%	1.61 (0.97 – 2.66)
Condensation – parent identified (house)	98%	88%	6.65 (2.00 – 22.04)*
Leaks/water damage			
- Researcher identified (bedroom)	13%	7%	2.26 (1.14 – 4.47)*
- Parent identified (house, 12mth)	50%	36%	1.82 (1.21 – 2.73)*
- Inspector identified	9%	3%	3.56 (1.46 – 8.67)*
qPCR static cloths	Median	Median	
- Cladosporium cladosporides^	294	304	1.00 (0.81 – 1.23)
- Penicillium/Aspergillius^	31360	28150	0.98 (0.82 – 1.19)
- Total fungi^	51470	48820	0.96 (0.76 – 1.20)
	Mean	Mean	
Mean temperature	18.2°C	18.1°C	1.02 (0.91 – 1.15)
Mean relative humidity	65.0%	64.6%	1.01 (0.98 – 1.04)

* Significant P≤0.05

BMJ

RESEARCH

Effects of improved home heating on asthma in community dwelling children: randomised controlled trial

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ABSTRACT

Objective To assess whether non-polluting, more effective home heating (heat pump, wood pellet burner, flued gas) has a positive effect on the health of children with asthma.

Design Randomised controlled trial.

Setting Households in five communities in New Zealand.

Participants 409 children aged 6-12 years with doctor diagnosed asthma.

Interventions Installation of a non-polluting, more effective home heater before winter. The control group received a replacement heater at the end of the trial.

Main outcome measures The primary outcome was change in lung function (peak expiratory flow rate and forced expiratory volume in one second, FEV_1). Secondary outcomes were child reported respiratory tract symptoms and daily use of preventer and relieverdrugs. At the end of winter 2005 (baseline) and winter 2006 (follow-up) parents reported their child's general health, use of health services, overall respiratory health, and housing conditions. Nitrogen dioxide levels were measured monthly for four months and temperatures in the living room and child's bedroom were recorded hourly.

Results Improvements in lung function were not significant (difference in mean FEV_1 130.7 ml, 95% confidence interval −20.3 to 281.7). Compared with children in the control group, however, children in the intervention group had 1.80 fewer days off school (95% confidence interval 0.11 to 3.13), 0.40 fewer visits to a doctor for asthma (0.11 to 0.62), and 0.25 fewervisits to a pharmacist for asthma (0.09 to 0.32). Children in the intervention group also had fewer reports of poor health (adjusted odds ratio 0.48, 95% confidence interval 0.31 to 0.74), less sleep disturbed by wheezing (0.55, 0.35 to 0.85), less dry cough at night (0.52, 0.32 to 0.83), and reduced scores for lowerrespiratory tract symptoms (0.77, 0.72 to 0.91) than children in the control group. The temperature in the living room increased by 1.04°C (0.46°C to 1.64°C) and in the child's bedroom of 0.57°C (0.05°C to 1.08°C). Lower levels of nitrogen dioxide were measured in the living rooms of the intervention households than in those of the control households (geometric mean 8.5 μg/m³ *v* 15.7 μg/m³, P<0.001). A similar effect was found in the children's bedrooms (7.3 μg/m³ *v* 10.9 μg/m³, P<0.001).

Conclusion Installing non-polluting, more effective heating in the homes of children with asthma did not significantly improve lung function but did significantly reduce symptoms of asthma, days off school, healthcare utilisation, and visits to a pharmacist.

Trial registration Clinical Trials NCT00489762.

INTRODUCTION

Asthma is one of the most prevalent chronic diseases in childhood. In New Zealand about 25% of children report symptoms of asthma, and asthma is the second most common reason for children being admitted to hospital.[1] As well as the stress associated with having a chronic disease, asthma can lead to higher utilisation of health services and drug costs.[2] Children with asthma are likely to have more days off school, with adverse effects on academic performance,[3] and their caregivers may lose significant time from work.[4]

Evidence is growing that symptoms of asthma can be aggravated or triggered by adverse aspects of the indoor environment.[5,6] Evidence from studies of excess morbidity and mortality during winter in temperate climates shows that temperatures in many homes are below the levels recommended by the World Health Organization for maintaining health in vulnerable populations.[7] This is the case in New Zealand, where home heating seems not to be treated as a necessity like it is in the cooler parts of continental Europe.[7-9]

Table 4 | Effect of heating intervention on daily differences of asthma symptoms and drug use as reported in daily diaries

Variable	No of person days	No of children	Unadjusted		Adjusted*	
			Mean ratio† (95% CI)	P value	Mean ratio† (95% CI)	P value
Lower respiratory tract symptoms	23 475	345	0.83 (0.66 to 1.05)	0.12	0.77 (0.73 to 0.81)	0.01
Cough at night	26 532	352	0.80 (0.63 to 1.00)	0.05	0.72 (0.59 to 0.89)	0.002
Wheeze at night	26 407	351	0.78 (0.54 to 1.12)	0.18	0.67 (0.49 to 0.93)	0.02
Cough on waking	26 514	352	0.74 (0.58 to 0.94)	0.02	0.67 (0.53 to 0.84)	<0.001
Wheeze on waking	26 417	351	0.68 (0.49 to 0.94)	0.02	0.60 (0.45 to 0.81)	0.001
Cough during day	27 348	365	0.90 (0.75 to 1.10)	0.31	0.84 (0.70 to 1.01)	0.06
Wheeze during day	27 117	363	0.85 (0.61 to 1.17)	0.32	0.78 (0.59 to 1.04)	0.09
Cough symptoms	23 713	349	0.82 (0.67 to 1.02)	0.08	0.75 (0.62 to 0.92)	0.005
Overall wheeze symptoms	23 532	345	0.76 (0.54 to 1.07)	0.11	0.67 (0.50 to 0.91)	0.01
No of reliever puffs	27 261	364	0.73 (0.46 to 1.14)	0.17	0.68 (0.44 to 1.05)	0.08
Reliever use at night (yes or no)‡	26 725	352	0.52 (0.24 to 1.13)	0.10	0.55 (0.28 to 1.08)	0.08
No of preventer puffs	27 567	363	1.05 (0.61 to 1.8)	0.87	1.08 (0.67 to 1.74)	0.74
Upper respiratory tract symptoms	26 844	360	0.95 (0.76 to 1.19)	0.65	0.92 (0.74 to 1.14)	0.43

*Adjusted for baseline outcome.
†Average score for intervention group divided by average score for control group.
‡Binary model used and results presented as odds ratio.

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The respiratory health effects of nitrogen dioxide in children with asthma

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ABSTRACT: **There is growing evidence that asthma symptoms can be aggravated or events triggered by exposure to indoor nitrogen dioxide (NO_2) emitted from unflued gas heating.**

The impact of NO_2 on the respiratory health of children with asthma was explored as a secondary analysis of a randomised community trial, involving 409 households during the winter period in 2006 (June to September).

Geometric mean indoor NO_2 levels were 11.4 $\mu g \cdot m^{-3}$, while outdoor NO_2 levels were 7.4 $\mu g \cdot m^{-3}$. Higher indoor NO_2 levels (per logged unit increase) were associated with greater daily reports of lower (mean ratio 14, 95% CI 1.12–1.16) and upper respiratory tract symptoms (mean ratio 1.03, 95% CI 1.00–1.05), more frequent cough and wheeze, and more frequent reliever use during the day, but had no effect on preventer use. Higher indoor NO_2 levels (per logged unit increase) were associated with a decrease in morning (-17.25 mL, 95% CI -27.63– -6.68) and evening (-13.21, 95% CI -26.03– -0.38) forced expiratory volume in 1 s readings. Outdoor NO_2 was not associated with respiratory tract symptoms, asthma symptoms, medication use or lung function measurements.

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$N0_2$ was associated with upper and lower respiratory tract symptoms and lung function

Asthma and domestic environment

- Asthma and allergies common in NZ
- Prevalence has increased and varies widely by country and within cities
- HDM – high levels feature of NZ homes.
- Poor quality housing – damp cold encourage mould growth
- Damp and mould – may initiate asthma and make it worse Why?
- Unflued gas heating makes asthma worse
- ?? Open fires stoves?

Domestic design and asthma

- Low allergy housing – Denmark (cold winters)
  - Heat recovery ventilation
  - Barrier bedding material
  - Minimise dust. Remove carpets?
- Warm, dry, weathertight homes✓
  - Dwelling aspect – Wellington
- Improve rental accommodation WoF
- Overcrowding (strep sore throats, Rh fever)
- Primary prevention study with bedding!