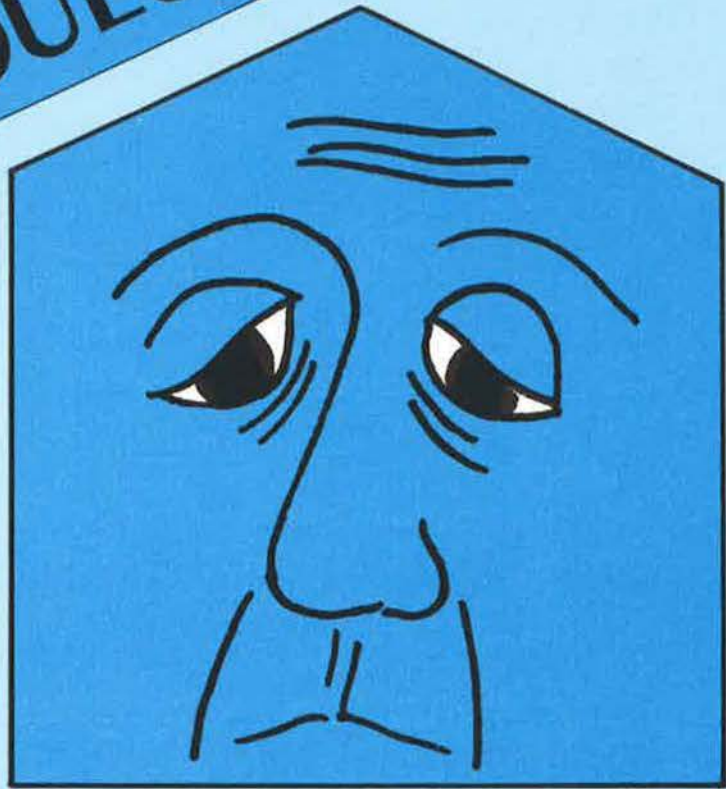


# 7206

# THE MM-QUESTIONNAIRES



## A TOOL WHEN SOLVING INDOOR CLIMATE PROBLEMS

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Cover design: Benita Rennes.

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telephone +46 582 15260, telefax +46 582 14733

## Introduction

Many occupants in modern buildings complain about the indoor climate and report medical symptoms which they ascribe to the indoor environment. These symptoms are common in the general population. Technical measurements in the buildings mostly show concentrations and levels within accepted limits.

A strategy is needed to handle these problems. One important part of this strategy is to use standardized questionnaires for structuring the information from the occupants.

## Strategy

The strategy is based on a WHO report (WHO, 1983) and the basic principles are:

- \*step-by-step investigation
- \*simple activities performed first
- \*measures followed up

### Basic steps

- \*discussion with the occupants about the problems
- \*study of building documents describing the construction and building materials
- \*visual inspection of the building
- \*visual inspection of the HVAC-system

### Step 1

- \*questionnaire
  - \*simple technical measurements, e.g., of
    - \*indoor air temperature
    - \*temperature of supply air
    - \*relative humidity of the indoor air and the building material
    - \*air exchange rates
- (when humidity problems are suspected a dog sensitive to moulds may sometimes be used to find the site of damage)

### Step 2

- \*more detailed investigation of the building, such as control of the drainage
- \*advanced chemical analysis of the indoor air and determination of the emission rates of surface materials
- \*in some cases, typing of species of moulds and bacteria

### Step 3

- \*more sophisticated methods are used. They cannot be recommended for normal investigations of indoor climate problems.

## The MM-questionnaires\*

The MM-questionnaires were devised to describe the indoor climate in buildings with indoor climate problems. In 1986, the first draft addressed to workplaces was compiled and tested. Versions of the questionnaires are now available for workplaces, primary schools, day care centres and family homes. The character and present status of the questionnaire for workplaces are described in the following pages.

### Basic principles

The basic aims in devising these questionnaires were to produce short questionnaires for self-administration, including

- \*simple and understandable questions
- \*valid and reproducible questions
- \*a common core of questions in the different versions of the questionnaires and
- \*relevant symptoms grouped together instead of using many detailed symptom questions

### Quality

It is difficult to validate questions concerning subjective perception. However, a comparison with the professional judgement of a physician showed acceptable agreement for the questions about mucous membrane irritations. The external validity of background factors that could be checked was very high.

The reliability of the questions concerning smoking habits, environmental factors and symptoms was fair to good with kappa-levels between 0.4 and 0.7 (Andersson, Stridh 1992).

### Study prerequisites

When making questionnaire inquiries it is important to

- \*obtain informed consent from house owners, occupants, etc.
- \*involve representatives of the occupants in a reference group
- \*inform all persons involved, especially about how integrity issues are handled
- \*always present the study results to the occupants.

\*MM is an abbreviation of the Swedish word **Miljö**medicin (=Environmental Medicine)

**1**

<b>INDOOR CLIMATE</b> Work environment <b>ENGLISH VERSION</b>		<b>MM 040 EA</b> Date	Name
Number		Occupation	Company/institution
User Filled in by investigator		Group	Department

This questionnaire concerns your indoor climate and possible symptoms you may be experiencing.

**2**

**BACKGROUND FACTORS**

Year of birth 19   Occupation \_\_\_\_\_

Sex male  female

Do you smoke? Yes  No

How long have you been at your present place of work? | . | years

**3**

**WORK ENVIRONMENT**

Have you been bothered during the last three months by any of the following factors at your work place?

	Yes, often (every week)	Yes, sometimes	No, never
18 Draught	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19 Room temperature too high	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20 Varying room temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21 Room temperature too low	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22 Stuffy "bad" air	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23 Dry air	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24 Unpleasant odour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25 Static electricity, often causing shocks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26 Passive smoking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27 Noise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28 Light that is dim or causes glare and/or reflections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29 Dust and dirt	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**4**

**WORK CONDITIONS**

	Yes, often	Yes, sometimes	No, seldom	No, never
30 Do you regard your work as interesting and stimulating?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31 Do you have too much work to do?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32 Do you have any opportunity to influence your working conditions?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33 Do your fellow-workers help you with problems you may have in your work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Andersson K, Fagerlund I, Bodin L, Ydreborg B  
Questionnaire as an instrument when evaluating Indoor Climate,  
Healthy Buildings '88, vol 3, p 139-145

Translator: Cheryl Suneborn

**5 Medical history of allergic diseases**

**6 Symptoms normally reported in buildings with indoor climate problems**

**7 Building-related symptoms reported by the occupants**

**1 MM 040 EA**  
Specific questionnaire for work places in English.

**2 Background factors**  
\*age  
\*sex  
\*smoking  
\*profession  
\*time of employment at the workplace

**3 Physical environmental factors**

**4 Psychosocial factors at the workplace**  
(See page 15)

**5 PAST/PRESENT DISEASES/SYMPTOMS**

	Yes	No
1 Have you ever had asthmatic problems?	<input type="checkbox"/>	<input type="checkbox"/>
2 Have you ever suffered from hayfever?	<input type="checkbox"/>	<input type="checkbox"/>
3 Have you ever suffered from eczema?	<input type="checkbox"/>	<input type="checkbox"/>
4 Does anybody else in your family suffer from allergies (e.g. asthma, hayfever, eczema)?	<input type="checkbox"/>	<input type="checkbox"/>

**6 PRESENT SYMPTOMS**

During the last 3 months have you had any of the following symptoms?

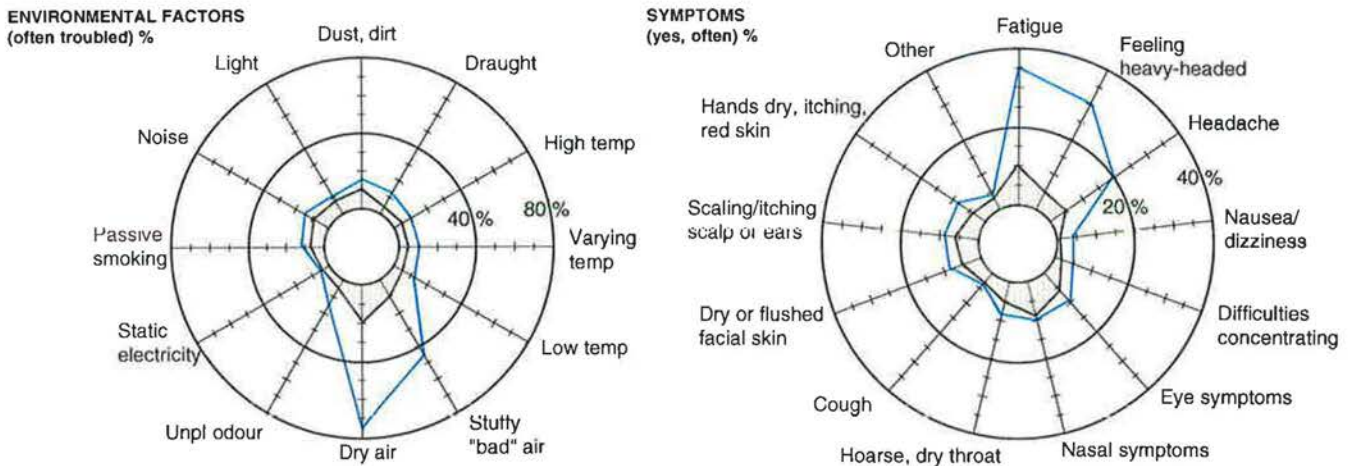
	Yes, often (every week)	Yes, sometimes	No, never	IF YES: Do you believe that it is due to your work environment?	
				Yes	No
5-8 Fatigue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9-10 Feeling heavy-headed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11-12 Headache	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13-14 Nausea/dizziness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15-16 Difficulties concentrating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17-18 Itching, burning or irritation of the eyes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19-20 Irritated, stuffy or runny nose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21-22 Hoarse, dry throat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23-24 Cough	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25-26 Dry or flushed facial skin	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27-28 Scaling/itching scalp or ears	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29-30 Hands dry, itching, red skin	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31-32 Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**7 FURTHER COMMENTS**

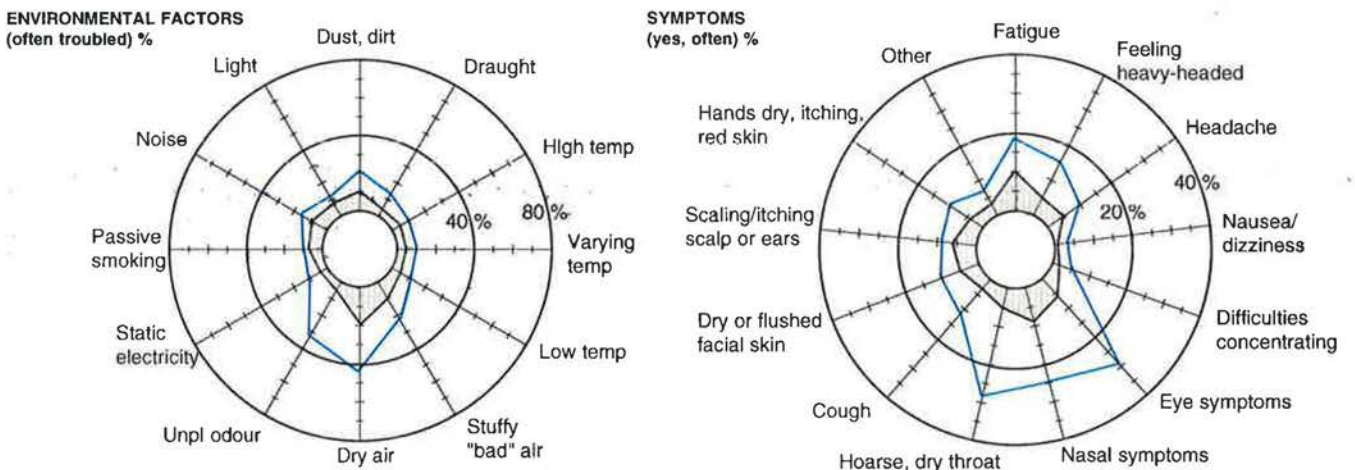
THANK YOU!

## Assessment

When evaluating the results of the questionnaires, comparisons between the pattern of environmental factors disturbing the occupants and the pattern of symptoms are essential. A graphic presentation, where the frequencies of the alternative "Yes, often" (every week) for every factor and symptom are plotted, make this comparison simple. In the same graphs reference frequencies are presented.

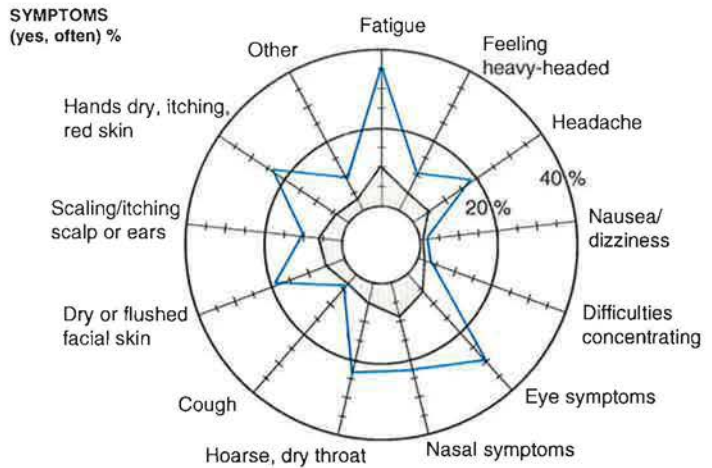
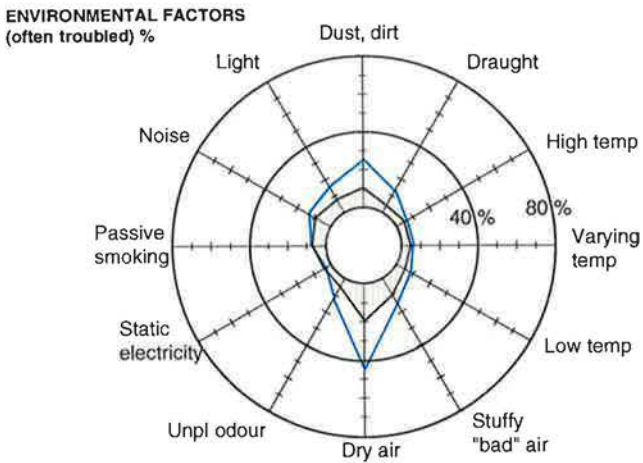


High frequencies of complaints about stuffy "bad" air, dry air and general symptoms (fatigue, feeling "heavy-headed", headache) very probably mean that the ventilation is inadequate. The completing technical investigations are aimed at checking the ventilation system.

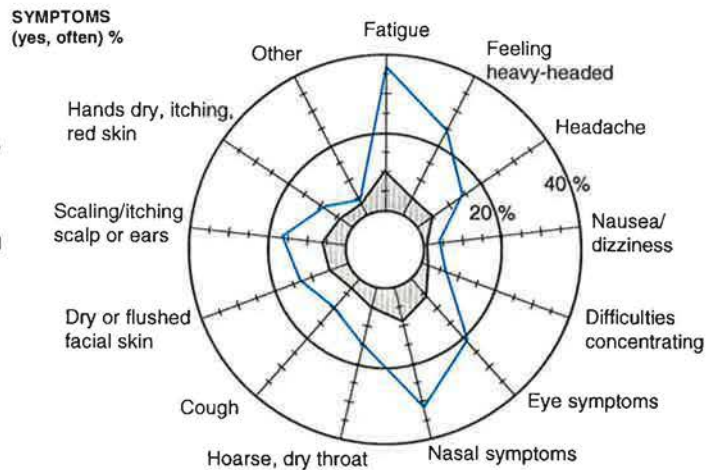
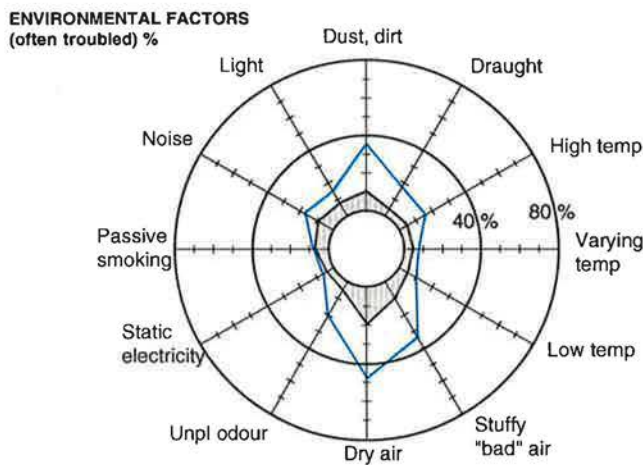


Complaints about unpleasant smells, dry air and high frequencies of symptoms from the mucous membranes in the eyes, nose and throat suggest the presence of chemical emissions. The technical investigations try to detect possible sources of emissions, especially the presence of humidity in the building.

Reference values represent the outcome of the questionnaires in "healthy" buildings, i.e., buildings with no known indoor climate problems. They differ for the various versions of the questionnaires which will be commented on later in this paper.



Complaints of dry air, dust and dirt, symptoms from dry throat, dry face and dry hands and eye and nose symptoms show a typical pattern when problems with dust exist and chemical compounds may be adsorbed to the particles.

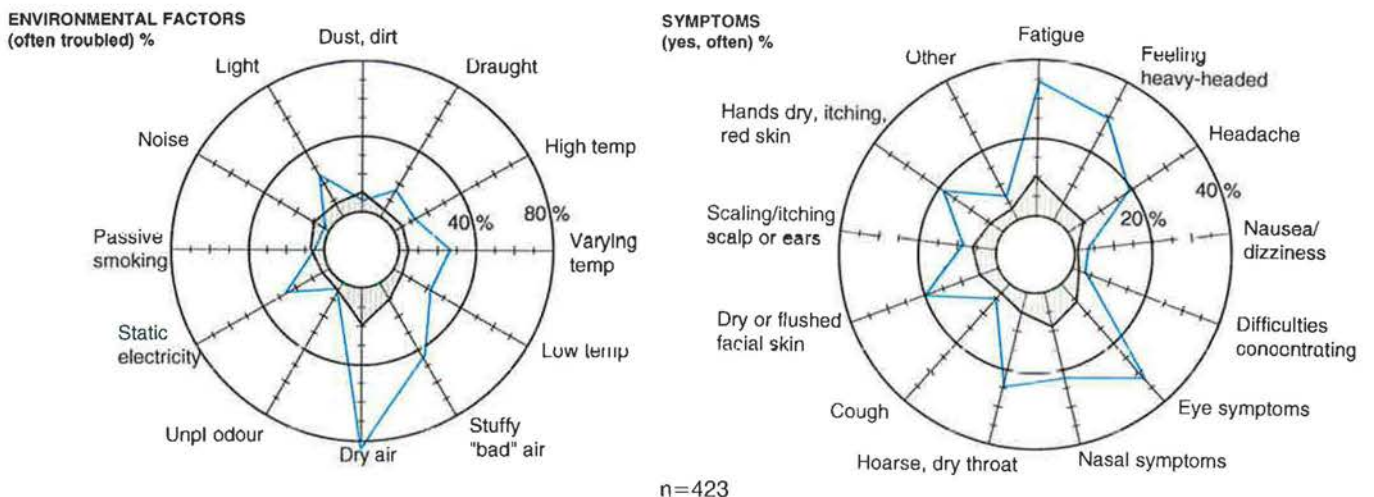


Complaints of stuffy "bad" air, dry air, unpleasant smells, dust and dirt and usually high prevalences of symptoms are associated with the typical pattern of emissions from self-levelling mortar containing casein.

## Work environment

### Example

Four hospital buildings were completed in 1984-1986. In 1986, employees and patients moved into the buildings. After a short period the occupants began to complain about discomfort and health problems associated with the indoor climate. A questionnaire survey with the MM-questionnaires was performed by the Company Health Care Service. The graphs below show the results of the questionnaire survey from one of the buildings.



### Assessment

The analysis of the questionnaire results for this building showed inadequate ventilation and probable emissions of chemicals or dust. However, few persons complained of unpleasant smells or dust. The high prevalence of dry hands is typical for medical personnel. The symptom patterns were similar but varied on the different floors.

### Technical measurements

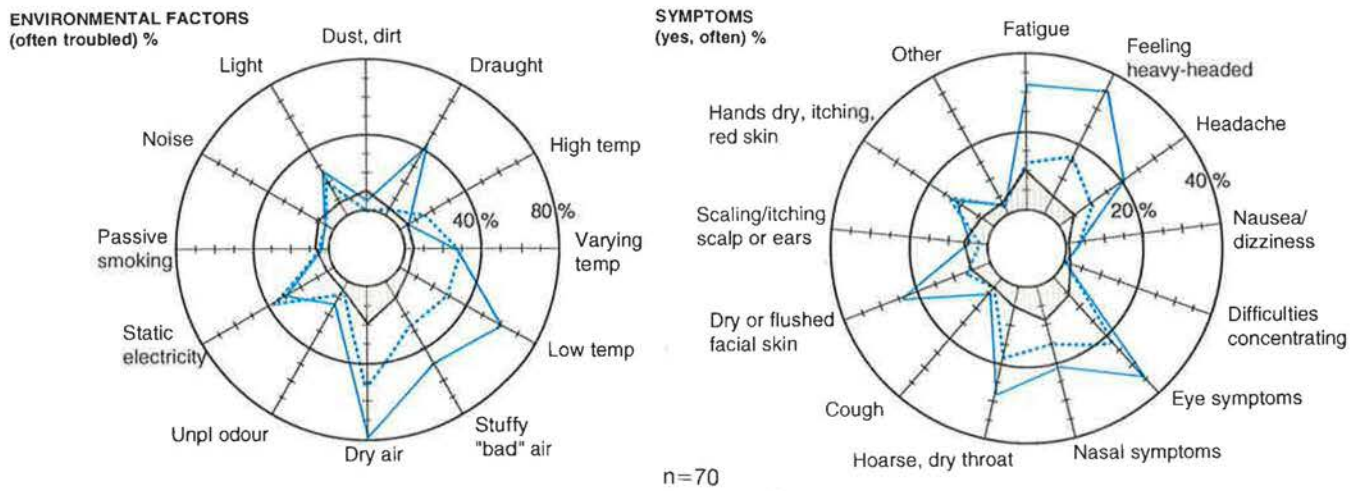
Technical measurements were performed, including measurements of ventilation flows and temperature of the supply air. Pieces of the PVC-flooring material were sent to a laboratory for analysis of the emissions.

The ventilation rates were far below those stated in the building contracts and the temperature of the supply air was generally too high. However, it could not be determined whether the HVAC-system was inadequately maintained or whether initial adjustments were not in accordance with the contract. The analysis of emissions from the PVC-flooring material showed no abnormal emissions, nor were any other obvious emission sources found in the building.



## Remedial measures

The ventilation system was adjusted. A new questionnaire survey was performed about 6 months later. Below, the results of the survey are presented concerning floor 8.



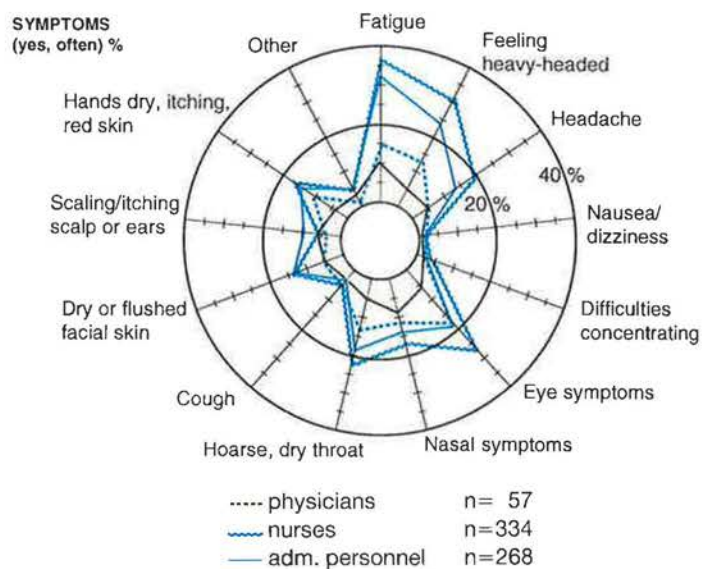
## Comments

The graphs show that the prevalences of general symptoms, such as headache and fatigue, have decreased considerably. The frequencies of mucous membrane irritations, however, are less affected. This suggests that the indoor air might contain chemicals, although analyses of the materials so far have been negative.

Consequently, further investigations must be done to find the sources of emissions. These may be found not only in the building itself but also in the clinical work. Of course, the psychosocial climate at the workplace must be considered, but the questionnaire results do not indicate such problems in this case.

## Symptoms within different categories of employees

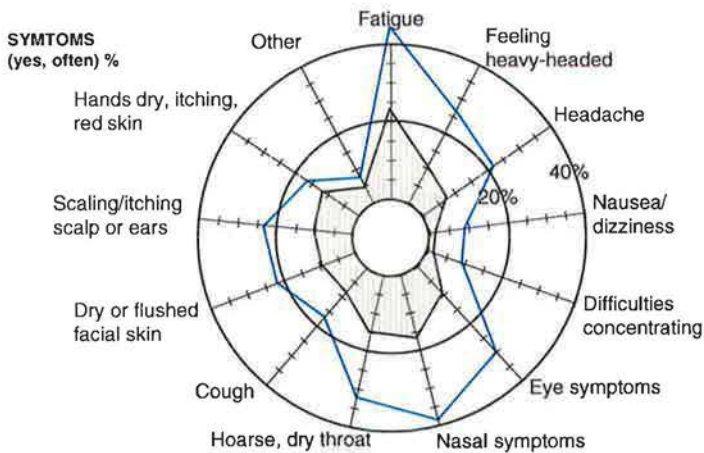
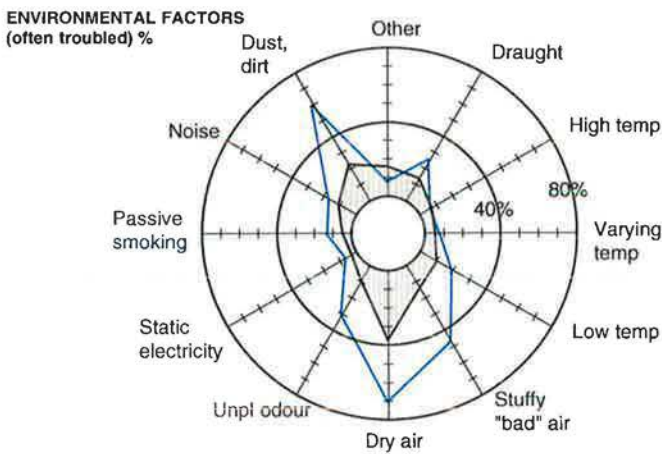
The symptom profiles for physicians, nurses and administrative personnel are presented below. The patterns are similar, but the prevalences of the symptoms vary. Physicians have the lowest prevalences of symptoms and the nurses the highest. This outcome is very common and one may speculate about the reasons.



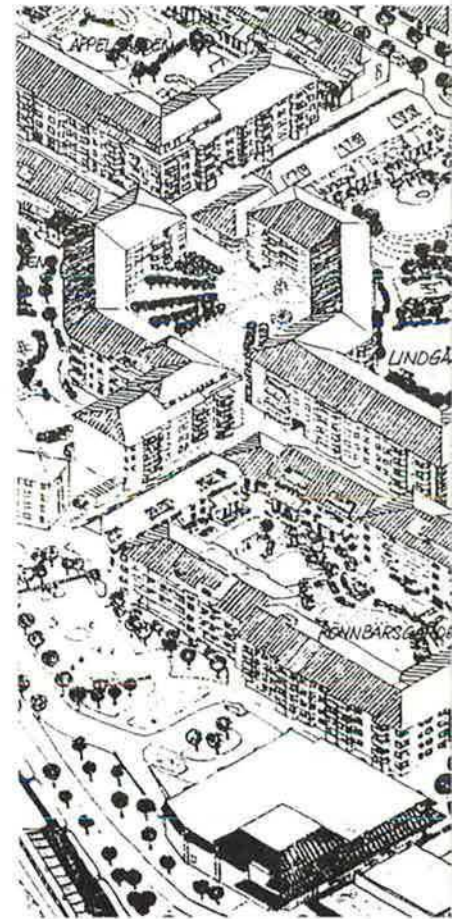
# Home environment

## Example

Shortly after 14 large apartment buildings with 1430 apartments were built in 1979-1981, complaints were reported about the indoor climate. A questionnaire study in 1989 gave the results presented below.



n = 1809



## Technical investigation

Most of the apartments had plastic carpet over self-leveling concrete. When humidity and pH are initiated that breaks down the carpet, releasing Ammonia, as well as other volatile organic compounds. The carpet plastiziser and a sweetener are also released in this process and a sweet oak parquet floor becomes discoloured in this manner.

Technical measurements in the apartment buildings showed concentrations of ammonia between 0 and 190 ppm, but in the indoor air. Concentrations of 36 µg/m<sup>3</sup> were recorded. The air change rate was between 0.1 and 2.1 air changes per hour.



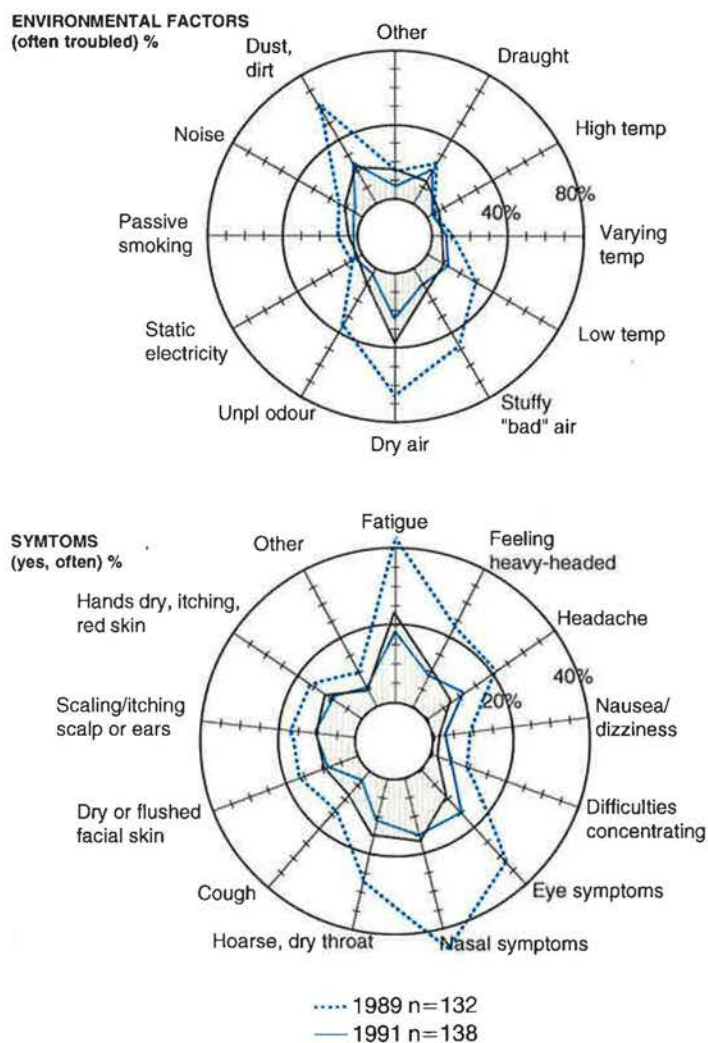
## Remedial measures

The self-levelling mortar was removed and a new layer without casein was laid. The carpets and oak parquets were changed. When the slab was on the ground and the humidity in the slab was high, a ventilated floor was constructed and the ventilation was connected to the basic ventilation system.

The latter was adjusted to an air flow of 0.7 air changes/h. Follow-up inquiries were made in 1990, 1991, 1992 and 1993. Below, the outcome in one of the apartment buildings is shown one year after remedial measures were taken.

oor construction with a mortar containing casein. n, a chemical process is casein into fragments. nicals, are then emitted. sives emit 2-ethylhexanol ll is noted. In addition the oloured in a characteristic

s area showed that the ow the carpet ranged ey were below 0.5 ppm s of 2-ethylhexanol below entilation rates varied s/h.

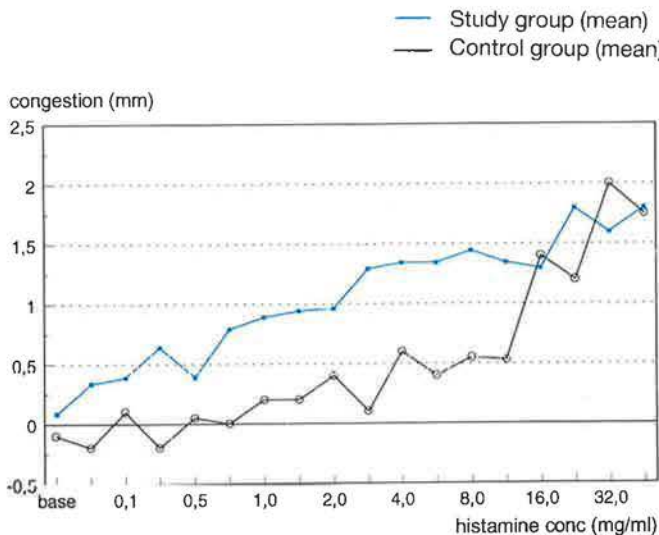
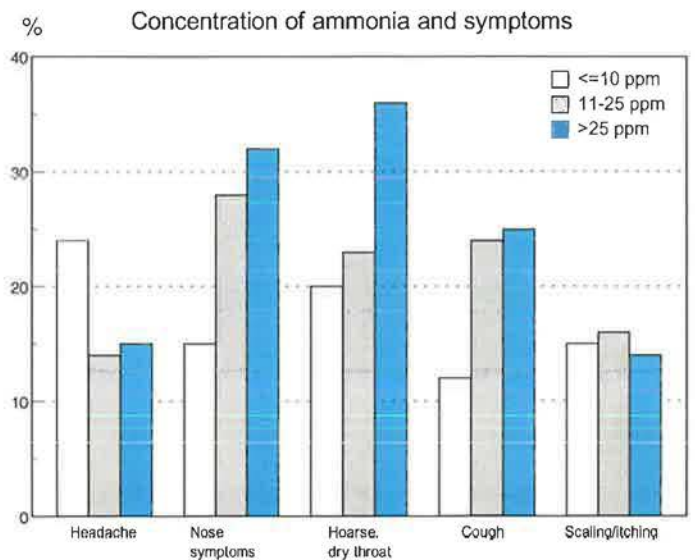
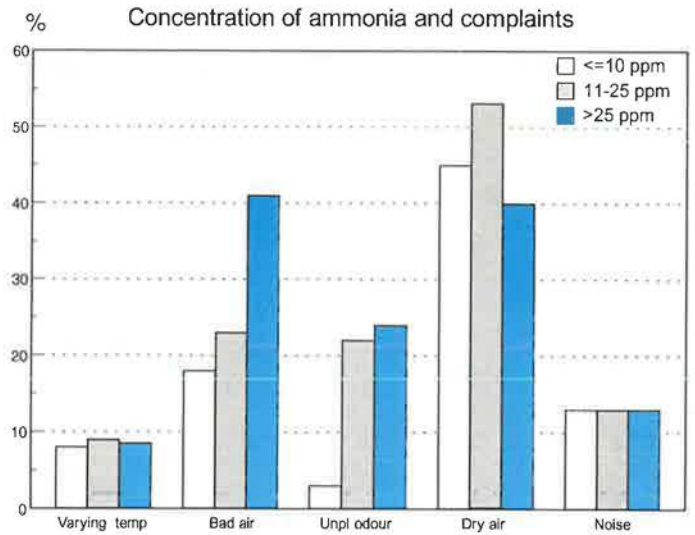


## Example

In a residential area with apartment buildings using the type of floor construction discussed on the last two pages, measurements of ammonia below the carpet were done in a standardized way in all 750 apartments.

The concentrations of ammonia below the carpet were compared with the results of an inquiry using MM-questionnaires filled out six months earlier.

Although the levels of ammonia never exceeded 0.5 ppm in the indoor air, a dose-response relationship was seen between the concentrations of ammonia below the carpet and unpleasant smell, stuffy "bad" air and symptoms from the mucous membranes. The same relationship was not seen for factors, such as temperature, noise or symptoms presumably not related to reactivity of the mucous membranes.



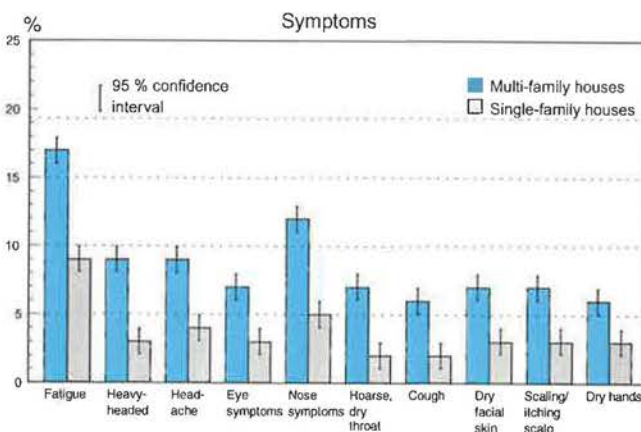
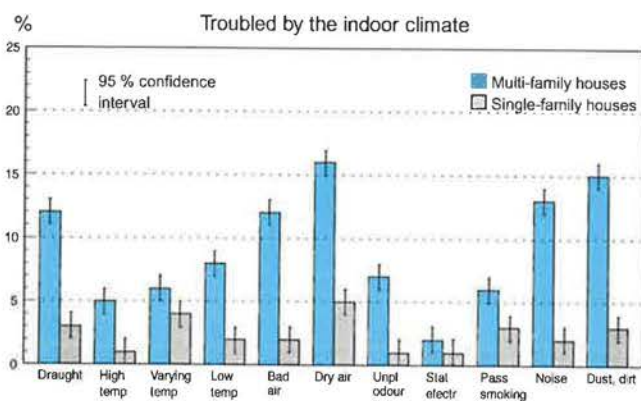
Histamine provocation of the nose, as determined by rhinostereometry, showed increased sensitivity in 16 of 18 persons tested with nasal symptoms they related to the indoor climate in their homes. They all lived in the residential area described on the last two pages. They had no history of allergy and no concomitant upper respiratory infection, confirmed by blood and skin tests.

These results support the hypothesis that tenants, living in this area who suffer from nasal distress they relate to their homes, have nasal hyperreactivity (Ohm et al, 1992).

## The ELIB-study

A nation-wide survey of the indoor climate in Swedish residential buildings was carried out 1991-1993 (Norlén, Andersson, 1993). Almost 20 000 residents in more than 3300 single- and multi-family houses participated in a postal questionnaire survey using the MM-questionnaires. Detailed technical inspections on site and indoor climate measurements were carried out in a sub-sample consisting of more than 1100 single- and multi-family houses. The measurements included ventilation rates, indoor temperatures, relative humidity of indoor air, and levels of formaldehyde, volatile organic compounds and radon.

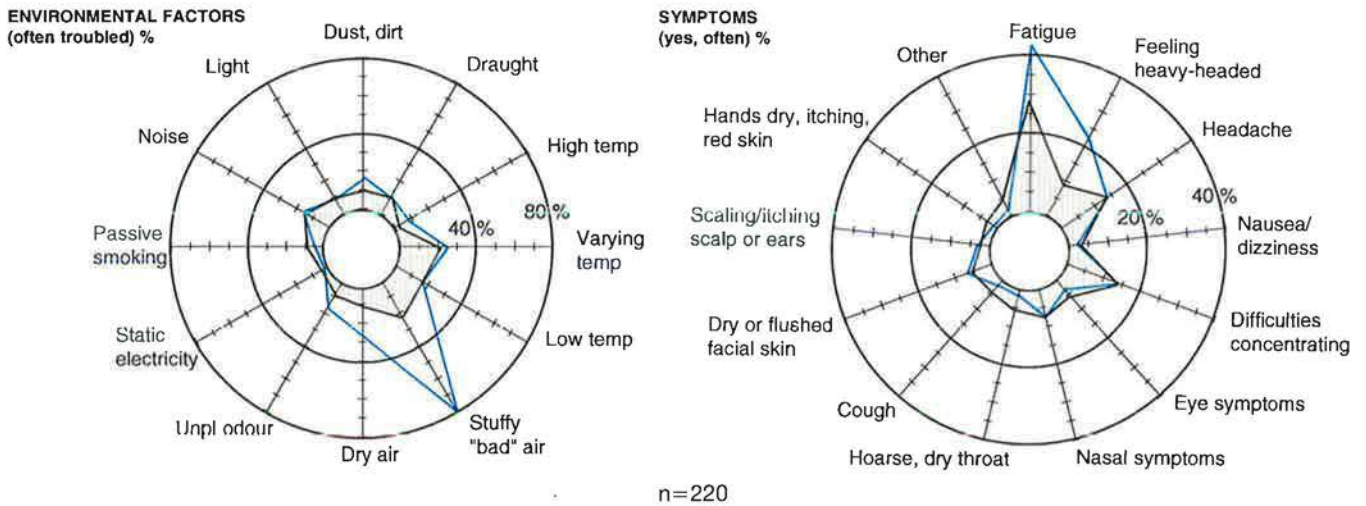
The survey provided strong evidence that Sweden has health problems related to indoor climate which affect many residents.



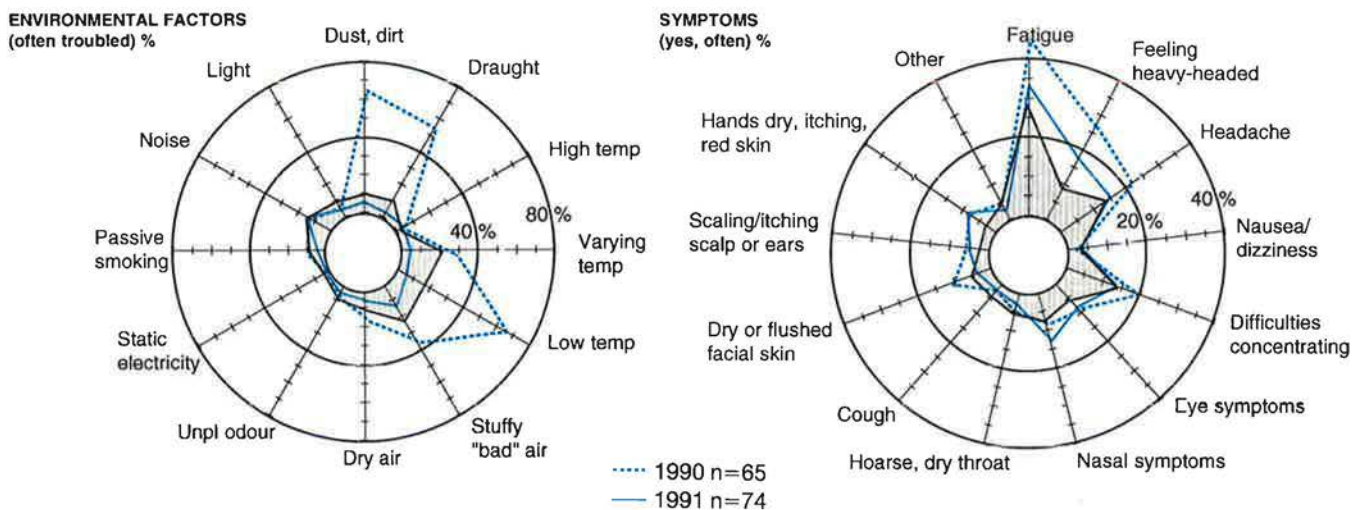
### Additional findings

- \* Complaints and symptoms are much commoner in multi-family houses than in single-family houses.
- \* Tenants living in multi-family houses in every second to every fourth case (depending on the symptom) ascribe their symptoms to the indoor climate. Those living in single family houses seldom relate their symptoms to the indoor climate.
- \* Complaints about temperature and stuffy "bad" air are commoner in multi-family houses built 1961-1975 than in others. Complaints about dry air are commoner in multi-family houses built after 1975.
- \* Women suffer more from poor indoor climate and report symptoms to a greater degree than men do.
- \* Persons with allergic diseases complain more about the indoor climate and have three to four times higher prevalences of symptoms from the eyes, nose and skin.

# School environments



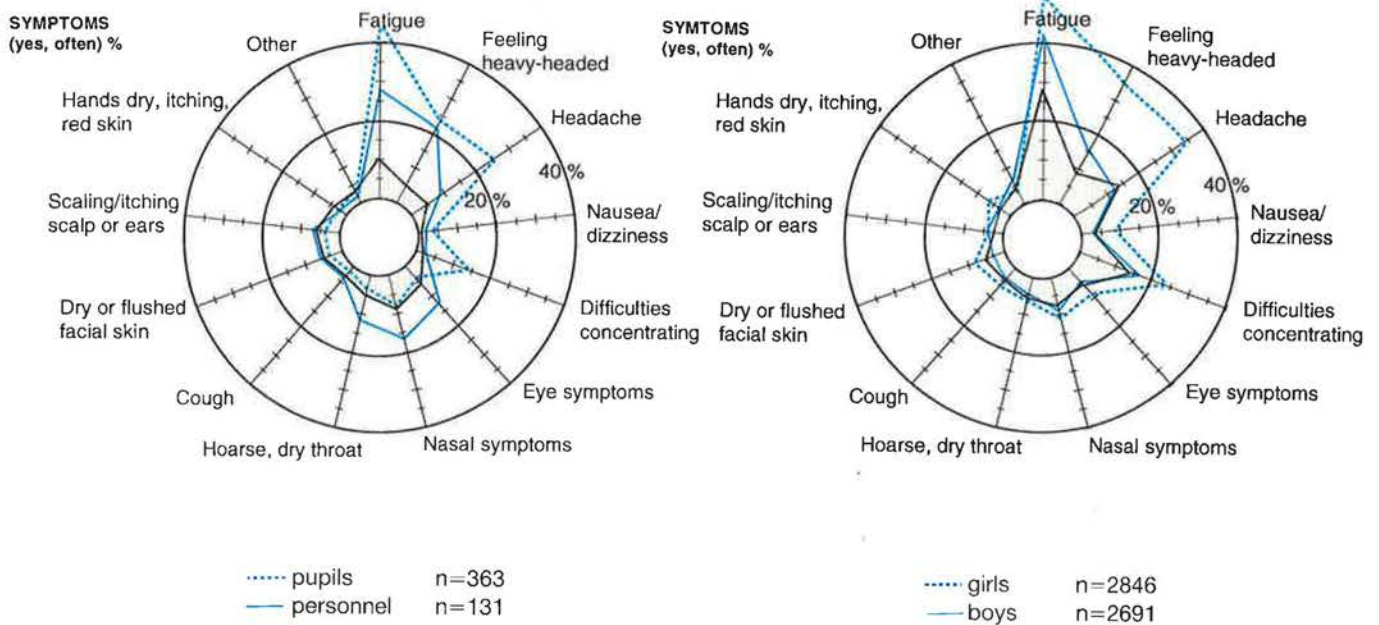
This school was originally ment as a control school in a study evaluating a "sick" school. Concentrations of carbon dioxide higher than 2500 ppm were recorded in a classroom after a 45 minute lecture. Technical investigations showed hardly any ventilation.



A questionnaire survey made in a high school with mechanical exhaust and supply ventilation gave the results presented above.

On the basis of these findings - verified by technical investigations - the draughty windows were replaced by new ones and the walls were painted in light colours instead of the brownish, dusty ones used before.

One year later, a new inquiry confirmed that the indoor climate was much better. Even the indoor air had improved greatly although nothing had been done about the ventilation system. This may have resulted from a generally positive attitude among the pupils, but it was probably due to more efficient ventilation system consequent to the air tight windows.



The pattern of symptoms in pupils differs considerably from that in the personnel residing in the same environment. Pupils report higher frequencies of general symptoms, especially concentration difficulties, than adults do, but they seldom report increased frequencies of symptoms from the mucous membranes. Even in damp problem houses with chemical emissions (as in the graph above, to the left), pupils report low frequencies of mucous membrane irritations.

Girls complain more than boys about such symptoms as headache and fatigue. The prevalences of mucous membrane irritations or skin problems are usually almost identical. This is demonstrated in the graph above, to the right.

Pupils are also exposed to environmental factors in their homes that are described to allergy. The prevalences of some of these factors among boys and girls are shown in the table below.

Environmental factors	Boys		Girls	
	Allergic*	Not allergic	Allergic*	Not allergic
	n=971	n=1658	n=1348	n=1439
Parental smoking	42	44	44	43
Domestic animals	48	53	60	63
Wall-to-wall carpet	51	56	46	50
Damp/mould	10	7	9	9

\*includes asthmatic problems, hay-fever or eczema

## Confirmational technical measurements

Indications of malfunctions from the questionnaire results have to be checked by technical measurements. No general set of measurements can be recommended because they vary from case to case. Below we describe some methods for use in the technical studies.

### Measurements of ventilation

If there are signs of excessively low ventilation flows, i.e., if complaints about poor air quality and high frequencies of general symptoms are reported, the total flow of the supply air (if a HVAC-system) and exhaust air must be checked. This is normally done using pitot-tubes.

At the valves in a room, measurements are made using hot wire anemometers. If both valves for supply and exhaust air are placed on the walls or in the roof, a simple measurement of the temperature of the supply air and room air may reveal short-cuts. With temperature differences less than a few degrees, there is a considerable risk of a short-cut.

In some cases efficiency of ventilation can be checked by measuring the carbon dioxide concentration in the indoor air over a long period. However, people must be present in the building. The carbon dioxide concentration in the supply air should not exceed 500 ppm and in the room air 1000-1200 ppm. High concentrations may also be due to an erroneous use of the room, such as having more persons in the room than the system was designed for.

### Measurements of relative humidity

The relative humidity of the indoor air can be measured by psychrometer or by electronic devices. The devices must be carefully calibrated.

Measurements of the relative humidity in the construction, i.e., the concrete in the slabs, require careful planning. Holes must be drilled, purified from drilling dust and plugged at least 48 hours before the measurements are made. The need for careful calibration at expected levels (using oversaturated salt solutions) must be emphasized.

### Measurements of chemicals

Chemicals in the indoor air are often sampled and analyzed in order to evaluate reported symptoms or discomfort. Such measurements must be assessed by experts. With normal concentration levels, i.e., from a few to some hundreds of ppb, dose-response relations to the later effect on health are little known.

On the other hand, a suspected damage from moisture can be confirmed by looking for certain specific compounds in the indoor air. Presence of mould can be verified by searching for geosmine. A humid slab will often affect the adhesive and the PVC-flooring material and result in the emission of specific alcohols. Samples of chemical compounds are generally taken on Tenax and than analysed by gas chromatography-mass spectrometry.



## Current development

### A. Development of the psychosocial aspects of the workplace questionnaire.

Below is a new sector of the questionnaire for workplaces, used in a multinational study during 1993, concerning psychosocial aspects of the workplace. These questions are planned for use in a revised version of the MM-questionnaire for workplaces.

PSYCHO-SOCIAL ASPECTS OF YOUR WORK					
	Yes very much so (1)	Yes, to some extent (2)	Only slightly (3)	No, very little (4)	
1 Do you have too much work to do?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2 Are you satisfied with the duties involved in your present job?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3 Are you given opportunity to perform your job the way that you find appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4 Do you feel that you are given enough responsibility for the job that you perform?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5 Do you feel that you are able to use all your knowledge and skills in your job?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6 Do you feel the majority of time and energy is spent on the right issues in the day to day work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7 Do you think that the various tasks that are performed in your job are adjusted to your abilities?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8 Do you feel that your job is a good use of your abilities?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

PSYCHO-SOCIAL ASPECTS OF YOUR WORK					
	Every day (1)	Once or twice a week (2)	Once or twice a month (3)	Rarely (4)	Never (5)
9 How often do you feel stressed because of your job?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 How often do you feel that your job bores you to such an extent that it seems trivial and uninteresting to you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13 - we are supported and encouraged when we present new ideas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14 - we trust one another	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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## **B. Reference values**

Reference values differ in the various versions of the MM-questionnaires. On the bases of results from the ELIB-study (Norlén U, Andersson K, 1993), reference values will be established for buildings with various types of technical characteristics.

The Swedish reference values for workplaces have been used in studies in the USA and Switzerland (Hill, 1991, Schultz et al, 1990). Hopefully, it will be possible to make international comparisons in the future.

## **C. Applications**

Hitherto the questionnaires have been used to describe the indoor climate, to point to essential technical measurements and perform follow-ups after remedial measures have been taken. It has also proved to be usable for evaluating ventilation systems or heating systems of specific types - i.e., the function of heating ventilation.

The MM-questionnaire for workplaces can in future be used as a complement to the ventilation measurements required by law. A project is initiated to evaluate these techniques in a large scale survey in Sweden.

## **D. Translations**

During 1993, the MM-questionnaire for workplaces will be made available in twelve languages - i.e., in Swedish, Norwegian, Danish, Finnish, French, English, German, Spanish, Portuguese, Italian, Greek and Dutch.

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