

## **EFFECTS ON HEALTH RELATED SYMPTOMS OF CARPET REMOVAL AND VENTILATION IMPROVEMENT IN ELEVEN SCHOOLS - A CONTROLLED INTERVENTION STUDY**

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### **ABSTRACT**

An intervention study was carried out in eleven elementary schools in Trondheim, Norway. Three schools with poor ventilation standard, four schools with carpets, and four reference schools participated. Carpets were replaced by vinyl flooring and the poor ventilation systems were upgraded. Altogether 1100 children aged twelve to thirteen years and 400 teachers were all included in the study. The baseline registration of health related symptoms were performed during January/February 1997. The questionnaires were repeated, after the interventions, in February 1998 and 1999. The questionnaire used corresponds to questions in the Örebro questionnaire, but was adjusted to be performed with three repetitions during two weeks. In addition, a questionnaire on symptoms and asthma management to identify hypersensitive children was used in 1998 and 1999. Compared to reference schools the results from the intervention schools showed that the number of health related symptoms were reduced for both children with and without hypersensitivity.

### **INDEX TERMS**

Ventilation, Carpets, Intervention, Health effects, Schools

### **INTRODUCTION**

The indoor environment has become more under scrutiny due to the extent of complaints regarding indoor environment factors in existing schools. Health authorities have observed an increase in the frequency of asthma and allergy among children (Helsedirektoratets utredningsserie 2-91. 1991). There has also been an increased attention on costs related to absenteeism, bad health, and well-being due to poor indoor environment.

In the city of Trondheim, Norway, in 1996 the municipality decided to renovate a large part of their older schools. The decision included an opportunity, in cooperation with the municipality, to evaluate the effect of measures through a controlled open intervention design.

#### *Main objectives of the study:*

The objectives were to assess exposures and effects of intervention measures before and after implementation of two preventive measures carried out in a controlled design.

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**METHODS**

Reference schools were compared with two different kinds of intervention schools. In three intervention schools carpet floorings were replaced with vinyl flooring. In four other intervention schools the ventilation was upgraded. Two of the reference schools had carpets and two had poor ventilation.

Table 1 shows schematically the study design. The questionnaire survey was repeated in 1999 to counteract that it could not be done in a blinded design.

**Table 1.** Accomplishment of questionnaire for children. The intervention took place in summer 1997.

<i>Birth year</i>	February 1997	Summer/Easter 1997	February 1998	February 1999
1984	A	Carpets removed summer 1997 Ventilation upgraded March to December 1997		
1985	B		C	
1986			D	E
1987				F

Twelve of the questions were on indoor related problems, Tiredness, Heavy-headed, Headache, Nausea/Dizziness, Difficulties on concentrating, Itching or irritated eyes, Hoarse or dry throat, Irritated, Stuffy or runny nose, Cough, Cold, Itching face or hands, Sick or unwell. These questions correspond roughly to the Örebro questionnaire (Andersson, Fagerlund, Bodin and Ydreborg 1988). Other questions were on perceived thermal, atmospheric, actinic and acoustic environmental factors. There were also some questions regarding the home situation like contact with animals and passive smoking.

The questionnaires were repeated three times within two weeks in 1997, 1998 and 1999. Each person was asked how he/she perceived the situation while at school, with alternatives yes or no at most of the questions. The average number of symptoms for each person were calculated and interpreted as: Yes always, sometimes or never.

From the twelve questions of health related symptoms a new variable (Skåret, Blom 1995) was calculated by counting the number of symptoms for each person. Only symptoms scoring "Yes, always" was counted. "Yes, always" meant that the person answered "Yes" in all questionnaires that were answered during the two-week period.

In 1998 and 1999, questions on asthma and allergic diseases were added.

Children and teachers having atopic eczema, asthma, or other allergic diseases, or reported using inhaled aerosol asthmatic medication regularly were considered hypersensitive children in the analysis. The other children were categorized as "Non hypersensitive" persons.

**RESULTS**

Due to absenteeism some children and a few teachers did not answer all three questionnaires. An analysis excluding children participating only once was compared to the results from analyses where all children were included in the analyses. There were only small and insignificant differences between the results from the two analyses. In the further analysis, therefore, all children and teachers that answered one or more time were included.

Table 2 shows the comparisons of the number of symptoms from the each person in 1997 and 1998. A lower limit in the confidence interval larger than zero indicates that there was significantly fewer symptoms reported in 1998. Children from groups B, C and D in Table 1 were used.

**Table 2.** Mean numbers of symptoms per person (both children and teachers) in schools where carpets were removed or ventilation were improved. Differences in mean number of symptoms in 1997 and in 1998 was tested by a T test procedure with 1997 against 1998. (Number of persons in brackets).

	Ventilation upgraded		Carpet flooring removed	
	Hypersensitive persons	Non-hypersensitive persons	Hypersensitive persons	Non-hypersensitive persons
1997	1,9 (50)	1.4 (116)	1.9 (41)	1.4 (91)
1998	1.5 (50)	0.9 (116)	1.6 (41)	1.2 (91)
Difference	0.4	0.5	0.3	0.2
Confidence interval of the difference	-0.16 to 0.96	0.1 to 0.8	-0.19 to 0.73	-0.22 to 0.55
p-value	<b>0.06</b>	<b>0.003</b>	0.384	0.442

Table 3 shows the change in mean number of symptoms per person in the reference schools. Since no measures were performed in the reference schools no changes in the number of symptoms should be expected. The reduction in mean number of symptoms from 1997 to 1998 was small and insignificant

**Table 3.** Mean number of symptoms per person in the four reference schools. (Number of persons in brackets).

	Children and teachers	All children
1997	1.54 (461)	1.45 (402)
1998	1.42 (406)	1.39 (306)

Due to the experimental design described in Table 1 it was not possible to make a paired comparison between 1997 and 1999. Alternatively, as shown in Table 4 and 5, a comparison between groups, i.e. years, was carried out. Children grouped A, B, E and F in Table 1 were included in “all children”. For analysing “non-hypersensitive children” and “hypersensitive children” groups B, E and F were used. An advantage of using the groups was an increase in the number of cases compared to using the paired data. For calculation of the significance level the figures were normalized by a logarithmic transform to achieve normal distribution.

Tables 4 and 5 indicate that the hypersensitive children accomplish approximately the same advantage from the two different measures. However, non-hypersensitive children seem to benefit especially from improving the ventilation.

**Table 4.** Mean number of symptoms per person in schools where carpets were removed. (Number of persons in brackets).

	All persons	All children	Non-hypersensitive children	Hypersensitive children
1997	1.9 (346)	1.9 (261)	1.4 (57)	2.0 (33)
1999	1.5 (321)	1.3 (201)	1.2 (131)	1.6 (45)
p-value	<b>0.036</b>	<b>0.002</b>	0.482	0.486

**Table 5.** Mean number of symptoms per person in schools where ventilation were improved.

	All persons	All children	Non-hypersensitive children	Hypersensitive children
1997	1.6 (582)	1.7 (433)	1.5 (64)	2.0 (34)
1999	1.2 (546)	1.3 (399)	1.0 (228)	1.6 (113)
p-value	<b>0.000</b>	<b>0.000</b>	<b>0.009</b>	0.148

## DISCUSSION

The mean number of symptoms per person in the different schools seems to be in accordance with for instance what is found for offices (Skåret and Blom 1995).

On the same data (Mathisen and Frydenlund, 2000) used a McNemars test on each symptom showing that only a few of the symptoms had a significant reduction. Probably the total reduction of symptoms for hypersensitive persons is due to a few symptoms that could be revealed by a more detailed study.

After the intervention had taken place the lowest mean number of symptoms per person were 0.9 among non-hypersensitive persons and 1.6 among hypersensitive. There were four ventilation schools and three carpet schools, so even lower number might be reached in the best schools.

Another experience is that studies like this one requires relatively large samples to give statistically significant results. Doubling the number of persons would have given even more reliable results.

Due to practical circumstances, it was not possible to select schools randomly since there were only a limited number of schools to choose between. The scattering of the results could also be influenced because it was not possible to control the quality of the work done by the construction companies.

Differences between schools could be of some influence. Some had the traditional classroom type while others had open landscapes, the room air volumes were different between old and new buildings and some schools had a complete mechanical ventilation system while others only had infiltration or window venting.

Time dependent changes from year to year could be:

- Outdoor air temperature and relative humidity. This were controlled by measurements and do not seem to represent a problem.
- Indoor air temperature and relative humidity. This was also controlled during measurements.
- Amount of air transported dust from road surface changes with the weather.
- Changes in the teacher staff may influence psychosocial relations.
- There might be different social background for pupils from different areas of the city.

Other factors that could be of some influence: Measures in the pupils' homes can influence on the results, other measures than agreed might have be done in the schools, the study itself might influence the results since it is not possible to arrange it as a blind test.

### **CONCLUSIONS AND IMPLICATIONS**

The main finding was that improving the ventilation and removing carpets reduced the number of reported health related symptoms in schools. Due to small numbers the results from small groups like hypersensitive children are hampered with some uncertainty.

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