

RESPIRATORY INFECTIONS AMONG CHILDREN IN MOISTURE DAMAGED SCHOOLS

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ABSTRACT

The occurrence of common respiratory infections were studied with self-reported questionnaires in 32 Finnish schools and the association between respiratory infections and moisture damage in different types of school buildings was estimated. Both old and new buildings with wooden and concrete/brick frame were included. An association was found between occurrence of common colds and moisture damage in all school buildings. In addition, sinusitis, tonsillitis and bronchitis were more common in concrete/brick buildings than in buildings with wooden frame irrespective with moisture observations. Occurrence of respiratory infection was also strongly correlated with background factors such as age, female gender, smoking, atopy and moisture damage in home environment.

INDEX TERMS

Moisture damages, School buildings, Children, Respiratory infections

INTRODUCTION

Indoor air quality of school buildings may be a significant factor for children's health. Adverse health effects in children that attend school in buildings damaged by moisture have not been well documented, although case reports from schools indicate health consequences associated with moisture problems (Haverinen *et al.* 1999, Taskinen *et al.* 1999). In residential buildings, poor indoor air quality has been reported to associate with respiratory symptoms and infections in both adults and children (Brunekreef *et al.* 1989, Waegemaekers *et al.* 1989, Koskinen *et al.* 1995, Koskinen *et al.* 1997). Common respiratory infections have major consequences in health economics in industrialized countries, but so far only few preventive actions in addition to vaccination programs have been taken to prevent respiratory infections among children. Even simple hygienic measures have been proven to be effective in reducing the occurrence of respiratory infections in preschool children (Uhari *et al.* 1999). Also, moving away from a moisture damaged day care center reduced the occurrence of severe respiratory infections among children (Koskinen *et al.* 1997), but similar research data is missing on school age children.

The aim of this study was to find out whether respiratory infections among school-aged children differed in schools with visible moisture and mold problems compared to non-damaged schools. The aim was also to identify other potential risk factors for respiratory infections that could be subject to preventive actions in health promotion.

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MATERIAL AND METHODS

School buildings

Trained civil engineers investigated 32 school buildings according to a standardized protocol described in detail by (Nevalainen *et al.* 1998). In general, Finnish schools can be grouped in two categories: old, wooden framed school buildings (51 % of schools) and newer, concrete/brick schools (45% of schools) (Statistics of Finland 1998). Both types of buildings were included. All schools were situated in central Finland and they were divided in moisture damage buildings (index schools) and non-damaged schools (reference schools) according to findings in building inspection. Both groups included buildings with concrete/brick frame and wooden frame. The area of the schools varied from 380 m² to 10 900 m². Among the studied schools, 17 were of wooden construction with a timber frame (built 1896 – 1994), and 15 were of concrete/brick construction (built 1923 – 1994).

Study population

Health data were collected by questionnaires. The total number of pupils in schools was 5522. The overall response rate for health surveys was 82%. The number of participating children was 4365 of which 3687 came from index schools and 678 from reference schools, with response rate of 82% and 78 % respectively. The material and methods have been described in detail by Meklin *et al.* (2002).

The questionnaire used was a modified version of those used in other Finnish studies on respiratory symptoms and diseases (Susitaival and Husman 1996, Husman 1995). The questionnaire comprised of 32 questions concerning personal characteristics, home environment, the occurrence of respiratory symptoms and infections, doctor calls, absence due to sick leaves and use of medication for respiratory diseases and symptoms.

Statistical analysis

Infections and moisture damage in index and reference schools were cross-tabulated and crude odds ratios were calculated with Khii²-test. Adjusted odds ratios were analyzed using logistic regression models, adjusting for gender, age, moisture observations at home and atopy. SAS statistical package (SAS Institute Inc. 1990) was used for all analyses.

RESULTS

When moisture damaged and reference school buildings were compared, in spring term after longer period of exposure, common colds were significantly more common ($p < 0.01$) in moisture damaged buildings than in non-damaged reference buildings. Common colds were slightly more frequently found in schools with concrete/brick frame than in school buildings with wooden structures (Table 1).

In other respiratory infections (e.g. sinusitis, infections of the middle ear, tonsillitis, bronchitis), no significant differences were found between moisture damaged buildings and reference buildings. However, when buildings with concrete or brick frame were compared with buildings with wooden frame, the same trend was found as in occurrence of common colds: the frequencies of sinusitis, tonsillitis and bronchitis were higher in concrete/brick buildings than in wooden buildings irrespective of possible moisture damages.

Table 1. The occurrence of respiratory infections in index and reference schools of concrete/brick buildings and wood framed school buildings

	Concrete/brick frame		Wood frame		Total	
	Index	refer.	index	refer.	index	refer.
	School	school	school	school	school	school
	N (%)	N (%)	N (%)	N (%)	N	N
Common cold						
- autumn	1867 (57.5)	298 (57.5)	204 (54.0)	75 (51.0)	2071	373
- spring	2191 (68.6)	277 (58.6)***	245 (64.5)	82 (56.2)#	2436	359
Tonsillitis						
- autumn	284 (8.7)	52 (10.0)	15 (4.0)	4 (2.7)	299	56
- spring	222 (6.9)	28 (5.9)	11 (2.9)	3 (2.0)	233	31
Infections of the middle ear						
- autumn	246 (7.5)	49 (9.4)	29 (7.6)	11 (7.3)	275	60
- spring	186 (5.8)	33 (6.9)	23 (6.0)	14 (9.3)	209	47
Sinusitis						
- autumn	314 (9.6)	59 (11.3)	20 (5.2)	6 (4.0)	334	65
- spring	241 (7.5)	40 (8.4)	13 (3.4)	9 (6.0)	254	49
Bronchitis						
- autumn	120 (3.7)	22 (4.2)	7 (1.8)	7 (4.6)#	127	29
- spring	111 (3.5)	22 (4.6)	7 (1.8)	4 (2.7)	118	26

p=0.08

*** p<0.001

Moisture damage at home was significantly associated with higher occurrence of common colds, sinusitis and infection of the middle ear. Female gender and atopy were strong risk factors for common colds. The risk for common cold and infections of the middle ear decreased with increasing age. On the contrary, tonsillitis and sinusitis were increased with age.

Moisture damage at school was not associated with the need of medical care due to respiratory infections. The number of doctor calls and antibiotic treatments were more strongly associated with atopy, female gender and moisture damages at home. Children in schools with concrete/brick frame used medical care services more often than children in wooden schools.

DISCUSSION

Respiratory infections are very common in young age groups. At least two thirds of school aged children have at least one respiratory infection per year. These diseases contribute of a vast majority of all outpatient visits in industrialized countries and thus result considerable economic consequences to the society. Reasonable measures that reduce morbidity of respiratory infections are health promoting and also help in reducing the costs of primary health care.

In this study, a clear association was observed between increased occurrence of common respiratory infections and moisture damage in the school building. This finding supports earlier preliminary findings by Haverinen *et al.* (1999). The occurrence of respiratory infections was higher in buildings with concrete/brick frame than in wooden buildings. This may be partly due to larger size and thus higher numbers of children in these schools and the rapid spread of infection epidemics in the building. The possible role of ventilation conditions could not be verified in this study, but may deserve attention in the future studies.

The association between moisture damage exposure and infections was consistent even when adjusted for possible confounding factors, eg. age, gender, atopy, smoking and moisture damage in home environment. Higher occurrence of respiratory infections among atopic children was found here, and has also been reported in previous studies (Pekkanen *et al.* 1999). Atopic children are probably more susceptible to harmful agents in their environment than non-atopic children.

CONCLUSION

Presence of moisture damage in school buildings is a risk factor for common respiratory infections in school children both in concrete/brick buildings and in wooden frame buildings. This supports the repair of damaged buildings also as measured with health effects.

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