

Damp housing and adult respiratory symptoms

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The relationship between home dampness and adult respiratory symptoms was investigated using data from a parent-administered questionnaire on childhood respiratory symptoms that also included questions on parental respiratory symptoms. Questionnaires were returned by the parents of 3344 children living in the town of Helmond, The Netherlands. The response was 73%. Home dampness was characterized by reports of damp stains or mould growth on indoor surfaces and was reported by 23.6% and 15.0% of the study population, respectively. Of the homes, 25.4% had dampness and/or mould. Information about respiratory symptoms was collected for the mothers and fathers of a population of 6–12-year-old schoolchildren. Symptoms analysed were cough, phlegm, wheeze, asthma, and allergy to pollen or house dust. Cough and phlegm in both men and women were found to be strongly associated with living in a damp home. Weaker associations were found for wheeze and asthma, and there was little association between living in a damp home and allergy to pollen or house dust. Current smoking was strongly associated with cough, phlegm and wheeze in both men and women. Smoking was inversely associated with allergy to pollen or house dust, suggesting that allergic subjects do not start smoking, or give up the habit. The results suggest that the association between home dampness and respiratory symptoms previously reported for children also applies to adults. Suggested mechanisms include exposure to biological contaminants produced by fungi or house dust mites, but it has not yet been documented to what extent these exposures are responsible. Also, the effects of potential biases related to selective migration or home amelioration, or to over-reporting of symptoms among subjects living in damp homes, or to over-reporting of home dampness by symptomatic subjects, need further investigation.

Key words: home dampness; respiratory symptoms; epidemiology.

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Several recent studies have reported associations between damp housing and respiratory symptoms among children (1, 3, 5, 7, 11, 12). By contrast, little is known about respiratory symptoms among adults exposed to home dampness. One recent report focusses exclusively on this issue (4) and describes a large study among approx. 15000 Canadian adults. The population consisted of respondents to a questionnaire that was mainly focused on the health of children between 5 and 8 years of age. The respondents were predominantly female (> 80%), with a mean age of about 33 years old. Questions were asked about dampness in the home, and about respiratory and other symptoms. The main findings were that, independent of smoking status, respiratory symptoms and doctor-diagnosed asthma were associated with living in damp homes, with crude and adjusted odds ratios generally in the range of 1.4 to 1.8. The authors also reported the results of an analysis stratified for doctor-diagnosed asthma or

doctor-diagnosed allergy to dust, pollen, moulds or animals. Between strata, the odds ratios for lower respiratory symptoms and exposure to dampness in the home were not significantly different, leading the authors to conclude that an immediate hypersensitivity allergic response was not likely to be responsible for the associations found. Other studies among much smaller populations have also reported positive associations between damp housing and respiratory symptoms among adults (9, 12). Both of these were conducted in areas where "damp homes" were a political issue, raising the question of potential bias that was also raised for associations between childhood respiratory symptoms and damp housing (11). The Canadian study (4) was conducted for reasons unrelated to citizen complaints about home dampness, and made use of an "over-reporting indicator" to check whether over-reporting of symptoms among those exposed would be a likely explanation of the association between symptoms and damp homes.

The authors concluded that this was not the case, as was also suggested by the results of a large study among children living in the United States (3).

In this report, we have analysed questionnaire data on damp housing and adult respiratory symptoms from a study on childhood respiratory health. The study was conducted for reasons unrelated to parental concerns about home dampness or other potential causes of respiratory disease, and was in several ways comparable in design to the Canadian study (4). Results for childhood respiratory symptoms will be published elsewhere (2).

Methods

The investigation was carried out in Helmond, a small town of about 65 000 inhabitants in the southern part of The Netherlands. Helmond was selected because excellent cooperation already existed with the local school health service in another, unrelated investigation.

All 37 primary schools in the town were asked to participate. Only 4 refused. All parents of children in classes 3 through 8 were invited to fill out a questionnaire. In these classes, children are generally 6 to 12 years old. Of the parents invited, 3344 filled out the questionnaire, a response of 73%. The questionnaires were completed mostly by the mothers of the children, either alone ($n = 2274$, 68.5%) or in cooperation with the child's father ($n = 562$, 16.9%). A total of 411 questionnaires (12.4%) were completed by the father alone, 75 (2.3%) by a guardian other than the mother or father, and for 22 questionnaires there was no indication of who had completed it. All non-responders were asked for their reasons for not participating; these were generally non-specific (no time, not interested, etc.).

Dampness in the home was assessed by questions about the presence, in the last 2 years, of damp stains and visible mould growth on surfaces inside the house, using a somewhat simplified version of a method used in an earlier study (12). Both items ("damp stains" and "visible mould growth") were evaluated independently, and a combination variable "home dampness" was constructed, being positive when damp stains and/or mould growth were reported.

A short respiratory symptom questionnaire was used to collect information about symptoms of chronic bronchitis (cough and phlegm) and asthma (wheeze, attacks of shortness of breath) for the mothers and fathers of the investigated children. A translation of the questions is given in Table 1. In addition to questions on respiratory symptoms and asthma, we also asked about allergy to house dust or pollen but not about allergy to moulds or pets.

Information about parental education was also

Table 1. Questions about adult respiratory symptoms

Questions about the biological mother of the child

- Did the child's mother cough on most days for 3 consecutive months in the last 2 years? (*cough*)
- Did the mother cough up phlegm on most days for 3 consecutive months in the last 2 years? (*phlegm*)
- Has the mother's chest ever sounded wheezy? (*wheeze*)
- Has a doctor ever diagnosed the mother to have attacks of shortness of breath? (*asthma*)
- Has a doctor even diagnosed the mother to have allergy for pollen or house dust? (*allergy*)

The same questions were repeated for the (biological) father of the child.

collected by questionnaire. The highest level of educational attainment was obtained for both parents. The information on parental education was condensed into 2 dummy variables for inclusion in the analyses, representing medium and high education level of the father. If no data on the father's education were obtained, the mother's education was used instead. Information about smoking habits was also collected. In the analyses, current active smoking (as assessed by questionnaire) was included, also current smoking by wife/husband as a measure of exposure to tobacco smoke in the home. There were no questions about whether the mothers and fathers went out to work or stayed at home. Information on the presence of gas-fired water heaters (geysers) was collected and included in the analyses. Geysers are potent sources of nitrogen dioxide in the home in The Netherlands (6). It was not considered necessary to collect data on ambient air pollution, as the complete investigation took place in one relatively small town without major air pollution sources.

In the statistical analysis, unadjusted estimates of the prevalence ratios were made for the following dependent and independent variables.

Health outcome variables used were the symptoms cough, phlegm, wheeze, asthma, allergy, and a lower respiratory symptom index. Lower respiratory symptoms were considered present when subjects reported cough and/or wheeze and/or phlegm and/or asthma. The symptom definitions are given in Table 1. The reported presence of damp stains and mould growth were evaluated independently as exposure variables in the analysis of the crude prevalence ratios. Current smoking was also evaluated. Multiple logistic regression was used to estimate odds ratios for the combined home dampness variable (indicating exposure to damp stains and/or mould growth), adjusted for educational level as a measure of socio-economic status, smoking by the subject, smoking by the spouse, and the presence of gas-fired water heaters in the home. All analyses were stratified by gender. Effectively, this means that the results for women were mostly based on self-reported symptoms and exposures, whereas for men,

Table 2. Characteristics of study population

Characteristic	Women (n=3,288) (%)	Men (n=3,148) (%)
Smoking		
current	45.1	46.2
ex	25.6	30.7
never	29.3	23.1
Dampness		
damp stains		23.6
mould growth		15.0
one or both		25.4
Cough	8.2	8.6
Phlegm	5.2	4.9
Wheeze	19.0	14.1
Asthma	9.9	6.4
Allergy	11.5	8.2
Lower respiratory symptoms	23.6	19.6

the results were mostly based on spouse reporting. To control for a resultant potential bias, part of the analysis was repeated for the men ($n=411$) and women ($n=2274$) who had answered the symptom questions for themselves.

All analyses were done using the SAS system (10) on an Olivetti M300 PC.

Table 3. Crude prevalence ratio estimates for respiratory symptoms associated with the reported presence of damp stains, mould in the home and smoking in a population of parents of Dutch children of 6–12 years old

Symptoms	Prevalence ratio estimate for:		
	Damp stains	Mould	Current smoking
Women			
Cough	1.52*** (1.19–1.95) ^a	1.44* (1.08–1.92)	2.04*** (1.62–2.58)
Phlegm	1.49* (1.09–2.04)	1.37 [#] (0.95–1.98)	1.6*** (1.24–2.22)
Wheeze	1.30*** (1.11–1.52)	1.33** (1.11–1.59)	1.35*** (1.17–1.55)
Asthma	1.28* (1.02–1.62)	1.19 (0.91–1.57)	1.01 (0.82–1.24)
Allergy	1.20 (0.96–1.48)	1.14 (0.88–1.47)	0.59*** (0.48–0.72)
Lower resp. symptoms	1.40*** (1.23–1.61)	1.41*** (1.21–1.65)	1.39*** (1.23–1.57)
Men			
Cough	2.36*** (1.88–2.97)	2.31*** (1.80–2.98)	2.04*** (1.62–2.59)
Phlegm	2.37*** (1.74–3.25)	2.58*** (1.84–3.61)	1.77*** (1.29–2.43)
Wheeze	1.49*** (1.24–1.80)	1.44*** (1.15–1.79)	1.21* (1.01–1.44)
Asthma	1.07 (0.78–1.47)	1.41 [#] (0.98–1.99)	0.76 [#] (0.58–1.01)
Allergy	1.26 [#] (0.96–1.64)	1.40* (1.03–1.90)	0.59*** (0.46–0.76)
Lower resp. symptoms	1.50*** (1.28–1.75)	1.51*** (1.27–1.81)	1.40*** (1.22–1.62)

^a 95% confidence limits; [#] 0.10 > p > 0.05 (two-sided); * p < 0.05 (two-sided), ** p < 0.01, *** p < 0.001.

Results

Table 2 contains descriptive information on the population studied. The proportion of smokers was equal among men and women, but more men were ex-smokers. Damp stains were reported in 23.6% of the homes, mould growth in 15.0%. Generally, the reported symptom prevalences were somewhat higher for women than for men. However, this was not because the women mostly reported for themselves. Self-reported symptom prevalences among the 411 fathers who filled out the questionnaire themselves were equal to the symptom prevalences reported for men in this population in general.

Table 3 shows the crude prevalence ratios for 2 measures of home dampness and for current smoking. Current smoking was strongly associated with cough and phlegm in both men and women, and inversely associated with allergy. Cough and phlegm were also strongly associated with the 2 measures of home dampness in men, and to a lesser extent in women. Wheeze was also associated with home dampness in both men and women, but the relationship between this and asthma and allergy was generally weak.

Table 4 shows the crude prevalence ratios for those men and women who answered the symptom questions for themselves. Comparison of the results in Tables 3 and 4 shows that the prevalence ratios were essentially unchanged for the women, and that the results for the men became more variable, presumably due to the much smaller sample size.

After adjustment for active and passive smoking, indoor nitrogen dioxide sources and educational level, the associations between home dampness and symptoms remained, as shown in Table 5. Again, the odds ratios were highest for cough and phlegm among men and women, and weakest for asthma and allergy.

Stratification by reported allergy for pollen or house dust, as suggested by Dales et al. (4), gave comparable associations between damp housing and lower respiratory symptoms among allergic and non-allergic subjects (results not shown). Stratification by reported asthma symptoms proved to be uninformative, as more than 80% of asthmatic subjects in all categories of exposure to home dampness reported lower respiratory symptoms.

Discussion

This investigation has documented significant associations between questionnaire reports of damp housing and respiratory symptoms among adults living in the town of Helmond in The Netherlands. The results can be compared to those obtained by Dales

Table 4. Crude prevalence ratio estimates for respiratory symptoms associated with the reported presence of damp stains, mould in the home and smoking in a population of parents of Dutch children of 6–12 years old; analysis restricted to men ($n=411$) and women ($n=2274$) who answered the symptom questions for themselves

Symptom	Prevalence ratio estimate for:		
	Damp stains	Mould	Current smoking
Women			
Cough	1.45* (1.08–1.96) ^a	1.40 [#] (0.99–1.98)	2.66*** (1.98–3.56)
Phlegm	1.40 [#] (0.97–2.04)	1.39 (0.91–2.13)	1.92*** (1.35–2.72)
Wheeze	1.39* (1.04–1.85)	1.17 (0.95–1.45)	1.35*** (1.15–1.58)
Asthma	1.26 (0.95–1.67)	1.28 (0.93–1.77)	0.91 (0.71–1.18)
Allergy	1.21 (0.94–1.56)	1.09 (0.81–1.47)	0.52*** (0.42–0.66)
Lower resp. symptoms	1.27** (1.08–1.49)	1.26* (1.05–1.51)	1.44*** (1.25–1.67)
Men			
Cough	2.90*** (1.56–5.38)	2.52* (1.22–5.22)	2.40** (1.31–4.41)
Phlegm	2.20 [#] (0.89–5.45)	2.13 (0.75–6.04)	5.60*** (2.17–14.44)
Wheeze	1.57 (0.86–2.85)	1.58 (0.78–3.17)	0.89 (0.53–1.50)
Asthma	3.00** (1.46–6.14)	4.23*** (2.08–8.16)	0.25** (0.10–0.64)
Allergy	1.09 (0.47–2.54)	1.81 (0.79–4.16)	0.65 (0.33–1.29)
Lower resp. symptoms	1.87** (1.18–2.93)	1.65 [#] (0.95–2.86)	1.33 (0.89–1.98)

^a 95% confidence limits; [#] 0.10 > p > 0.05 (two-sided); * p < 0.05 (two-sided), ** p < 0.01, *** p < 0.001.

et al. (4) in Canada, so far the only other report on this subject in a large population of adults. The adjusted association between damp housing and lower respiratory symptoms in our study was as strong as in the Canadian study (adjusted odds ratios were 1.55 and 1.70 in our study, and 1.50 in the Canadian). The odds ratios we found for asthma were weaker, however (1.25 and 1.29 in our study vs 1.56 in the Canadian). Stratification by reported allergy to pollen or house dust gave comparable associations between damp housing and lower respiratory symptoms in allergic and non-allergic subjects, a finding also reported by Dales et al. (4). This and the relatively strong associations found between home dampness and cough and phlegm (as opposed to wheeze and asthma) suggest that mechanisms other than immediate hypersensitivity allergic reactions could predominate. Gaseous contaminants produced by fungi are one hypothesis (8). However, it should be pointed out that both our results and the Canadian were obtained in cross-sectional studies with little control over potential selection bias caused by selective migration or home amelioration by allergic and asthmatic subjects.

Table 5. Adjusted odds ratio estimates for respiratory symptoms associated with the reported presence of damp stains and/or mould in the home in the parents of a population of about 3000 Dutch children 6–12 years old

Symptom	Odds ratio estimate
Women	
Cough	1.75*** (1.30–2.36) ^a
Phlegm	1.66** (1.16–2.38)
Wheeze	1.43** (1.15–1.77)
Asthma	1.25 (0.94–1.66)
Allergy	1.03 (0.79–1.35)
Lower resp. symptoms	1.55*** (1.27–1.89)
Men	
Cough	2.56*** (1.94–3.38)
Phlegm	2.26*** (1.57–3.24)
Wheeze	1.63*** (1.30–2.06)
Asthma	1.29 (0.92–1.81)
Allergy	1.24 (0.95–1.73)
Lower resp. symptoms	1.70*** (1.38–2.09)

^a 95% confidence limits; [#] 0.10 > p > 0.05 (two-sided); * p < 0.05 (two-sided), ** p < 0.01, *** p < 0.001.

Over-reporting of symptoms by subjects living in damp homes could also lead to biased study results, as suggested by Strachan (11). Two studies among random population samples have made some attempt to investigate this form of bias, and could not document that it existed (2, 4). The study reported in this paper was conducted among a random sample of parents of school age children in a community where no specific concerns over home dampness had been raised. The questions about home dampness were embedded in a questionnaire mostly focused on childhood respiratory symptoms, that included questions on other factors, such as smoking and indoor nitrogen dioxide sources. This does not exclude the possibility that over-reporting is to some extent responsible for the associations found. Other forms of bias could be operating; e.g. symptomatic subjects could be more liable to report home dampness than symptom-free subjects.

Further studies are needed in which objective measures of house damp, exposure to biological contaminants and health effects are used in addition to questionnaires, so that the associations found in our study and other studies can be substantiated or refuted.

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