

Asthma related to workplace dampness and impaired work ability

Kirsi Karvala · Henrik Nordman ·
Ritva Luukkonen · Jukka Uitti

Received: 21 June 2012 / Accepted: 13 November 2012
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Abstract

Purpose To examine the long-term effects on work ability among patients previously diagnosed with occupational asthma (OA) or work-exacerbated asthma (WEA) or symptoms in relation to workplace dampness.

Methods A questionnaire follow-up was used to study 1,098 patients (of whom 87 % were female) examined because of a suspected occupational respiratory disease caused by building dampness and mold. Self-rated work ability and early withdrawal from work were the two outcomes of the study. As determinants, we investigated the influence of the asthma diagnosis given in the initial examinations (OA or WEA), the number of persistent indoor air symptoms, and the psychosocial factors at work.

Results With a mean follow-up of 7.8 years, 40 % of the OA patients, under 65 years of age, were outside worklife versus 23 % of the WEA patients and 15 % of the patients with only upper respiratory symptoms at baseline. The diagnosis of OA was associated with a nearly sixfold risk for early withdrawal from work in a comparison with a reference group with upper respiratory symptoms. A perceived poor social climate at work and poor experiences with supervisory co-operation were associated with impaired work ability outcomes. Those with multiple, long-term indoor air symptoms considerably more often

perceived their work ability to be poor when compared with those with less significant symptoms.

Conclusions Adverse work ability outcomes are associated with asthma in relation to workplace dampness. The study raises the need for effective preventive measures in order to help workers with indoor air symptoms sustain their work ability.

Keywords Dampness · Disability · Occupational asthma · Mold · Work ability

Introduction

Asthma, including occupational asthma (OA), is a multifactorial, usually persistent disease, and several studies have shown it to be associated with work disability (Thaon et al. 2008; Toren et al. 2009). Building moisture and mold damage in work environments are associated with adverse respiratory health effects, of which asthma is the most frequently diagnosed disease (WHO 2009). In Finland since the 1990s, asthma induced by exposure to workplace dampness and mold at work has been recognized as OA (Piipari and Keskinen 2005; Karvala et al. 2010). According to the national register of occupational diseases, indoor air molds have been the commonest cause of OA for a decade (Riihimäki et al. 2004).

Whereas OA refers to asthma caused by occupational exposures, work-exacerbated asthma (WEA) is defined as the worsening of asthma due to conditions at work (Henneberger et al. 2011). Worsening may be caused by exposures to various irritant agents or conditions associated with physical conditions such as low temperature or physical strain. For asthma exacerbation and dampness or mold, the epidemiological evidence is strong to document

K. Karvala (✉) · H. Nordman
Occupational Medicine Team, Finnish Institute of Occupational Health (FIOH), Topeliuksenkatu 41 a A, 00250 Helsinki, Finland
e-mail: kirsi.karvala@ttl.fi

R. Luukkonen
Statistics and Health Economics Team, FIOH, Helsinki, Finland

J. Uitti
Occupational Medicine Team, FIOH, Tampere, Finland

association (Mendell et al. 2011). WEA can have clinical characteristics similar to those of OA (i.e., need for medication, as well as adverse socioeconomic outcomes such as unemployment and reduction in income) (Henneberger et al. 2011).

Respiratory ill-health and multiple non-specific symptoms related to building dampness are usually transient, but long-lasting symptoms appear to be common for some persons, even despite building repairs (Patovirta et al. 2004; Haverinen-Shaughnessy et al. 2008; Iossifova et al. 2011) or a change to an unexposed, alternative work environment (Jarvis and Morey 2001; Al-Ahmad et al. 2010). Some researchers have suggested that incomplete remediation may explain the lack of symptom improvement (Haverinen-Shaughnessy et al. 2008; Iossifova et al. 2011).

In general, poor perceived work ability is an individual experience. It can be related to a deterioration of health or to other resources of the worker, to factors related to work and the workplace, or even to the environment outside work (Ilmarinen and Tuomi 2004; van den Berg et al. 2009). Not all of the factors leading to work disability and connected to indoor air problems have been recognized (Walsh and Solomon 1994; Hodgson 2002). In many cases, symptoms and complaints develop from the interaction between environmental, individual, and psychosocial factors (Norbäck 2009). Little has been published about long-term work outcomes in dampness-related or other building-related conditions (Edvardsson et al. 2008). According to our clinical experiences, patients often encounter work limitation, along with prolonged symptoms (Karvala et al. 2010).

In a follow-up study examining the quality of life of patients with asthma related to damp and moldy workplace, we reported that a conspicuous part of the OA patients were outside worklife still 3–12 years after the diagnosis (Karvala et al. 2012). The aim of the present study was to further assess the work ability among the same patient series. We also wanted to investigate the association between long-lasting symptoms, as well as social factors at work, and impaired work outcomes.

The study was approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa.

Methods

Study participants and design

We conducted a follow-up questionnaire study on patients who had been examined at the Finnish Institute of Occupational Health (FIOH) in 1995–2004 because of a suspicion of an occupational disease related to exposure to

workplace dampness and molds. All of the 2200 patients had had work-related respiratory symptoms. Careful clinical examinations had been conducted, including asthma tests if symptoms were suggestive of asthma. Altogether 186 patients had been diagnosed with OA, and 726 patients were found to suffer from WEA. Pulmonary function evidence indicating asthma, as well as evidence of exposure, has been described earlier (Karvala et al. 2010).

The basic criteria for OA had been workplace exposure to indoor air molds, onset of asthma (that started) during the exposure, work-relatedness of asthma symptoms (appearing or worsening at work and improving away from work), and absence of conflicting findings (of other etiology). The compensation policy at the time favoured specific inhalation challenge tests. Thus, the diagnosis of OA was primarily confirmed with the use of a positive specific inhalation challenge test with commercial mold extracts (Piipari and Keskinen 2005; Karvala et al. 2010).

WEA was determined when the asthma symptoms of asthmatic patients had been exacerbated by workplace exposures, and the criteria for OA were not fulfilled.

For the rest of the patients ($n = 1,288$), there had been no objective clinical evidence of asthma in examinations performed at FIOH or in earlier examinations. They either had work-related asthma-like symptoms (cough, dyspnoea, or wheeze) without asthma or work-related upper airway and mucosal symptoms (like nasal congestion, rhinorrhoea, or hoarseness). All of the patients, including those with asthma, had had accompanying symptoms (e.g., eye irritation, fatigue, headache, fever or chills, or dermal symptoms).

In 2007 (3–12 years after the examinations), the patients were followed up by a questionnaire. We excluded the 66 patients for whom the symptoms were assessed as being caused by factors other than building dampness. During the follow-up, 20 patients had died. Consequently, the questionnaire was sent to 2,114 persons, and 1,295 participated (61.3 %). From present analyses, we also excluded the 28 respondents who were diagnosed with hypersensitivity pneumonitis in the baseline examinations.

To examine work limitation among the persons of typical working age, we restricted our analyses to respondents who were under 65 years of age. Thus, the study population consisted of 1,098 respondents (Fig 1). The common age limit for an old-age pension is 63–68 years in Finland. For some occupations, like teachers and nurses, the age limit may be even lower.

Outcome variables

For an indicator of work ability, we asked the participants to estimate their current work ability compared with their lifetime best on a scale from 0 to 10. A score of 0

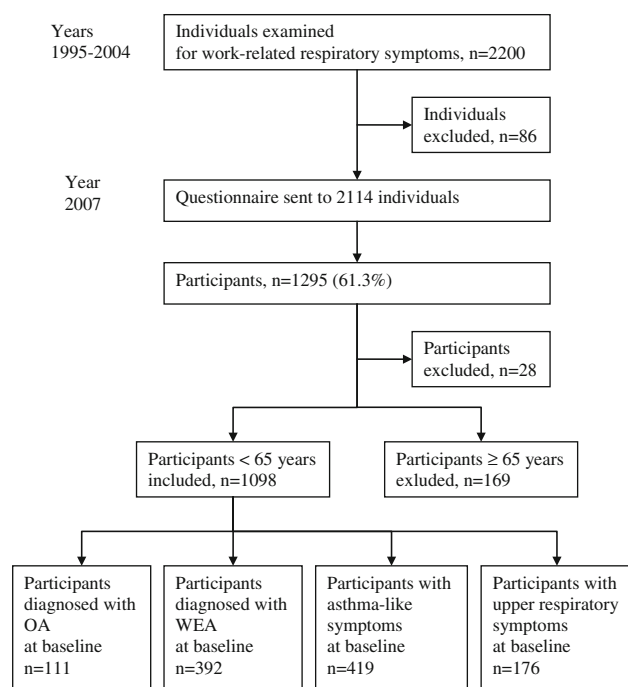


Fig. 1 Distribution of the participants. OA occupational asthma, WEA work-exacerbated asthma

represented full work disability, and a score of 10 indicated work ability at its best. The question is an item included in the Work Ability Index (WAI), which is a validated tool for measuring self-assessed work ability (Tuomi et al. 1998). Those who were on pension were permitted to leave the work ability question unanswered.

We used withdrawal from work as another, more severe outcome than perceived work ability. The criterion for withdrawal from work was (1) early retirement because of disability (being on disability pension or on a workers' compensation pension) or (2) unemployment. In the Finnish social security system, a disability pension is paid to a person who is incapable of work due to illness, handicap, or injury. Disability caused by an occupational disease or a work accident entitles to a workers' compensation pension.

Determinants

As a main determinant of interest, we investigated the asthma diagnosis (OA or WEA) given in the initial examinations. The study population was divided into the following four groups (Fig 1): (1) patients diagnosed with OA ($n = 111$), (2) patients with WEA ($n = 392$), (3) patients with asthma-like symptoms without clinical asthma ($n = 419$), and (4), as a reference group, patients with upper but no lower respiratory symptoms ($n = 176$).

Whether or not indoor air symptoms were long lasting was inquired about using the question "How much do the same symptoms that were initiated in the moisture

damaged workplace bother you nowadays?" The respondents were asked to rate the following 14 symptoms on a scale from 1 (not at all) to 5 (very much): eye irritation, hoarseness, nasal congestion, rhinorrhoea, sneezing, sinus symptoms, dyspnoea, cough, wheeze, fatigue, fever and chills, dermal symptoms, arthralgia or myalgia, and headache. Ratings of 1–3 were considered non-significant ($=0$), and only ratings of 4–5 (much or very much) were taken into consideration ($=1$). A symptom sum variable with four categories was constructed: 0 = no significant long-term symptoms, 1–3 symptoms, 4–5 symptoms, or >5 long-term indoor air symptoms.

The social climate at work was measured by three items adapted from the General Nordic Questionnaire (QPSNordic) (Lindström et al. 2000). It is a validated tool measuring psychological and social factors at work. The given question was "What was the climate like in your workplace with moisture problems?", the alternative responses being (1) "encouraging and supportive", (2) "relaxed and comfortable", (3) "rigid and rule-based". The scale ranged from 1 (little or not at all) to 5 (very much). The Cronbach's alpha was 0.85. A sum variable was calculated with the third item reverted. The sum variable was grouped into the following three equal-sized categories: poor, moderate, and good.

Using three items, we inquired about the respondent's experiences with his or her supervisor's co-operation. We used non-validated items since no established questionnaire for the issue was available. We requested responses to the following statements on a scale from 1 (disagree totally) to 5 (agree totally): (1) "The supervisor reacted appropriately when I suspected workplace dampness as a cause of my symptoms"; (2) "The supervisor took measures to investigate the damage in a reasonable time"; (3) "The supervisor took measures to remediate the damage in a reasonable time". The Cronbach's alpha was 0.91. A sum variable was calculated, and it was grouped into the following three equal-sized categories: low, intermediate, and high.

Other explanatory variables

The background factors included in the analyses were age (dichotomized as ≥ 54 and <54 years), gender, occupational group, smoking, atopic history, and concomitant chronic diseases. Of the mental health factors, depression and somatization were included.

On the basis of job titles, the respondents were classified into the following occupational groups: upper white-collar (e.g., managers and senior officials, teachers, physicians, and other professionals), lower white-collar (e.g., nurses, secretaries, office and customer service clerks, and technicians), and blue-collar (e.g., cleaners, cooks, kitchen

helpers, hospital ward assistants, door keepers, repairmen, and machinery mechanics) employees.

Atopic history was defined as a history of infantile eczema or atopic dermatitis, hay fever, or other allergic rhinitis or conjunctivitis.

As all common chronic diseases decrease work ability, co-morbidity was included (Gould et al. 2008). The respondents were asked to mark a list for the presence or absence of their current chronic diseases or injuries that had been diagnosed by a physician. The conditions included accidental injury, musculoskeletal disease, cardiovascular disease, mental disorder, endocrine or metabolic disease, neurological or sensory disease, malignancy, and other disease (Tuomi et al. 1998). Respiratory diseases were ignored. Co-morbidity was classified as (1) no, (2) one, or (3) two or more chronic conditions.

For depression, we used the 7-item depression subscale from the 14-item Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith 1983). A total score for the subscale is in the range of 0–21. A value of 7 or less was interpreted as non-clinical, 8–10 represented possible clinical relevance, and values of 11 or higher indicated important relevance.

Tendencies toward somatization were measured with the 12-item somatization subscale (SCL SOM) from the Hopkins Symptom Checklist (SCL-90) (Derogatis et al. 1973). A sum index of the 12 items (given on a 5-point Likert scale) was calculated. The classification in the analyses was based on tertiles.

Statistical analysis

Our data set consisted of both continuous and categorical variables. In our preliminary study, we wanted to determine whether the study groups (i.e., those who had OA, WEA, asthma-like symptoms, or upper respiratory symptoms) differ from each other. When comparing the differences between groups, we applied the chi-square tests for categorical variables and one-way analysis of variance (ANOVA) for continuous variables. However, our main interest was to examine the associations between the determinants and the outcome variables. At first, we studied the associations by applying cross-tabulations. After these preliminary studies, we began to build models. Before the modeling, we dichotomized the outcome variables. The outcome variable for work ability was dichotomized as follows: 0–7 = “poor”, 8–10 = “good”. The outcome variable withdrawal from work was dichotomized as no/yes. Using models, we wanted to estimate the risks of reduced work ability and withdrawal from work. Logistic regression analyses were used when we examined the associations between the different explanatory factors and the dichotomized outcome variables. Our model

strategy was as follows: In the beginning, we estimated the univariate models using asthma group, number of long-term indoor air symptoms, and social climate at work or co-operation of the supervisor as an explanatory variable. Then, by adding potential confounders into the models, we estimated multivariate regression models. The odds ratios (OR) with their 95 % confidence intervals (95 % CI) have been presented in tables.

A *p* value of <0.05 was considered statistically significant. All of the analyses were performed using SAS 9.1 (SAS Institute Inc., Cary, NC, USA).

Results

The study population consisted of 1,098 participants aged 26–64 years. The non-participants in the same age group were slightly younger (mean age 50.5 (SD = 8.6) vs 52.2 (SD = 8.0) years) and had a slightly lower proportion of females (83 vs 87 %). They were about equally likely to have WEA (35 vs 36 %), but less often diagnosed with OA (6 vs 10 %) than the participants.

The characteristics of the study group are shown in Table 1 according to the asthma or symptom group. The mean time from the initial examinations at FIOH to the follow-up questionnaire was 7.8 (SD = 2.8) years. Most of the patients in our population were female, the vast majority of whom worked in occupations with only light physical demands. Altogether 88 % of the respondents were upper or lower white-collar employees (e.g., teachers, health and day care nurses, other professionals, office workers, and administrators). The initial exposure had generally taken place in office-like workplaces (23 %), hospitals and health clinics (22 %), schools and colleges (18 %), or children’s day care centers (10 %).

The OA patients rated their work ability with the lowest scores, 31 % of them assessing their work ability as very poor (score 0–5) versus 9 % of the respondents in the group of upper respiratory symptoms. The work ability score in both asthma groups was lower than that of the symptom groups.

At the follow-up, 40 % of the OA group was outside worklife (Table 1). Retirement because of disability or being without a job was also the most frequent (33 %) in the OA group, whereas 13 % of the WEA patients, 13 % of the patients with asthma-like symptoms, and 13 % of the patients with only upper respiratory symptoms belonged to this category. Of all of those who were retired because of disability or who were without a job, 91 (61 %) claimed that the disability or unemployment was a consequence of persisting dampness-related symptoms.

Altogether 128 persons (12 %) of the respondents reported that they had changed occupation. In addition, 136

Table 1 Background characteristics of the participants with OA, WEA, asthma-like symptoms, or upper respiratory symptoms at baseline

	OA (n = 111)	WEA (n = 392)	Asthma-like symptoms (n = 419)	Upper respiratory symptoms (n = 176)	p value
Age, mean (SD)	52.7 (8.0)	52.3 (8.0)	52.6 (7.7)	51.1 (8.3)	0.171
Gender, n (%)					0.044
Female	96 (86)	352 (90)	367 (88)	143 (81)	
Male					
Atopic history, n (%)	49 (44)	207 (53)	173 (41)	72 (41)	0.005
Smoking habit ^a , n (%)					0.904
Never smoker	65 (60)	217 (58)	246 (60)	101 (58)	
Ex-smoker	28 (26)	110 (29)	105 (25)	45 (26)	
Current smoker	15 (14)	50 (13)	62 (15)	28 (16)	
Number of co-morbid conditions ^b , n (%)					0.094
No co-morbidity	37 (33)	134 (34)	165 (39)	77 (44)	
One co-morbid condition	39 (35)	135 (34)	134 (32)	64 (36)	
Two or more co-morbid conditions	35 (32)	123 (31)	120 (29)	35 (20)	
Depression, mean (SD)	3.4 (3.3)	3.5 (3.4)	3.5 (3.3)	3.1 (3.1)	0.566
Somatization, mean (SD)	2.2 (0.9)	2.1 (0.9)	2.1 (0.9)	2.0 (0.8)	0.204
Social climate at work, mean $\pm$ SD	9.7 (3.6)	9.5 (3.4)	9.7 (3.1)	9.7 (3.2)	0.834
Supervisor's co-operation, mean $\pm$ SD	6.7 (3.6)	7.8 (3.8)	7.8 (3.9)	8.1 (4.0)	0.022
Occupational group, n (%)					0.016
Upper white collar	36 (32)	96 (24)	116 (28)	52 (29)	
Lower white collar	56 (50)	262 (67)	243 (58)	105 (60)	
Blue collar	19 (17)	34 (9)	60 (14)	19 (11)	
Employment status ^c , n (%)					<0.001
Working	66 (60)	302 (77)	326 (79)	149 (85)	
Not working	44 (40)	88 (23)	88 (21)	27 (15)	
Without job	2 (2)	8 (2)	23 (6)	5 (3)	
Disability pension	17 (15)	38 (10)	29 (7)	8 (5)	
Workers' compensation pension	18 (16)	2 (1)	0 (0)	0 (0)	
Retirement due to age	3 (3)	18 (5)	22 (5)	6 (3)	
Other reason ^d	4 (4)	22 (5)	14 (3)	8 (5)	
Work ability score ^e , n (%)					0.001
9–10 points	14 (18)	78 (23)	111 (29)	54 (34)	
8 points	20 (26)	88 (27)	116 (31)	52 (32)	
6–7 points	20 (26)	97 (29)	87 (23)	40 (25)	
0–5 points	24 (31)	69 (21)	64 (17)	15 (9)	

OA occupational asthma, WEA work-exacerbated asthma

^a Information missing for 26 individuals^b Respiratory diseases ignored^c Employment status was unknown for 8 individuals^d Other reason included, for example, vocational training, maternity or sabbatical leave, and long-term sick leave for any reason^e Altogether 149 individuals did not evaluate their work ability score

(13 %) reported having changed their employer because of dampness-related symptoms.

The distributions of both of the work ability outcomes are presented in Table 2, according to the determinants and other explanatory variables.

The OA patients ran a markedly increased risk of poor work ability compared to those with upper respiratory

symptoms; when adjusted for individual variables (age, gender, occupational group, smoking, atopic history and co-morbidity), the odds ratio was 2.6 (95 % CI 1.4–4.7) (Table 3). In addition, the WEA patients had an increased risk of poor work ability (OR 1.8, 95 % CI 1.2–2.8). OA had a strong association with withdrawal from work due to early retirement or unemployment (adjusted OR 5.7, 95 %

CI 2.8–11.9) (Table 3). For the WEA and asthma-like symptoms groups, the associations with early withdrawal from work were not statistically significant. When depression and somatization were added to the model, the risks remained statistically significant.

Multiple long-term indoor air symptoms at follow-up increased the risk of poor self-assessed work ability. When adjusted for individual factors, the OR was 2.7 (95 % CI 1.9–3.8) for those with one to three symptoms, increasing to 9.7 (95 % CI 5.7–16.5) for those with more than five symptoms (Table 3). After adjustment for depression and somatization, the risks remained significantly elevated. Multiple long-term symptoms were not associated with early withdrawal from work.

A poor social climate at the workplace and poor experiences with the supervisor's co-operation were associated with both poor self-assessed work ability and early withdrawal from work when adjusted for the individual variables (Table 3). When depression and somatization were added to the models, the associations remained for early withdrawal from work, but not for self-assessed work ability (Table 3).

Discussion

In this follow-up study among workers previously examined because of a suspicion of an occupational disease related to respiratory symptoms in damp and moldy workplaces, OA and WEA were associated with impaired work ability. The diagnosis of OA was associated with a strong, nearly sixfold risk for withdrawal from work due to early retirement or unemployment, in comparison with a reference group with upper respiratory symptoms only. In addition, a perceived poor social climate at work and poor experiences with the supervisor's co-operation at an early stage of symptoms were determinants for impaired self-assessed work ability and early withdrawal from work.

The participants rated their work ability as being worse than in an earlier population-based study from Finland (Gould et al. 2008). Altogether 44 % of the entire study population, and even 57 % of the OA group, assessed their work ability as 7 or lower (on a scale 0–10) compared with the lifetime best versus 19 % of the women aged 45–54 years in the Finnish general population (Gould et al. 2008). In addition, in comparison with analyses conducted among asthmatics in the same aforementioned population-based study, self-rated work ability was lower in both asthma groups in our study (Gould et al. 2008). The item has been proven to be a good predictor of retirement due to work disability (Ilmarinen and Tuomi 2004).

The major reason for work cessation was retirement because of disability, altogether for 31 % of the OA cases.

In comparison, 7.4 % of the Finnish general population aged 16–64 years was on a disability pension in 2007, as was 20.2 % of the age group of 55–64 years (Finnish Centre for Pensions and the Social Insurance Institution of Finland 2008). The proportion of employed persons appears surprisingly low, as the majority of our patients with OA were in occupations with no high physical demands (i.e., teachers, nurses, office workers, etc.). They should not become disabled to work when adequately medicated and removed from exposure to moist and moldy environments. In previous studies, OA has been found to be associated with significant socioeconomic impacts (Ameille et al. 1997; Larbanois et al. 2002; Vandenplas et al. 2003, 2011) related to the need of leaving a job, changing occupation, and finding alternative work. To avoid exposure, there is no need for patients with building-related asthma to change occupation, unlike in OA induced by work sensitizers. Instead, building repairs or a change of workplace is required. In OA studies, removing the worker from the workplace has been linked to better medical outcomes, but invariably to worse socioeconomic outcomes (Henneberger et al. 2011; Vandenplas et al. 2011). Although OA in relation to workplace dampness and mold has been compensated in Finland as an occupational disease in a liberal way, our study shows that, as regards building-related asthma, it has not resulted in the prevention of disability.

Several possible explanations for the worse outcomes in the OA group can be considered, environmental and disease-related, as well as psychosocial factors. Our results may reflect the fact that the remediation of the building may be time-consuming and not always successful (Haverinen-Shaughnessy et al. 2008; Iossifova et al. 2011) and arrangements for relocation are not always easy to achieve. These factors may, at least at an early stage of symptoms, lengthen sickness absences and delay return to work, which in turn may lead to permanent disability. There are several studies that have shown evidence that lengthy periods of sickness absence are associated with an increased risk of disability pension (Lund et al. 2008; Wallman et al. 2009).

The patients in the OA and WEA groups had a well-defined disease. Asthma has, in several studies, been associated with work disability, specified in various ways (Thaon et al. 2008; Toren et al. 2009). The same has been shown for OA (Ameille et al. 1997; Larbanois et al. 2002; Vandenplas et al. 2003) and WEA (Henneberger et al. 2011). In earlier studies, however, no differences in socioeconomic consequences between OA and WEA could be shown (Larbanois et al. 2002; Henneberger et al. 2011). It is unclear whether asthma severity explained the differences between the asthma groups in our study. According to a systemic review of cohort studies, asthma severity has been found to have a weak positive relation to work

Table 2 Distributions of the two work ability outcomes (poor or good self-assessed work ability and early withdrawal from work or not) by the determinants and the other explanatory variables

	Self-assessed work ability ^a		<i>p</i> value	Early withdrawal from work ^b		<i>p</i> value
	Poor (<i>n</i> = 416) <i>n</i> (%)	Good (<i>n</i> = 533) <i>n</i> (%)		Yes (<i>n</i> = 150) <i>n</i> (%)	No (<i>n</i> = 940) <i>n</i> (%)	
<i>Determinants</i>						
Asthma or symptom status at baseline			<0.001			<0.001
Upper respiratory symptoms	55 (34)	106 (66)		13 (7)	163 (93)	
Asthma-like symptoms	151 (40)	227 (60)		53 (13)	362 (87)	
WEA	166 (50)	166 (50)		47 (12)	342 (88)	
OA	44 (56)	34 (44)		37 (34)	73 (66)	
Number of long-term indoor air symptoms			<0.001			0.102
0	111 (26)	314 (74)		54 (11)	432 (89)	
1–3	154 (50)	156 (50)		61 (17)	303 (83)	
4–5	62 (61)	40 (39)		15 (13)	100 (87)	
>5	89 (79)	23 (21)		20 (16)	105 (84)	
Social climate at work			0.005			<0.001
Good	119 (38)	191 (62)		28 (8)	311 (92)	
Moderate	96 (40)	142 (60)		29 (11)	233 (89)	
Poor	152 (51)	148 (49)		63 (18)	291 (82)	
Experiences of supervisor's co-operation			<0.001			<0.001
Good	108 (35)	198 (65)		29 (9)	306 (91)	
Moderate	137 (45)	168 (55)		33 (10)	308 (90)	
Poor	153 (51)	148 (49)		72 (20)	284 (80)	
<i>Other explanatory variables</i>						
Age			<0.001			<0.001
<54 years	196 (37)	337 (63)		39 (7)	514 (93)	
≥54 years	220 (53)	196 (47)		111 (21)	426 (79)	
Gender			0.096			0.289
Female	354 (43)	473 (57)		127 (13)	825 (87)	
Male	62 (51)	60 (49)		23 (17)	115 (83)	
Occupational group			0.005			<0.001
Upper white-collar	99 (37)	168 (63)		32 (11)	267 (89)	
Lower white-collar	260 (45)	319 (55)		85 (13)	576 (87)	
Blue-collar	57 (55)	46 (45)		33 (25)	97 (75)	
Smoking habit			0.005			0.477
Never smoker	218 (40)	328 (60)		79 (13)	544 (87)	
Ex-smoker	108 (45)	133 (55)		45 (16)	243 (84)	
Current smoker	79 (55)	65 (45)		22 (14)	133 (86)	
Atopic history			0.367			0.410
No	230 (45)	279 (55)		86 (15)	505 (85)	
Yes	186 (42)	254 (58)		64 (13)	435 (87)	
Number of co-morbid conditions			<0.001			<0.001
No co-morbidity	109 (29)	272 (71)		29 (7)	380 (93)	
One co-morbid condition	147 (46)	170 (54)		49 (13)	320 (87)	
Two or more co-morbid conditions	160 (64)	91 (36)		72 (23)	240 (77)	
Depression			<0.001			<0.001
0–7	321 (38)	520 (62)		108 (11)	833 (89)	
8–10	59 (87)	9 (13)		17 (21)	63 (79)	
11–21	32 (94)	2 (6)		20 (39)	31 (61)	

Table 2 continued

	Self-assessed work ability ^a		<i>p</i> value	Early withdrawal from work ^b		<i>p</i> value
	Poor (<i>n</i> = 416) <i>n</i> (%)	Good (<i>n</i> = 533) <i>n</i> (%)		Yes (<i>n</i> = 150) <i>n</i> (%)	No (<i>n</i> = 940) <i>n</i> (%)	
Somatization			<0.001			0.002
<1.5	57 (19)	239 (81)		27 (8)	299 (92)	
1.5–1.9	93 (44)	116 (56)		36 (15)	200 (85)	
>2.0	256 (62)	160 (38)		81 (17)	407 (83)	

WEA work-exacerbated asthma, OA occupational asthma

^a Altogether 149 individuals did not evaluate their work ability score^b Employment status was unknown for 8 individuals

disability. One study found a positive relation, while another study found no such relation (Detaille et al. 2009). In a study conducted among OA patients, the severity of asthma was not an important determinant of working status (Ameille et al. 1997). Therefore, the fact that we did not examine the effect of asthma severity may be a source of bias, but probably not a major one.

Those with multiple long-term indoor air symptoms considerably more often perceived their current work ability to be poor compared with those with less significant symptoms. In previous studies, long-lasting symptoms have been shown to be common in some individuals with earlier exposure to building dampness and mold (Al-Ahmad et al. 2010; Karvala et al. 2010), but the association with impaired work ability is a new finding. Multiple long-term symptoms were not found to be associated with early withdrawal from work, and this finding may reflect the heterogeneity of the groups. Along with leaving work, the symptoms become alleviated or not. The findings of Al-Ahmad et al. (2010) suggest that mold-exposed persons whose symptoms initially could be attributed to asthma or other allergic responses have long-term respiratory symptoms that cannot be explained on the basis of asthma and that overlap with sick building symptoms. In our study, the patients in both asthma groups had a non-specific symptom complex similar to that of the sick building syndrome, which was common to all of the groups at baseline (Karvala et al. 2010). It seems that asthma amplifies the effect of non-specific symptoms with respect to work limitation.

The findings that a perceived poor social climate at work and poor experiences with the supervisor's co-operation were associated with the outcomes are in accordance with the findings of previous studies showing a correlation between the psychosocial work environment and indoor air symptoms (Mendelson et al. 2000; Lahtinen et al. 2004; Runeson et al. 2006; Bakke et al. 2007). Low social support has been found to be associated with indoor air complaints and symptoms (Mendelson et al. 2000; Runeson et al.

2006). In a Finnish study, Lahtinen et al. (2002) found problems with co-operation for 71 % of the workplaces with moisture and mold damage, the employees being more unsatisfied with the co-operation than the superiors. The employees generally felt that the problems they experienced were being downplayed by the management, and they also felt mistrust toward the implemented measures (Lahtinen et al. 2002). As we had often heard these comments from our patients, we wanted to examine the effects of these factors on long-term work disability. It appears that those who perceive their psychosocial work environment more negatively are at an increased risk of long-term adverse work outcomes.

A recent paper argues that the sudden onset of OA in a previously healthy person may cause psychological impacts (Lavoie et al. 2009). The stressful nature of an OA diagnosis could be true, especially in our patients, who, according to our experiences, had serious health concerns. This finding may at least partly explain the worse outcomes in the OA group than in the WEA group. Of the psychological personal risk factors, neither depression nor somatization modified our results. Somatization has, in an earlier study, been shown to be associated with indoor air symptoms (Berglund and Gidlof Gunnarsson 2000). Some other factors, like negative affectivity (Gomzi et al. 2007) and low sense of coherence (Runeson et al. 2003), have also been shown to be associated, but the studies are sparse and work ability was not focused on.

The large study population belongs to strengths of the study. It includes a representative sample of patients with dampness-related asthma, as the majority of OA cases in the country were diagnosed at our clinic, with known expertise in occupational diseases. For the same reason, the reference group may have had a more severe condition than all symptomatic, exposed individuals in general, and this possibility may have diluted the effect. Consequently, some selection bias cannot be ruled out. The two outcomes we used supplement each other in that self-rated work

Table 3 Results of univariate and multivariate logistic models for the risks of poor self-assessed work ability and early withdrawal from work

	Poor self-assessed work ability				Early withdrawal from work			
	Univariate models		Adjusted for individual variables ^a , depression and somatization		Univariate models		Adjusted for individual variables ^a	
	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)
Asthma or symptom status at baseline								
Upper respiratory symptoms ^b	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Asthma-like symptoms	1.3 (0.9–1.9)	1.2 (0.8–1.7)	1.0 (0.6–1.5)	1.0	1.8 (1.0–3.5)	1.6 (0.8–3.1)	1.3 (0.7–2.6)	1.3 (0.7–2.6)
WEA	1.9 (1.3–2.8)	1.8 (1.2–2.8)	1.8 (1.1–3.0)	1.8 (1.1–3.0)	1.7 (0.9–3.3)	1.6 (0.8–3.1)	1.4 (0.7–2.7)	1.4 (0.7–2.7)
OA	2.5 (1.4–4.4)	2.6 (1.4–4.7)	2.5 (1.3–4.9)	2.5 (1.3–4.9)	6.4 (3.2–12.7)	5.7 (2.8–11.9)	4.6 (2.2–9.8)	4.6 (2.2–9.8)
Number of long-term, indoor air symptoms								
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1–3	2.8 (2.0–3.8)	2.7 (1.9–3.8)	2.0 (1.4–3.0)	2.0 (1.4–3.0)	1.6 (1.1–2.4)	1.2 (0.8–1.9)	1.0 (0.6–1.5)	1.0 (0.6–1.5)
4–5	4.4 (2.8–6.9)	4.4 (2.7–7.1)	2.7 (1.6–4.7)	2.7 (1.6–4.7)	1.2 (0.7–2.2)	0.9 (0.4–1.7)	0.6 (0.3–1.3)	0.6 (0.3–1.3)
>5	10.9 (6.6–18.2)	9.7 (5.7–16.5)	6.1 (3.4–11.2)	6.1 (3.4–11.2)	1.5 (0.9–2.7)	1.1 (0.6–2.0)	0.6 (0.3–1.3)	0.6 (0.3–1.3)
Social climate at work								
Good	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Moderate	1.1 (0.8–1.5)	1.1 (0.7–1.6)	0.9 (0.6–1.4)	0.9 (0.6–1.4)	1.4 (0.8–2.4)	1.4 (0.8–2.4)	1.3 (0.7–2.4)	1.3 (0.7–2.4)
Poor	1.6 (1.2–2.3)	1.5 (1.1–2.2)	1.2 (0.8–1.8)	1.2 (0.8–1.8)	2.4 (1.5–3.9)	2.3 (1.4–3.8)	2.1 (1.2–3.6)	2.1 (1.2–3.6)
Experiences with supervisor's co-operation								
Good	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Moderate	1.5 (1.1–2.1)	1.5 (1.0–2.1)	1.3 (0.9–1.9)	1.3 (0.9–1.9)	1.1 (0.7–1.9)	1.1 (0.7–2.0)	1.3 (0.7–2.2)	1.3 (0.7–2.2)
Poor	1.9 (1.4–2.6)	1.7 (1.2–2.5)	1.4 (0.9–2.1)	1.4 (0.9–2.1)	2.7 (1.7–4.2)	2.4 (1.5–4.0)	2.5 (1.5–4.1)	2.5 (1.5–4.1)
WEA work-exacerbated asthma, OA occupational asthma								

^a Individual variables included age, gender, occupational group, smoking, atopic history, and co-morbidity^b Neither asthma nor asthma-like symptoms, but upper respiratory symptoms in the initial examinations

ability is a good predictor of disability and the second outcome, early withdrawal from work, is a more objective measure of disability, even though dependent on the social context. Health and work are the most important determinants of work ability among people of all ages (Gould et al. 2008), though various factors, involving factors outside the workplace, may contribute to impaired work ability. We were able to adjust for most of the factors that, based on the literature and prior knowledge, are related to indoor air symptoms (Norbäck 2009) or work disability among asthmatics, like gender and occupation type (blue-collar versus white-collar) (Detaille et al. 2009). Hence, we think the observed associations are unlikely due to confounding by unmeasured factors of major importance.

A limitation of our study was its cross-sectional study design. The assessments of social climate at work were measured at the same time as the outcomes; therefore, temporal order could not be demonstrated. If a person attributes disability to workplace conditions, he or she may be more inclined to criticize factors at work. Another limitation was the questionnaire study design; thus, the variables are based on subjective assessments. With respect to the small difference in the proportion of OA patients between the participants and non-participants, we do not believe that it is a serious source of bias. The response rate, 61.3 %, for the questionnaire can be regarded as satisfactory when the long follow-up time is considered.

This follow-up study on the patient material of an occupational clinic introduces long-term adverse work outcomes in patients with asthma related to workplace dampness and mold. Our results also indicated that persons who evaluated their social work environment more negatively had a slightly increased risk of impaired work ability and early withdrawal from work. This finding is in accordance with the widely recognized fact that causes of disability are multifactorial and not associated with medical conditions alone. Research for the causes of disability and the effectiveness of preventive measures (e.g., building repairs or relocation of workers) must continue. It should permit us to better understand and treat these conditions. The study raises the need for effective disability prevention and return-to-work strategies, in order to help workers with indoor air symptoms to sustain their work ability. According to our findings, special attention should be paid to individuals who have developed asthma in a moisture damaged workplace.

Acknowledgments We thank all of the study participants and the staff of the Finnish Institute of Occupational Health. The study was supported by the Finnish Work Environment Fund.

Conflict of interest The authors declare that they have no conflict of interest.

References

- Al-Ahmad M, Manno M, Ng V, Ribeiro M, Liss GM, Tarlo SM (2010) Symptoms after mould exposure including *Stachybotrys chartarum*, and comparison with darkroom disease. *Allergy* 65:245–255. doi:[10.1111/j.1398-9995.2009.02157.x](https://doi.org/10.1111/j.1398-9995.2009.02157.x)
- Ameille J, Pairon JC, Bayeux MC, Brochard P, Choudat D, Conso F et al (1997) Consequences of occupational asthma on employment and financial status: a follow-up study. *Eur Respir J* 10:55–58. doi:[10.1183/09031936.97.10010055](https://doi.org/10.1183/09031936.97.10010055)
- Bakke JV, Moen BE, Wieslander G, Norback D (2007) Gender and the physical and psychosocial work environments are related to indoor air symptoms. *J Occup Environ Med* 49:641–650. doi:[10.1097/JOM.0b013e31806e5fa0](https://doi.org/10.1097/JOM.0b013e31806e5fa0)
- Berglund B, Gidlof Gunnarsson A (2000) Relationships between occupant personality and the sick building syndrome explored. *Indoor Air* 10:152–169. doi:[10.1034/j.1600-0668.2000.010003152.x](https://doi.org/10.1034/j.1600-0668.2000.010003152.x)
- Derogatis LR, Lipman RS, Covi L (1973) SCL-90: an outpatient psychiatric rating scale—preliminary report. *Psychopharmacol Bull* 9:13–28
- Detaille SI, Heerkens YF, Engels JA, van der Gulden JW, van Dijk FJ (2009) Common prognostic factors of work disability among employees with a chronic somatic disease: a systematic review of cohort studies. *Scand J Work Environ Health* 35:261–281. doi:[10.5271/sjweh.1337](https://doi.org/10.5271/sjweh.1337)
- Edvardsson B, Stenberg B, Bergdahl J, Eriksson N, Linden G, Widman L (2008) Medical and social prognoses of non-specific building-related symptoms (Sick Building Syndrome): a follow-up study of patients previously referred to hospital. *Int Arch Occup Environ Health* 81:805–812. doi:[10.1007/s00420-007-0267-z](https://doi.org/10.1007/s00420-007-0267-z)
- Finnish Centre for Pensions and The Social Insurance Institution of Finland (2008) Statistical Yearbook of Pensioners in Finland 2007. Official Statistics of Finland, Helsinki. <http://www.etk.fi/en/service/home/770/publications>
- Gomzi M, Bobic J, Radosevic-Vidacek B, Macan J, Varnai VM, Milcovic-Kraus S et al (2007) Sick building syndrome: psychological, somatic, and environmental determinants. *Arch Environ Occup Health* 62:147–155. doi:[10.3200/AEOH.62.3.147-155](https://doi.org/10.3200/AEOH.62.3.147-155)
- Gould R, Ilmarinen J, Järvisalo J, Koskinen S (2008) Dimensions of work ability. Results of the Health 2000 Survey. Finnish Centre for Pensions, Helsinki. <http://www.etk.fi/en/service/home/770/publications>
- Haverinen-Shaughnessy U, Hyvärinen A, Putus T, Nevalainen A (2008) Monitoring success of remediation: seven case studies of moisture and mold damaged buildings. *Sci Total Environ* 399:19–27. doi:[10.1016/j.scitotenv.2008.03.033](https://doi.org/10.1016/j.scitotenv.2008.03.033)
- Henneberger PK, Redlich CA, Callahan DB, Harber P, Lemiere C, Martin J et al (2011) An official American thoracic society statement: work-exacerbated asthma. *Am J Respir Crit Care Med* 184:368–378. doi:[10.1164/rccm.812011ST](https://doi.org/10.1164/rccm.812011ST)
- Hodgson M (2002) Indoor environmental exposures and symptoms. *Environ Health Perspect* 110(Suppl 4):663–667. doi:[10.1289/ehp.02110s4663](https://doi.org/10.1289/ehp.02110s4663)
- Ilmarinen J, Tuomi K (2004) Past, present and future of work ability. *People Work Res Rep* 65:1–25
- Iossifova YY, Cox-Ganser JM, Park JH, White SK, Kreiss K (2011) Lack of respiratory improvement following remediation of a water-damaged office building. *Am J Ind Med* 54:269–277. doi:[10.1002/ajim.20910](https://doi.org/10.1002/ajim.20910)
- Jarvis JQ, Morey PR (2001) Allergic respiratory disease and fungal remediation in a building in a subtropical climate. *Appl Occup Environ Hyg* 16:380–388. doi:[10.1080/10473220117482](https://doi.org/10.1080/10473220117482)

- Karvala K, Toskala E, Luukkonen R, Lappalainen S, Uitti J, Nordman H (2010) New-onset adult asthma in relation to damp and moldy workplaces. *Int Arch Occup Environ Health* 83:855–865. doi: [10.1007/s00420-010-0507-5](https://doi.org/10.1007/s00420-010-0507-5)
- Karvala K, Uitti J, Luukkonen R, Nordman H (2012) Quality of life of patients with asthma related to damp and moldy work environments. *Scand J Work Environ Health* Published Online First: 11 Mar 2012. doi: [10.5271/sjweh.3289](https://doi.org/10.5271/sjweh.3289)
- Lahtinen M, Huuhtanen P, Kahkonen E, Reijula K (2002) Psychosocial dimensions of solving an indoor air problem. *Indoor Air* 12:33–46. doi: [10.1034/j.1600-0668.2002.120105.x](https://doi.org/10.1034/j.1600-0668.2002.120105.x)
- Lahtinen M, Sundman-Digert C, Reijula K (2004) Psychosocial work environment and indoor air problems: a questionnaire as a means of problem diagnosis. *Occup Environ Med* 61:143–149. doi: [10.1136/oem.2002.005835](https://doi.org/10.1136/oem.2002.005835)
- Larbenois A, Jamart J, Delwiche JP, Vandenplas O (2002) Socio-economic outcome of subjects experiencing asthma symptoms at work. *Eur Respir J* 19:1107–1113. doi: [10.1183/09031936.02.00272202a](https://doi.org/10.1183/09031936.02.00272202a)
- Lavoie KL, Joseph M, Bacon SL (2009) Psychological distress and occupational asthma. *Curr Opin Allergy Clin Immunol* 9:103–109. doi: [10.1097/ACI.0b013e32832498c1](https://doi.org/10.1097/ACI.0b013e32832498c1)
- Lindström K, Elo A-L, Skogstad A, Dallner M, Gamberale F, Hottinen V et al (2000) User's Guide for the QPSNordic: General Nordic Questionnaire for Psychological and Social Factors at Work. Nordic Council of Ministers, Copenhagen
- Lund T, Kivimäki M, Labriola M, Villadsen E, Christensen KB (2008) Using administrative sickness absence data as a marker of future disability pension: the prospective DREAM study of Danish private sector employees. *Occup Environ Med* 65:28–31. doi: [10.1136/oem.2006.031393](https://doi.org/10.1136/oem.2006.031393)
- Mendell MJ, Mirer AG, Cheung K, Tong M, Douwes J (2011) Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. *Environ Health Perspect* 119:748–756. doi: [10.1289/ehp.1002410](https://doi.org/10.1289/ehp.1002410)
- Mendelson M, Catano V, Kelloway K (2000) The role of stress and social support in Sick Building Syndrome. *Work Stress* 14:137–155. doi: [10.1080/026783700750051658](https://doi.org/10.1080/026783700750051658)
- Norbäck D (2009) An update on sick building syndrome. *Curr Opin Allergy Clin Immunol* 9:55–59. doi: [10.1097/ACI.0b013e32831f8f08](https://doi.org/10.1097/ACI.0b013e32831f8f08)
- Patovirta RL, Husman T, Haverinen U, Vahteristo M, Uitti JA, Tukiainen H et al (2004) The remediation of mold damaged school—a three-year follow-up study on teachers' health. *Cent Eur J Public Health* 12:36–42
- Piipari R, Keskinen H (2005) Agents causing occupational asthma in Finland in 1986–2002: cow epithelium bypassed by moulds from moisture-damaged buildings. *Clin Exp Allergy* 35:1632–1637. doi: [10.1111/j.1365-2222.2005.02386.x](https://doi.org/10.1111/j.1365-2222.2005.02386.x)
- Riihimäki H, Kurppa K, Karjalainen A, Palo L, Jolanki R, Keskinen H et al (2004) Occupational diseases in Finland in 2002. Finnish Institute of Occupational Health, Helsinki
- Runeson R, Norback D, Stattin H (2003) Symptoms and sense of coherence—a follow-up study of personnel from workplace buildings with indoor air problems. *Int Arch Occup Environ Health* 76:29–38. doi: [10.1007/s00420-002-0372-y](https://doi.org/10.1007/s00420-002-0372-y)
- Runeson R, Wahlstedt K, Wieslander G, Norback D (2006) Personal and psychosocial factors and symptoms compatible with sick building syndrome in the Swedish workforce. *Indoor Air* 16:445–453. doi: [10.1111/j.1600-0668.2006.00438.x](https://doi.org/10.1111/j.1600-0668.2006.00438.x)
- Thaon I, Wild P, Mouchot L, Monfort C, Touranchet A, Kreutz G et al (2008) Long-term occupational consequences of asthma in a large French cohort of male workers followed up for 5 years. *Am J Ind Med* 51:317–323. doi: [10.1002/ajim.20570](https://doi.org/10.1002/ajim.20570)
- Toren K, Zock JP, Kogevinas M, Plana E, Sunyer J, Radon K et al (2009) An international prospective general population-based study of respiratory work disability. *Thorax* 64:339–344. doi: [10.1136/thx.2008.105007](https://doi.org/10.1136/thx.2008.105007)
- Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Tulkki A (1998) Work ability index. Finnish Institute of Occupational Health, Helsinki
- van den Berg TI, Elders LA, de Zwart BC, Burdorf A (2009) The effects of work-related and individual factors on the Work Ability Index: a systematic review. *Occup Environ Med* 66:211–220. doi: [10.1136/oem.2008.039883](https://doi.org/10.1136/oem.2008.039883)
- Vandenplas O, Toren K, Blanc PD (2003) Health and socioeconomic impact of work-related asthma. *Eur Respir J* 22:689–697. doi: [10.1183/09031936.03.00053203](https://doi.org/10.1183/09031936.03.00053203)
- Vandenplas O, Dressel H, Wilken D, Jamart J, Heederik D, Maestrelli P et al (2011) Management of occupational asthma: cessation or reduction of exposure? A systematic review of available evidence. *Eur Respir J* 38:804–811. doi: [10.1183/09031936.00177510](https://doi.org/10.1183/09031936.00177510)
- Wallman T, Wedel H, Palmer E, Rosengren A, Johansson S, Eriksson H et al (2009) Sick-leave track record and other potential predictors of a disability pension. A population based study of 8,218 men and women followed for 16 years. *BMC Public Health* 9:104. doi: [10.1186/1471-2458-9-104](https://doi.org/10.1186/1471-2458-9-104)
- Walsh FW, Solomon DA (1994) Disability evaluation in building-related health problems. *J Allergy Clin Immunol* 94:376–379. doi: [10.1053/ai.1994.v94.a56019](https://doi.org/10.1053/ai.1994.v94.a56019)
- WHO (2009) WHO guidelines for indoor air quality: dampness and mould. WHO Regional Office for Europe, Copenhagen. <http://www.euro.who.int/document/E92645.pdf>
- Zigmond AS, Snaith RP (1983) The hospital anxiety and depression scale. *Acta Psychiatr Scand* 67:361–370