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SHORT REPORT

Work-related peak flow and asthma symptoms in a damp building

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Background	Working in damp conditions is associated with asthma, but few studies have used objective testing to document work-related patterns.
Aims	To describe the relationship of peak flow measurements to work-related asthma (WRA) symptoms and WRA among occupants in a damp office building.
Methods	At the beginning of the study, all workers were offered a questionnaire and methacholine challenge testing. Participants were then instructed to perform serial spirometry using handheld spirometers five times per day over a 3 week period. Peak flow data were analysed using OASYS-2 software. We calculated the area between the curves (ABC score) using hours from waking. We considered a score >5.6 L/min/h to be indicative of a work-related pattern.
Results	All 24 employees participated in the questionnaire. Seven participants (29%) reported physician-diagnosed asthma with onset after starting work in the building. Almost two-thirds (63%) of participants reported at least one lower respiratory symptom (LRS) occurring one or more times per week in the last 4 weeks. Twenty-two (92%) consented to participate in serial spirometry. Fourteen participants had adequate quality of serial spirometry, five of whom had ABC scores >5.6, ranging from 5.9–23.0. Of these five, two had airways responsiveness, three had current post-hire onset physician-diagnosed asthma and four reported work-related LRS.
Conclusions	We found evidence of work-related changes in serial peak flows among some occupants of an office building with a history of dampness. Serial peak flows may be a useful measure to determine WRA in office settings.

Key words	Asthma; dampness; lower respiratory symptoms; OASYS; serial spirometry.

Introduction

In 2009, the World Health Organization concluded there is sufficient evidence of an association between asthma onset, asthma exacerbation and asthma-like symptoms with exposure to damp indoor spaces [1]. Few studies of health effects in damp indoor environments have used objective testing to document work-related patterns of respiratory health effects. In this report we describe the use of serial peak flows as part of an investigation of employee health concerns in an office building with reports of water leaks, mould growth on carpet and wallboard, musty odours, inadequate ventilation and work-related symptoms.

Methods

A computer-based interview was conducted, which included questions on health-related conditions, demographics, smoking and work history. We compared current asthma prevalence with national data, adjusting for age, race, gender and smoking status [2]. To indicate bronchial hyper-reactivity (BHR), we measured the provocative concentration of methacholine resulting in a 20% fall in forced expiratory volume in 1 s (PC_{20}). We considered a response <4.0 mg/ml as BHR and between 4.0 and 16.0 as borderline BHR [3]. We also obtained information on current medications. The National Institute for Occupational Safety and Health (NIOSH)

Institutional Review Board approved the study, and all study participants provided written informed consent.

We offered serial spirometry with handheld spirometers (EasyOne™, Ndd Medical Technologies, Chelmsford, MA) to all occupants for a 3-week period. Participants were instructed on proper technique and asked to perform five recordings throughout the day, beginning upon wakening, with at least three blows per recording. The highest peak flow value was used for analysis. At each session, participants made entries into the spirometer that included time of day, location, symptoms, last medication and tobacco use and any odours or exposures.

Serial peak flow data were analysed using OASYS-2 software (OASYS Research Group, Birmingham, UK) [4,5] to identify work-related asthma (WRA). WRA includes both occupational asthma and work-aggravated asthma. We calculated the area between the curves for peak flow values at work and away from work, divided by the total hours from waking (ABC score). The ABC score is sensitive and specific in the diagnosis of occupational asthma and requires fewer days of testing than the work-effect index score. We took scores >5.6 L/min/h as indicative of a work-related pattern [6]. We required participants to complete a minimum of 10 work days and three rest days with an average of at least 3.5 recordings per day. This gave a sensitivity and specificity of at least 69 and 72%, respectively [Personal e-mail communication, VC Moore, 25 October 2011].

Results

Eight participants (33%) reported physician-diagnosed asthma, six (25%) with current asthma, which was 4.6-fold higher than national rates (95% confidence interval: 2–10). Seven (29%) participants reported an asthma diagnosis after starting work in the building. Almost two-thirds (15, 63%) reported at least one lower respiratory symptom (LRS) occurring at least once a week in the last 4 weeks: wheezing, chest tightness, coughing, shortness of breath or being awakened by difficulty breathing. Over 40% (10) reported one or more LRS that improved away from work. Two-thirds (16/24) reported at least one of the following symptoms occurring at least once a week in the last 4 weeks: fever/chills, flu-like achiness and excessive fatigue.

The majority of employees (22/24, 92%) consented to participate in serial spirometry. Eight employees were excluded due to insufficient peak flow data.

Among the 14 participants with sufficient data, five (36%) had ABC scores above the threshold indicating a work-related pattern (5.6 L/min/h) (Table 1). All five had LRS in the past 4 weeks, with four reporting a work-related pattern. Three of the five had a current post-hire onset asthma diagnosis, and four were on asthma medications. Two showed evidence of BHR. The person with the highest ABC score did not report a diagnosis of asthma, but the presence of work-related LRS and borderline BHR, along with the high ABC score, strongly suggests WRA (Figure 1).

For the nine remaining participants with ABC scores below the work-related threshold, six (67%) reported LRS in the past 4 weeks, four of which were work related. One reported current asthma and two had a past diagnosis of asthma. Only one had borderline BHR.

Discussion

Our study found evidence of work-related peak flow patterns occurring among occupants of an office building

Table 1. Reported symptoms, asthma diagnosis, medication use, airways hyper-reactivity and serial spirometry patterns of participants with adequate peak flow data quality

Subject	Asthma diagnosis	Current asthma medication use	LRS present in last 4 weeks	Work-related LRS present in last 4 weeks	Methacholine challenge PC_{20}	ABC score using wake time
1	No	No	Yes	Yes	5.3	**23.0**
2	No	Yes	Yes	Yes	33.0	**10.8**
3	Current[a]	Yes	Yes	Yes	1.2	**8.1**
4	Current[a]	Yes	Yes	No	33.0	**7.5**
5	Current[a]	Yes	Yes	Yes	33.0	**5.9**
6	No	No	No	No	33.0	1.5
7	Past[a]	Yes	Yes	Yes	17.0	1.0
8	No	Yes	Yes	Yes	33.0	−4.6
9	Past[a]	No	Yes	Yes	33.0	−1.9
10	No	No	Yes	Yes	33.0	−2.3
11	No	No	No	No	33.0	−2.4
12	No	No	Yes	No	33.0	−3.6
13	Current[a]	Yes	No	No	12.6	−19.4
14	No	No	Yes	No	33.0	−26.0

Bold indicates a possible work-related pattern.
[a]Reported diagnosis after building occupancy.

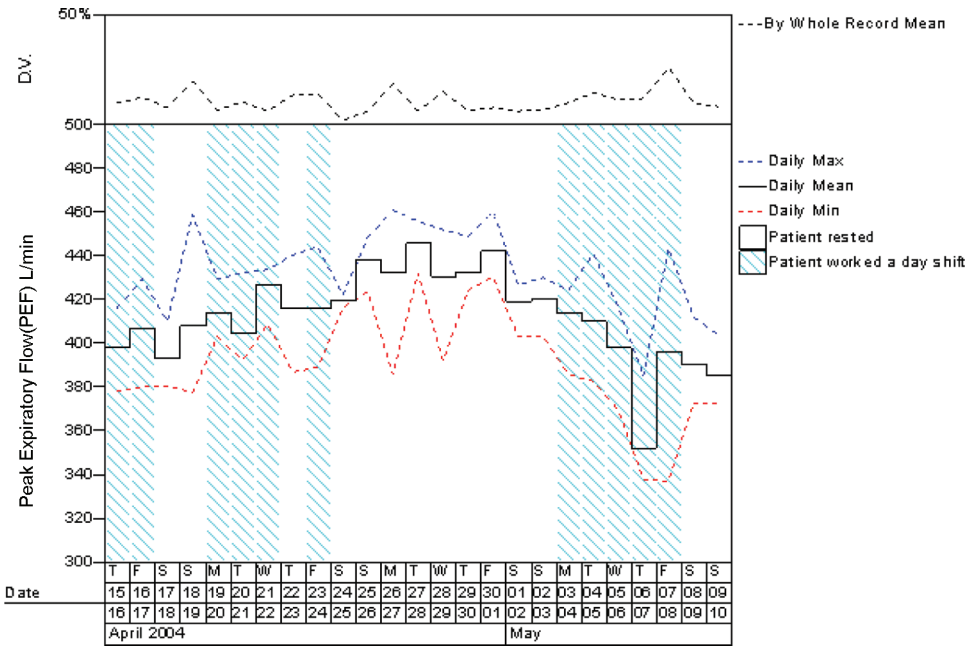

Figure 1. Maximum, mean and minimum peak expiratory flow measurements over a 3 week period in a participant with a high ABC score (ABC score = 23.0). The hatched areas represent work days and the other areas represent days away from the workplace. D.V. = diurnal variation.

with dampness. Environmental sampling found elevated CO_2 levels in the office area and the presence of mould [via tape-lift] and standing water in the basement (data not shown). To our knowledge, very few studies have used peak flow to document WRA in a damp office building. Five of the 11 (45%) participants reporting any LRS in the last 4 weeks had elevated ABC scores. These results are consistent with a study done on female domestic cleaners, where 30% that reported asthma or chronic bronchitis symptoms had WRA based on serial peak flow measurements [7]. In both studies, a number of participants with WRA did not have BHR, although Medina-Ramón *et al.* used a PC20 of <1 mg/ml to classify BHR. However, BHR has been found to be transient in patients and can return to normal after cessation of exposure [8].

It was difficult for participants to maintain compliance, even though a technician was stationed at the office building during the testing. Participants who had sufficient data quality but had fewer sessions or days of testing lowered the sensitivity and specificity of the study. Conversely, we may have failed to identify persons with work-related patterns due to insufficient data.

Although no participants reported a diagnosis of hypersensitivity pneumonitis (HP), the five with elevated ABC scores did report one or more HP-like symptoms (fever/chills, flu-like achiness, fatigue) in the last 4 weeks. Therefore, it is possible that HP was not being diagnosed in this workforce.

From this study, we were able to determine work-related peak flow patterns occurring among symptomatic occupants of a damp office building, even in the absence of BHR. Peak flows may be a useful measure to determine WRA in office settings if compliance can be maintained.

Key points

- This study documented objective evidence of work-related asthma in symptomatic employees in an office building with a history of water incursion.
- Work-related peak flow patterns can be detected among symptomatic workers, even in the absence of bronchial hyper-reactivity.
- Serial peak flow data can provide useful information in determining work-related asthma in office settings.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of NIOSH.

Mention of any company or product does not constitute endorsement by NIOSH.

Conflicts of interest

None declared.

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