

Indoor air problems among employees at a hotel in Copenhagen

Gitte J. Holst¹, Henrik Harboe² and Torben I. Sigsgaard^{1,*},

¹University of Aarhus, Department of Environmental and Occupational Health, Aarhus, Denmark.

² ALECTIA A/S, Virum, Denmark.

*Corresponding email: ts@mil.au.dk

SUMMARY

The aim of the study was to investigate indoor air related complaints and symptoms among the employees at a hotel in Copenhagen. A technical inspection of the office environment was performed and showed only minor problems with mould spore counts within normal range. Moreover a questionnaire covering complaints and symptoms was filled out (response rate 93%). An exceptional pattern was found with the bulk of indoor air related complaints among smokers and showed significantly more symptoms of itchy, irritated nose, irritation in the throat, and wheezing in smokers compared to non-smokers. When reporting these unexpected findings a hotel employee drew our attention to the hotel's smoking room, a shelter in the basement of the hotel building without ventilation. However, a lot of the hotel staff smoked down there so an ozone generator was installed in order to clean the air. After this meeting the smokers were asked to smoke outside and the problems disappeared.

IMPLICATIONS

This case report underpins the problem that sometimes the solution of one environmental problem creates a new problem for others. In this case the smokers were cramped into an un-vented room creating a very polluted environment. Secondly the study underpins that the use of ozone generators is increasing the irritative potential effect of ETS-particles.

KEY WORDS

Environmental tobacco smoke; interaction smoke and ozone; hotels.

INTRODUCTION

Environmental tobacco smoke (ETS) is recognized by scientific evidence as a major public health concern worldwide causing disease, disability and death (WHO, 2005; WHO, 2006). ETS is exhaled by smokers and is emitted from the burning end of tobacco products and contains at least 250 chemicals known to be toxic or carcinogenic (California Environmental Protection Agency, 2005). To avoid the adverse health effects of ETS an increasing number of countries have passed legislation mandating smoke-free environments in workplaces in many European Union countries, Australia, New Zealand and some of the United States. Despite the legislation workers worldwide are still exposed to ETS while at work (WHO, 2010). Occupational exposure to ETS is found to be high in the hospitality sector compared to other occupational groups (Howard 2004). In a Chinese study 49% of 739 hotel workers reported exposure to SHS compared to 0.5% of 206 kindergarten workers (Zheng et al. 2010). Moreover, the hotel workers reported on more respiratory symptoms such as shortness of breath, frequent cough, phlegm, sore eyes, runny nose, and sore throat compared to kindergarten workers (OR 5.6, 4.7, 1.7, 2.4, 2.0, 2.0, respectively) (Zheng et al. 2010). An American study of fine particulate matter (pm) in casino restaurants found high levels of pm_{2.5} despite implementation of the Nevada's Clean Indoor Air Act (York and Lee 2010). In contrast, in Scotland a study found a marked reduction in pm by 86% in 41 Scottish pubs in relation to the

implementation of the smoke-free legislation (Semple et al. 2007). Similarly, in a study of the impact of the Irish smoking ban on ETS exposure in 15 hotels it was found that passive smoking and associated risks were significantly reduced from a median of 30 hours a week to zero (<0.001), air nicotine concentrations were reduced by 80% and saliva cotinine concentrations were reduced by 70%. However, exposure to ETS was not totally eliminated due to smoke migrating from smoking areas to smoke-free areas (Mulcahy et al. 2005). A Japanese study has questioned the use of ozone deodorization to remove tobacco and body odor in hotel rooms. The study found the levels of ozone in a hotel room during and after ozone generation to be 21 times higher than the Occupational Exposure Limit recommended by the Japan Society of Occupational Health (Tashiro et al. 2004).

The present study was initiated due to health complaints among personnel working in the office area of a new hotel. The problems had been mucosal irritation and sinusitis among a part of the staff since the building was inaugurated. The aim of the study was to investigate indoor air related complaints and symptoms among the employees at a hotel in Copenhagen.

METHODS

Procedures and participants

In 2002 a consultancy on occupational health in Denmark was contacted by the management of a hotel in Copenhagen because of suspicion of a mould problem in the hotel building. In July 2002 the Occupational Health Service visited the office area of the hotel. An inspection of the buildings, the ventilation equipment, the office environment, and monitoring of temperature and mould growth in the office were performed, showing only minor problems with mould spore counts within normal range. Moreover a questionnaire was distributed and returned by 25 office employees (response rate 93%).

Technical measurements

A site visit was arranged, and temperature was logged for a period of 7 days including a weekend in the Eastern and Western part of the office using Testostor 175, Testo Germany.

Questionnaire

The hotel office employees provided information on demographics, working environment complaints and indoor air related symptoms by self-administered questionnaires. The respondents were asked if they had been bothered by working environment conditions during the last 4 weeks. Complaints included: draught, cold floors, varying temperatures, too low or too high temperatures, bad odor, unpleasant odor, static electricity, dry air, environmental tobacco smoke, dust or dirt, noise in the office, noise from other rooms, outside noise, poor lightning, disturbing light reflections, and cramped conditions. Moreover the hotel workers were asked if they had had any indoor air related symptoms during the last 4 weeks. The symptoms included: itchy, dry or irritated eyes or nose, stuffy or running nose, wounds or crusts in the nose, dry or irritated throat, hoarseness, cough, wheeze, breathing difficulties, dry skin on hands and forearms, dry skin on legs or feet, skin rash, rash, dry or red skin in the face, fatigue, headache, difficulty concentrating, and dizziness.

Statistical analysis

All calculations were done using SPSS version 10. The data are presented as discrete numbers (n) and percents (%). Differences in categorical variables were tested using χ^2 -test or Fischers exact test. The probability value for evaluating statistical significance was $p \leq 0.05$.

RESULTS

Participants

Table 1 shows the demographics of the hotel workers. The proportion of men and women were roughly 50%. Among employees 24% had been employed one year or less and 36% were smokers. When using self-reported allergy asthma and hay-fever as the basis for diagnosing atopy 10 persons (40%) were atopic.

Table 1. Demographics of the hotel workers.

	Male N = 11	Female N = 14	P
Age (Years), median (Range)	27 (17)	28 (21)	[§] > 0.05
Smokers, N (%)	4 (36)	5 (36)	ⁿ > 0.05
Atopics, N (%)	5 (46)	5 (36)	ⁿ > 0.05

[§]; χ^2 ⁿ; Fishers exact test

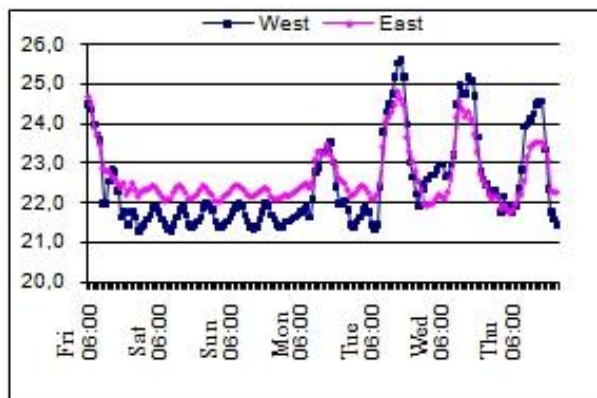


Figure 1. Log of the temperature at two positions in the hotel office during 7 days.

Complaints and symptoms

Table 2 shows the complaints of the hotel workers. Significantly more women complained about noise in the office compared to men. Smokers complained in particular more about varying temperatures, too low or too high temperatures, bad odor, dry air, and dust and dirt compared to non-smokers (figure 1). According to tenure and work place no differences were found between a long and short tenure and working on 1st floor, 2nd floor or other place.

Table 2. Prevalence of indoor environment complaints of the hotel workers.

	Gender		P [§]	Smoking status			P [§]	Workplace (floor)			P [§]	Atopic status		
	Male	Female		Smoker	Non-smoker			1st	2nd	Other		Atopy	No atopy	
	%	%	%	%	%	%	%	%	%	%	%	%	P [§]	
Draught	18	15	> 0.05	19	12	> 0.05	13	0	25	> 0.05	11	20	> 0.05	
Cold floors	0	14	> 0.05	13	0	> 0.05	25	0	0	> 0.05	0	13	> 0.05	
Varying temperatures	55	50	> 0.05	50	56	> 0.05	50	60	50	> 0.05	47	60	> 0.05	
Too low temperatures	36	21	> 0.05	25	33	> 0.05	13	20	42	> 0.05	26	30	> 0.05	
Too high temperatures	55	64	> 0.05	56	67	> 0.05	63	60	58	> 0.05	60	60	> 0.05	
Bad odor	55	64	> 0.05	56	67	> 0.05	63	60	58	> 0.05	60	60	> 0.05	
Unpleasant odor	18	7	> 0.05	12	11	> 0.05	13	0	17	> 0.05	20	0	> 0.05	
Static electricity	9	21	> 0.05	19	11	> 0.05	25	0	17	> 0.05	20	10	> 0.05	
Dry air	46	71	> 0.05	50	78	> 0.05	63	80	50	> 0.05	60	60	> 0.05	
Environmental tobacco smoke	27	7	> 0.05	18	11	> 0.05	13	20	17	> 0.05	13	20	> 0.05	
Dust or dirt	18	43	> 0.05	38	22	> 0.05	38	40	25	> 0.05	20	40	> 0.05	
Noise in the office	0	43	< 0.05	19	33	> 0.05	38	40	8	> 0.05	20	27	> 0.05	
Noise from other rooms	0	0	> 0.05	0	0	> 0.05	0	0	0	> 0.05	10	15	> 0.05	
Outside noise	0	7	> 0.05	6	0	> 0.05	0	0	8	> 0.05	1	0	> 0.05	
Poor lightning	18	21	> 0.05	19	22	> 0.05	25	20	17	> 0.05	20	20	> 0.05	
Disturbing light reflections	9	14	> 0.05	13	11	> 0.05	13	0	17	> 0.05	20	7	> 0.05	
Cramped condition	9	21	> 0.05	13	22	> 0.05	13	40	8	> 0.05	10	20	> 0.05	

[§] Fischers exact test

Table 3 shows the prevalence of symptoms of the hotel workers. No significant difference in the reporting of symptoms between genders was found. A tendency towards more symptoms among newly employed people was found. However, this was only significant for breathing difficulties. In relation to work place the highest proportion of mucosal symptoms was seen among people with job tasks outside the office area. Among people working on the 1st floor the only significant difference was found for dry and red skin in the face. Smoking was significantly associated to a range of symptoms including itchy irritated nose, irritated throat and wheezing compared to nonsmokers (figure 2). Atopic people had significantly more skin symptoms compared to non-atopic people.

Table 3. Prevalence of symptoms of the hotels workers.

	Gender			Smoking status			Workplace (floor)				Atopic status		
	Male	Female	P [§]	Smoker	Non-smoker	P [§]	1st	2nd	Other	P [§]	Atopy	No atopy	P [§]
	%	%		%	%		%	%	%		%	%	
Itchy, dry and irritated eyes	36	29	>0.05	44	25	>0.05	25	0	50	>0.05	40	27	>0.05
Itchy, dry and irritated nose	36	36	>0.05	69	19	<0.05	38	0	50	>0.05	50	27	>0.05
Stuffy or running nose	36	43	>0.05	56	31	<0.05	38	20	50	>0.05	40	40	>0.05
Wounds or crusts in the nose	27	15	>0.05	25	19	>0.05	14	0	33	>0.05	30	14	>0.05
Dry or irritated throat	9	36	>0.05	56	6	<0.05	25	20	25	>0.05	30	20	>0.05
Hoarseness	9	0	>0.05	0	6	>0.05	0	0	8	>0.05	0	7	>0.05
Cough	18	0	>0.05	56	25	>0.05	38	40	33	>0.05	40	33	>0.05
Wheeze	0	14	>0.05	56	6	>0.05	14	0	33	>0.05	30	20	>0.05
Breathing difficulties	0	8	>0.05	25	19	>0.05	29	20	17	>0.05	10	29	>0.05
Dry skin on hands or forearms	27	31	>0.05	63	13	<0.05	29	40	25	>0.05	60	7	>0.05
Dry skin on legs or feet	9	36	>0.05	44	13	>0.05	25	20	25	>0.05	50	7	>0.05
Skin rash	0	21	>0.05	11	13	>0.05	13	0	17	>0.05	30	0	>0.05
Nettle rash	0	7	>0.05	11	0	>0.05	0	0	8	>0.05	10	0	>0.05
Dry or red skin in the face	9	33	>0.05	11	29	>0.05	57	0	9	<0.05	20	23	<0.05
Fatigue	36	29	>0.05	33	31	>0.05	38	40	25	>0.05	30	33	>0.05
Headache	36	43	>0.05	67	25	>0.05	50	40	33	>0.05	40	40	>0.05
Difficulty concentrating	9	0	>0.05	0	6	>0.05	0	0	8	>0.05	0	7	>0.05
Dizziness	18	7	>0.05	11	13	>0.05	0	20	17	>0.05	10	13	>0.05

[§] Fischers exact test

Temperature

The temperature log showed that there was a rapidly incline in temperature of 2-5 centigrades during the normal working hours.

Reporting of findings

We went to the hotel and reported our findings at a meeting with all office staff. We explained that the temperature regulation of the office space could be improved, and that contrary to our experience, we found the smokers to be the group with all the problems. During the subsequent discussion someone asked us if we had seen the “smoking room”. Since the Hotel had become smoke-free this room had been retro-fitted as a smoking room, with PC’s and arm-chairs. All the smokers from the hotel-staff a lot of people smoked down there and eventually an ozone generator was put into work in this room “in order to clean the air”. However, no ventilation was installed in the smoking room and within the short operation time the room had had to be repainted twice. During the inspection we found a room extremely contaminated with tobacco smoke during the visit. After the meeting the hotel management closed down the smoking room facility. The smokers were asked to smoke outside, the ventilation and the temperature control of the office space was improved, and the problems disappeared.

DISCUSSION

The evident negative health effect of tobacco smoke has led to legislations of indoor smoke-free environments in many public places including bars, restaurants and Hotels. As a result several studies have shown a significant reduction in ETS levels and improvement of the indoor air quality. A Scottish study of bar workers' exposure to ETS found a reduction in non-smokers cotinine levels of 89% [CI 95% 85-92%] and 12% [CI 95% 3-20%] in smokers (Semple et al. 2007). Similar to this finding another study assessed the air quality in 128 Irish pubs in 15 countries and found that the overall air pollution inside the smoke-free Irish pubs was 93% lower than the level found in pubs where smoking was permitted (Connolly et al. 2009).

The hotel management of a hotel in Copenhagen initiated a smoke free environment as soon as in 2001 the management accommodated the employees smoking needs by establishing a smoking room in a shelter in the basement of the hotel building. As a result the smoking room was well used by all the smoking hotel staff including service employees as well as office employees. The smoking room contained up to 15 people at the time and no ventilation was installed so in order to fresh up the air an ozone generator was installed. Our questionnaire survey a year later revealed an exceptional pattern with the bulk of problems among smokers. Smokers reported more indoor air complaints and more symptoms in almost all categories compared to non-smokers. When we tried to look for other risk parameters like sex, atopy, tenure or work-place we did not find a relation to the complaints.

For the purpose of reducing indoor pollutants including tobacco smoke generation of ozone has been used. A study of the effect of ozone on a subset of volatile organic compounds (VOC) found in tobacco smoke showed that at moderate ozone concentrations (<0.115 ppm) there was little effect on the monitored VOC's but at high ozone concentrations (<1.4 ppm) there was an unexpected reduction in some VOC's (Shaughnessy, 2001). An American study comparing smokers and non-smoker found smaller decrements in lung function and fewer symptoms after ozone exposure among smokers. However, this study did not take account for the interaction between ozone and other indoor air pollutants, since the exposure was administered as ozone to inhaled air, and not to the ambient air (Frampton, 1997). A Danish study found an interaction of dust and ozone, showing a larger effect of simultaneous exposure to ozone and dust on the release of cytokines and changes of the respiratory function compared to the effect of these two pollutants individually (Molhave et al. 2005).

The current case clearly shows that the creation of a smoking room without ventilation and retrofitting the ozone generator is a hazardous cocktail leading to inflammation in the airways of smokers on top of what they already experience due to their smoke exposure. Unfortunately we have no measurements of the contamination of the room as it was experienced by the employees, because the room was abandoned within a few days after our meeting, and when we came back for a control only one month later the room had been painted and turned into a storage room, while the smokers now had to go outdoors in order to smoke during work hours.

CONCLUSION

The conclusion is to keep your mind open towards unexpected solutions to environmental problems. This problem only arised because of the smoke-free hotel trying to accommodate the smokers in a fashion never envisioned by the people building the hotel. This created a very bad indoor air quality in the smoking room. However, the smokers faithfully used this room every day and on top of this installed an ozone generator to improve the air. This might have removed some of the odor, however, at the same time created more aggressive particles

ready to be inhaled. So in order to avoid ETS related complaints and symptoms the solution must be to smoke outdoors only.

ACKNOWLEDGEMENT

This article was a part of the CISBO project and funded by REALDANIA.

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