Work related respiratory symptoms in radiographers

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Abstract

Objective—To determine the prevalence of work related symptoms among radiographers compared with a control group of physiotherapists.

Method—A postal questionnaire was used to collect information from radiographers and physiotherapists who registered in the United Kingdom during 1985–9.

Results—Satisfactory questionnaires were returned by 2354 (65%) of the radiographers and 3048 (69%) of the physiotherapists. There was a clear excess of work related symptoms among the radiographers. In particular, they were more likely to complain of symptoms that were worse at work, mouth soreness, sore, itchy, or runny eyes, persistent blocked nose, persistent itchy nose or sneezing, sore throat, headache, and of lower respiratory tract symptoms, which were also worse on workdays. These symptoms were associated particularly with the use of automatic processing machines. 235 radiographers gave a history of wheeze or chest tightness that had been worse at work or on days when at work.

Conclusion—Work related symptoms suggesting irritation of the eyes and upper airways were more common in radiographers than controls, and may be related to exposure to x ray film processing chemicals. Men and women who reported work related wheeze or chest tightness will be followed up in more detail to assess the prevalence of occupational asthma in the cohort.

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Reports published in the past 15 years have suggested that radiographers are at increased risk of various symptoms including headache, upper respiratory tract irritation, fatigue, eye soreness, arthralgia, dermatitis, dyspnoea, palpitations, and chest pain.^{1–4} These complaints have been attributed to a toxic effect of photographic chemicals. x Ray film processing involves exposure to a complex mixture of substances,³ some of which are known to have adverse health effects. In particular glutaraldehyde,^{5,6} formaldehyde,^{7,8} sulphur dioxide,⁹ and acetic acid¹⁰ have been associated with irritation of the eyes and upper airways. Also, glu-

taraldehyde and formaldehyde are known sensitising agents and both have given rise to cases of occupational asthma.^{11–13} Three cases of occupational asthma have been described in radiographers, including one caused by sensitisation to glutaraldehyde used as a hardening agent in developer, and another by fixative chemicals.¹⁴ The third was tentatively attributed to glutaraldehyde.¹⁵ Apart from these cases, however, the evidence for chemical toxicity is largely circumstantial. Moreover, the scale of the problem is unknown.

To find out more about the hazard and the extent of its impact, we have carried out a retrospective cohort study of radiographers who registered with the United Kingdom Council for Professions Supplementary to Medicine (CPSM) during 1985–9, and compared them with a control group of physiotherapists.

Method

From the records of the CPSM we identified all radiographers and physiotherapists who registered during 1985–9, who trained in the United Kingdom, and who were resident in the United Kingdom both at the time of registration and in 1992. For each subject we abstracted the name, date of birth, sex, date of registration, and most recent address. We then sent each person a postal questionnaire asking about occupational history, smoking, and a range of symptoms. These included upper and lower respiratory tract complaints, and also several symptoms such as dysuria and abdominal pain that had not previously been linked with work in radiography. Questions about respiratory symptoms were modified from a validated questionnaire which was designed for use in epidemiological studies on asthma. A positive report of two or more of a series of nine symptoms has 80% sensitivity (and 80% specificity) to detect asthma diagnosed by either self reported history of asthma or bronchial hyperresponsiveness to histamine.¹⁶ The reproducibility of these questions was high. Radiographers were asked about the frequency of specified activities—for example, loading film into an automatic processing machine, use of a table top processor, processing films by hand—in each of the jobs that they had held. These questions were developed specifically for this study and were designed to include work activities which were markers of high or low exposure to processing fumes. The questionnaire was piloted in radiographers employed by Southampton University Hospitals NHS Trust. Subjects had

no difficulty in understanding or answering any of the questions. The covering letter that accompanied the questionnaire presented the study as a survey of symptoms in various health professions, and did not indicate a specific focus on radiographers. Non-responders were sent a single reminder after four weeks.

In our analysis we compared the lifetime and one year period prevalences of symptoms in radiographers and physiotherapists. Prevalence ratios (PRs) and associated 95%

confidence intervals (95% CIs) were adjusted for potential confounders (age, sex, and smoking) by a modified form of Cox's proportional hazards regression analysis,¹⁷ in which follow up time was constant for all subjects.^{18 19}

Similar methods were used to explore the association of work related symptoms reported by radiographers with specific occupational activities. Also, the combined influence of different occupational activities was examined by forward, stepwise, Cox's regression.

Results

From the records of the CPSM we identified 3629 radiographers and 4440 physiotherapists who satisfied the criteria for entry to the study. Completed questionnaires were returned by 2354 (65%) of the radiographers and 3048 (69%) of the physiotherapists. The non-responders were of similar age to the responders, but included a higher proportion of men (22% *v* 13% in the radiographers and 16% *v* 8% in the physiotherapists). We excluded from further analysis 37 radiographers and 52 physiotherapists who were working abroad at the time of the survey although their registered address was in the United Kingdom; and 24 radiographers and 14 physiotherapists who had never worked in their respective professions after registration.

Table 1 shows the distribution of the 2293 radiographers and 2982 physiotherapists included in the main analysis according to their age, sex, smoking habits, and history of asthma or wheezy bronchitis diagnosed by a doctor before they started training, and whether they had worked in their profession at some time in the past 12 months. The two groups were similar, except that the radiographers included a higher proportion of men.

Table 2 compares the lifetime prevalence of various lower respiratory symptoms in radiographers and physiotherapists. After adjustment for age, sex, and smoking habits, the overall prevalence of wheeze at any time and of two or more asthma symptoms were similar in the two professions, as were rates of exercise induced wheeze and chest tightness, and nocturnal wheeze and dyspnoea. Radiographers reported exercise induced cough less often than physiotherapists. On the other hand, they were more likely to report wheeze and dyspnoea on waking, and wheeze provoked by a smoky or dusty environment. The biggest difference, however, was in the frequency of lower respiratory symptoms that were worse at work or on workdays (PR 2.09, 95% CI 1.63–2.69).

Table 3 compares the one year period prevalence of lower respiratory symptoms in radiographers and physiotherapists. Wheeze overall and exercise induced symptoms occurred at a similar rate in both professions. However, report of two or more asthma symptoms was more common in radiographers (PR 1.23, 95% CI 1.09–1.40). Six of the individual symptoms were significantly more common in radiographers, the largest difference being in dyspnoea on waking (PR 1.69, 95% CI 1.37–2.09).

Table 1 Characteristics of radiographers and controls (%)

	Radiographers n = 2293	Physiotherapists n = 2982
Age:		
< 25	0.3	1.3
25–29	78.9	79.3
≥ 30	20.8	19.4
Sex:		
Male	13.1	7.5
Female	86.9	92.5
Smoking:		
Never smoked	83.1	84.2
Ex-smoker	10.0	11.0
Current smoker	6.9	4.8
Asthma or wheezy bronchitis diagnosed by a doctor before start of training:		
No	91.0	92.5
Yes	9.0	7.5
Worked as a radiographer or physiotherapist during the previous 12 months:		
No	7.8	7.4
Yes	92.2	92.6

Table 2 Lifetime prevalence of lower respiratory symptoms in radiographers and controls

Symptom	Lifetime prevalence (%)		Prevalence ratio* (95% CI)
	Radiographers n = 2293	Physiotherapists n = 2982	
Wheeze at any time	41.2	41.6	0.97 (0.89–1.06)
Asthma marker symptoms:			
Exercise induced cough	15.8	18.8	0.84 (0.73–0.96)
Exercise induced wheeze	20.0	20.2	0.97 (0.85–1.10)
Exercise induced chest tightness	19.2	20.0	0.96 (0.85–1.10)
Nocturnal wheeze	12.2	12.1	1.01 (0.86–1.18)
Nocturnal dyspnoea	14.9	14.1	1.05 (0.91–1.21)
Wheeze on waking	15.3	13.0	1.14 (0.99–1.33)
Dyspnoea on waking	12.5	9.6	1.31 (1.11–1.55)
Wheeze provoked by:			
Smoky room	22.2	18.3	1.22 (1.08–1.38)
Dusty place	24.9	21.0	1.17 (1.05–1.32)
Two or more of asthma marker symptoms	29.0	27.2	1.05 (0.94–1.17)
One or more of above symptoms worse at work or on work days	7.2	3.4	2.09 (1.63–2.69)

*Adjusted for age, sex, and smoking habits.

Table 3 One year period prevalence of lower respiratory symptoms in radiographers and controls

Symptom	One year period prevalence (%)		Prevalence ratio* (95% CI)
	Radiographers n = 2293	Physiotherapists n = 2982	
Wheeze	31.3	28.9	1.06 (0.96–1.18)
Asthma marker symptoms:			
Exercise induced cough	11.6	12.0	0.96 (0.81–1.13)
Exercise induced wheeze	14.0	12.7	1.08 (0.93–1.26)
Exercise induced chest tightness	14.2	12.8	1.13 (0.97–1.31)
Nocturnal wheeze	7.4	5.7	1.30 (1.05–1.61)
Nocturnal dyspnoea	8.7	6.3	1.40 (1.15–1.72)
Wheeze on waking	10.6	8.5	1.20 (1.01–1.44)
Dyspnoea on waking	8.9	5.3	1.69 (1.37–2.09)
Wheeze provoked by:			
Smoky room	17.9	14.2	1.27 (1.10–1.45)
Dusty place	19.9	16.3	1.22 (1.07–1.39)
Two or more asthma marker symptoms	22.9	18.4	1.23 (1.09–1.40)

*Adjusted for age, sex, and smoking habits.

Table 4 One year period prevalence of other symptoms experienced for eight days or more among radiographers and controls

Symptom	One year period prevalence (%)			One year period prevalence (%) of symptoms noted to be worse at work		
	Radiographers n = 2293	Physiotherapists n = 2982	Prevalence ratio* (95% CI)	Radiographers n = 2113	Physiotherapists n = 2762	Prevalence ratio* (95% CI)
Excessive fatigue	28.9	22.1	1.32 (1.18–1.47)	20.5	14.4	1.41 (1.23–1.62)
Nausea	9.9	10.3	1.01 (0.84–1.21)	3.1	3.1	1.04 (0.75–1.44)
Dizziness	6.5	4.2	1.58 (1.23–2.03)	3.2	2.3	1.42 (1.00–2.00)
Skin rash	12.7	10.1	1.26 (1.06–1.49)	6.1	4.8	1.26 (0.99–1.61)
Mouth soreness	4.9	2.6	1.84 (1.35–2.51)	1.9	0.5	3.60 (1.95–6.64)
Mouth ulcers	11.2	8.6	1.29 (1.07–1.54)	1.4	0.6	2.18 (1.20–3.98)
Sore, itchy, or runny eyes	25.3	18.2	1.40 (1.23–1.58)	15.1	6.2	2.46 (2.04–2.96)
Persistent blocked nose	20.2	15.9	1.27 (1.11–1.45)	10.6	5.3	1.98 (1.61–2.44)
Persistent itchy nose or sneezing	24.2	20.0	1.23 (1.09–1.39)	12.6	6.6	1.93 (1.59–2.33)
Persistent runny nose	17.2	16.4	1.07 (0.93–1.23)	7.9	5.4	1.46 (1.17–1.83)
Sore throat	26.5	16.5	1.63 (1.44–1.84)	16.2	6.8	2.42 (2.02–2.90)
Dysuria	2.9	2.8	1.07 (0.76–1.50)	0.8	0.8	0.96 (0.50–1.83)
Joint pain or stiffness	16.7	16.3	1.03 (0.89–1.18)	7.4	9.2	0.82 (0.67–1.00)
Headache	40.1	25.5	1.61 (1.45–1.78)	28.8	15.2	1.94 (1.71–2.21)
Blurred vision	2.7	1.8	1.49 (1.01–2.20)	1.2	0.9	1.29 (0.75–2.23)
Numbness in face, hands, or feet	2.5	1.6	1.59 (1.06–2.40)	0.6	0.5	1.04 (0.49–2.20)
Abdominal pain	9.6	9.0	1.08 (0.90–1.31)	1.9	1.7	1.12 (0.73–1.72)

*Adjusted for age, sex, and smoking habits.

Table 5 Association of work related symptoms with occupational activities carried out by radiographers in the past year

Occupational activity	Number who reported activity	Mouth soreness	Sore, itchy or runny eyes	Persistent blocked nose	Persistent itchy nose or sneezing	Sore throat	Headache
≥ 20 Hours a week in a room with an automatic x ray processing machine	876	3.2 (1.6–6.4)	1.6 (1.3–2.0)	2.1 (1.6–2.7)	1.6 (1.2–2.0)	2.0 (1.6–2.5)	1.4 (1.2–1.7)
Work at some time in a room where a processing machine was obviously leaking	638	2.5 (1.4–4.7)	1.6 (1.3–2.0)	1.9 (1.4–2.4)	1.7 (1.4–2.2)	1.9 (1.6–2.4)	1.5 (1.2–1.7)
Loading film into an automatic processing machine every day	1579	6.3 (1.5–26.0)	1.2 (1.0–1.6)	1.9 (1.3–2.7)	1.5 (1.1–2.0)	1.9 (1.4–2.5)	1.5 (1.2–1.8)
Removing film from an automatic processing machine every day	1715	4.3 (1.0–17.7)	1.3 (1.0–1.8)	1.9 (1.2–2.9)	1.4 (1.0–1.9)	2.1 (1.5–3.0)	1.5 (1.2–1.8)
Freeing an automatic processing machine that had jammed	1618	2.0 (0.8–5.2)	1.6 (1.2–2.2)	2.2 (1.5–3.3)	1.9 (1.3–2.7)	2.1 (1.5–2.9)	1.5 (1.2–1.8)
Unblocking a processor drain	141	1.5 (0.5–4.2)	1.7 (1.2–2.4)	1.6 (1.0–2.5)	2.0 (1.4–2.9)	1.7 (1.2–2.4)	1.6 (1.2–2.1)
Loading chemicals into an automatic processing machine at least once a week	731	2.1 (1.1–3.8)	1.3 (1.1–1.6)	1.5 (1.1–1.9)	1.2 (0.9–1.5)	1.5 (1.2–1.9)	1.3 (1.1–1.5)
Removing chemicals from an automatic processing machine	627	1.2 (0.6–2.4)	1.0 (0.8–1.2)	1.0 (0.7–1.3)	1.2 (0.9–1.5)	1.3 (1.0–1.6)	1.2 (1.0–1.5)
Use of a table top processor	1164	1.7 (0.9–3.3)	1.5 (1.2–1.9)	1.4 (1.1–1.8)	1.5 (1.2–1.9)	1.5 (1.2–1.9)	1.3 (1.1–1.6)
Processing films by hand	616	2.0 (1.1–3.7)	1.5 (1.2–1.8)	1.8 (1.4–2.4)	1.4 (1.1–1.8)	1.3 (1.1–1.7)	1.4 (1.2–1.7)

The analysis was restricted to the 2113 men and women who had worked as radiographers at sometime during the past year. A symptom was considered to be present if it was reported to have occurred on eight or more days during the past year and to have been worse at work. The figures are prevalence ratios (adjusted for age, sex, and smoking habits) (95% CIs) for radiographers whose job involved the activity compared with those whose job did not.

Table 4 shows the one year prevalence of the other symptoms examined and the frequency with which the same symptoms were reported to have been worse at work. All of the complaints except nausea were reported more frequently by the radiographers. The highest prevalence ratios were for mouth soreness (PR 1.84, 95% CI 1.35–2.51), sore throat (PR 1.63, 95% CI 1.44–1.84), headache (PR 1.61, 95% CI 1.45–1.78), numbness of face, hands, or feet (PR 1.59, 95% CI 1.06–2.40), and dizziness (PR 1.58, 95% CI 1.23–2.03). In contrast, the differences for nausea, persistent runny nose, dysuria, joint pain or stiffness, and abdominal pain were small and non-significant.

The analysis of work related symptoms was restricted to the 2113 radiographers and 2762 physiotherapists who had worked at some time during the past year. Again, most of the complaints were more common in radiographers, although it is notable that physiotherapists were significantly more likely to report work related joint pain or stiffness. Radiographers had particularly striking excesses of mouth soreness, sore, itchy, or runny eyes, persistent blocked nose, persistent itchy nose or sneez-

ing, sore throat, and headache that were reported to be worse at work (lower 95% confidence limits for PR > 1.5).

Table 5 summarises the associations of these work related symptoms with various occupational activities carried out by radiographers in the past year. (Analysis was again restricted to the 2113 radiographers who had worked during the 12 months before completing the questionnaire). When considered singly, all of the occupational tasks were associated with an increased prevalence of symptoms.

When they were examined together in a forward, stepwise Cox's regression analysis (table 6) up to four tasks showed significant associations with any individual symptom. However, only two tasks consistently entered the model for each of the six symptoms. These were working for at least 20 hours a week in a room with an automatic processing machine, and working at some time in a room where a processing machine was obviously leaking. Also, unblocking a processor drain was significantly associated with three symptoms—sore, itchy, or runny eyes, persistent itchy nose or sneezing, and headache.

Table 6 Associations of work related symptoms with occupational activities carried out by radiographers in the past year as assessed in a stepwise logistic regression analysis

Occupational activity	Number who reported activity	Mouth soreness	Mouth ulcers	Sore, itchy or runny eyes	Persistent blocked nose	Sore throat
> 20 Hours a week in a room with an automatic x ray processing machine	876	2.5 (1.2-5.0)	—	1.6 (1.2-2.0)	1.9 (1.4-2.5)	1.9 (1.4-2.4)
Work at some time in a room where a processing machine was obviously leaking	638	—	—	1.5 (1.2-2.0)	1.6 (1.2-2.2)	1.9 (1.4-2.4)
Loading film into an automatic processing machine every day	1579	4.3 (1.0-18.5)	—	—	—	—
Removing film from an automatic processing machine every day	1715	—	—	—	—	—
Freeing an automatic processing machine that had jammed	1618	—	—	—	—	1.6 (1.1-2.3)
Unblocking a processor drain	141	—	—	1.8 (1.2-2.8)	—	—
Loading chemicals into an automatic processing machine at least once a week	731	—	—	—	—	—
Removing chemicals from an automatic processing machine	627	—	—	0.7 (0.6-1.0)	—	—
Use of a table top processor	1164	—	—	1.3 (1.0-1.7)	—	—
Processing films by hand	616	—	—	—	1.6 (1.2-2.2)	—

The analysis was restricted to the 2113 men and women who had worked as radiographers at some time during the past year. A symptom was considered to be present if it was reported to have occurred on eight or more days during the past year and to have been worse at work. The figures presented are mutually adjusted odds ratios (adjusted also for age, sex, and smoking habits) (95% CIs) for radiographers whose job involved the activity as compared with those whose job did not. Odds ratios are omitted if they made no significant ($P < 0.05$) additional contribution to the logistic regression model.

Discussion

This survey has shown clear excesses in the prevalence of work related symptoms reported by radiographers compared with physiotherapists. In particular, radiographers were more likely to complain of symptoms that were worse at work, mouth soreness, sore, itchy, or runny eyes, persistent blocked nose, persistent itchy nose or sneezing, sore throat, headache, and of lower respiratory symptoms, which were also worse on workdays. Among the radiographers, the occurrence of work related symptoms was particularly associated with the use of automatic processing machines.

The overall prevalence of wheeze in the two professional groups was similar. However, when we used a validated series of nine questions designed to identify asthma, the one year period prevalence of probable asthma (classed as the presence of two or more symptoms) was higher in radiographers.

It is possible that subjects with the symptoms under study were more motivated to respond to the questionnaire than those who were symptom free. If so, some of our prevalence estimates may be exaggerated. However, this should not have biased comparisons between radiographers and physiotherapists as the response rates for the two groups were similar.

More difficult to assess is the potential for biased recall of symptoms. Physiotherapists were chosen as a control group, because they have a similar age and sex distribution to radiographers, and comparable medical knowledge. Also, when writing to subjects, we did not indicate our specific interest in radiography. Nevertheless, there had been a lot of publicity about darkroom disease among British radiographers before our survey began, and this may have increased some radiographers' awareness of symptoms.

Two features of our findings suggest that the reported excess of symptoms may arise, at least in part, from genuine toxicity. The first is the specificity of the complaints that were reported to be worse at work. The symptoms most consistently linked with work as a radiog-

rapher were those indicating irritation of eyes, nose, mouth, throat, and lower airways. No comparable association was found with nausea, abdominal pain, dysuria, and joint pain or stiffness. The second feature is the differential association of work related symptoms with specific activities carried out by radiographers. Most radiographers undertook many of the occupational tasks examined, and this limited our ability to disentangle their independent relation to symptoms. However, in a stepwise Cox's regression analysis, the excess of work related symptoms did seem to be associated mainly with use of automatic processing machines, which are known to produce irritant emissions including sulphur dioxide, formaldehyde, and glutaraldehyde.⁴

Symptoms seemed to be particularly common in people working with faulty machines, perhaps because blocked or leaking machines produce higher exposures to irritants. However, it is also possible that radiographers with symptoms were more aware of machine faults and reported them more completely. A useful way forward, therefore, would be to conduct a hygiene survey in a sample of radiology departments in parallel with a survey of symptoms. The degree of correlation between symptoms and measured concentrations of airborne irritants would allow better assessment of the contribution of chemical toxicity, and guide the formulation of any control measures that were needed.

As well as a specific effect of processing chemicals, it is possible that some of the symptoms reported by radiographers are explained by more general features of the environment in which they work. It is notable that the symptoms reported in excess were similar to those that have been described in association with the sick building syndrome.²⁰ x Ray departments are particularly likely to have the architectural features such as small rooms, lack of external windows, poor lighting, excessive heat, and low humidity, which are thought to predispose to the syndrome. Physiotherapy departments are less likely to exhibit these features and physiotherapists tend to work in

more than one location—for example, on wards and in outpatient departments.

Potentially more important than the irritant effects discussed is the risk of respiratory sensitisation in radiographers. This study found a slightly higher one year period prevalence of probable asthma in radiographers than controls. To date, three cases of occupational asthma have been reported in radiographers,^{14 15} but our survey identified 235 radiographers with wheeze or chest tightness that was worse at work or on working days. To establish the true prevalence of occupational asthma in the cohort, we intend to collect further information from these people, including assessment with serial peak flow measurements where appropriate.

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