Stomach cancer and work in dusty industries

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Abstract

The city of Stoke-on-Trent, whose major industries include coalmining, iron and steel, ceramics, and rubber, has death rates from stomach cancer some 80% above the national average. To explore the hypothesis that work in these dusty industries is responsible for the local excess of stomach cancer, we compared 95 incident cases with 190 age and sex matched community controls. Lifetime occupational histories and premorbid consumption of foods suspected of causing or protecting against stomach cancer were ascertained by a self administered questionnaire, supplemented at interview. Sixty eight cases had at some time held a manual job in one of the four dusty industries (relative risk = 1.4, 95% confidence interval 0.8-2.4). After allowance for diet, rubber manufacture was the industry most strongly associated with stomach cancer (relative risk = 2.5, 95% CI 1.0-6.4). Associations were also found with coal mining and ceramics but these were not statistically significant at a 5% level. The estimated proportion of stomach cancer attributable to the four dusty industries was 23%. It is concluded that the high incidence of stomach cancer in Stoke-on-Trent is unlikely to be explained solely by occupational exposure to dust.

Analyses of occupational mortality and incidence of cancer have repeatedly shown high rates of stomach cancer in coal miners^{1,2} and rubber workers.¹⁻³ Other dusty occupations have also been linked with the disease^{2,4} but less consistently. The excess risk could be a direct effect of the occupational environment. For example, it has been suggested that coal and other dusts contain carcinogens that reach the stomach by being first inhaled, then cleared by the lung, and swallowed.⁵ Alternatively, the association

could be due to confounding by non-occupational factors. There is now good evidence that diet is an important determinant of stomach cancer. In particular, the disease has been associated with high intake of salt and low consumption of fresh fruit and salad vegetables.⁶ The joint effects of occupation and diet on stomach cancer have been little explored.

The midland city of Stoke-on-Trent has had high death rates from stomach cancer for many years.⁷ During 1979-85 mortality was some 80% above the national average in both men and women (data supplied by the Office of Population Censuses and Surveys). Many of the local population work or have worked in dusty industries, in particular coal mining and the production of iron and steel, ceramics, and rubber tyres. We have carried out a case-control study to examine the contribution of these dusty industries to the high incidence of stomach cancer in the city, after allowance for the effects of dietary risk factors.

Method

The study population comprised the 373 000 residents of Stoke-on-Trent and Newcastle-under-Lyme county districts. (Newcastle-under-Lyme is adjacent to Stoke and part of the same conurbation.) By monitoring pathology reports and by regular inquiry of the endoscopy, radiology, and surgical departments at the local hospitals we attempted to identify all members of the study population aged 70 or less in whom gastric carcinoma was newly diagnosed during the period January 1985 to August 1987.

We then sought lifetime occupational histories from these patients by means of a self administered questionnaire posted to them after their discharge from hospital. The questionnaire also inquired about the frequency of consumption (before the onset of symptoms) of foods suspected of causing or protecting against stomach cancer. Married women were asked to give their husband's last full time job. A research assistant subsequently visited the patients at home to collect the questionnaires and clarify any uncertain answers. If the questionnaire had not been completed by the time of the visit the patient (or, exceptionally, a close relative) was interviewed to obtain the required information.

For each case who completed the questionnaire we selected two controls, matched for age (to within two years) and sex, from a list of all members of the study

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Table 1 Jobs with high dust exposure

Industry	Job
Coal mining	Underground coal miners, coal miners (so described)
Iron and steel	Moulders and coremakers*
Ceramics	Ceramic formers, kilnmen, labourers
Rubber	Production workers

*No subjects had worked as fettlers.

population registered with National Health Service general practitioners (in Britain almost everyone is registered with the NHS). Information about the occupations and dietary habits of these controls was obtained in the same way as for the cases. Controls who could not be contacted or refused to participate were replaced.

Subjects were classified according to whether they had held manual jobs in the local dusty industries, and within each industry we distinguished further those subjects who had worked in the most dusty occupations (table 1). The designation of these occupations was carried out before any analysis of the data. Associations with stomach cancer were examined by conditional logistic regression for matched sets with a multiplicative model for combining risks.⁸ In making allowance for diet we took account of four variables—salad consumption in summer, salad consumption in winter, consumption of fresh and frozen fruit, and intake of salt. Social class was classified to three levels (I–III N, III M, IV–V) on the basis of the most recent full time job or, for married women and widows, that of their husband.

Results

Occupational and dietary histories were obtained for 95 patients (73 men, 22 women) with gastric carcinoma. Their ages ranged from 39 to 70 with mean 61 and median 64. A further 38 cases were identified in the course of the study but did not complete questionnaires because they died soon after diagnosis (28), were too ill for interview (5), or declined to participate for other reasons (5). To obtain the required 190 controls it was necessary to replace 55 of the subjects originally selected. Further details of the case group and of the response to the questionnaire are reported elsewhere.⁶

Table 2 Dietary variables for which allowance was made in the analysis of occupation

Variable	Level	Relative risk	95% CI
Salad vegetables in summer	< once a week	1	
	1–2 times a week	0.8	0.3–1.9
	> twice a week	0.3	0.1–1.0
Salad vegetables in winter	< once a month	1	
	1–3 times a month	1.4	0.6–3.2
	> 3 times a month	0.4	0.2–1.0
Fresh and frozen fruit	< once a week	1	
	1–5 times a week	1.5	0.7–3.1
	> 5 times a week	0.7	0.3–1.6
Salt*	Low	1	
	Intermediate	3.0	1.1–8.6
	High	5.4	1.9–15.1

*Levels of salt intake were defined as follows: low = subjects who never or only occasionally ate salty foods and never or only occasionally added salt to food at table; intermediate = subjects who frequently ate salty foods or frequently added salt to food at table but did not do both; high = subjects who both frequently ate salty foods and frequently added salt to food at table.

Table 2 shows the levels of risk associated with the four potentially confounding dietary variables when they were examined together in a multivariate model but without allowance for occupation. As expected, risks were highest in low consumers of salads and fruit and in high consumers of salt. Again, the findings are presented in greater detail elsewhere.⁶

Sixty eight cases and 122 controls had at some time held a manual job in one of the four local dusty industries (relative risk = 1.4, 95% CI 0.8–2.4). Table 3 shows the associations between stomach cancer and manual employment in each individual industry. Separate analyses were carried out with and without allowance for diet. The effect of allowing for diet was, if anything, to increase risk estimates. The strongest association was with manual work in the rubber industry, and when diet was taken into account this bordered on statistical significance at a 5% level (relative risk = 2.5, 95% CI 1.0–6.4). Increased risks were also found for coal mining and the ceramics industry but these were not statistically significant. There was no association with iron and steel production.

With allowance for current social class as well as diet, the risk in rubber workers increased to 3.3 (95% CI 1.2–9.2). Associations with manual work in the other dusty industries were virtually unchanged.

Table 3 Associations between stomach cancer and manual work in dusty industries. (The four industries have been examined simultaneously in a multivariate analysis. Risks are for ever v never manual employment in each industry)

Industry	No of cases	Analysis without allowance for diet		Analysis with allowance for diet	
		Relative risk	95% CI	Relative risk	95% CI
Coal mining	26	1.4	0.8–2.6	1.7	0.8–3.6
Iron and steel	6	0.7	0.2–2.0	0.8	0.2–2.8
Ceramics	50	1.4	0.8–2.4	1.5	0.8–3.0
Rubber	15	1.7	0.7–3.7	2.5	1.0–6.4

Table 4 Associations between stomach cancer and manual work in dusty industries taking into account duration of employment and latency. (The four industries have been examined simultaneously in a multivariate analysis with allowance for diet. Risks are relative to subjects never employed manually in the industry)

Industry	Five years manual employment in industry completed at least ten years before interview			Shorter or more recent manual employment in industry		
	No of cases	Relative risk	95% CI	No of cases	Relative risk	95% CI
Coal mining	19	2.0	0.8-4.8	7	1.0	0.3-3.2
Iron and steel	5	0.6	0.1-2.6	1	1.4	0.1-16.1
Ceramics	29	1.1	0.5-2.3	21	3.0	1.2-7.4
Rubber	11	3.5	1.1-11.0	4	0.9	0.2-4.3

Table 4 gives risk estimates for subjects who had completed five years manual employment in the industries under study at least ten years before interview. The risks associated with coal mining and rubber manufacture were higher in subjects with longer service and after a latent interval from first exposure. In contrast, the association with the ceramics industry was restricted to subjects with shorter or more recent employment.

Table 5 shows risk estimates for the most dusty occupations in each industry. In the ceramics industry risk was slightly higher in subjects who had worked in the most dusty jobs than in other manual employees. There was no indication of this type of dose-response relation in the coal or rubber industries.

With no allowance for confounders, the estimated proportion of stomach cancer in the study population that was attributable to manual work in the four dusty industries was 21% (95% CI -15%—+46%). The estimate was little changed (23%) when dietary factors and social class were taken into account.

Analyses restricted to the 178 subjects who completed their own questionnaires before the interviewer visited produced results similar to those for the total study sample. So too did an analysis of the 58 cases with intestinal type carcinomas.⁹ Twenty nine cases had antral tumours. The association between antral carcinoma and work in dusty industries (relative risk = 1.2) was weaker than for all stomach tumours.

Discussion

Our findings give only limited support to the hypo-

thesis that dusts in the workplace are a cause of stomach cancer. The strongest association that we found was with manual work in the rubber industry. This observation could not be explained by differences in consumption of fruit, salad vegetables, or salt, nor by a confounding effect of social class. Moreover, the risk was higher in subjects with longer service in the industry and after an interval of at least 15 years from first employment. Within the industry the risk was lower in process workers than in other occupations presumed to be less dusty. Nevertheless, this assessment of exposure to dust was necessarily crude and, for example, made no distinction between different stages of the manufacturing process. The finding of an excess of stomach cancer in rubber workers is consistent with most cohort studies of the industry^{3 10-15} and may well arise from a true occupational hazard. Several studies have suggested that the risk is related particularly to work early in the production line where exposure to dust is greatest.^{11 16 17}

The association that we found with coal mining was much weaker than that for rubber workers. In particular, the relative risk for underground coal miners and men who described themselves simply as coal miners without further specification (most of these men would have worked underground at some stage) was only 1.2. Many previous studies have shown high rates of stomach cancer in coal miners,^{1 18-21} but the finding has not been universal. Case-control studies from the United States²² and the Netherlands²³ have both failed to show an association, and in a cohort study of a community in south Wales mortality from stomach cancer in miners and ex-miners was not clearly higher than that of other

Table 5 Associations between stomach cancer and manual work in dusty industries according to occupation within each industry. (The four industries have been examined simultaneously in a multivariate analysis with allowance for diet. Risks are relative to subjects never employed manually in the industry)

Industry	Employment in industry in a job with high dust exposure			Manual employment in industry but never in a job with high dust exposure		
	No of cases	Relative risk	95% CI	No of cases	Relative risk	95% CI
Coal mining	18	1.2	0.5-2.9	8	3.6	1.1-12.2
Iron and steel	2	1.4	0.2-13.7	4	0.7	0.2-2.8
Ceramics	32	1.7	0.8-3.5	18	1.5	0.6-3.7
Rubber	11	2.0	0.6-6.3	4	3.2	0.7-13.4

men.²⁴ One explanation for this discrepancy might be that the excess of stomach cancer in coal miners is not a direct consequence of their working environment but results from other features of the way of life in mining communities. Alternatively, if there is an occupational hazard the risk may vary with the type of coal being mined or with the geological formation in which the coal seam lies.¹⁸

The ceramics industry has been much less studied than coal mining or rubber manufacture, but in one cohort study of pottery workers from the United States there were 39 deaths from stomach cancer with 36.7 expected.²⁵ Our data are consistent with this and suggest that any risk of stomach tumours in the industry is small.

Few conclusions can be drawn about the risk of stomach cancer in iron and steel workers because the number of subjects who had been employed in iron and steel manufacture was too small. Again, however, there was no indication of a large increase in risk.

In a study on the incidence of cancer in Los Angeles Wright and colleagues found that the association of stomach cancer with dusty occupations was strongest for antral tumours.⁴ Our data, however, give no support to this hypothesis. The relative risk for antral tumours was lower than for all stomach cancers. Nor did we find any evidence that the relation to dust was stronger for intestinal type carcinomas as defined by Lauren.⁹

If dusty industries do have a causative role in stomach cancer our best estimate of the proportion of cases in our study population that is attributable to such work is 23%. In an earlier study in the same community Veys estimated the attributable proportion as 45%,²⁶ but this higher value may have been related in part to a different method of selecting controls. It seems unlikely that the high incidence of stomach cancer in Stoke-on-Trent can be explained solely by an occupational hazard in local industries.

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