Nasal cancer in the textile and clothing industries

LOUISE A BRINTON, W J BLOT, AND J F FRAUMENI JR

From the Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD, USA

ABSTRACT A case-control study of 160 patients with cancers of the nasal cavity and paranasal sinuses and 290 controls showed an excess risk associated with employment in the textile or clothing industries, with the increase (relative risk [RR] = 2.1) found only among female workers. There was, however, no increasing trend in risk with years of employment or duration since first exposure. Both male and female workers were at an increased risk of adenocarcinoma (RR = 2.5), with further enhancement of risks for those experiencing dusty work conditions. Although aetiological inferences cannot be drawn from this study, the finding of raised risk supports some previous observations and the need for further investigation of the cancer experienced by textile and clothing workers.

Although the aetiology of cancers of the nasal cavity and sinuses has not been well studied, the available evidence indicates that the tumour often results from occupational exposures. Many of these relations have been attributed to dusty working conditions, such as furniture manufacturing,¹ nickel production,²⁻⁴ and the leather shoe industry.^{5,6} Of interest, therefore, are several observations of a raised risk of nasal cancer among workers in the textile industry⁷⁻¹⁰ where there is considerable exposure to dust.

To examine the relation of employment in the textile and clothing industries and the risk of nasal cancer, data from a case-control study in North Carolina and Virginia were analysed. The concentration of these industries in this region allowed examination of various specific exposures. In addition, this area has experienced high mortality rates for cancers of the nasal cavities and sinuses, particularly in women (see figure).

Methods

This case-control study included patients diagnosed with primary malignancies of the nasal cavity and sinuses (ICD-8 160.0; 160.2-160.5; 160.8-160.9) at four hospitals in North Carolina and Virginia between 1 January 1970 and 31 December 1980. Cases were limited to those aged 18 or older who were residents of the state in which the admitting hospital was located. Control subjects came from

several sources: for each case determined to be alive at the time of interview (1980-2) two hospital controls were selected, matched to the case in hospital, year of admission (± 2 years), age (± 5 years), sex, race (white, other), and state economic area (or county, if possible) of usual residence. The controls had to be alive at the time of interview. Patients with a primary admission diagnosis of malignant neoplasms of the buccal cavity and pharynx (ICD-8 codes 140-149), oesophagus (150), nasal cavity, middle ear and accessory sinuses (160), larynx (161), or secondary neoplasms (197.9, 198.9); benign neoplasms of the respiratory system (212); mental disorders (290-315); acute sinusitis (503); deflected nasal septum (504); or nasal polyps (505) were excluded. For cases determined to be dead at the time of interview, two different controls were selected. One consisted of hospital controls derived in the same manner as above, except that they need not be alive. The other series consisted of dead individuals identified through state vital statistics offices. Matching criteria were similar to those used for living cases and included age (± 5 years), sex, race, country of usual residence, and year of death.

A total of 193 cases, 232 hospital controls, and 140 death certificate controls were identified for study. Telephone interviews, from study subjects or their next of kin, averaged 30-40 minutes and focused on occupational exposures, medical and family history, smoking and alcohol consumption, and sociodemographic factors. Interviews were successfully conducted for 160 of the cases (82.9%) and 290 controls (78.0%) (178 hospital controls, 112 death certificate controls). Interviews were

Cancer mortality 1950–69 by state economic area: nose, nasal cavities, and sinuses in white women.

obtained directly from study subjects for 32.5% of the cases and 39.3% of the controls. Reasons for non-response included refusal (6.2% of cases v 4.0% of controls), illness (0.5% v 1.6%), inability to locate study subject or trace an eligible living respondent (4.7% v 8.1%), and lack of a telephone (5.7% v 8.3%).

In addition to the interviews details of the disease were abstracted from medical records. This resulted in the classification of 86 squamous cell carcinomas; 24 adenocarcinomas or adenoid cystic carcinomas; 36 other carcinomas (five transitional cell, two mucoepidermoid, four anaplastic, six undifferentiated, and 19 otherwise unspecified carcinomas); and 14 other histological types (three malignant melanomas, five sarcomas, three esthesioneuroblastomas, one fibrous histiocytoma, one angiofibroma, and one lymphoma). In the analysis the two histological entities adenocarcinoma and adenoid cystic carcinoma were combined on the grounds that they are both rare non-squamous cell glandular tumours that appear to have similar natural histories. Additionally, there is no reason to suspect that they have

different aetiologies, although there has been little mention of adenoid cystic tumours in previous studies. A total of 61 tumours arose in the nasal cavity, 71 in the maxillary sinuses, and 28 in other sinuses or in multiple sites.

The measure of association used for evaluating the effect of an exposure was the relative risk (RR) as approximated by the odds ratio. Confounding variables were evaluated by stratified techniques, with maximum likelihood estimates of combined ratios and 95% confidence intervals (CI) derived.¹¹ For multiple levels of exposure, significance was assessed using a one tailed linear trend test.¹² Multi-variate analyses using a disease probability logistic model were also used to control simultaneously for various potential confounding variables.¹³

Since matching was used in the study design, analyses were also conducted using a logistic approach for matched data.¹⁴ The results were similar to those derived from the unmatched, stratified analyses. Since the matched analyses required elimination of unmatched elements and presented difficulties in interpreting results according to specific histologies,

Table 1 *Relative risks of cancers of the nasal cavity and sinuses by employment in the textile or clothing industries*

<i>No employed in textiles or clothing industries</i>	<i>Cases</i>	<i>Controls</i>	<i>RR</i>	<i>(95% Confidence interval)</i>
Men:				
No	81	155	1.00	—
Yes	12	28	0.82	(0.4–1.7)
Women:				
No	45	87	1.00	—
Yes	22	20	2.13	(1.1–4.3)
Total:				
No	126	242	1.00	—
Yes	34	48	1.32	(0.8–2.2)

Total relative risk is adjusted for sex.

analyses disregarding the individual matching were chosen for presentation.

Results

A total of 14.5% of the male and 24.1% of the female study subjects reported employment in the textile or clothing industries (table 1). The overall RR, adjusted for sex, was 1.3 (95% CI 0.8–2.2), but among the men fewer cases than controls had been employed in the textile or clothing industries (RR = 0.8) whereas among the women, significantly more cases than controls reported such employment (RR = 2.1, 1.1–4.3). Although various other risk factors were found for nasal cancer in this study,¹⁵ none exerted any confounding influences on these associations, including smoking or snuff taking; employment in industries involving wood dust, chemicals, or chromates; and a history of nasal polyps, recurrent nose bleeds, or sinus trouble. In addition, the results did not vary according to source of information (direct or next of kin interview).

Table 2 examines further details regarding employment in the textile or clothing industry. No clear relation of risk was observed according to duration of employment. Most of the women worked for less than 10 years, and these short term workers were at higher risk (3.9, 1.4–11.0) than those who worked 10 years or more (1.4, 0.5–3.8). Furthermore, there was no evidence of an increase in risk with years since initial employment, either for men or for women. Among women, a significant rise in risk (5.8) was observed for those first employed less than 20 years before diagnosis, most of whom began work in the 1960s or later, but those employed earlier showed no significant excess risk. These women typically began work at older ages, resulting in a nearly linear increase in risk with age at first employment, reaching a non-significant risk of 3.9 for those employed at age of 30 or later. The risk was raised (2.3, 0.9–5.5) for women employed in occupations involving exposure to dust.

Table 3 gives details regarding the employment histories of male and female cases. The nature of

Table 2 *Relative risks of cancers of the nasal cavity and sinuses by employment in the textile or clothing industries. (Numbers of cases given in parentheses)*

<i>Employment parameters</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>
Never employed	1.00 (81)	1.00 (45)	1.00 (126)
Years worked:			
<10	0.55 (4)	3.87* (12)	1.50 (16)
≥10	1.49 (7)	1.35 (7)	1.42 (14)
Unknown	0.38 (1)	1.45 (3)	0.85 (4)
Years since initial employment:			
<20	0.96 (3)	5.80* (9)	2.51* (12)
20–39	1.91 (8)	1.38 (5)	1.67 (13)
≥40	0.21 (1)	1.50 (7)	0.83 (8)
Unknown	0.00 (0)	1.93 (1)	0.32 (1)
Age at first employment:			
<20	0.77 (4)	1.55 (8)	1.14 (12)
20–29	0.96 (4)	2.26 (7)	1.50 (11)
≥30	1.53 (4)	3.87 (6)	2.39 (10)
Unknown	0.00 (0)	1.93 (1)	0.32 (1)
Dust exposure:			
No	0.48 (3)	1.69 (7)	0.95 (10)
Yes	1.22 (7)	2.28 (13)	1.72 (20)
Unknown	0.77 (2)	3.87 (2)	1.28 (4)

Total relative risks are adjusted for sex.

*p < 0.05.

Table 3 Occupational details regarding employment in the textile or clothing industries for patients with cancer of the nasal cavity and paranasal sinuses

Yr of birth	Entry to industry	Yr left industry	Year of diagnosis	Nature of industry	Occupation in industry	Dust exposure	Origin of dust	Histology	Site
Men									
1911	1942	1970	1970	Cotton mill	Folder/rag packer	Yes	Lint, dust	Squamous	Max sinus
1918	1965	1972	1973	Sleeping bag company	Trimmer/sweeper/weaver/dyer	Yes	Cloth	Squamous	Max sinus
1923	1948	Unknown	1973	Carpet plant	Scarrer	Yes	Unknown	Squamous	Cavity
1914	1949	1970	1970	Clothing	Trimmer	Yes	Cotton	Adenocarcinoma	Cavity
1938	1959	1959	1975	Clothing	Cloth spreader	Yes	Lint	Adenoid cystic	Other sinus
1907	1923	1943	1974	Textiles	Weaver/fixer/foreman	No		Squamous	Other sinus
1903	1932	1947	1970	Textiles	Worked with velvet	Unknown		Neoplasm, NOS	Cavity
1918	1937	1956	1974	Cotton mill	Oiler/spinner/dyer	Yes	Cotton	Carcinoma, NOS	Cavity
1916	1949	1954	1979	Textiles	Weaver	No		Squamous	Cavity
1941	1961	1974	1979	Nylon company	Operator	Unknown		Adenocarcinoma	Cavity
1931	1950	1950	1975	Hosiery	Factory worker	No		Squamous	Unspec sinus
1933	1952	1971	1976	Textiles	Weaving machine fixer	Yes	Cotton	Adenoid cystic	Max sinus
Women									
1893	1909	1912	1970	Textiles	Mill worker	No		Squamous	Max sinus
1924	1970	1972	1974	Textiles	Inspector	No		Adenocarcinoma	Other sinus
1899	1916	1920	1972	Cotton mill	Sweeper	Yes	Cotton, lint	Angiofibroma	Max sinus
1937	1958	1964	1975	Textiles	Loom operator	Yes	Lint, dust	Adenoid cystic	Max sinus
1913	1930	1937	1978	Hosiery mill	Looper	No		Squamous	Cavity
1934	1959	1962	1972	Cotton mill	Thread machine operator	Yes	Thread, cotton	Squamous	Max sinus
1928	1962	1969	1980	Clothing	Presser	No		Squamous	Max sinus
1906	1922	1965	1975	Cotton mill	Operator-automatic washer	Yes	Cotton	Squamous	Max sinus
1897	1926	1961	1977	Hosiery mill	Folder	No		Transitional cell	Cavity
1921	1942	1976	1976	Hosiery mill	Inspector	Yes	Lint	Squamous	Cavity
1894	1910	1954	1971	Textiles	Cleaner	Yes	Cotton	Squamous	Cavity
1907	1940	1941	1970	Cotton mill	Unknown	Unknown		Squamous	Other sinus
1915	1934	1974	1978	Clothing	Seamstress/dressmaker	No		Carcinoma, NOS	Max sinus
1908	1967	Unknown	1979	Clothing	Presser	No		Carcinoma, NOS	Other sinus
1940	1964	1973	1974	Textiles	Seamstress	Yes	Cotton	Squamous	Cavity
1917	1950	1952	1973	Hosiery mill	Unknown	Unknown		Squamous	Max sinus
1885	Unknown	Unknown	1974	Hosiery mill	Ran winder/inspector	Yes	Unknown	Adenocarcinoma	Max sinus
1920	1944	1980	1980	Hosiery/clothing	Seamstress	Yes	Nylon, cotton	Adenocarcinoma	Other sinus
1948	1968	1978	1978	Hosiery mill	Folder/seamer	Yes	Lint	Rhabdomyosarcoma	Cavity
1929	1975	1980	1980	Clothing	Asst manager	Yes	Lint	Squamous	Cavity
1926	1943	1968	1980	Textiles/yarn	Operator-roving frame/winder	Yes	Cotton	Esthesio-neuroblastoma	Cavity
1956	1975	1977	1980	Silkscreen factory	Printer	Yes	Wood	Osteosarcoma	Max sinus

Max = Maxillary. NOS = Not otherwise specified.

specific industries and occupations showed a fair amount of heterogeneity. The industries primarily included textile and cotton mills, clothing manufacturing, and hosiery. No specific occupations predominated, although weavers, winding operators, trimmers, and seamstresses were well represented. The primary origin of dust was cotton, although other substances (lint, nylon, wood) were mentioned.

Further analyses related work in the textile industry to tumour histology (table 4). Among women, the risk was highest for adenocarcinoma (RR = 2.5, 0.7-9.0), although there was a non-significant excess risk (RR = 1.9-2.2) for the other tumours. A higher risk of adenocarcinoma (RR = 2.5, 0.7-8.3) among

textile workers was also noted for men. The risk for adenocarcinomas among both men and women was highest when dusty working conditions were reported, being 4.7 (1.2-17.8) in men and 3.4 (0.8-14.1) in women.

No significant associations were observed according to site of the tumour, with the occupational risks being 1.5 for nasal cavity, 1.2 for maxillary sinus, and 1.7 for other sinus cancers.

Associations with employment in the textile or clothing industries were also examined according to the levels of other nasal cancer risk factors. The increased risk among women was not differentially affected by smoking (RRs of 1.8 and 2.2 for smokers and non-smokers, respectively). Similarly, snuff

Table 4 Relative risks of nasal cancer histologies by employment in the textile or clothing industries. (Numbers of cases given in parentheses)

Employed in textiles or clothing	Squamous cell (n = 86)	Adenocarcinoma (n = 24)	Other (n = 50)
Men:			
No	1.00 (47)	1.00 (9)	1.00 (25)
Yes	0.71 (6)	2.46 (4)	0.44 (2)
Women:			
No	1.00 (22)	1.00 (7)	1.00 (16)
Yes	2.17 (11)	2.49 (4)	1.90 (7)
Total:			
No	1.00 (69)	1.00 (16)	1.00 (41)
Yes	1.24 (17)	2.47 (8)	1.06 (9)

Total relative risks are adjusted for sex.

usage did not appear to modify the textile/clothing associations. Among women, the highest risks were observed among textile workers without prior sinus trouble (RR = 3.0, 1.2–7.4) or nasal polyps (2.3, 1.1–4.8), although the detection of associations in the other subgroups was limited by small numbers of individuals with prior medical conditions. Employment in other high risk industries, including the manufacturing of furniture and other wood products, and exposure to chemicals and chromates, did not substantially alter the associations with exposures in the textile/clothing industries.

Discussion

This case-control study provided limited evidence that exposures in the textile or clothing industries increase the risk of nasal cavity and sinus cancers. Overall, employment in the industry was associated with a 32% excess risk, with only women being adversely affected (RR = 2.1). This finding may account for the high rates of nasal cancer reported among women in those counties of North Carolina and Virginia where a high percentage of residents have been employed in the textile industry. When histological types of nasal cancer were evaluated, both men and women were found to be at increased risk of nasal adenocarcinoma (RR = 2.5). Textile exposures have been suggested previously as a risk factor for nasal cancer in studies from several other countries, including England,^{7,8} Sweden,¹⁰ and Finland,¹⁶ although the specific occupations have varied. In England one survey showed an increased incidence of nasal cancer among male upholsterers, tailors, and dressmakers but not textile workers.⁸ Bross *et al.*, however, noted an excess of nasal cancer in New York among men employed as operatives in the textile mill industry.⁹ Corresponding information among women is largely unavailable, although one survey in Finland showed an excess risk of nasal cancer for knitters,¹⁶ an occupation where working conditions in the home apparently resemble those

experienced in many industrial settings (H S R Walker, personal communication). Engzell *et al.* also reported a high proportion of textile workers among women with squamous cell and poorly differentiated nasal carcinomas,¹⁰ although exposure details were limited and the absence of a control group prevented risk estimation.

The reason for the association with employment in the textile or clothing industries, notably among women in our study, is uncertain, especially since no relation existed with years of employment or time since first exposure. The fact that those first employed in later periods were at the highest risk suggests either the influence of a recently introduced agent or some promotional effect, but such relations were not hypothesised before the start of the study. Although it has been suggested that exposure to formaldehyde in the textile industry might increase the risk of nasal cancer,¹⁷ few individuals in our study reported such exposure (2 cases and 10 controls), and it was actually associated with a non-significant decrease in risk (RR = 0.4). Instead, the excess risk associated with employment in the textile industry seemed more closely related to occupations with significant exposure to dust. In our survey most subjects reported exposure to cotton dust, although contact with other substances was also noted. The association with cotton dust may merely reflect the widespread nature of this industry in states where the study was conducted, but a large proportion of cases in the survey of Acheson *et al.* also reported exposure to cotton dust.⁷

It is noteworthy that exposure to dust in the textile or clothing industry primarily increased the risk of nasal adenocarcinomas, although there was some excess risk of other tumours in women. Similarly, employment in industries involving exposure to wood dust, notably in furniture making, raises the risk of nasal adenocarcinomas.^{15,6,18} In several investigations heavy exposure to wood dust has been shown to decrease mucociliary clearance¹⁹ and produce other disturbances in the upper airway.²⁰

Chronic nasal mucosal changes have also been documented among workers at a nickel refinery.²¹

In summary, our study provided some evidence for an association between employment in the textile industry and the risk of nasal cancer, but the findings to date are not definite. Arguing against an association is a recent proportional mortality study in female textile workers in North Carolina that failed to show an increased frequency of nasal cancer.²² If, however, as indicated in our study, the raised risks pertain mainly to adenocarcinomas or to workers with substantial exposure to dust, or both, cohort approaches may fail to have sufficient power to detect raised risks of nasal cancer. Future investigations should thus focus not only on the nature of the textile exposures but also on disease characteristics (such as histological types and precursor lesions) to help delineate possible carcinogens and mechanisms of action.

References

- ¹ Rang EH, Acheson ED. Cancer in furniture workers. *Int J Epidemiol* 1981;10:253-61.
- ² Doll R, Morgan LG, Speizer FE. Cancers of the lung and nasal sinuses in nickel workers. *Br J Cancer* 1970;24:623-32.
- ³ Pedersen E, Hogetveit AC, Andersen A. Cancer of respiratory organs among workers at a nickel refinery in Norway. *Int J Cancer* 1973;12:32-41.
- ⁴ Enterline PE, Marsh GM. Mortality among workers in a nickel refinery and alloy manufacturing plant in West Virginia. *JNCI* 1982;68:925-33.
- ⁵ Acheson ED. Nasal cancer in the furniture and boot and shoe manufacturing industries. *Prev Med* 1976;5:295-315.
- ⁶ Cecchi F, Buiatti E, Kriebel D, Nastasi L, Santucci M. Adenocarcinoma of the nose and paranasal sinuses in shoemakers and woodworkers in the province of Florence, Italy (1963-77). *Br J Ind Med* 1980;37:222-5.
- ⁷ Acheson ED, Cowdell RH, Rang E. Adenocarcinoma of the nasal cavity and sinuses in England and Wales. *Br J Ind Med* 1972;29:21-30.
- ⁸ Acheson ED, Cowdell RH, Rang EH. Nasal cancer in England and Wales: an occupational survey. *Br J Ind Med* 1981;38:218-24.
- ⁹ Bross IDJ, Viadana E, Houten L. Occupational cancer in men exposed to dust and other environmental hazards. *Arch Environ Health* 1978;33:300-7.
- ¹⁰ Engzell U, Englund A, Westerholm P. Nasal cancer associated with occupational exposure to organic dust. *Acta Otolaryngol* 1978;86:437-42.
- ¹¹ Gart JJ. Point and interval estimation of the common odds ratio in the combination of 2×2 tables with fixed marginals. *Biometrika* 1970;57:471-5.
- ¹² Mantel N. Chi-square tests with one degree of freedom, extensions of the Mantel-Haenszel procedure. *Journal of the American Statistical Association* 1963;58:690-700.
- ¹³ Breslow N, Powers N. Are there two logistic regressions for retrospective studies? *Biometrics* 1978;34:100-5.
- ¹⁴ Lubin J. A computer program for the analysis of matched case-control studies. *Computers and Biomedical Research* 1981;14:138-43.
- ¹⁵ Brinton LA, Blot WJ, Becker JA, et al. A case-control study of cancers of the nasal cavity and paranasal sinuses. *Am J Epidemiol* 1984;119:896-906.
- ¹⁶ Tola S, Hernberg S, Collan Y, Linderborg H, Korkala M. A case-control study of the etiology of nasal cancer in Finland. *Int Arch Occup Environ Health* 1980;46:79-85.
- ¹⁷ Halperin WE, Goodman M, Stayner L, Elliott LJ, Keenlyside RA, Landrigan PJ. Nasal cancer in a worker exposed to formaldehyde. *JAMA* 1983;249:510-2.
- ¹⁸ Ironside P, Matthews J. Adenocarcinoma of the nose and paranasal sinuses in woodworkers in the state of Victoria, Australia. *Cancer* 1975;36:1115-21.
- ¹⁹ Black A, Evans JC, Hadfield EH, Macbeth RG, Morgan A, Walsh M. Impairment of nasal mucociliary clearance in woodworkers in the furniture industry. *Br J Ind Med* 1974;31:10-7.
- ²⁰ Andersen HC, Andersen I, Solgaard J. Nasal cancers, symptoms and upper airway function in woodworkers. *Br J Ind Med* 1977;34:201-7.
- ²¹ Torjussen W, Solberg LA, Hogetveit AC. Histopathological changes of the nasal mucosa in active and retired nickel workers. *Br J Cancer* 1979;40:568-80.
- ²² Delzell E, Grufferman S. Cancer and other causes of death among female textile workers, 1976-78. *JNCI* 1983;71:735-40.