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Mortality among retired fur workers

Dyers, dressers (tanners) and service workers

by Marie H Sweeney, MPH,¹ Judy Walrath, PhD,² Richard J Waxweiler, PhD¹

SWEENEY MH, WALRATH J, WAXWEILER RJ. Mortality among retired fur workers: Dyers, dressers (tanners) and service workers. *Scand J Work Environ Health* 11 (1985) 257–264. A retrospective cohort mortality study was conducted on 807 fur dyers, fur dressers (tanners), and fur service workers who were pensioned between 1952 and 1977 by the Fur, Leather and Machine Workers Union of New York City. Workplace exposures of fur workers varied with job category. Dyers were exposed to oxidative dyes used in commercial hair dyes; dressers and service workers were exposed to tanning chemicals. In a comparison with the New York City population, no significant increases in mortality were observed among the fur dyers. Among fur dressers, mortality from all malignant neoplasms [standardized mortality ratio (SMR) 151] and lung cancer (SMR 232) was significantly elevated, as was mortality from cardiovascular disease (SMR 126) among fur service workers. When examined by ethnic origin, the elevated SMR values and directly age-adjusted rate ratios suggested that foreign-born fur dressers and eastern European-born fur workers experienced the highest risks for lung and colorectal cancers, respectively. These data support previous findings of increased mortality from colorectal cancer in the foreign-born population of the United States and suggest a possible occupational etiology for the observed lung cancer excess.

Key terms: cardiovascular disease, dyes, ethnic groups, leather tanning, lung cancer, occupational exposures, retrospective study.

In 1975 Ames observed that certain constituents of permanent or oxidative dyes were mutagenic (1). Since then there has been concern about the safety of hair care products containing dyes or tints. Of particular interest were the phenylenediamines which had been the primary ingredients of dark, permanent hair dyes since the turn of this century. Subsequent animal studies have confirmed the carcinogenicity of a few compounds in the phenylenediamine family (also known as substituted aniline and azo dyes) (table 1) (3, 17, 23, 24, 25, 26, 27, 28, 30, 45).

In terms of the epidemiologic evidence, hair dye use or hairdressing as an occupation (which includes beauticians and cosmetologists) has been associated with multiple disease outcomes (table 2) (2, 4, 9, 15, 19, 28, 36, 37, 38, 39, 40, 43). Unfortunately, these data lack sufficient specificity to relate cause-specific mortality or morbidity to a certain dye product or chemical. This limitation is partly a result of the absence of reliable information on the extent of personal exposure to hair dyes, eg, length of use and type(s) of dye applied, and on the presence of possible confounding exposures. It may also be related to the inadequacy of current information on the me-

tabolism, target organ specificity, and implications of long-term exposure to oxidative dyes.

In an effort to clarify the relationship between oxidative dye exposure and certain diseases, we examined the mortality experience of workers exposed to oxidative dyes in a retrospective cohort mortality study of union-pensioned fur dyers, fur dressers, and fur service workers.

Fur dyers have a long history of exposure to oxidative dyes, particularly para-phenylenediamine (14, 18, 35, 42). From the late 1890s, when phenylenediamines were first synthesized, to the mid-1970s, para-phenylenediamine was almost exclusively used to dye furs to shades of black and brown. During that period it was considered a principal occupational exposure of fur dyers (20, 35, 42).

The current workforce employed by the fur industry in the United States (US) is less than 10 000, of which less than one quarter are fur dyers. Yet prior to World War II, the fur industry in the New York City area employed approximately 20 000 individuals annually (20). At the same time, the fur industry flourished in the Chicago area, as well as in the eastern provinces of Canada.

In general, fur processing involves the activities of three categories of workers. Fur dressers flesh and tan all skins before the furs are dyed. Fur service workers grade, match, and bale raw and dressed furs; and fur dyers color or tint the furs with natural or synthetic dyes. Of these categories, both fur dyers and fur dressers are believed to have had considerable exposure to potential carcinogens (table 3). Fur dyers are exposed to oxidative dyes, and fur dressers

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Table 1. Tumors found in animal studies evaluating the carcinogenicity of monoaromatic diamines in hair and fur dyes.^a

Tumor site	2,4 Toluenediamine	Phenylenediamines			
		4-Methoxy meta ^b	2-Nitro para	4-Chloro ortho	4-Chloro meta
Liver	Yes (17, 45)	No	Yes (27)	Yes (24)	Yes (23)
Bladder	Yes (45)	No	No	Yes (24)	No
Lymph	Yes (26)	No	No	No	No
Forestomach	No	No	No	Yes (24)	No
Lung	No (26)	No	No	No	No
Skin	No	Yes (25)	No	No	No
Mammary glands	Yes (26)	Yes	No	No	No
Thyroid	No	No (25)	No	No	No
Adrenal	No	No	No	No	Yes (23)

^a Reference numbers in parentheses.^b Also known as 2,4 diaminoanisole.**Table 2.** Conditions associated with hair dye use or hair-dressing as an occupation.^a

Hair dye use	Hairdressing
Aplastic anemia (1, 39)	Bladder cancer (2)
Breast cancer (36)	Brain cancer (39)
Cancer of cervix uteri (19)	Digestive system cancers (37)
Cancer of vulva (15)	Leukemia (43)
Cancer of vagina (15)	Lung cancer (39)
	Multiple myeloma (9, 38)
	Ovarian cancer (38)
	Stomach cancer (19, 28)

^a Reference numbers in parentheses.

to a variety of tanning chemicals (18, 35). Fur service workers are potentially exposed to residual tanning materials while handling previously dressed furs.

Materials and methods

The study population consisted of all pensioned members of the Joint Board of the Fur, Leather and Machine Workers Union located in New York City (NYC). The pensioned fur workers were union members of separate locals, which include fancy fur, lamb, and rabbit dyers; fur dressers; and fur service workers. In 1952 the Union began awarding its members normal and disability retirement benefits. To be eligible for a retirement benefit, a union member must have accumulated at least 20 years of continuous active membership. Retirees receiving regular pension benefits must be at least age 62 to retire; however disability (full benefit) recipients can retire at any age after meeting the length of service requirement. To eliminate selection bias due to disability, we included disability retirees in the cohort only if they lived to their 62nd birthday.

For each retiree, name, social security number, date of birth, race, sex, place of birth, date of retirement, and union local number were abstracted from the pension application. Union records indicate that very few fur workers switched locals. Therefore, since neither detailed job histories nor environmental exposure data were available from the pension appli-

cation or other union records, we used the fur worker category (local union number) from the pension application as the best indicator of usual occupation.

Retirees for whom race was not available and those with Hispanic surnames were classified as white. Nonwhite male retirees (N = 59) and female retirees (N = 74) were excluded from further evaluation due to the small number of deaths. Twenty-five males who retired outside the US were also excluded because their emigration date was not available. Eight of these were deceased. The final study cohort was composed of 807 white male pensioned fur workers, of whom 432 were dyers, 168 were fur dressers, and 207 were fur service workers. Of the total cohort, 25 fur dyers, 1 fur dresser, and 17 service workers were disability retirees.

Vital status for cohort members as of 31 December 1977 was determined through union records, the Social Security Administration, the Internal Revenue Service, the New York State Bureau of Motor Vehicles, and state and city bureaus of vital statistics. Underlying cause of death was coded by a nosologist using the International Classification of Diseases revision in effect at the time of death. Cause of death for individuals known to be deceased but for whom no death certificate could be obtained was coded as cause of death unknown and included in the total number of deaths.

With the use of the modified life-table analysis system of the National Institute for Occupational Safety and Health (44), person-years at risk were accumulated for each retiree beginning with his 62nd birthday. If the individual retired after age 62, the person-years at risk began on his date of retirement and ended on the date of death, or, if the retiree was alive at the end of the study, 31 December 1977. Expected numbers of deaths were calculated for five-year age groups and five-year calendar time periods based on the cause-specific mortality rates of white males in both the US (44) and NYC (obtained from the American Cancer Society). For each cause, standardized mortality ratio (SMR) values were calculated as the ratio of the observed to the expected number of deaths, multiplied by 100. The statistical significance of elevated

Table 3. Job descriptions and exposures common to fur processing operations.

Occupation	Job description ^a	Job exposures
Dyers	Tint or color furs using a semiautomated vat process or brush-dyeing	p-Toluenediamine; nitro, chloro phenylenediamines; lead acetate; potassium permanganate; sodium dichromate; wood and vegetable dyes; wood dust
Dressers	Remove excess flesh/fat from the skin with knives; tan leather component of the skin	Sodium arsenate; chromium acetate; formaldehyde; potassium dichromate; sodium dichromate; sulfuric, lactic, and formic acids; wood dust; antimony; sand
Service workers	Clean, grade, match, and bale raw and dressed furs	Possible residual tanning chemicals

^a Description taken from Kirk & Othmer (18) and Schwartz et al (35).

Table 4. Distribution of pensioned members by birthplace and occupational category.

Birthplace	Occupational category							
	Dyers		Dressers		Service workers		Total	
	N	%	N	%	N	%	N	%
United States	73	17	12	7	75	36	160	19.8
Eastern Europe	101	23	68	41	60	29	229	28.4
Italy	171	40	68	41	15	7	254	31.4
All other countries	87	20	20	12	57	28	164	20.3
Total	432	53	168	21	207	26	807	100

SMR values was tested with the Fisher's exact test, assuming an underlying Poisson distribution (34). Two-sided confidence limits at the 95 % level were computed to determine the variability of calculated point estimates.

Seventy-nine percent of the cohort was determined to be foreign-born. Place of birth was unknown for less than 1 % of the cohort. Because of previously demonstrated associations between country of birth and increased risk of death from certain malignancies, mortality trends were also examined by ethnicity as determined by birthplace. Within each fur worker category, the cohort was stratified into the following four ethnic/birthplace categories: United States, Eastern Europe, Italy, and other countries (table 4). The classification of Eastern Europe included individuals born in Russia, Poland, Rumania, Hungary, Lithuania, Yugoslavia, and Czechoslovakia; the classification other countries included persons from countries not previously specified or whose place of birth was unknown.

For selected malignancies, both the SMR and the directly age-adjusted rate ratios were calculated based on NYC rates. For rate ratios, age-specific mortality rates for NYC white males for 1965 to 1969 (the midperiod of the distribution of person-years at risk of the retiree cohort) were used for comparison and were standardized by the total number of person-years at risk of the entire retiree cohort. Rate ratios specific for cause, occupation, and birthplace were then calculated by dividing the directly age-adjusted rates for the cohort by the age-adjusted rates for NYC.

Results

Vital status was ascertained as of 31 December 1977 for all cohort members. A total of 225 fur dyers, 139 fur dressers, and 104 fur service workers were deceased. Death certificates were obtained for 448 (96 %) of the 468 decedents. Many of the pensioners retired after age 65 (table 5), and, on the average, subjects lived for 7.8 years after retirement.

SMR values based on both the US and NYC white male population comparisons are reported in tables 6, 7, 8. However, discussion of the results is limited to those findings based on the NYC comparison group because regional death rates, rather than death rates for the US, were thought to control better for variations in mortality patterns due to population composition, geographic location, and urban residence.

Total mortality among the fur dyers (table 6) was approximately 20 % lower than expected. This overall

Table 5. Characteristics of the white male pensioners by occupational category.

	Occupational category		
	Dyers (N = 432)	Dressers (N = 168)	Service workers (N = 207)
Average age at retirement (years)	68.0	69.9	68.1
Average length of retirement (years)	8.3	8.7	6.4
Average year of retirement	1965	1959	1967
Total person-years at risk	3 552	1 468	1 308

Table 6. Observed and expected deaths with standardized mortality ratios by cause of death among the retired fur dyers.

Causes of death	ICD ^a	United States			New York City ^b		Confidence limits (95 %)
		Observed	Expected	Standardized mortality ratio	Expected	Standardized mortality ratio	
All causes	000—999	225	262.18	86	276.80	81	71—93
Malignant neoplasms	140—205	53	43.51	122	51.79	102	77—134
Esophagus	150	1	0.93	108	1.30	77	2—429
Stomach	151	8	3.12	256*	4.47	179	77—353
Colon and rectum	152—154	12	6.65	180*	9.93	121	62—211
Liver	155, 156A	1	1.24	81	..	..	..
Trachea, bronchus, lung	162—163	16	10.18	157	11.71	137	78—222
Genital organs	177—179	2	6.57	30	5.58	36	4—129
Urinary organs	180—181	4	2.96	135	3.61	111	100—281
Lymphatic	200—205	2	3.61	55	3.63	55	7—199
Other malignancies	..	10	12.79	78	..	..	..
Vascular lesions of the central nervous system	300—334, 345	19	32.43	59	20.71	92	55—143
Cardiovascular disease	400—468	111	133.87	83	152.03	73	60—88
Nonmalignant respiratory diseases	470—527	13	18.78	69	19.40	67	36—115
All other causes	..	29	34.66	84	..	..	..

^a International Classification of Diseases, seventh revision.^b .. = rates not available.* $p < 0.05$.**Table 7.** Observed and expected deaths with standardized mortality ratios by cause of death among the retired fur dressers.

Causes of death	ICD ^a	United States			New York City ^b		Confidence limits (95 %)
		Observed	Expected	Standardized mortality ratio	Expected	Standardized mortality ratio	
All Causes	000—999	139	117.55	118	125.44	111	93—131
Malignant neoplasms	140—205	34	18.44	184**	22.53	151*	104—211
Buccal cavity and pharynx	140—148	1	0.48	208	0.58	172	4—961
Stomach	151	2	1.46	137	2.07	97	12—349
Colon and rectum	152—154	6	2.91	206	4.44	135	50—294
Liver	155, 156A	1	0.55	182	..	..	..
Pancreas	157	2	1.06	187	1.27	157	19—569
Larynx	161	1	0.23	435	0.32	313	8—1741
Trachea, bronchus, lung	162—163	11	3.83	287**	4.74	232*	116—415
Genital organs	177—179	2	2.98	67	2.52	79	1—287
Lymphatic	200—205	2	1.55	129	1.55	129	16—466
Other malignancies	..	8	6.37	126	..	..	..
Vascular lesion of the central nervous system	300—334, 345	10	15.22	66	9.55	104	50—191
Cardiovascular disease	400—468	67	60.71	110	69.73	96	74—122
Nonmalignant respiratory diseases	470—527	10	8.18	122	8.80	114	54—209
Pneumonia/influenza	480—493	8	4.36	183	6.12	131	56—258
Other conditions	470—479, 494—527	2	3.82	52	2.58	75	9—270
All other causes	..	18	14.97	120	..	..	..

^a International Classification of Diseases, seventh revision.^b .. = rates not available.* $p < 0.05$, ** $p < 0.01$.

reduction was due to the decreased risks of death from almost all causes, including heart disease and non-malignant respiratory diseases. There were, however, statistically nonsignificant increases in the risk of mortality from stomach, lung, and colorectal malignancies.

Among the fur dressers (table 7), the slightly elevated total mortality (SMR 111) and the significantly increased risk of death from all malignancies combined (SMR 151, $p < 0.05$) reflected the significant-

ly higher than expected risk from lung cancer (SMR 232, $p < 0.05$). Mortality from colorectal cancer, as well as from nonmalignant respiratory diseases, was also slightly elevated. The fur service workers (table 8) experienced an overall mortality pattern slightly higher than expected compared to NYC white males. In this group, only risk of death from cardiovascular disease was significantly increased. Mortality from cancer of the colon and rectum was approximately 50 % above the expected level.

Table 8. Observed and expected deaths with standardized mortality ratios by cause of death among the retired fur service workers.

Causes of death	ICD ^a	United States			New York City ^b		
		Observed	Expected	Standardized mortality ratio	Expected	Standardized mortality ratio	Confidence limits (95 %)
All causes	000—999	104	88.60	117	92.96	112	91—136
Malignant neoplasms	140—205	21	15.32	137	17.91	117	73—179
Esophagus	150	1	0.33	303	0.46	217	6—1211
Stomach	151	2	1.03	194	1.48	135	16—488
Colon and rectum	152—154	5	2.27	220	3.36	149	48—347
Pancreas	157	1	0.87	115	1.01	99	3—552
Larynx	161	1	0.20	500	0.27	370	9—2064
Trachea, bronchus, lung	162—163	4	3.88	103	4.26	94	26—240
Genital organs	177—179	2	2.16	93	1.85	108	13—391
Bladder	181	2	0.71	282	0.87	230	28—830
Lymphatic	200—205	2	1.25	160	1.26	159	19—573
Other malignancies	.	4	5.65	71	..	..	..
Vascular lesion of the central nervous system	300—334, 345	5	10.50	48	6.73	74	24—173
Cardiovascular disease	400—468	64	44.96	142**	50.75	126*	101—161
Nonmalignant respiratory diseases	470—527	2	6.37	31	6.42	31	04—113
Other conditions	470—479, 494—527	2	3.37	59	2.23	90	11—324
All other causes	.	12	11.45	105	..	..	..

^a International Classification of Diseases, seventh revision.

^b .. = rates not available.

* $p < 0.05$, ** $p < 0.01$.

Table 9. Observed and expected deaths and rate ratios for lung cancer by birthplace and occupational category.

Birthplace	Observed : expected			Dressers		Dyers and service workers	
	Dressers	Dyers	Service workers	Standardized mortality ratio	Rate ratio ^a	Standardized mortality ratio	Rate ratio ^a
United States	0 : 0.3	1 : 1.2	2 : 1.0	—	—	136	1.1
Eastern Europe	5 : 1.6	4 : 2.8	1 : 1.4	314	2.8	120	1.2
Italy	4 : 2.3	9 : 5.6	0 : 0.4	172	1.6	148	1.5
Other countries	2 : 0.5	2 : 2.1	1 : 1.4	400	0.8	85	0.7
Total	11 : 4.7	16 : 11.7	4 : 4.2	234	2.2	126	1.2

^a Based on the age-adjusted mortality rate for lung cancer among white males in New York City (338 deaths per 10 000 annually).

Table 10. Observed and expected deaths and rate ratios for colorectal cancer by birthplace and occupational category.

	Observed : expected				Eastern Europe		Italy, United States and others	
	Eastern Europe	United States	Italy	Other countries	Standardized mortality ratio	Rate ratio ^a	Standardized mortality ratio	Rate ratio ^a
Dyers	5 : 2.6	1 : 0.7	5 : 5.0	1 : 1.6	189	1.7	96	0.9
Dressers	3 : 1.5	0 : 0.2	3 : 2.2	0 : 0.5	205	2.1	101	1.1
Service workers	2 : 1.2	2 : 0.7	0 : 0.4	1 : 1.1	166	1.1	137	1.6
Total	10 : 5.3	3 : 1.6	8 : 7.6	2 : 3.2	190	1.8	104	1.0

^a Based on the age-adjusted mortality rate for colorectal cancer among males in New York City (289 deaths per 10 000 annually).

Death rates for cancer and cardiovascular disease in the foreign-born population residing in the US are differentially distributed according to country of origin (11). In our study, the elevated SMR values and directly age-adjusted rate ratios suggested that risk of death from lung cancer was highest among the foreign-born fur dressers, particularly among those

from Eastern Europe (table 9). The slightly elevated mortality from colorectal cancer observed in all the fur worker categories appeared to occur the most often in Eastern European fur workers, regardless of job category (table 10), and this finding suggests that ethnic factors rather than occupational factors contributed to this observed increase (11, 22).

Discussion

The objective of this study was to examine the effects of long-term exposure to oxidative dyes on the mortality experience of an exposed worker population. Retired fur dyers were selected for study because of their long history of exposure to para-phenylenediamine and other dye components. Although objective quantitative measurements of dye exposure were not available from either the union or the dye shops, historical accounts of workplace conditions imply that worker contact with the dyes and the dyed furs was commonplace (35).

The findings of this study suggest that retired fur dyers are somewhat healthier than expected compared to men of NYC in general, particularly for cardiovascular disease and nonmalignant respiratory disease. This absence of increased overall mortality is consistent with the results of several previous studies of nondisabled retirees in other industries (6, 13, 29).

Due to the small number of deaths among the fur dyers in our study, the slight excesses in mortality from cancer of the stomach, colon and rectum, lung, and urinary organs do not provide clear evidence that oxidative dyes, and specifically para-phenylenediamine, are human carcinogens. However, they provide a lead for further follow-up and for studies of other fur dyer groups that also control for smoking and other potentially confounding factors.

One concern about retiree studies is that an occupational carcinogen might selectively manifest itself only at preretirement ages. Studies of coke oven workers (5, 31) and gas workers (6, 7) found this selection bias to be minimal. Significantly increased risks from lung cancer occurred in both retiree and nonretiree groups. The limitations of existing data on fur workers who left the industry before retiring do not permit evaluation of the magnitude of this potential bias in our study.

The significantly increased mortality from cardiovascular disease among fur service workers was an unexpected finding. SMR values for cardiovascular disease in other occupational cohorts of normal retirees are typically not elevated (5, 6, 12, 29). Furthermore, occupational exposures usually associated with increased risk of cardiovascular disease or sudden deaths due to cardiac failure, such as carbon disulfide (41), carbon monoxide (16), nitroglycerin (21), fluorocarbon aerosol propellants, freon, and halogenated hydrocarbons (33), are not suspected of being present to any great extent in the work environment of the fur service worker. The primary personal risk factors of cardiovascular disease, obesity, hypertension, diabetes, cigarette smoking, and family history of cardiovascular disease could not be evaluated with these data. If this excess risk is confirmed by further follow-up, then both previously unrecognized occupational risk factors and known personal risk factors should be investigated.

The etiology of the significantly elevated lung cancer mortality among the fur dressers may be a result of two presently unquantified factors, occupational exposures and cigarette smoking. During the early part of this century and through the late 1950s, chrome (hexavalent) tans were used extensively in the preparation of animal skins and hides (18). Neither intensity nor duration of exposure to chrome tans is documented; however, as little as 10–14 years of exposure to chromates by chromium ore reduction workers was responsible for a manifold excess of respiratory cancer (18). In addition, previous surveys have found elevated risks of lung cancer among furriers and tailors (10) and among shoemakers, leather workers, and leather tanners (32). However, none of these studies have considered smoking histories. Smoking histories for the fur dressers were also not available but would be a crucial component of any prospective follow-up of this cohort.

Conclusions

The primary purpose of this study was to assess the carcinogenicity of oxidative dyes in an occupationally exposed population. From historical accounts, fur dyers experienced considerable exposure to oxidative dyes, particularly the phenylenediamines which were also used in permanent hair dyes. Yet, when we compared the death rates for fur dyers to those of NYC males, we found no statistically significant increases in mortality for any cause.

Fur dressers were reported to have been exposed to hexavalent chromium and arsenic tans, and they experienced a significant increase in deaths from lung cancer. The significance of these findings and of the excess cardiovascular disease among service workers could be evaluated more thoroughly by a prospective follow-up of this cohort that assesses cigarette smoking and other risk factors of cardiovascular disease.

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