Cancer Mortality Among Textile Workers in Shanghai, China: A Preliminary Study

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Objective: *We assessed the association between cotton textile work and cancer mortality.* ***Methods:*** *The cancer mortality experience of 912 (444 cotton, 468 silk) textile workers in Shanghai, China, was compared. Workers were followed from 1981 to 2003. The associations between cotton textile work and death due to all cancers combined (with and without lung cancer) and to gastrointestinal cancers were estimated with Cox models, adjusting for age, work years, and pack-years.* ***Results:*** *There were 69 deaths. The adjusted hazard rate ratio (HR) was 2.10 (95% confidence interval [CI], 0.98–4.47) for all cancers combined and 2.56 (95% CI, 1.14–5.74) after excluding lung cancer. For gastrointestinal cancers, the adjusted HR was 2.09 (95% CI, 0.83–5.27).* ***Conclusions:*** *These preliminary data suggest that, with the exception of lung cancer, cotton workers have significantly higher cancer mortality rates than silk workers.* (J Occup Environ Med. *2006;48: 955–958*)

A number of mortality and cancer incidence studies found that cotton workers were healthier than the general population and experienced lower than expected rates of cancer.[1–5] However, these results were based on comparisons with the general population and may be biased by the healthy worker effect.[6] With regard to lung cancer, cotton dust exposure has been shown to have a protective effect, which is hypothesized to be related to the antineoplastic-mediating effects of endotoxin.[7] However, the association between cotton textile work and other site-specific cancers is unclear. Associations with specific cancers have been reported for larynx cancer in male workers,[2] non-Hodgkin lymphoma,[8] sinonasal cancer,[5] and gastrointestinal cancer.[2,9,10]

To better understand cancer mortality among cotton textile workers exposed to endotoxin-containing cotton dust, we compared the mortality experience of a group of cotton workers with a demographically similar group of silk workers in Shanghai, China, using Cox regression models. Workers were followed for more than 20 years from 1981 to 2003. This is the only mortality study of cotton textile workers to use an occupational cohort as a reference group.

Materials and Methods

Study Population

A cohort of textile workers followed in a longitudinal study on the respiratory health effects of cotton dust and endotoxin was assessed in this study for cancer mortality. The study population included 912 textile workers em-

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ployed for ≥2 years in the yarn preparation areas of two cotton textile mills in Shanghai and in a nearby silk-thread processing mill. One subject with an unknown date of death was excluded from the analysis.

Data Collection

Study procedures and data collection for the longitudinal study of respiratory symptoms are described elsewhere.[11] In brief, subjects had completed a modified ATS questionnaire and undergone pulmonary function testing at baseline in 1981 with subsequent follow ups in 1986, 1992, 1996, and 2001. Data on years worked, smoking status, and pack-years smoked were collected at each survey. Vital status through 2003 and cause of death was determined through records of the Shanghai Textile Industry Bureau, the death registry in Shanghai, and family members. Cancer cases were confirmed by pathologic or other diagnostic examination. Vital status was ascertained for all but one subject, who was censored on the date of last follow up. Subjects alive in 2003 were censored on March 1, 2003.

Statistical Analysis

Exposure status was dichotomized as cotton worker and nonexposed silk worker. Person-years of observation were accrued from the date of entry into the study in 1981 until the date of death or end of follow-up. Kaplan-Meier survival estimates were plotted to compare the survival experience of each group. The difference was tested with a log-rank test.

The associations between cotton textile work and cancer mortality were assessed with Cox regression models. Cancer mortality was examined with and without lung cancer cases. The small number of deaths precluded assessing site-specific cancers. Gastrointestinal cancers, however, were the largest subgroup of cancer and were assessed following the same multivariable model as for all cancers and cancers excluding lung cancer for comparability. Age (years) was used as the time scale in the model to most finely adjust for confounding. Potential confounders considered were years worked, smoking status (current smoker vs nonsmoker), pack-years smoked, and gender. Covariates were included if they changed the effect estimate by more than 10%. Akaike's information criterion was used to choose the best multivariable model.

To verify the proportional hazards assumption of the Cox model, an interaction term between the indicator for exposure and age was included in the proportional hazards model. Log cumulative hazard plots were also used to verify the proportional hazards assumption.

Results

Among the 912 workers, a total of 19,742 person-years of observation were accumulated. During an overall mean follow-up of 21 years, 69 deaths occurred (38 cotton workers, 31 silk workers). The mean follow-up time and distributions of age and gender were similar for cotton and textile workers (Table 1). Using silk workers as the reference group, mean percent predicted forced expiratory volume in 1 second (FEV_1) at baseline was slightly greater than expected in cotton workers (103.0; standard deviation, 19.6). There was no significant difference in baseline percent predicted FEV_1 in cotton workers by vital status (data not shown). Cotton workers were slightly older when starting work in the textile mill (20.9 ± 4.5 years) compared with silk workers (19.1 ± 4.3 years, $P < 0.0001$). In both groups, a greater proportion of the dead were male and ever smokers at baseline (data not shown). Deceased in both groups were also older at baseline and had been working approximately 10 years longer at study entry.

Overall mortality was similar, but cotton workers experienced significantly greater cancer risk ($P = 0.03$). This difference was more pronounced after exclusion of the lung cancer cases ($P = 0.01$; Fig. 1). Cotton workers also experienced significantly greater risk with respect to gastrointestinal cancers ($P = 0.05$). Unadjusted mortality rates per 100,000 person-years and corre-

TABLE 1
Characteristics of Cotton and Silk Textile Workers in Cohort

	Cotton		Silk	
	N	Percent	*N*	Percent
Total	444	100.0	468	100.0
Female gender	233	52.5	271	57.9
Deceased	38	8.7	31	6.6
Cause of death				
All causes of death	38	100.0	31	100.0
All cancers	24	63.2*	11	35.5
Gastrointestinal	17		7	
Lung cancer	1		2	
Stroke	8	21.1	12	38.7
Other	6	15.8	8	25.8
Percent predicted forced expiratory volume in 1 second at baseline, mean (SD)	102.5 (13.6)†		100.0	
Year of birth, mean	1943		1944	
Age at end of follow up, mean (SD)	57.9 (10.3)		57.0 (10.5)	
Age at death for decedents, mean (SD)	60.2 (9.9)		61.6 (9.7)	
Age started work, mean (SD)	20.9 (4.5)‡		19.1 (4.3)	
Years worked at baseline, mean (SD)	16.4 (10.4)		17.3 (11.8)	
Total yrs worked, mean (SD)	26.6 (8.7)		27.2 (10.2)	
Years followed, mean (SD)	21.6 (3.1)		21.7 (2.2)	

*$P = 0.02$.
†$P < 0.001$.
‡$P < 0.0001$.
SD indicates standard deviation.

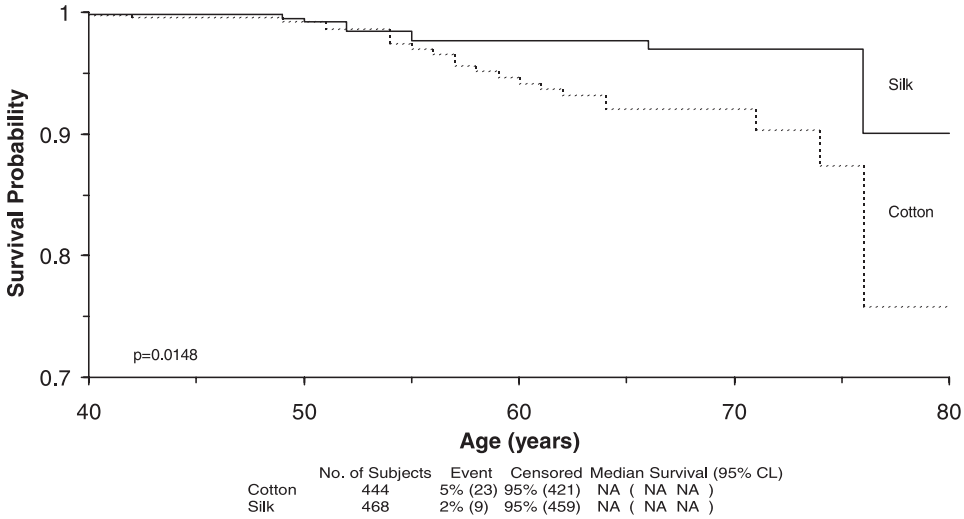

Fig. 1. Kaplan-Meier curves for cancer survival (excluding lung cancer) for cotton and silk textile workers.

TABLE 2
Crude Mortality Rates*

		All Cancers Combined		Cancers Excluding Lung Cancer		Gastrointestinal Cancer	
	Person-Yrs	No.	Deaths/10^5 Person-Yrs (95% CI)	No.	Deaths/10^5 Person-Yrs (95% CI)	No.	Deaths/10^5 Person-Yrs (95% CI)
Silk	9862	11	111.54 (45.62–177.45)	9	91.26 (31.64–150.88)	7	70.98 (18.40–123.56)
Cotton	9357	21	224.43 (128.44–320.42)	21	224.43 (128.44–320.42)	15	160.31 (79.18–241.43)

*Person-years with missing information on smoking were excluded from analysis.
CI indicates confidence interval.

TABLE 3
Hazard Ratio for Death Due to Selected Causes Among Cotton Workers Compared With Silk Workers, Adjusted for Work Years and Pack-Yrs of Cigarettes Smoked (from multivariable Cox regression models)*

	All Cancers			Cancers Excluding Lung Cancer			Gastrointestinal Cancers		
	HR	95% CI	*P*	HR	95% CI	*P*	HR	95% CI	*P*
Cotton vs silk worker	2.10	0.98–4.47	0.06	2.56	1.14–5.74	0.02	2.09	0.83–5.27	0.12
Work yrs	1.04	0.98–1.11	0.24	1.04	0.97–1.11	0.25	1.00	0.93–1.08	0.93
Pack-yrs	1.02	0.99–1.04	0.19	1.02	1.00–1.05	0.12	1.02	1.00–1.05	0.07

*Analyses based on 19,219 person-yrs of observation.
HR indicates hazard ratio; CI, confidence interval.

sponding 95% confidence intervals (CIs) are presented in Table 2. In general, the crude rate ratios were similar to the adjusted hazard ratios (HRs) obtained from Cox models (data not shown).

The multivariable Cox model included pack-years and work years. Gender was not included in the model with pack-years because few women smoked and was thus collinear with pack-years and did not further change the effect estimate. The adjusted hazard ratio for death from cancer comparing cotton to silk workers increased from the crude by approximately 10% to 2.10 (95% CI, 0.98–4.47, $P = 0.06$) (Table 3).

Exclusion of the lung cancer cases resulted in an adjusted HR of 2.56 (95% CI, 1.14–5.74, $P = 0.02$) for all other cancers combined. For death from gastrointestinal cancers, the adjusted HR was 2.09 (95% CI, 0.83–5.27, $P = 0.12$).

For all three models, an interaction term for age and exposure status was not significant in the model, thus suggesting the proportional hazards assumption of the Cox models was appropriate. However, log cumulative hazard plots showed some minor deviation from proportional hazards,

indicated by slight curvature of the plots at lower log cumulative hazard values.

Discussion

In this cohort study of cotton and silk textile workers, the overall mortality of cotton and silk workers was comparable. Cotton workers, however, had an increased risk of death from cancer in comparison to silk workers after adjusting for age, work years, and pack-years. The relative risk of death from cancer increased further when lung cancer deaths were excluded from the analysis. Although the number of deaths from lung cancer was small, an increased adjusted HR for cancer deaths after removal of the lung cancer cases is consistent with the pattern of reduced lung cancer rates observed in other cohorts of cotton workers[3,12–14] and in case–control studies.[15] Our findings also suggest that cotton dust-exposed textile workers were at increased risk of gastrointestinal cancers, which were the most common types of cancers observed. This association should be assessed further with larger populations potentially exposed to cotton dust or other organic endotoxin-containing dusts.

Our finding that cotton workers experienced a more than twofold increased risk of cancer differs from the results of other studies. This difference may be due to the use of general populations as the reference group in the other studies. Working populations are, in general, healthier than the general population. Comparing mortality rates between cotton and silk textile workers reduces bias from the healthy worker effect and better controls confounding from unmeasured factors such as socioeconomic status.[6] Some occupational mortality studies that have used both the general population as a reference group as well as an internal or external unexposed occupational reference population have found favorable mortality experiences of the population of interest in comparison to the general population while finding increased risks when compared to the occupational reference.[16,17]

Our findings reflect a small number of events and the earliest deaths in this cohort and are further limited by the small sample size of the cohort. However, workers were followed for more than 20 years to a mean age of 58 years among cotton workers and 57 years among silk workers, which is slightly younger than typical cancer death ages. Therefore, it is possible that the increased risk of death from cancer observed in this study may become more pronounced with extended follow-up. It is unlikely that some of the effect seen in cotton workers was due to exposures from other work because job mobility was restricted for this cohort and workers stayed in the same sector for their entire working lives. It is possible that the relative excess of cancer mortality among the cotton workers may be due to an unmeasured confounder that is protective against cancer among silk workers. However, we know of no such substances.

Future analyses of this cohort as follow-up is extended will determine whether these patterns persist. When we have sufficient power, we will take advantage of available data on cotton dust and endotoxin exposure to investigate an exposure–response relationship with cancer mortality.

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