ONLINE DATA SUPPLEMENT

Cross-Shift Airway Responses and Long-Term Decline in FEV_1 in Cotton Textile Workers

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Subjects and methods

The study subjects were selected from the initial cohort established in 1981, which consisted of 447 cotton workers from two cotton mills. The control group was selected from 472 silk workers from a silk mill. All of the mills were located in the same municipal area of Shanghai, China. Subsequent follow-up surveys were undertaken at almost every five years, i.e., in 1986, 1992, 1996 and 2001. The overall follow-up rates ranged from 74% to 86% over the 20-years.

Work status of both cotton and silk groups were relatively stable until the completion of the first three surveys (through 1992), when only a few dozen workers retired from textile industry. More than a half of the workers in both groups, however, retired by 1996, and nearly all did by 2001, largely because of closures of the mills. Cross-shift spirometric data were available at baseline, 1986 and 1992 surveys, while pre-shift spirometric data were obtained from each survey for both groups. Additionally, cross-shift data from 1996 survey were available in the cotton workers who then remained work. Eventually, 408 cotton and 417 silk workers were included in this analysis because of their available cross-shift measurements, which accounted for 91% and 88% of the original cotton and silk cohorts, respectively. Among them, 173 (42%) in the cotton group and 175 (42%) in the silk group had cross-shift FEV_1 data from all of three surveys, and 143 (35%) in the cotton and 141 (34%) in the silk had two of them.

A modified ATS standardized questionnaire was administered to collect detailed information with regard to work history, respiratory symptoms/diseases and smoking history at each survey. Inhalable air samplings on airborne cotton dust in various work area were measured using a Vertical Elutriator, and endotoxin assays were performed on the dust samples at all, but the last, surveys (Christiani, 2001). Estimated cumulative individual exposures to cotton dust and endotoxin were calculated in terms of workplace dust measurements and specific working period.

All spirometric maneuvers were performed in accordance with American Thoracic Society criteria (ATS, 1987) with consistent methodology, operated by same technicians.
An 8-L water-sealed filled spirometer (W. E. Collins, Braintree, MA), calibrated twice a day with a 3-L syringe was used to record spirometric maneuvers throughout the surveys. Forced expiratory spirograms were performed before and after work shifts on the first day back to work after a 2-day rest. Workers were required to refrain from smoking for at least 1 hour before performing the test. The best tracing of forced expiratory volume in one second (FEV_1) was derived from three acceptable curves that were allowed to vary by no more than 10% or 200 ml, whichever was greater. All values were corrected to conditions of body temperature and pressure saturated with water vapor (BTPS).

Cross-shift changes in FEV_1 (ΔFEV_1), which were calculated by post-shift FEV_1 subtracted from pre-shift FEV_1, denoted acute changes that were responses to cotton dust exposure; annualized changes in FEV_1 calculated based on differences in pre-shift measurements between consecutive 5-year surveys or over the entire 15 years of follow-up were used to express chronic changes. The primary focus of data analysis was to assess the relationship between acute airway response and longitudinal changes in lung function. Generalized estimating equations (GEE) model (Liang, 1986), which is capable of handling repeated and correlated measurements and making a full use of available data, was applied to fit repeated measurements. Identity link function and exchangeable correlation structure were used to construct the models. Specifically, two different models were constructed to achieve the goal of analysis:

The first model, using GEE, fit ΔFEV_1 data of both cotton and silk workers, measured at baseline, 1986 and 1992 follow-up surveys, as a primary predictor variable, along with other covariates and confounding factors including exposure status (cotton vs. silk), age, height, gender and smoking; subsequent 5-year period annual changes in FEV_1 over 15-years (with three-points through 1996) were incorporated in the model as outcome variable. All the variables, but exposure status and gender, were time-dependent (repeated measurements). Potential interactions between age, smoking and gender were examined as well. Then the similar model was applied in cotton workers only. Their ΔFEV_1 measurements were available at 1996 survey and included in the model as well. Annualized changes in FEV_1 over 20-years (with four-points through 2001) were incorporated as outcome variable. In addition to other covariates, as stated in the first model, estimated cumulative personal exposures to cotton dust and endotoxin, and years since retirement were also added to the model.

The second model, using multiple linear regression approach, was constructed to determine the association between repeated acute drops and chronic declines in FEV_1. The data of cotton and silk workers were analyzed in separate modes. The outcome variable was annualized change in FEV_1 over 15-years, which was computed by dividing the difference in FEV_1 between baseline (1981) and 1996 by 15. Acute drop, as a predictor variable, was defined as a binary variable, in which 1 was assigned if ΔFEV_1 below 0, otherwise 0 was assigned. Then, repeated acute drops were defined as *none, once*, *twice* and *thrice* based on the occurring frequency up to 1992. Three dummy variables were defined with *none* as the referent. Meanwhile, gender, age, height and smoking status were included in the models. In addition to using all available data in cotton and silk workers, similar analysis was performed, restricting to 173 cotton and 175 silk workers who had completed measurements of ΔFEV_1 from all three surveys. All of the analysis was carried out using the SAS personal computer software (version 9.1, 2002) (SAS Institute Inc., Cary, NC).