ORIGINAL ARTICLE

A cross sectional study of the respiratory health of workers handling printing toner dust

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Background: Although recent case reports have suggested possible respiratory effects of solid toner dust inhalation, this hypothesis has not been verified by epidemiological studies.
Objectives: To conduct a cross sectional study to evaluate the association between the biological indices of lung fibrosis and toner dust exposure in an occupational cohort handling solid toner dust in their work life.
Methods: A total of 600 male toner workers and 212 control subjects were surveyed in terms of their subjective respiratory symptoms, pulmonary functions, and chest radiographic findings. In addition to the exposure history, the current working conditions and personal exposure levels to toner dust were also examined.
Results: Although subjects handling toner for more than 20 years tended to show a higher prevalence of respiratory symptoms and minimal chest x ray abnormalities, there was no consistent relation between the exposure to toner dust and the biological responses of the respiratory system.
Conclusion: Deterioration of respiratory health related to toner dust exposure is less likely to occur in current well controlled work environments, especially if the powdered toner is handled carefully. Nonetheless, it is important to collect further epidemiological evidence on the biological effects of toner dust inhalation, preferably using a longitudinal study design.

As a result of rapid progress in office and home automation, the number of instruments used for computing, information, and communication has steadily increased in developed countries. Among these are laser printers, facsimiles, and photocopier machines, which use powdered toner for printing characters and images. Thus, a substantial section of the population may currently be exposed to this toner dust.

The adverse effects of photocopier toner dust have, until now, been considered to be minimal. However, several recent reports have suggested possible significant adverse health effects from toner dust inhalation.[1–3] Gallardo and co-workers reported a case of siderosilicosis,[1] and Armbruster and co-workers reported a case of granulomatous pneumonitis[2] possibly related to toner dust inhalation at the workplace. Furthermore, the size of the toner particles has also been progressively decreased to improve the quality of printing. These smaller sized particles penetrate deeper into the respiratory system and are more likely to be deposited in the lungs when inhaled. Until now, however, there have been no epidemiological studies evaluating the effects of toner dust exposure on the respiratory health in a human population sample. In this study, we conducted a cross sectional survey of several health related respiratory parameters among workers handling toner dust in their work life, in order to accumulate some scientific evidence regarding the risk of adverse respiratory effects associated with toner dust inhalation.

METHODS

Subjects

The subjects were male workers, ranging in age from 20 to 61 years, selected from a business machine producing company and a regional branch of an affiliated maintenance service company; they consisted of all those who handled powdered toner routinely in their current work life and randomly selected controls of similar age distribution. Of the total of 845 subjects selected, 627 were exposed workers and the remaining 218 were controls.

Three major categories of toner handling were identified; involvement in the production of powdered toner materials, development of machines using powdered toner, and maintenance of these machines for customers. Workers engaged in the production of toner were exposed to the toner dust on a regular basis at fixed workplaces, where the environmental levels of the dust were maintained at relatively low levels. On the other hand, those involved in machine development work were exposed occasionally to toner dust at laboratories, where environmental regulation was sometimes insufficient and the toner dust concentration reached relatively high levels; however, the exposure was irregular and also infrequent. Machine maintenance workers handled toner materials while conducting maintenance work at customers' offices; they were exposed to toner dust intermittently, but regularly. Thus, the work environments were inconsistent and varied among customers' offices depending on each one's maintenance of the office environment.

Measurement of the health outcomes

A survey of the health status of the workers was conducted twice during the same months of two consecutive years, under the approval of the Institutional Review Board on medical ethics of Showa University. Before each of the surveys, the objectives and outline of the study were explained to the subjects, and written informed consent was obtained from each participant.

Questionnaire survey: detailed information regarding respiratory symptoms, allergic symptoms, past medical history, and lifetime smoking history was obtained using a translated version of a self administered questionnaire standardised by the American Thoracic Society (ATS), with slight modification.[4] The responses were checked by several

Abbreviations: ATS, American Thoracic Society; ILO, International Labor Organization; JSIH, Japan Society of Industrial Health

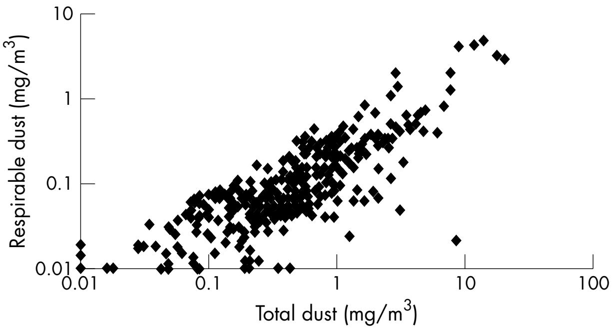

Figure 1 Two way scattergram of personal exposure levels. Total dust concentration on the abscissa is plotted against the respirable fraction on the ordinate.

trained interviewers and supplemental interviews were held when necessary. Information on the lifetime working history was also confirmed at this interview.

Three chronic respiratory symptoms, namely, chronic cough+phlegm, chronic wheeze, and breathlessness were selected as the outcome variables for comparison by the pattern of toner exposure, because they are all closely related to fibrotic lung changes. Chronic cough+phlegm was considered to be present when the duration of both cough and phlegm exceeded three months in a year. Chronic wheeze was considered to be present when the subject suffered from the symptom in the absence of a cold, or on most days/nights. Breathlessness was considered to be present when a subject walked slower than his counterparts of the same age on level ground.

Chest *x* ray findings: chest radiography was conducted using prescribed standard procedures to detect mineral dust pneumoconiosis in Japan.[5] All *x* ray films were read by a single reader with sufficient experience in the radiographic diagnosis of pneumoconiosis. He conducted a single reading session for each film, always referring to standard films for the diagnosis,[6] while having no information regarding the exposure status of the subjects. The severity of the changes in the lung fields was classified into 12 grades, from 0/− to 3/+, according to the distribution and density of the small opacities. This classification was compatible with that of the International Labor Organization (ILO).[7]

Pulmonary functions: subjects were asked to repeat the forced expiratory manoeuvre up to a maximum of five times in the standing position, in order to obtain acceptable and reproducible spirometric results. The mechanical specifications of the spirometer used (DISCOM-21FX2, CHEST Co Ltd, Japan) met the standards stipulated by the ATS.[8] Routine BTPS correction and back extrapolation were carried out. Calibration of the spirometer, spirometric measurements, and evaluation of the results were based on prescribed procedures, described in detail elsewhere.[9]

To adjust for differences in the body size, height squared proportional values of forced vital capacity (FVC/HT2), forced expiratory volume in one second (FEV1/HT2), and maximal expiratory flow at 50% and 25% FVC (MEF50/HT2 and MEF25/HT2, respectively), as well as the percentage FEV1 by FVC (FEV1%), were calculated from the best manoeuvre yielding the largest sum of FVC and FEV1.[10]

Exposure evaluation

Exposure assessment was conducted in two ways. Firstly, the concentration of the toner dust in the work environment was measured by collecting air samples from some fixed points considered to represent the actual environmental condition at the workplace. The distribution was evaluated using several percentile values. The other method was direct measurement of the individual exposure concentration in the subjects. The personal exposure level was measured at least once in about 20% of all the subjects—that is, in 150 subjects in the first year and 200 subjects in the second year of the study.

Analysis

For comparison of the health outcomes, the current work type and the cumulative years spent in toner handling were used. The former was taken as an index of the current exposure status, and the health outcomes in the subjects engaged in the three types of toner handling work were compared with those in the control group. The latter, ranging from one to 31 years, was taken as an index of the cumulative exposure status, and was divided into four categories: Never (control subjects), 1–10 years, 11–20 years, and 21 years or over.

Chi square test and Fisher's exact test, as well as multiple logistic regression analysis were conducted to analyse the rates, and analysis of covariance was employed to analyse the numeric variables, with the alpha error level set at 0.05. All

Table 1 Current working category and exposure level

	Working category*		
	Toner production	Machine development	Machine maintenance
Example of work	Crushing Mixing Bottling	Toner supply Testing Dissembling	Cleaning Toner bottle replacement Repairing
Work environment (mg/m^3)	0.09 (0.04, 0.21)	0.03 (0.01, 0.09)	0.03 (0.01, 0.07)
Personal exposure (mg/m^3)			
Total	0.5 (0.09, 2.3)	0.2 (0.05, 2.8)	1.0 (0.8, 1.8)
Respirable	0.09 (0.03, 0.4)	0.06 (0.01, 0.7)	0.2 (0.08, 0.4)
Exposure duration (years)†	7.7 (5.8)	9.1 (5.7)	12.3 (5.1)
Decade of starting work in toner dust environments†‡			
1970s	6 (4.2)	2 (1.8)	21 (6.2)
1980s	31 (21.8)	43 (38.1)	197 (58.3)
1990s	105 (73.9)	68 (60.2)	120 (35.5)

*The 212 control subjects are excluded from this table.
†Excluding seven subjects with unverified exposure length.
‡Percentage of column total in parentheses.
Values are the median, and the 10th and 90th percentiles for work environment and personal exposure measurements, the arithmetic means and standard deviations for the duration of exposure, and the number of subjects starting work in toner dust environments in the 1970s, 1980s, and 1990s.

Table 2 Comparison of the possible confounding factors among the different exposure categories

		Exposed						
			Current work type*			Cumulative exposure length, years†		
	Control	Total	Production	Development	Maintenance	1–10	11–20	21+
Surveyed, n	212	600	142	114	344	271	295	27
Age (years)	38 (9)	35§ (8)	39 (11)	36§ (6)	32§ (5)	33§ (9)	35§ (5)	44§ (5)
Height (cm)	170 (6)	171 (6)	170 (6)	171 (5)	172§ (6)	171 (6)	171 (6)	170 (6)
BMI (kg/m^2)	23 (3)	23 (3)	23 (3)	23 (3)	23 (3)	23 (3)	23 (3)	23 (4)
Smoking habit‡								
Never	58 (27)	157 (26)	32 (23)	45 (40)	80 (23)	84 (31)	64 (22)	7 (26)
Former	27 (13)	71 (12)	17 (12)	21 (19)	33 (10)	31 (12)	36 (13)	3 (11)
Current	127 (60)	371 (62)	93 (65)	47 (41)	231 (67)	155 (57)	195 (66)	17 (63)

*Production: toner production; development: machine development; maintenance: machine maintenance.
†Excluding seven subjects with unverified exposure length.
‡One machine development worker with a duration of exposure of 1–10 years was excluded because of unspecified smoking history.
§Significant difference from the mean value in the control group by analysis of variance.
The figures show the means (standard deviation) for age, height, and body mass index (BMI), and the number of subjects (% of the column total) with a current smoking habit.

statistical tests and estimations were carried out using the SAS statistical package on a personal computer (PC-SAS version 6.12).

RESULTS

Of the total of 845 workers initially selected, 33 did not participate in this study; of the 33, 27 were exposed workers (two, six, and 19 workers in toner production, machine development, and maintenance work, respectively) and six were controls. There were no significant differences in the participation rate among the work categories. The mean (SD) age of the participants and non-participants was comparable, namely, 35.6 (8.3) and 34.8 (7.7) years, respectively. Four hundred and thirty subjects participated in both the surveys, while 64 participated only in the first survey and 318 participated only in the second one. Preliminary analyses conducted separately on the data obtained from the two surveys revealed no significant differences. Therefore, for the subsequent analyses, we basically used the data from the second year when acceptable measurements were available from both the surveys.

Table 1 describes the several aspects of the toner dust exposure status as stratified by the current working categories. There seemed to be an inverse correlation between the current exposure level to toner dust and the exposure duration of the workers; subjects engaged in machine maintenance work had a significantly longer duration of exposure than those in the other two categories, whereas the ambient toner dust concentration was higher in areas of toner production work as compared with that of machine development and machine maintenance work, which showed similar concentrations. However, the concentrations in all of these work areas were well below the threshold limit of exposure for harmful dusts as stipulated by the Japan Society of Industrial Health (JSIH).[11] The personal exposure levels also varied widely, as shown in figure 1. The values for several individuals exceeded the exposure limit set by JSIH,[11] although the estimations were based on relatively short durations of air sampling. As expected from the results obtained in relation to exposure duration, maintenance workers tended to start toner handling work earlier in their work history than other work categories.

Table 2 summarises the distribution of the potential confounding factors stratified by the exposure categories. Only a significant difference in age was revealed in the comparison between the control and the exposed groups as a whole, as well as in the comparison among the subcategories of exposure. Other factors were comparable among the exposure categories, except that the frequency of smoking tended to be lower among the machine development workers

Table 3 Respiratory symptoms according to the exposure category

	Respiratory symptoms					
	Chronic cough+phlegm		Chronic wheeze		Breathlessness	
	Prev	OR (95% CI)†	Prev	OR (95% CI)†	Prev	OR (95% CI)†
Control	4.7	1.00	3.8	1.00	3.1	1.00
Exposed						
Total	2.5	0.61 (0.26–1.43)	6.5	1.81 (0.82–4.00)	1.9	0.64 (0.22–1.81)
Current status*						
Production	3.6	0.74 (0.25–2.22)	7.8	2.14 (0.84–5.45)	0.8	0.24 (0.03–2.03)
Development	1.8	0.48 (0.10–2.27)	7.0	1.91 (0.69–5.28)	3.7	1.40 (0.37–5.30)
Maintenance	2.4	0.57 (0.21–1.60)	5.8	1.60 (0.66–3.84)	1.8	0.67 (0.26–1.77)
Cumulative status						
1–10	3.0	0.78 (0.29–2.09)	8.5	2.49 (1.07–5.81)	1.6	0.54 (0.15–2.02)
11–20	1.7	0.38 (0.12–1.15)	5.1	1.43 (0.59–3.48)	2.3	0.72 (0.23–2.23)
21+	7.4	1.57 (0.31–7.82)	3.8	0.92 (0.19–4.54)	0	–
Confounders						
Age (/10 years)	–	1.38 (0.88–2.16)	–	1.05 (0.73–1.52)	–	1.09 (0.61–1.95)
Smoking (/pack)	–	2.28 (1.21–4.33)	–	0.96 (0.74–1.23)	–	1.26 (0.85–1.89)

*Production: toner production; development: machine development; maintenance: machine maintenance.
†Prev: crude prevalence; OR: odds ratio; CI: confidence interval.
Values shown are the crude prevalence and odds ratio, estimated by logistic regression analysis, for each exposure category relative to those for the control group, after adjustment for age and smoking status. The effects of age and smoking as confounding factors in these regression models are also shown.

Table 4 Comparison of pulmonary function indices by exposure variables

	Pulmonary function indices									
	FVC/HT2		FEV1/HT2		MEF50/HT2		MEF25/HT2		FEV1%	
	Mean (SD)	b (SE)†	Mean (SD)	b (SE)†	Mean (SD)	b (SE)†	Mean (SD)	b (SE)†	Mean (SD)	b (SE)†
Control	1480 (170)	–	1220 (160)	–	1590 (500)	–	570 (290)	–	82.6 (7.0)	–
Adjusted means and effect of exposure										
Total	1520 (170)	20 (14)	1270 (160)	19 (12)	1660 (470)	12 (38)	620 (270)	−4 (19)	83.9 (6.2)	0.1 (0.5)
Current status*										
Production	1500 (190)	16 (18)	1240 (190)	16 (16)	1570 (490)	−18 (50)	580 (300)	5 (25)	82.7 (6.7)	0.1 (0.6)
Development	1540 (150)	37 (20)	1280 (140)	33 (17)	1660 (450)	15 (54)	620 (270)	17 (27)	83.7 (6.4)	0.2 (0.7)
Maintenance	1520 (170)	15 (15)	1290 (150)	15 (14)	1700 (460)	27 (42)	630 (250)	−16 (22)	84.4 (5.8)	0.1 (0.5)
Cumulative status										
1–10	1530 (170)	25 (16)	1300 (170)	32 (14)‡	1690 (480)	23 (44)	680 (310)	33 (22)‡	84.9 (6.7)	0.6 (0.6)
11–20	1520 (170)	22 (15)	1260 (150)	15 (13)	1640 (450)	11 (42)	570 (210)	−33 (21)	83.2 (5.4)	−0.3 (0.5)
21+	1420 (150)	−36 (34)	1150 (140)	−32 (30)	1460 (500)	−60 (94)	460 (170)	−17 (48)	80.9 (6.7)	−0.2 (1.2)
Confounders										
Age	–	−45 (7)	–	−80 (6)	–	−137 (20)	–	−147 (10)	–	−2.9 (0.3)
Smoking	–	−7 (10)	–	−21 (9)	–	−74 (28)	–	−44 (14)	–	−1.1 (0.4)

*Production: toner production; development: machine development; maintenance: machine maintenance.
†Mean: crude mean; SD: standard deviation; b: regression coefficient; SE: standard error.
‡Significantly negative tendency ($p<0.01$) associated with exposure duration.
Values shown are the crude arithmetic mean (standard deviation) and independent effect for each exposure category after adjustment for age and smoking status, estimated as regression coefficients in analysis of covariance models. The effects of age and smoking as confounding factors in these regression models are also shown.

as compared with that in the other categories. Thus, it was considered that a comparison of the biometric parameters should take into consideration differences in the age and smoking status, where necessary. It should also be noted in the following analyses that the number of workers in the 21+ subcategory (the group with the longest cumulative years of exposure) was rather small as compared to that in the other three groups.

The prevalence of chronic respiratory symptoms was generally found to be comparable among the exposure categories, as shown in table 3. Only 1.9% of the subjects in the exposed groups complained of breathlessness, a typical subjective respiratory symptom of pneumoconiosis. Similarly, the prevalence of chronic cough+phlegm, as an indicator of chronic bronchitis, was only 2.5% in the exposed workers. However, the prevalence of chronic wheeze was slightly higher in the exposed group, as a whole, as compared to that in the control group. This slight increase in prevalence of wheezing was noted in all the three toner exposure groups, although the differences from the control group were not statistically significant. The odds ratio of chronic wheeze was highest in the 1–10 years' exposure category, and was inversely correlated with the cumulative length of exposure.

Table 5 Chest *x* ray abnormalities by exposure categories

	Fibrotic changes	
	n (%)	OR (95%CIs)
Control	6 (2.9)	1.00
Exposed		
Total	22 (3.7)	1.78 (0.68–4.60)
Current status*		
Production	8 (5.6)	1.87 (0.63–5.57)
Development	5 (4.4)	1.64 (0.58–7.05)
Maintenance	9 (2.7)	1.53 (0.48–4.86)
Cumulative status		
1–10	9 (3.4)	1.59 (0.54–4.69)
11–20	9 (3.1)	1.44 (0.48–4.29)
21+	4 (14.8)	4.66 (1.21–17.89)
Confounder		
Age	–	1.99 (1.33–2.98)

*Production: toner production; development: machine development; maintenance: machine maintenance.
Figures represent the number of subjects who had chest *x* ray abnormalities. The prevalence is also shown in parentheses. The odds ratio (OR) and 95% confidence interval were obtained after adjustment for age in multiple logistic regression analysis.

Table 4 compares the crude arithmetic mean (SD) of the pulmonary function indices and the expected contribution of each work category estimated as a regression coefficient in covariate analysis models, after adjustment for age and current smoking amount. No significant differences by the current exposure status were observed in these indices. In fact, the indices were slightly better in the exposure groups than in the control group. However, in the comparison by cumulative exposure status, the longest cumulative exposure group tended to show lower pulmonary function values as compared with the other groups, even after adjustment for age and smoking habit; a strong tendency towards decline in relation to the length of exposure was significant in the FEV1/HT2 ($p = 0.04$) and MEF25/HT2 ($p = 0.02$). Multivariate analyses revealed a significant contribution of age and smoking habit on pulmonary function, which is consistent with the results of many previous studies.[12]

In this study, no typical pneumoconiotic changes were observed in any of the subjects. Only atypical and small irregular opacities were observed in a small number of subjects. Therefore, in table 5, the subjects are classified as being positive for radiographic abnormalities, even when there were only atypical or minimal changes. All of the six positive subjects in the control group had grade 0/1 changes, representing the mildest positive change in the 12-grade classification, whereas 15, six, and one out of the 22 positive subjects in the exposed group had changes classified in the 0/1, 1/0, and 1/1 categories, respectively. After adjustment for age as a potential confounding factor, all the three current work groups showed an insignificant but similarly elevated OR (ranging from 1.53 to 1.87) compared with that in the control group. Although the number of subjects was small, the 21+ years' exposure group showed a significantly higher prevalence rate of radiographic abnormalities than the control group.

DISCUSSION

Various types of mineral dusts have been reported to cause fibrotic changes when inhaled deeply into the lungs. These changes can be detected in chest radiographs as small or irregular opacities in the lung fields. The diagnostic standards for these changes have already been established by the ILO and other authorities. Fibrotic changes in the lung periphery also result in deterioration of the pulmonary functions. This can be detected by conventional spirometric measurements, for which reliable reference values are easily available.

In this study, these established diagnostic methods were also employed in addition to the subjective symptoms, as outcome variables. Almost none of the comparisons of these biological parameters, however, revealed any significant differences associated with toner dust exposure. None of the exposure categories showed reduced pulmonary functions or increased frequency of chest *x* ray abnormalities or respiratory symptoms. No tendency towards increased frequency of abnormalities in these variables related to the cumulative exposure length was consistently observed. Thus, no definitive evidence of fibrogenic effects attributable to toner dust inhalation at the workplace was found in this study.

Using standardised procedures, we found differences in the outcome variables associated with age and the smoking habit in multivariate analyses, consistent with previous reports; there was an increase in the frequency of chronic cough+phlegm and chest *x* ray abnormalities, and decrease in the spirometric measurements, in association with smoking and/or aging. In these multivariate analyses, current smokers and older subjects could be considered as the so-called ''positive controls''. Thus, we consider that the outcome variables employed in this study to detect possible changes in the respiratory system were appropriate.

Because of the cross sectional nature of this study, it would have been difficult to differentiate the effects of current exposure from those of cumulative exposure, even if significant changes related to exposure were found. In the comparison by the current exposure status, similarly increased odds ratios for chronic wheeze and mild chest *x* ray abnormalities were observed in all the three work groups. In the comparison by the cumulative exposure status, on the other hand, the exposure groups tended to show reduced values of FEV1/HT2 and MEF25/HT2 in proportion to the length of exposure. However, these changes were not statistically significant. The prevalence of mild radiographic abnormalities was clearly higher in the group with the longest cumulative length of exposure, but the number of subjects in this group was small. Thus, it would be difficult to reasonably conclude that these findings were the adverse effects of toner exposure.

Since we evaluated the respiratory outcomes using data only from current workers at the time of this study, some selection bias may have affected the results of this study. For example, subjects with serious health problems potentially related to cumulative exposure to toner dust may have quit the toner handling occupation. In such a scenario, cross sectional evaluation of the current work population may underestimate the effects of toner exposure. Actually we found an inverse relation between the exposure levels and the exposure duration in the study subjects. This might have resulted in a health related selection bias in this study because of the relatively small number of exposed workers with sufficient exposure dose to induce health deterioration. Another noteworthy observation in this context was that while the odds ratio for chronic wheeze in the 1–10 years' exposure category in terms of the cumulative exposure status was apparently elevated, that in the 11–20 years' or 21+ years' exposure groups was not. This finding may suggest the possibility that toner dust causes some irritation or elicits an allergic response, resulting in these subjects being laid off toner handling work. In order to avoid this type of bias, a longitudinal evaluation of the workers' respiratory health is necessary.

As to the overall quality of this study, we achieved high participation rates that were comparable among the job categories. Although there was limited availability of the personal data of the non-participants, the age distribution among the participants and non-participants was comparable. Therefore, it would seem reasonable to conclude that the selection bias on account of the non-participants was unlikely.

The exposure measurement data in this study indicated that the working environment, on average, was well controlled, in reference to the guidelines in Japan, as described before.[11] This current status is, in all likelihood, a result of gradual improvement of the work environment and of the procedures used for handling toner materials. In other words, it may be assumed that the exposure levels in the work environment in the past may have been higher than the levels today, and that the current health status of each subject would also reflect on the effects of past exposure. However, no health deterioration consistently attributable to toner dust inhalation was revealed in this study. These results suggest that the current exposure levels may be sufficiently safe in terms of their effects on workers' health, particularly if toner materials are handled with care. At this point, however, it must also be pointed out that the inhalability of toner particles into the peripheral regions of the lungs appears to be increasing because of the progressive decrease in the size of the particles. Another important observation is that a large variability was observed in relation to the results of the personal exposure data. Careless handling of toner may result in unexpectedly high levels of exposure, even if the environmental condition is appropriately regulated.

In conclusion, this cross sectional survey of workers handling powdered toner suggested that the likelihood of respiratory health deterioration occurring in relation to toner dust exposure is rather low in current well controlled work environments. However, significant differences in the respiratory symptoms and pulmonary function indices were observed in several comparison settings, and insignificant, though consistent, increases in the prevalence rates of mild atypical radiographic abnormalities and chronic wheeze were noted in all three exposure categories in this study. Some limitations of this study must also be mentioned here, although the study itself appears to have been carried out reasonably satisfactorily: the unavailability of exposure measurements for the early years, the small number of workers with long duration of exposure, and the health related selection bias because of the cross sectional nature of the study. These results and considerations suggest that

Main messages

- Respiratory health deterioration related to toner dust exposure is less likely to occur in current well controlled work environments, especially if the powdered toner is handled carefully.
- Large variability exists in personal exposure levels to toner dust, even for similar concentrations of particles in the environment.

Policy implication

- Further epidemiological evidence should be accumulated on the possible biological effects of inhaled powdered toner used in printing devices, preferably using a longitudinal study design.

efforts to examine the possible fibrogenicity of toner dust must be continued and that further epidemiological evidence on the biological effects of toner dust inhalation should be accumulated, preferably using a longitudinal study design.

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