Comprehensive health evaluation of workers in the ceramics industry

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Abstract

A cross sectional study on ceramics workers in the Seto area of Japan was conducted to determine whether there are differences in the morbidity pattern and overall health among the working populations employed by different sized companies engaged in the ceramics industry. The study population consisted of 3324 male ceramics workers (age range 40-69) who participated in the Seto occupational health screening programme in 1990. The prevalences of pulmonary diseases (silicosis and tuberculosis) and findings of some non-pulmonary diseases were compared in terms of company size by categories of 1-19, 20-49, 50-99, and 100 or more employees. The values of various screening tests were subjected to principle component analysis to extract factors representing key indices of health state. The average factor scores stratified by company size were used to quantitatively evaluate the comprehensive health level. Both prevalence and multivariate analysis showed that the employees working for smaller companies had overall worse health. The smaller the company, the higher the prevalence and the lower the health scores for silicosis and pulmonary tuberculosis tended to be; significantly increased rates and lower health scores for hypertension, anaemia, and glucosuria among small companies were also found when compared with larger companies. The high morbidity of silicosis and pulmonary

tuberculosis in smaller companies contributed most to the decline in the overall health level.

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It is well recognised that workers engaged in ceramics-related industries are at risk for pulmonary disease, lead poisoning, and other toxic reactions caused by exposure to clays, glazes, and kiln emissions.¹ A high incidence of silicosis and pulmonary tuberculosis (TB) in the Japanese ceramics working population has been reported during the past several decades.²⁻⁶ Most companies in the Japanese ceramics industry are small, employing less than 50 workers, sometimes in cottage industries or in the home. Some previous investigations have indicated that the incidence of silicosis and silico-tuberculosis in such small ceramics firms was significantly higher than that in larger ones.²⁻⁵ The poor environmental conditions and the lack of protective equipment in these smaller companies are key contributing factors in the development of occupational disease. Small companies generally have longer and irregular working hours, a higher percentage of elderly employees, limited opportunities for health education or health inspection, and insufficient health promotion facilities compared with large companies. Although these factors are considered to play an important part in the development of occupational diseases, and some non-specific diseases such as psychosomatic, cardiovascular, and locomotor diseases,⁷ little research has been carried out with respect to how these factors that type small firms in the ceramics industry influence the morbidity pattern and overall health state of the working population.^{8,9}

The present study was set up to establish the characteristics of the morbidity pattern of pulmonary and non-pulmonary diseases or health risk factors in ceramics workers of the Seto area, a well known centre for ceramics craftsmanship in Japan. We focused our attention on the comprehensive evaluation and comparison of the overall health of workers employed by different sized companies. We attempted to clarify any decline in the overall health level,

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Table 1 Characteristics of male ceramics workers (age range 40–69) participating in Seto health screening programme in 1990

Company size (No of employees)	Company		No of participants	Age (y)		Working duration (y)*	
	No	%		Mean	SD	Mean	SD
1–19	358	(75.7)	969	53.1	7.1	19.3	12.2
20–49	77	(16.3)	943	52.7	6.9	16.8	12.1
50–99	24	(5.1)	691	51.9	6.5	16.7	11.2
100–	14	(3.0)	721	51.7	6.8	20.1	10.9
Total	473	(100.0)	3324	52.4	6.9	18.2	11.7

*The employment duration for the present job.

both as to occupational pulmonary diseases and other non-specific, chronic diseases, among the working population of the small companies in the ceramics industry of the Seto area.

Population and methods

STUDY POPULATION

Seto city, located in central Japan, boasts a ceramics tradition of over 1000 years. The main products are tableware, novelties, electromagnetic materials, and ceramic tiles. In this area, about 11 000 workers, or about 65% of the regional manpower, are currently engaged in work related to ceramics. The Seto Health Service Centre, which was established under the sponsorship of the Seto Pottery Federation in 1954, has been providing the occupational health services to regional industry by pooling financial resources in a cooperative scheme. In 1990, 8186 regional ceramics workers (men 4954, women 3232) from 473 companies participated in the Seto occupational health screening programme. Among them were 3369 male ceramics workers aged between 40 and 69, and they were chosen as our study population. After exclusion of 45 subjects whose data were not complete, 3324 subjects were finally enrolled in this study. Table 1 presents characteristics of the study population in terms of company size.

HEALTH EVALUATION

The occupational health screening protocol consisted of an interview to obtain the medical history, family history, and occupational history, a general physical examination, the measurement of body weight, height, and blood pressure, a battery of biochemical studies on blood (blood cell count, liver function tests, serum lipid metabolism), urinalysis, a resting electrocardiogram, audiometric test, and 8 × 8 cm chest x ray film examination. The assessment of the clinical data was by an occupational physician. x Ray films were reviewed independently by at least two trained physicians. The diagnosis of silicosis was made by radiographic appearances and a positive history of exposure to dust. If a suspected case of silicosis or TB was found, a larger radiograph was taken and evaluated by trained experts. The

classification of silicosis and pulmonary TB was based on Japanese criteria.^{10,11}

DATA ANALYSIS

All information from the health screening was keyed into an NEC-9801 personal computer. The statistical analysis was performed using a numerical analysis program package for medical sciences (NAP).¹² The prevalences of various clinical findings stratified by company size were compared with a χ^2 test. The method proposed by Tanaka *et al*¹³ was used to quantitatively evaluate and compare the overall health level among the population subgroups. Briefly, principal component analysis was conducted to reduce a matrix of correlations between various medical test items to a smaller number of representative dimensions or factors. The factor scores of each extracted factor were averaged by company size. Then, the mean factor scores were simplified to a 10 grade estimation, and the sum of the simplified scores, T, was used as the index of overall health level. Tanaka *et al*¹³ indicated that this method could be used to quantitatively evaluate the comprehensive health state of a community with a small population.

Results

A total of 473 ceramic companies participated in the Seto health screening programme in 1990. Among them, 358 companies (75.7%) employed less than 20 workers, and 77 companies (16.3%) employed between 20 and 49 workers (table 1). The subjects enrolled in this study were stratified by company size in the categories of 1–19 employees, 20–49 employees, 50–99 employees, and 100 or more employees. The mean ages of the subjects for each category at the time of the survey were 53.1, 52.7, 51.9, and 51.7 years respectively. No significant differences in mean age were found between the subgroups compared. Table 2 shows prevalences of various clinical findings. A high prevalence of silicosis (17.4%) and pulmonary TB (14.1%) was found with a clear tendency for workers in smaller companies to show higher prevalences of dust related pulmonary diseases than in larger ones. The analysis by age also

Table 4 Average factor scores (FS) and simplified scores (SS) calculated by company size

Company size (No of employees)	Factor 1		Factor 2		Factor 3		Factor 4		Factor 5		Factor 6		Factor 7		Factor 8		Total SS (T value)
	FS	SS	FS	SS	FS	SS	FS	SS	FS	SS	FS	SS	FS	SS	FS	SS	
1-19	-0.025	5	-0.072	4	-0.122	3	-0.343	0	0.072	4	-0.036	5	0.044	5	0.025	5	31
20-49	-0.054	4	-0.053	4	-0.114	3	-0.089	4	-0.026	5	0.002	5	-0.107	4	0.005	5	34
50-99	0.035	5	-0.037	4	-0.002	5	0.182	7	-0.073	6	-0.067	6	-0.076	4	0.066	4	41
100-	0.034	5	0.148	7	0.220	8	0.169	7	0.043	4	0.130	3	0.151	7	-0.104	6	47

See text for composition of factors. Factor scores were calculated by principal component analysis with varimax rotation. The SS were obtained by dividing the average factor scores into 10 grades ranged between 0-10. The greater the SS, the better the health state.

serum total cholesterol, serum triglyceride); factor 6, electrocardiogram abnormality; factor 7, glucosuria (urinary glucose); factor 8, proteinuria (urinary protein).

Factor scores for each subject were calculated and then averaged by company size. To obtain greater scores when the health state was better, the average factor scores (range -0.4 to +0.4) were divided into 10 grades ranged between 0 and 10. The simplified scores (0-10) obtained were used to represent the health level of the corresponding factor dimensions. The sum of the simplified scores (T value) was used as the comprehensive index of overall health. As shown in table 4, the smaller the companies were, the smaller the T value. This indicates that the overall health level reduced with company size, being lowest in the companies with less than 20 employees, and highest in the ones with 100 or more. The simplified scores for factor 2, 3, 4, and 7 were smaller in the small companies than in larger ones. The score for factor 4 (silicosis/pulmonary TB), however, was the most reduced, suggesting this was the factor contributing most to the decline in the overall health level in smaller firms.

Discussion

This cross sectional study showed the existence of a different morbidity pattern in terms of the size of a company in the ceramics industry of the Seto area. Both the prevalences and multivariate analysis suggested that the employees working for smaller companies had an overall lower level of health. The higher prevalence of silicosis and pulmonary TB in small firms contributed significantly to the decline in overall employee health. Itakura² previously investigated 24 small ceramic factories in the Seto area, and reported that the airborne silica dust concentrations ranged between 6.8 to 46.8 mg/m³, which were far beyond the Japanese hygienic standard, and much higher than that in large enterprises. There is no doubt that the previous exposure to high concentrations of silica dust in Seto ceramic workplaces was associated with the development of silicosis. Also, our data show an apparently increased incidence of

pulmonary TB among ceramics workers. The association between silicosis and TB has been well established. Epidemiological and experimental studies also suggest that exposure to silica dust, even in the absence of radiographical silicosis, may be responsible for the increased rate of pulmonary TB.¹⁴⁻¹⁶

Several recent World Health Organisation reports have indicated that the work environment and the performance of work contribute significantly not only to the development of classical occupational diseases, but also to the causation of some non-specific, chronic diseases with a complex and multiple aetiology.^{7, 17, 18} Epidemiological investigations have shown that an increased prevalence or risk of multifactorial diseases such as hypertension, ischaemic heart disease, chronic non-specific respiratory diseases, gastric and duodenal ulcers, and some behavioural disorders, may be found among certain segments of the working population.^{7, 18} By comparing the frequency of clinical findings and overall poor health patterns among various sized company groupings, we found raised prevalences and lower scores of health state for hypertension, anaemia, and glucosuria in workers at small companies. There was no significant difference in mean age among the subgroups, thus the influence of age factor on morbidity pattern could be excluded. The poor work environment and work performance, unhealthy lifestyle, high susceptibility of employees, and the lack of health control and promotion activities in small firms are considered to be associated with a decline in the overall level of health.

The occupational conditions and environment in the Seto ceramic workplace has greatly improved in the past two decades. Recent environmental data show that airborne silica dust and lead concentrations are generally below the Japanese hygienic standards. With the decrease in occurrence of well recognised occupational diseases in the working population, occupational health care is now more concerned with the prevention and control of multifactorial chronic diseases.¹⁵ The health screening programme has become multidimensional, usually consisting of a series of medical tests for detecting the most common disease or health risk factors in

working populations, such as respiratory disease, cardiovascular disease, liver damage, anaemia, hyperlipaemia, diabetes, and obesity. In the present study, we applied principle component analysis to evaluate such a multifactorial screening programme. This model considers the interrelations among various medical tests, and by extracting and scoring the principal factors that reflect the overall morbidity pattern of a population, we can evaluate the overall health state quantitatively and comprehensively. From table 4, we can evaluate and compare the overall health level by the T value, and identify what factors mostly influence the overall health pattern.

In conclusion, the present study shows the necessity of improving the health state of Japanese ceramics workers, particularly those working for small companies. The high morbidity of silicosis and pulmonary TB seems to be a key factor contributing to the decline in overall health in our study population. Also, our data suggest that some non-specific disorders or health risk factors such as hypertension, anaemia, and glucosuria may well influence overall worker health. Health promotion programmes should also stress the prevention and control of these non-specific disorders or health risk factors in the working population of the ceramics industry.

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