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Originals

PREVALENCE OF RESPIRATORY SYMPTOMS AND PULMONARY FUNCTION OF RUBBER INDUSTRY WORKERS

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ABSTRACT

The work environment of rubber factories is contaminated with hazardous substances and workers may be exposing to these hazards during rubber manufacturing. The study aimed to evaluate pulmonary function status of rubber industry workers in West Bengal, India. This study was carried out on 252 participants. Among them, 150 were rubber industry workers and 102 were office workers (control). Pulmonary function parameters of the participants were determined by a portable spirometer. Respiratory symptoms such as cough, phlegm, dyspnea, wheezing and chest pain were studied. The lung function parameters of the rubber industry workers were significantly lower than those of the control subjects. The most prevalent symptom among the workers was phlegm which followed by dyspnea, productive cough, chronic cough, wheezes and chest pain. The lung function parameters of the workers were found to be related to the duration of exposure and smoking habits. The likelihood of having different respiratory symptoms was significantly higher among the rubber industry workers compared to the controls. It may be concluded that the respiratory efficiency of rubber industry workers was decreased and the occurrence of respiratory symptoms was higher than that of non-exposed healthy persons, which may be due to exposure to hazardous substances during rubber manufacturing.

Keywords: Rubber industry workers; lung function parameters; duration of exposure; smoking habit

INTRODUCTION

Small-scale industries in India are the lifeline of the Indian economy, and they offer many job opportunities. These small-scale industries in India employ over 100 million people, the second largest after agriculture. Rubber products such as automobile tires, rubber gloves, footwear, mattresses, cushions and prophylactics are an important part of our daily life. The increasing demand for rubber by different sectors has resulted in rapid growth of rubber small-scale industries in different regions of India. In the rubber industry a sequential work pattern is done such as raw materials handling, weighing and mixing, milling, extruding and calendaring, component assembly and building, curing or vulcanizing, finishing, storage, etc. to produce tyres and general rubber goods (IARC, 2012). The production of these rubber items involves heterogeneous mixtures of several chemicals subjected to heat, pressure and catalytic action during manufacturing processes (IARC, 2012). As a result, the work environment may be contaminated with a lot of hazards such as gases, vapours, dusts, fumes and chemical byproducts (Irfani, 2015). Therefore, the rubber industry workers are exposed to significant amounts of health-damaging air pollutants in their work which may lead to deterioration of health (IARC, 2012; Powers and Lampel, 2015). IARC (2012) reported that in the rubber industry, inhalation is the main route of exposure, although workers may have dermal exposure. During vulcanization processes, rubber releases N-nitrosamines and polycyclic aromatic hydrocar-

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bons, both known as carcinogens (Powers and Lampel, 2015). Many epidemiologic studies reported that excess deaths from lung, hematopoietic, bladder, stomach and other cancers have occurred among the rubber industry workers (Iavicoli and Carelli, 2006; Dost et al., 2007; Jonsson et al., 2009; de Vocht et al., 2009).

The rubber industry has been increased considerably in Asia over the past century; however, the majority of health studies regarding the rubber industry arises from western countries (IARC, 2012). In India, the rubber manufacturing industries that have been established in different part of the country produce a wide range of rubber goods, and, although they are founded on the use of traditional materials and processes, they also use modern technology. As its compounding processes require the use of different chemical compounds, this industry is heavily dependent on the use of chemical engineering skills. The workers employed in this industry in India are mostly unskilled and illiterate or semiliterate who are unaware of hygienic working conditions and safety norms. However, India has a fairly comprehensive set of environmental laws and regulations while their implementation has been ineffective. Due to lack of education and unawareness of the hazards of the occupation, those who work in this industry, therefore, are exposed to the potential hazards involved in the handling and use of those chemicals, in addition to the mechanical hazards. Therefore, in the present investigation, some efforts have been given to evaluating the pulmonary function status of rubber industry workers in West Bengal, India.

MATERIALS and METHODS

Study design and participants

This cross-sectional study was carried out on 150 male workers in 42 rubber manufacturing industries in Howrah, the industrial hub of West Bengal, India. The number of workers in each industry was 6 to 10, and all the selected industries were working on day shifts. The workers generally worked for at least 8 to10 hours a day for 6 days per week, without using any self-protective measures. The required sample size was determined by the G*Power statistical software (version 3.1.9.7) using the following assumption: effect size ω: 0.3, α error: 0.05; power (1-β error): 0.95, Df: 1. The required sample size was 145 workers, with 10% was added for exclusion and another 10% added for non-responses. Thus, the final sample size was 175 (rounded off to 180) participants for the present study. The eligibility criteria for the recruitment of the participants in the study were being aged 20 years and above, having at least two years of work experience in the rubber industry, and not having any physical deformity. Participants were excluded if they had the previous history of occupational exposure of air pollutants in work other than the rubber industry. A systematic random sampling method was employed to identify the participants. The total number of workers (312) in the industries was listed and was divided by the required number of participants (180) to get the sampling interval. The first worker was randomly selected by using the lottery method, and then subsequent workers were identified by adding the sampling interval to the random number. The authors disqualified 17 workers because they were not eligible based on the eligibility criteria. Among the 163 eligible workers, 9 were not interested in participating in the present study. Thus, 154 (49% of total workers) workers have participated in the present study. However, four participants were excluded from the study due to missing or incomplete data. In addition to rubber industry workers, 102 male office workers without occupational exposure of air pollutants, matched by sex, age, residence and social class were studied as a control group. The control participants were randomly recruited from 12 non-government offices in Howrah. Ethical approval and prior permission were obtained from the institutional ethics committee before commencement of the study and the study was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration. Prior to the data collection, the protocol was explained verbally in the local language (Bengali) to the participants to obtain their understanding and cooperation and informed consent was obtained from the participants. The principal investigators used to go to the field to check the interview and measurement by field examiners and every questionnaire was supervised and reviewed for completeness. At the end of everyday data collection, a meeting was held between the principal investigators, the research team and the field examiners, to discuss practical problems and issues of major

concern.

Questionnaire

Baseline characteristics such as work history, respiratory symptoms and smoking status of the study participants were collected by using questionnaires. The severity of smoking was also studied (Nitti et al., 1976). The work histories were assessed through questions on daily working time, job description, working conditions and protective measures used. Respiratory symptoms such as cough, phlegm, dyspnea, wheezing and chest pain were documented.

Pulmonary function tests (PFT)

Different pulmonary function parameters of the rubber industry workers and controls were determined by a portable PC based spirometer in standing position. Participants were instructed to take maximum inspiration and blow into the pre-vent pneumotach as rapidly, forcefully and completely as possible for a minimum of 6 seconds, followed by full and rapid inspiration to complete the flow volume loop. The best of the three trials were considered for data analysis. Calibration of the spirometer and all testing protocols were performed as outlined in the instruction manual of the spirometer.

Statistical analysis

First the data were checked for completeness and consistency. Data were summarized by using frequencies and percentages for categorical data and mean and standard deviations for continuous data. Differences were assessed by employing Student's t-test for continuous and Chi-square test for categorical variables, respectively. Bivariate logistic regression analyses were performed to determine the association of respiratory symptoms and smoking status and years of exposure of the workers. The statistical association was checked by 95% confidence interval. Bivariate logistic regression analyses were performed to determine the risk of respiratory symptoms among the rubber industry workers. Multivariate logistic regression analysis was used to examine the risk of respiratory symptoms after adjustment for individual risk factors (age, smoking habit, smoking severity). All analyses were performed by using SPSS (Version 20). A p value <0.05 was considered statistically significant.

RESULTS

The physical characteristics of the rubber industry workers and controls were shown in Table 1. The average age of the rubber industry workers and controls was 36.7±9.8 years and 36.3±8.4 years, respectively. The average length of employment (years of exposure) of the rubber industry workers was 15.8±8.3

Table 1. Characteristics of the study populations.

Parameters		Exposed (Rubber industry workers) (n=150)	Non-exposed (Control) (n= 102)
Age (years)		36.7±9.8	36.3±8.4
Height (cm)		162.1±4.3	162.6±4.1
Weight (kg)		54±6.2	53.2±5.3
BMI (kg/m^2)		20.5±2	20.1±1.7
Work per day (h)		9.1±2.8	8.9±2.7
Duration of employment (Year)		15.8±8.3	15.1±7.9
Duration of exposure (Year)	<10 years	51 (34%)	-
	≥10 years	99 (66%)	-
Smoking history			
Smokers		79 (52.7%)	26 (25.5%)
Smoking index			
Mild		12 (8%)	5 (4.9%)
Moderate		23 (15.3%)	9 (8.8%)
Heavy		44 (29.3%)	12 (11.8%)

years. About 34% of workers had work experience less than 10 years and 66% had work experience at least 10 years or more. About 53% of rubber industry workers and 25% of the control group were smokers.

Pulmonary parameters of the rubber industry workers were studied before joining the work and after the end of work. It was noted that a significant reduction in forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) was found after exposure compared to before exposure. The lung function parameters of exposed individuals were significantly lower than those of controls. Moreover, there was a significant decline in lung function parameters in rubber industry workers whose work exposures at least of 10 years or more, compared to those whose work exposures were less than 10 years. Regarding smoking status, there was a significant decline in lung function parameters among smokers compared to non-smokers (Table 2).

It is found that phlegm (52.7%) was the most frequent symptom among the rubber industry workers. The other symptoms were dyspnea (38.7%), productive cough (35.3%), wheezes (31.3%), chronic cough (23.3%) and chest pain (11.3%) (Table 5). Chronic cough, productive cough and phlegm were found to be significantly related to the smoking habit of the rubber industry workers (Table 3). Increased odds of chronic cough (OR- 2.8) and productive cough (OR- 2.1) were observed among the workers who were smokers compared to non-smokers. Higher risk of phlegm was also noted among the smokers (OR- 2) compared to the non-smokers.

Wheezes, productive cough and phlegm were found to be related to the duration of exposure of the rubber industry workers (Table 4). The risk of wheezes tended to be 3.5 times higher among workers whose work exposures were at least 10 years or more than that of the workers whose work exposures were less than 10 years. Similarly, increased odds of productive cough (OR-2.7) and phlegm (OR-2) were observed

Table 2. Pulmonary function test of the study participants in relation to duration of exposure and smoking habit.

		FVC	FEV1	FEV1/FVC	PEF	FEF 25%-75%
Exposed (n=150)	Pre-shift	69.7±13.5	66.2±11	83.9±14.2	58.2±20.9	83.8±22.7
	Post-shift	66±14.7	63.1±15.3	81.1±10	56.9±20.8	82.1±23.8
Non-exposed (n=102)		86.3±7.1	86±7.4	92.2±14.1	78.8±13.4	91.1±13.4
t (p) value of Pre and Post-shift		2.271 (p<0.05)	2.026 (p<0.05)	1.963 (p>0.05)	0.56 (p>0.05)	0.615 (p>0.05)
t (p) value of Exposed (Pre-shift) and Non-exposed		12.719 (p<0.001)	17.056 (p<0.001)	4.561 (p<0.001)	9.514 (p<0.001)	3.203 (p<0.01)
Year of exposure						
Exposed <10 years (n=51)		78.2±10.4	69.7±7.6	87.1±13.6	63.4±22.2	90.1±20.5
Exposed ≥10 years (n=99)		65.3±12.9	64.4±12	82.3±13.1	55.6±20.3	80.5±23.2
t (p) value		6.69 (p<0.001)	3.214 (p<0.01)	2.207 (p<0.05)	2.256 (p<0.05)	2.674 (p<0.01)
Smoking status						
Smokers (n=79)		65.9±13.9	63±11.9	80.6±14.4	53.3±19.8	79±21.2
Non-Smokers (n=71)		73.9±13.2	69.7±9.7	87.5±14	63.7±22.2	89.1±19.8
t (p) value		3.632 (p<0.001)	3.774 (p<0.001)	2.979 (p<0.01)	3.037 (p<0.01)	3.038 (p<0.01)

FVC-forced vital capacity; FEV1-forced expiratory volume in first second; PEF-peak expiratory flow;
FEF 25%-75%-force expiratory flow between the 25% and 75% of FVC.

Table 3. The prevalence of respiratory symptoms among the rubber industry workers according to smoking status.

	Non-smokers (n=71)	Smokers (n=79)	χ^2 (p value)	OR (95% CI)	p value
Chronic cough	10 (14.1)	25 (31.6)	6.641 (0.01)	2.8 (1.2-6.4)	0.013
Phlegm	31 (43.7)	48 (60.8)	4.404 (0.036)	2 (1-3.8)	0.037
Productive cough	19 (26.8)	34 (43)	4.383 (0.036)	2.1 (1-4.1)	0.039
Dyspnea	23 (32.4)	35 (44.3)	2.248 (0.134)	1.7 (0.8-3.2)	0.136
Wheezes	17 (23.9)	30 (38)	3.459 (0.063)	1.9 (1-3.9)	0.066
Chest pain	6 (8.4)	11 (13.9)	1.133 (0.287)	1.7 (0.6-5)	0.296

Table 4. The prevalence of respiratory symptoms among the rubber industry workers according to year of exposure.

	Exposed <10 years (*n*=51)	Exposed ≥10 years (*n*=99)	χ^2 (*p* value)	OR (95% CI)	*p* value
Chronic cough	8 (15.7)	27 (27.3)	2.651 (0.103)	2 (0.8-4.8)	0.116
Phlegm	21 (41.2)	58 (58.6)	4.103 (0.043)	2 (1-4)	0.044
Productive cough	11 (21.6)	42 (42.4)	6.702 (0.01)	2.7 (1.2-5.8)	0.013
Dyspnea	15 (29.4)	43 (43.4)	2.848 (0.092)	1.8 (0.9-3.8)	0.097
Wheezes	8 (15.7)	39 (39.4)	9.456 (0.002)	3.5 (1.5-8.2)	0.004
Chest pain	4 (7.8)	13 (13.1)	0.989 (0.32)	1.8 (0.5-5.7)	0.338

Table 5. Respiratory symptoms among rubber industry workers and the control group

	Non-exposed	Exposed	χ^2 (*p* value)	COR (95% CI)	*p* value	AOR (95% CI)[a]	*p* value
Chronic cough	4 (3.9)	35 (23.3)	20.432 (0.000)	7.5 (2.6-21.7)	0.000	5.5 (1.8-16.9)	0.003
Phlegm	8 (7.8)	79 (52.7)	61.2 (0.000)	13.1 (5.9-28.8)	0.000	12.6 (5.4-29.5)	0.000
Productive cough	4 (3.9)	53 (35.3)	40.858 (0.000)	13.4 (4.7-38.4)	0.000	11.7 (3.9-35.2)	0.000
Dyspnea	2 (2)	58 (38.7)	56.775 (0.000)	31.5 (7.5-132.7)	0.000	31.3 (7.2-135.7)	0.000
Wheezes	4 (3.9)	47 (31.3)	33.584 (0.000)	11.2 (3.9-32.2)	0.000	9.8 (3.2-29.7)	0.000
Chest pain	0 (0)	17 (11.3)	18.469 (0.000)	-	-	-	-

COR-Crude Odd Ratio; AOR- Adjusted Odd Ratio;
[a]Adjusted for age, smoking habit, smoking severity.

among the workers whose work exposures were at least 10 years or more compared to those with work exposures of less than 10 years.

The prevalence of different respiratory symptoms among the rubber industry workers was significantly higher than that of control participants (Table 5). In the unadjusted model, the likelihood of having different respiratory symptoms was significantly higher among the rubber industry workers than that of controls. In the adjusted model, even after adjusting the effect of several co-variables (age, smoking habit, and severity of smoking) on pulmonary disorders, the occupation exposure had a strong significant impact on respiratory symptoms of the rubber industry workers.

DISCUSSION

The rubber industry workers are potentially exposed to a number of toxic particles and gases including vapors, dusts, fumes and chemical byproducts (Irfani, 2015). Some of these contaminants may lead to acute or chronic effects on the respiratory system. In the present study, it was noted that lung function parameters of rubber industry workers were significantly lower than those of the control group. Moreover, there was a significant decline in FVC and FEV1 among the workers after the end of work shift. In a study involving 45 workers exposed to rubber dust particles in a rubber factory, spirometric results were found to be lower in the workers compared to the controls (Sridevi et al., 2014). Kayhan et al. (2013) and Pellegrino et al. (2005) reported that a reduction in FVC and FEV1 was an indicator of obstructive abnormalities. The present study revealed that there was a significant decline in spirometric results in the workers with increasing duration of exposure. In a study by Mehta et al. (2005) among the workers exposed to chemicals in a paper production factory reported that reductions in respiratory parameters were associated with the duration of exposure. Sridevi et al. (2014) reported that the lung function of rubber factory workers was affected by

the rubber dust particles. They demonstrated that the severity of the effect was duration-dependent. Sridevi et al. (2014) also reported that the effect was less in short time-exposure but more in long time-exposure. The results of the present study stated that the lung function parameters were found to be lower in the workers who were smokers. Akca et al. (2011) performed a study on 141 workers of a rubber factory in Turkey and reported that there was significant impairment of respiratory parameters of smokers compared to non-smoker workers.

The present study demonstrated that the most prevalent symptom among the rubber industry workers was phlegm. Dyspnea, productive cough, chronic cough wheezes and chest pain were also highly prevalent. The present study also demonstrated that cough and phlegm were significantly related to the smoking habits of the workers. Furthermore, this study revealed that wheezes, productive cough and phlegm were found to be related to the duration of exposure of the rubber industry workers. This is consistent with other studies. Akca et al. (2011) demonstrated that exposure to dust and smoking in the rubber industry seemed to be associated with the development of respiratory symptoms and diseases. Thomas et al. (1986) stated that smoking and exposure to industrial particles have been suggested to be important risk factors of developing respiratory diseases in the rubber industry. A study by Rao et al. (1991) demonstrated that cigarette smokers exposed to NO2 and CO showed the effect in the terminal bronchioles. Shadab et al. (2013) stated that smoking aggravates dust-induced bronchitis and airway obstruction. Zuskin et al. (1994) reported that the co-existing factors such as smoking with dust exposure have negative impact on respiratory functions among the workers leading to some illnesses.

Even after adjusting the effect of several co-variables on respiratory symptoms, the likelihood of having different respiratory symptoms was significantly higher among the rubber industry workers than that among the controls. As the work shift of the rubber industry workers was long and they generally worked without using any self-protective measures, the workers may be subjected to exposure of a lot of harmful dust particles, fumes, smoke, gases, vapours, mists and heterogeneous mixtures of several chemicals which may cause an adverse effects on their respiratory functions. A prospective cohort study by Straif et al. (1999) on 11,633 German rubber workers in five different plant departments in rubber industry reported that the highest mortality rate was noted in the early production stages involving mixing and weighing of uncured rubber products. The International Agency for Research on Cancer reviewed three decades of new data on the rubber industry and reconfirmed that there was sufficient evidence of excess risk of lung, bladder, stomach and leukemia cancer in the modern rubber manufacturing industry (IARC, 2012). Carlo et al. (1993) reported that the rates of mortality due to emphysema, bronchitis and asthma were markedly higher among the rubber industry workers.

The current study has certain limitations. In the present study, some important confounding variables such as work history, smoking habit and the severity of smoking of the study participants were studied. However, some important risk factors such as exposure level, environmental conditions, social and demographic characteristics, etc. which might have an effect on respiratory functions, could not be adjusted in the present study due to lack of resources. There may be desirability bias for daily working time and duration of employment which may overestimate the association between the predictors and the outcome variables. However, we reduce this probable bias with attention to the register of the industry for work history of the workers.

In the present study, the lung function parameters of rubber industry workers were significantly lower than those of the control group. The most prevalent symptom among the workers was phlegm followed by dyspnea, productive cough, chronic cough, wheezes and chest pain. The lung function parameters of the rubber industry workers were found to be related to the duration of exposure and smoking habit. The likelihood of having different respiratory symptoms was significantly higher among the rubber industry workers. It may be concluded that the respiratory efficiency of the rubber factory workers was decreased and the occurrence of respiratory symptoms was higher than that of non-exposed healthy persons, which may be due to exposure of dusts, gases, vapors, fumes and chemical byproducts during work.

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REFERENCES

Akca, ASD, Demircan, N, Kart, L and Altin, R (2011) Evaluation of respiratory symptoms in workers of a rubber factory. *Eur. J. Gen. Med.*, **8**: 302-307.

Carlo, GL, Jablinske, MR, Lee, NL, Sund, KG and Corn, M (1993) Reduced mortality among workers at a rubber plant. *Occup. Med.*, **35**: 611-616.

de-Vocht, F, Sobala, W, Wilczynska, U, Kromhout, H, Szeszenia-Dabrowska, N and Peplonska, B (2009) Cancer mortality and occupational exposure to aromatic amines and inhalable aerosols in rubber tire manufacturing in Poland. *Cancer Epidemiol.*, **33**: 94-102.

Dost, A, Straughan, J and Sorahan, T (2007) A cohort mortality and cancer incidence survey of recent entrants (1982-91) to the UK rubber industry: findings for 1983-2004. *Occup. Med.(Lond).*, **57**: 186-190.

Iavicoli, I and Carelli, G (2006) Evaluation of occupational exposure to N-nitrosamines in a rubber manufacturing industry. *J. Occup. Environ. Med.*, **48**: 195-198.

Irfani, TH (2015) Occupational injuries and illnesses in rubber factory: profile, potential hazards, and possible prevention. *Public Health Indones.*, **1**: 32-37.

Jonsson, LS, Lindh, CH, Bergendorf, U, Axmon, A, Littorin, M and Jonsson, BA (2009) N-nitrosamines in the southern Swedish rubber industries - exposure, health effects, and immunologic markers. *Scand. J. Work Environ. Health*, **35**: 203-211.

Kayhan, S, Tutar, U, Cinarka, H, Gumus, A and Koksal, N (2013) Prevalence of occupational asthma and respiratory symptoms in foundry workers. *Pulm. Med.* doi: 10.1155/2013/370138

Mehta, AJ, Henneberger, PK, Toren, K and Olin, AC (2005) Airflow limitation and changes in pulmonary function among bleachery works. *Eur. Respir. J.*, **26**: 133-139.

Nitti, V, de-Michele, G, Famiglietti, B, Miniccuci, E, Ortolani, G, Sessa, T and Lauro, N (1976) Epidemiological survey of chronic bronchitis in the city of Napels with special reference to the role and possible interaction of various exogenous factors. *Bull. Int. Union Tuberc.*, **51**: 685-699.

IARC, (2012) Occupational exposures in the rubber manufacturing industry. In: *Chemical Agents and Related Occupations*. Lyon, France: International Agency for Researh on Cancer.

Pellegrino, R, Viegi, G, Brusasco, V, Crapo, RO, Burgos, F, Casaburi, R, et al. (2005) Interpretative strategies for lung function tests. *Eur. Respir. J.*, **26**: 948-968.

Powers, C and Lampel, HP (2015) The rubber manufacturing industry: a case report and review of cutaneous exposure and sequelae. *J. Occup. Med. Toxicol.*, **10**:33.

Rao, NM, Petel, TS, Raiyani, CV, Kulkarni, PK, Agarwal, AL and Kashyap, SK (1991) A dose response relationship between pollution index and pulmonary function in shopkeepers exposed to auto exhaust. *Indian J. Environ. Protect.*, **11**: 737-740.

Shadab, M, Agrawal, DK, Ahmad, Z and Aslam, M (2013) A cross sectional study of pulmonary function tests in street cleaners in Aligarh, *India. Biomed. Res*, **24**: 449-452.

Sridevi, G, Chandrasekar, M and Sembulingam, P (2014) Duration-dependant effect of exposure to rubber dust particles on lung functional status among rubber factory workers. *IOSR J. Pharm.*, **4**: 49-55.

Straif, K, Chambless, L, Weiland, SK, Wienke, A, Bungers, M, Taeger, D, et al. (1999) Occupational risk factors for mortality from stomach and lung cancer among rubber workers: an analysis using internal controls and refined exposure assessment. *Int. J. Epidemiol.*, **28**: 1037-1043.

Thomas, RJ, Bascom, R, Yang, WN, Fischer, JF, Baser, ME, Greenhut, J and Baker, JH (1986) Peripheral eosinophilia and respiratory symptoms in rubber injection press operators: A case-control study. *Am. J. Ind. Med.*, **91**: 551-559.

Zuskin, E, Mustajbegovic, J, Doko-Jelinic, J, Schachter, EN, Kern, J and Sonicki, Z (1994) Respiratory symptoms and ventilatory capacity in rubber workers. *Croat. Med. J.*, **35**: 42-48.