PRINT: ISSN 0970-9274 ONLINE: 2456-6608 DOI: 10.31901/24566608.1990/01.03.11

JOURNAL OF
HUMAN ECOLOGY

J. Hum. Ecol. 1 (3): 305-309 (1990)

Impact of Stone Dust on Physiological Functions and Body Size: Data From Malis of Rajasthan

Anju Swami and S.L. Malik
Department of Anthropology, University of Delhi, Delhi-110 007, India

KEY WORDS Mali, Lung Function. Stone Dust. Exposure. Rajasthan. Body Measurements.

ABSTRACT Cross-sectional data on lung functions, body measurements, pulse rate, hand grip strength and blood pressure were collected from 250 exposed and 250 control workers from Malis, an endogamous caste groups of Rajasthan. The study aims at investigating the effect of stone dust on lung functions (FVC, FEV_1, PEFR), blood pressure, pulse rate and body measurements. In both the sexes, control subjects have significantly higher FVC, FEV_1, and PEFR than exposed group. Mean values of hand grip strength, pulse rate and blood pressure were significantly higher in control group. Although the two groups have similar linear dimensions, the control subjects (both males and females) are significantly heavier, possess greater breadths, circumferences, skinfolds than exposed group. Higher pulse rate and blood pressure, a sign of cardiovascular stress on one hand and lower respiratory volumes in the exposed group, on the other hand, demonstrates definite effect of stone dust on physiology of man.

Lung function studies in occupational groups have delineated that workers exposed to organic dust are at respiratory risk and show an increase in respiratory symptoms and reductions in lung functions. Workers exposed to coal dust (Kellie et al., 1987) silica and talc (Thomas et al., 1987) wood dust (Goldsmith and Shy, 1988) grain (Cotton et al., 1983; Dosman et al., 1988) cotton dust (Holness et al., 1983) exhibit reduced pulmonary functions and high prevalence of cough, phlegm production, dyspnea, wheezing and chronic bronchitis.

In stone quarries, stone dust is produced during several processes, such as grinding, milling and blasting. Results from the studies on the hazards of exposure of organic dust reinforce the notion that stone quarry workers are at risk of dust related occupational lung diseases, *i.e.* greater prevalence of respiratory symptoms and greater risk of impaired pulmonary functions than workers not exposed to stone dust (Jorensen et al., 1980; Haglind and Rylander 1987; Mur et al., 1987). Stone dust produced inside quarries could be hazardous to human health as dust particles are capable of entering the respiratory system during breathing. Also, once the dust particles enter the respiratory system, they can be readily taken up and transported to the other organs. Any adverse effect of dust on vital pulmonary functions may lead to the malfunctioning of other organs as well. Keeping this in view, the present study was designed with the following objectives:

1. to examine the effect of stone dust on forced vital capacity, forced expiratory volume 1 second, and peak expiratory flow rate.
2. to evaluate the impact of stone dust on blood pressure.
3. to study the variation in body size and physique between non-exposed and exposed workers to dust in stone quarries.

MATERIAL AND METHODS

Cross-sectional data on lung functions and body measurements were collected from 250 exposed and 250 control workers from Malis—an endogamous caste group of Alwar district of Rajasthan. Members of the exposed group were employed (actively) in different stone quarries in Alwar district of Rajasthan. The control group, as also the exposed group, comprised of 125 adult males and 125 adult females. In many earlier studies, on occupational hazard investigation, availability of a proper control group has been difficult (Guidotti, 1988). But, in the present study, an appropriate control group of similar age, smoking habits, social status, same sex but not occupationally exposed to stone dust was available from the same geographic area. The member of the non-exposed group do business and trade in milk.

Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and peak expiratory flow rate were measured with a portable spirometer, following the method of Weiner and Lourie (1969). Best of the three attempts were taken to record the respiratory functions. Stature, sitting height, lower extremity length, transverse chest diameter, antero-posterior chest diameter, bicondylar humerus, bicondylar femur, biacromial diameter, calf circumference, skinfolds at triceps, subscapular, suprailiac and calf were taken using the standard technique (Tanner et al., 1969).

Hand grip strength of right and left hand was measured using standard method of Weiner and Lourie (1969) and recorded in kg.

Pulse rate and blood pressure were taken following the method of Weiner and Lourie (1969) using indirect ausculatory method. Blood pressure was recorded in mm Hg.

One way analysis of variance test was used for comparing exposed and control group in pulmonary function tests, body measurements, pulse rate and blood pressure.

RESULTS

In the present study, in both the sexes, control subjects have significantly higher forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1.0}$) peak expiratory flow rate (PEFR) than exposed workers. Mean values of pulse count and blood pressure were significantly greater in exposed than in control group (Tables 1 & 2) than exposed males though the difference is statistically non significant at 5% probability level. However, in control females, hand grip strength of both right and left hand was significantly greater as compared to exposed females.

In both the sexes, the control subjects are significantly heavier, possess greater breadths, circumstances, and skinfolds than exposed group but the two groups have similar linear dimensions such as stature, sitting height and lower extremity length (Tables 3 & 4). The mean age of exposed and control subjects are similar in both males and females.

DISCUSSION

It is evident from the results that significant differences exist in the pulmonary functions between control and exposed workers. The exposed workers have consistently lower values of forced vital capacity (FVC), forced expiratory volume one second ($FEV_{1.0}$) and peak expiratory flow rate (PEFR) than the controls.

When human beings are exposed to stone dust, stone particles of respirable fraction can be deposited in the gas exchanging portion and in the conducting airways of the lungs. Deposition of particles in the lung affects respiration by controlling the velocity and amount of gas as they come down in the airways and reach the lungs (West, 1974). Any airway obstruction/pathophysiological change in the lungs results in the lowered pulmonary functions (Cotes, 1978).

Comparison of lung functions of exposed workers with those of non-exposed ones indicate functional impairment in the lungs of stone quarry workers. Though these tests are not disease specific but they help in distinguishing a normal individual from an affected person. These findings clearly indicate that stone quarry workers are at risk of developing lung diseases as a result of inhaled stone dust. A significant reduction in FVC and $FEV_{1.0}$ among exposed quarry workers may be attributed to the blockage, injuries or infection due to inhalation of stone dust. Depo-

Table 1: Variation in physiological variables between males exposed to stone dust and control subjects

Variables	*Control*		*Exposed*		*F Value**	*Probability*
	Mean	*S.D.*	*Mean*	*S.D.*		
Forced Vital Capacity	3.25	0.38	2.85	0.34	78.27	P<.001
Forced Expiratory Volume in One Second	2.93	0.35	2.72	0.36	21.15	P<.001
Peak Expiratory Flow Rate	330.56	36.10	312.99	43.19	12.18	P<.001
Pulse Rate	70.30	5.82	76.60	7.75	52.78	P<.001
Systolic Blood Pressure	124.99	10.22	136.46	14.40	52.74	P<.001
Diastolic Blood Pressure	69.60	6.43	77.02	9.92	54.37	P<.001
Hand Grip Strength (Right)	38.76	8.09	37.29	8.11	2.04	.01>P>.001
Hand Grip Strength (Left)	38.12	8.34	36.66	8.33	1.92	.01>P>.001

*All F values are significant at 5% probability level.

Table 2: Variation in physiological variables between females exposed to stone dust and control subjects

Variables	*Control*		*Exposed*		*F Value**	*Probability*
	Mean	*S.D.*	*Mean*	*S.D.*		
Forced Vital Capacity	2.13	0.33	1.35	0.28	387.01	P<.001
Forced Expiratory Volume in One Second	2.02	0.31	1.17	0.26	528.72	P<.001
Peak Expiratory Flow Rate	250.64	45.88	192.04	64.51	68.47	P<.001
Pulse Rate	68.75	5.55	74.71	7.00	55.57	P<.001
Systolic Blood Pressure	118.57	9.30	126.76	11.23	39.57	P<.001
Diastolic Blood Pressure	66.85	6.05	72.56	7.65	42.71	P<.001
Hand Grip Strength (Right)	23.34	6.49	21.20	6.46	6.79	0.1>P>.001
Hand Grip Strength (Left)	22.15	5.89	19.98	5.55	8.95	.01>P>.001

*All F values are significant at 5% probability level.

Table 3: Impact of stone dust on anthropometric variables: mean and analysis of variance between males exposed to stone dust and control subjects

Variables	*Control*		*Exposed*		*F Value**	*Probability*
	Mean	*S.D.*	*Mean*	*S.D.*		
Stature	168.48	7.92	167.22	8.22	2.52	P<.001
Sitting Height	85.33	4.41	84.78	4.10	3.82	P<.001
Lower Extremity Length	94.22	6.29	92.96	6.39	2.45	P<.001
Transverse Chest Diameter	27.21	2.37	26.64	2.47	14.66	P<.001
Anterior Posterior Chest Diameter	21.20	2.42	20.10	2.43	12.80	P<.001
Bicondylar Humerus	6.79	0.83	5.65	0.78	123.30	P<.001
Bicondylar Femur	7.83	0.74	6.71	0.63	163.56	P<.001
Biacromial Diameter	25.54	3.10	34.40	3.13	8.38	P<.001
Calf Circumference	31.49	3.49	30.67	3.50	3.37	.01>P>.001
Upper Arm Circumference	24.71	2.99	23.72	3.06	6.78	.01>P>.001
Chest Circumference	85.70	7.38	81.83	6.86	18.42	P<.001
Weight	58.67	9.45	56.32	9.65	3.78	.01>P>.001
Skinfold at Triceps	7.03	5.99	5.35	2.88	8.02	.01>P>.001
Skinfold at Subscapular	8.97	2.32	7.95	2.39	11.47	.01>P>.001
Skinfold at Suprailiac	5.84	2.24	4.84	2.37	11.72	.01>P>.001
Skinfold at Calf	7.79	2.86	6.86	3.07	6.12	.01>P>.001
Age	30.32	9.48	30.68	9.83	0.09	.80>P>.70

*All F Values are significant at 5% probability level (except age).

Table 4: Impact of stone dust on anthropometric variables: mean and analysis of variance between females exposed to stone dust and control subjects

Variables	*Control*		*Exposed*		*F Value**	*Probability*
	Mean	*S.D.*	*Mean*	*S.D.*		
Stature	154.92	5.59	153.69	5.27	3.22	.01>P>.001
Sitting Height	79.47	4.18	78.04	4.19	7.33	.01>P>.001
Lower Extremity Length	80.03	4.12	86.70	3.87	6.92	.01>P>.001
Transverse Chest Diameter	25.61	1.83	24.31	1.71	33.44	P<.001
Anterior Posterior Chest Diameter	19.15	1.93	18.05	2.05	19.02	P<.001
Bicondylar Humerus	6.23	0.84	4.97	0.71	160.83	P<.001
Bicondylar Femur	7.27	0.78	5.96	0.59	226.07	P<.001
Biacromial Diameter	32.58	2.70	31.37	2.59	13.20	.01>P>.001
Calf Circumference	29.77	4.31	28.55	4.40	4.92	P<.001
Upper Arm Circumference	24.48	3.73	23.19	3.52	7.84	.01>P>.001
Chest Circumference	73.29	6.22	71.92	6.01	3.16	.01>P>.001
Weight	52.22	6.87	48.79	6.66	16.05	.01>P>.001
Skinfold at Triceps	9.23	3.84	7.91	3.68	7.67	.01>P>,001
Skinfold at Subscapular	9.64	2.71	8.36	2.66	14.18	.01>P>.001
Skinfold at Suprailiac	6.97	2.84	5.52	2.82	16.28	.01>P>.001
Skinfold at Calf	9.71	3.08	8.50	3.07	9.61	.01>P>.001
Age	34.46	9.65	34.85	10.18	0.10	80>P>.70

*All F Values are significant at 5% probability level (except age).

sition of stone dust not only ruptures the anterior walls of the lungs but also causes stiffness in the walls.

Stone quarry workers have significantly higher pulse rate and blood pressure than the non-exposed workers living in same geographic area and belonging to same ethnic group. Thus cardiovascular system is affected by the inhalation of toxicants. This finding is in agreement with the results of the studies that certain chemicals such as lead, cadmium, and oral contraceptive steriods increase systemic arterial (systolic and diastolic) blood pressure and heart rate as an acute event by a variety of mechanism (Billinghan, 1980; Rubin and Rubin, 1982; Van Stee, 1982; Zakari and Aviado, 1982; Merin, 1981; Steffy 1982). However, not much work has been done to study the effect of mineral dust or organic dust on cardiovascular system. In the present study also workers have significantly higher pulse rate and blood pressure than the non-exposed workers. Higher blood pressure, a sign of cardiovascular stress on one hand and lower respiratory volumes in the exposed group on the other hand demonstrate definite effects of stone dust on physiology of man.

Lighter body weight of quarry workers could be due to greater work load and limited food intake due to loss of appetite. This limited food consumption along with lowered respiratory functions limit the release of energy for other metabolic processes reducing the body weight.

In conclusion, the findings of the study demonstrate rather striking differences in pulmonary functions, pulse count, blood pressure, and anthropometric variables between a fairly large group of stone quarries workers and non-exposed community control. These findings indicate the presence of a significant respiratory problems among the large number of stone quarry workers in Rajasthan.

REFERENCES

Billingham, M.F.: Morphologic changes in drug induced heart diseases. pp.129-149. In: *Drug Induced Heart Diseases*, M.R. Bristow (Ed.). Elsevier/North Holland Press, Amsterdam (1980).

Cotes, J.E.: *Lung Function: Assessment and Application in Medicine*. Blackwell Scientific Publication, Oxford, 4th Edition (1978).

Cotton, D.J., Graham, B.L., Li, Kyr., Froh, F., Bermett, G.D. and Dosman, J.A.: Effects of grain dust exposure and smoking on respiratory symptoms and lung functions, *J. Occup. Med., 25:* 131-141 (1983).

Dosman, J.A., Graham, B.L., Hall, D., Pahwa, P., Mcduffif, H.H., Lucewicz, M and Teresa, T.: Respiratory symptoms and alterations in pulmonary function test in swine procedures in Saskatchewan: Result of a survey of farmers. *J. Occup. Med., 30:* 38-43 (1988).

Goldsmith, D.F. and Shy, C.M.: Epidemiological study of respiratory health effects in a group of North Carolina furniture workers. *J. Occup. Med., 30:* 81-85 (1988)

Guidotti, T.L.: Exposure to hazard and individual risk: When occupational medicine gets personal. *J. Occup. Med., 30:* 570-588 (1988).

Haglind, S.M. and Rylander, E.: Lung function measurement among workers in swine confinement buildings. *J. Occup. Med., 29:* 904-907 (1987).

Holness, D.L., Taraschuk, I.G., and Pelmear, P.L.: Effect of dust exposure in Ontario cotton textile mills. *J. Occup. Med., 25:* 26-29 (1983).

Jorensen, H.S., Hedman, B.K. and Stijerberg, B.: Follow up study of pulmonary function and respiratory tract symptoms in workers in a Swedish iron ore mine. *J. Occup. Med., 30:* 228-233 (1988)

Kellie, S.E., Attfield, M.D., Hankinson, J.L. and Castellah, R.M.: Spirometry variability criteria association with respiratory morbidity and mortality in a context of coal miner. *Am. J. Epidemiol., 125:* 437-444 (1987).

Merin, R.G.: Cardiac oxicology of inhalation anesthetics. pp. 1-15. In: *Cardiac Toxicology* II, I. Balaza (Ed.). CRC Press Inc., Boca Raton, F.I. (1981).

Mur, J.M., Bisch, C.M., Phar, Q.T., Massim, M., Moulin, J.J., Covelier, C. and Sadoul, A.: Risk of lung cancer among iron ore miner: A proportional mortality study of 1,075 deceased miners in Lorraine, France. *J. Occup. Med., 29:* 762-768 (1977).

Steffy, E.P.: Cardiovascular effects of inhalation anesthetics. pp. 259-81. In: *Cardiovascular Toxicology.* E.W. Van Stee (Ed.). Raven Press, New York (1982).

Tanner, J.M., Hiernaux, J. and Jarman, S.: Growth and Physique studies. In: *Human Biology: A Guide to Field Methods.* J.S. Weiner and J.A. Lourie (Eds.). Blackwell Scientific Publication, Oxford (1969).

Thomas, T.L. and Stewart, P.A.: Mortality from lung cancer and respiratory diseases among pottery workers exposed to silica and talc. *Am. J. Epidemiol., 125:* 35-43 (1987).

Van Stee, F.W. : Cardiovascular toxicology: Foundation and scope. pp 1-35. In: *Cardiovascular Toxicology,* F.W. Van Stee, (Ed.). Raven Press, New York (1982).

West, J.B.: *Pulmonary Pathophysiology—The Essentials.* Williams and Wilkins Co., Baltimore (1977).

Weiner, J.S. and Lourie, J.A.: *Human Biology. A Guide to Field Methods, IBP Handbook No.9.* Blackwell Scientific Publication, Oxford (1969).

Zakhari, E. and Aviado D.M.: Cardiovascular toxicology and aerosol propellants, refrigerants and related solvents. pp 81-327. In: *Cardiovascular Toxicology.* E.W. Van Stee (Ed). Raven Press, New York (1982).