

Review Article

Occupational Health Research in India

Habibullah N SAIYED* and Rajnarayan R TIWARI

National Institute of Occupational Health, Meghani Nagar, Ahmedabad-380016, Gujarat, India

Received January 16, 2004 and accepted February 20, 2004

Abstract: India being a developing nation is faced with traditional public health problems like communicable diseases, malnutrition, poor environmental sanitation and inadequate medical care. However, globalization and rapid industrial growth in the last few years has resulted in emergence of occupational health related issues. Agriculture (cultivators i.e. land owners+ agriculture labourers) is the main occupation in India giving employment to about 58% of the people. The major occupational diseases/morbidity of concern in India are silicosis, musculo-skeletal injuries, coal workers' pneumoconiosis, chronic obstructive lung diseases, asbestosis, byssinosis, pesticide poisoning and noise induced hearing loss. There are many agencies like National Institute of Occupational Health, Industrial Toxicology Research Centre, Central Labour Institute, etc. are working on researchable issues like Asbestos and asbestos related diseases, Pesticide poisoning, Silica related diseases other than silicosis and Musculoskeletal disorders. Still much more is to be done for improving the occupational health research. The measures such as creation of advanced research facilities, human resources development, creation of environmental and occupational health cells and development of database and information system should be taken.

Key words: India, Occupational health research, Researchable issues, Silicosis

Introduction

India is a vast country with a surface area of about 3.3 million square km. Total population of India according to Census 2001¹⁾ was 1.025 billion. About 72% of the population lives in rural area. India is a developing nation and presents the demographic features similar to the other developing nations of the world. Growing population is the major concern of the government and is considered as the principal obstacle to the economic growth of the country. Emerging occupational health problems are to be tackled along with the existing traditional public health problems like communicable diseases, malnutrition, poor environmental sanitation and inadequate medical care. Globalization and rapid industrial growth (about 7% annual economic growth) in the last few years have further complicated the occupational

health related issues.

Employment status

Census report is the major source of reliable information on employment and related issues. The general census in India is carried out every 10 yr. The information provided in this communication is based on the census reports of 2001. Table 1 depicts the status of active employment in 2001 according to sex and the area of economic activities¹⁾. Agriculture (cultivators i.e. land owners+ agriculture labourers) is the main occupation in India giving employment to about 58% of the people. This is in contrast to the industrialized nations, like USA and Western Europe where the employment in the agricultural sector is between 4 and 12%. Similarly, the proportion of employment in manufacturing and service sector is much lower in India compared to other developing nations. Along with the increase in population, there is an increase of about 28%

*To whom correspondence should be addressed.

Table 1. Employment (in millions) in different economic sectors of activities in urban and rural areas

Total	Persons			Agricultura	Household	
Rural	Males	Total workers	Cultivators	Labourers	Industry	Other Workers*
Urban	Females				workers	
Total	Persons	403	128	107	16	151
	Males	275	86	57	8	123
	Females	127	41	50	8	28
Rural	Persons	311	125	103	12	71
	Males	199	84	55	6	55
	Females	111	41	48	6	16
Urban	Persons	92	3	4	5	80
	Males	76	2	3	3	69
	Females	16	1	2	2	11

*: Other workers = Mining and Quarrying, Manufacturing, Processing, Servicing and Repairs, Construction, Trade and Commerce.

Table 2. Prevalence of some of the occupational lung diseases studies carried by National Institute of Occupational Health

Industry	Morbidity	Prevalence (%)
Slate Pencil ⁵	Silicosis	54.5
Agate Polishing ⁶	"	38
Stone Quarries ⁷	"	21
Potteries ⁸	"	15.2
Stone Crushing ⁹	"	12
Coal Mines ¹⁰ (Underground)	Coal workers' pneumoconiosis	2.84
	Other respiratory morbidities	45.4
Coal Mines ¹⁰ (Open Cast)	Coal workers' pneumoconiosis	2.1
	Other respiratory morbidities	42.2
Asbestos mine & mill ¹¹	Asbestosis	11
Asbestos Textile workers ¹²	"	9
Asbestos cement ¹³	"	3-5
Textile Mills (Blow Room) ¹⁴	Byssinosis	30
Textile Mills (Card Room) ¹⁴	"	38
Jute Mills ^{15,16}	Byssinosis and other chronic obstructive lung diseases	48.8

male workers and 45% female workers from 1991 to 2001. This relative increase female workers is observed in all the economic activities. The proportion of male:female working population which was 78:22 in 1991 was 68:32 in 2001. This increase working female population leads to certain concerns. For example, when exposed to occupational hazards, women of reproductive age are susceptible to specific adverse effects on reproduction, like abortions and malformations of the foetus from exposure to toxic chemicals in the work place. Moreover, female workers often suffer from musculoskeletal disorders because neither the tasks nor the equipment they use, which is normally designed for men, are adapted to their built and physiology. In addition,

female workers have specific stress-related disorders, resulting from job discrimination (such as lower salaries and less decision-making), a double burden of work (workplace and home) and sexual harassment.

General status of Occupational Health in the Country

Occupational injuries and diseases

The statistics for the overall incidence/prevalence of occupational disease and injuries for the country is not available. Leigh *et al.*²⁾ have estimated an annual incidence of occupational disease between 924,700 and 1,902,300 and

121,000 deaths in India. Based on the survey of agriculture injury incidence study by Mohan and Patel (1992)³⁾ in Northern India, they estimated annual incidence of 17 million injuries per year, (2 million moderate to serious) and 53,000 deaths per year in agriculture alone.

The major occupational diseases/morbidity of concern in India are silicosis, musculo-skeletal injuries, coal workers' pneumoconiosis, chronic obstructive lung diseases, asbestosis, byssinosis, pesticide poisoning and noise induced hearing loss. Table 2 shows the prevalence of some of these diseases⁴⁻¹⁶⁾.

Laws and regulations

The major legal provisions for the protection of health and safety of the working populations are Factories Act and Mines Act. The Factories was amended in 1987 following Bhopal gas tragedy. A special chapter on occupational health and safety to take care of the workers of hazardous industry was added. Under this chapter, pre-employment and periodic medical examination and periodic monitoring of work environment is mandatory for the industries defined as hazardous under the Act. The maximum permissible limit has been laid down for a number of chemicals. This Act is implemented by the State Factory Inspectorate, which are supported by the industrial hygiene laboratories. There are similar provisions under the Mines Act. This Act is applicable only to factories employing 10 or more workers and covers only about 10 million workers. Some other legal provisions for protection of special working groups are the Plantation Labour Act, 1951, the Dock Workers (Safety, Health and Welfare) Act, 1986, the Building and other Construction Workers (Regulation and the Employment and Conditions of Service) Act, 1996, the Beedi and Cigar Workers (Conditions of Employment) Act, 1966, Child labour (Prohibition and Regulation) Act and the Insecticides Act, 1968.

Research Activities in Occupational Health

Universities/institutes working in the field of occupational health

The major institutes, which are engaged in occupational health activities in the country, are:

1. National Institute of Occupational Health, (NIOH) Ahmedabad
2. Industrial Toxicology Research Centre (ITRC), Lucknow
3. Central Labour Institute (CLI), Mumbai
4. All India Institute Of Hygiene And Public Health (AIHH & PH)
5. Sri Ramachandra Medical College And Research Institute,

Chennai

6. Centre For Occupational & Environmental Health, Delhi

1. National Institute of Occupational Health

NIOH, established in 1966 is one of the permanent institutes of the Indian Council of Medical Research and has two regional centres namely Regional Occupational Health Centre (Eastern) at Kolkata and Regional Occupational Health Centre (Southern) at Bangalore to cater regional needs. Institute has a staff strength of about 270 including 60 scientists belonging to disciplines such as medicine, industrial hygiene, physiology, ergonomics, psychology, chemistry, bio-chemistry, medical statistics, physics, electronics etc. Major research areas covered by the institute are occupational lung diseases such as silicosis, asbestosis, coal workers' pneumoconiosis, byssinosis, pesticide poisoning, ergonomics, auditory and non-auditory effects of occupational and ambient noise exposure, psychological effects of work, chemical exposure, work related injuries etc. The institute scientists also carry out basic research in the areas like biomarkers and geno-toxicity and carcinogenic toxicity. NIOH scientists have developed dust control modules for small scale industries with silica exposure like agate polishing, silica flour mills, stone quarries and slate pencil industry. Institute developed and popularized the use of gloves to prevent acute nicotine poisoning (green tobacco sickness) in tobacco harvesters. NIOH also pays attention to the special group of vulnerable population such as child labour and women workers' problems. The Institute has published over 500 research papers in peer reviewed national and international journals. The other activities of the Institute include development of human resource through regular degree (Ph. D), diploma (Dip. Occ. Health) and certificate (Certificate in Industrial Health) course and short term training programmes for industrial medical officers, industrial hygienists, factory inspectors, workers and trade unions etc. The institute advises the Ministry of Health, Ministry of Labour Ministry of Environment and Ministry of commerce on issues related to occupational health, safety and environment related issues.

2. Industrial Toxicology Research Centre, Lucknow

Established in 1965, the Industrial Toxicology Research Centre (ITRC), Lucknow, a constituent laboratory of Council of Scientific & Industrial Research is carrying out research in occupational health problems of industrial and agriculture workers through epidemiological studies and basic research. The major contribution of ITRC is in the field of experimental pneumoconiosis¹⁷⁻¹⁹⁾ and effects of toxicants on

Table 3. Topics of papers published in annual conference of IAOH

Topics	Number of papers presented in the Conference		
	IAOH Conference	IAOH Conference	IAOH Conference
	2001 ¹⁷ (N=36)	2002 ¹⁸ (N=38)	2003 ¹⁹ (N=32)
Occupational health services	12	10	7
Ergonomics and injury prevention	10	7	1
Occupational toxicology	5	4	1
Occupational and environmental respiratory diseases	5	1	5
Miner's health	4	2	1
Others	–	14	17

neurotransmitters^{20–24}). In recent years, ITRC is expanding in the field of genomics.

3. Central Labour Institute (CLI), Mumbai

Central Labour Institute was established in 1966. It is working under the Ministry of Labour and has four regional labour institutes situated in Kolkata, Chennai, Kanpur. The institute carries out research related to industrial safety and health. The institute also tests and develops personal protective equipments. It conducts certificate course, which is mandatory for the industrial medical officers employed in hazardous industries.

4. All India Institute Of Hygiene And Public Health (AIHH & PH)

The physiological and industrial hygiene department of the AIHH & PH was established in 1951 and it conducts regular courses on diploma in industrial health and also carries out epidemiological studies in the field of occupational health.

5. Sri Ramachandra Medical College And Research Institute, Chennai

Department of environmental health at Sri Ramachandra Medical College and Research Institute (SRMC), Chennai was started in 1998. It carries out studies of job exposure profile through industrial hygiene surveys in large and medium scale industries like leather tanneries, textile, automobile industry etc. in southern India. This department runs masters degree course in occupational health and industrial hygiene and safety.

6. Centre For Occupational & Environmental Health, Delhi

Centre for Occupational & Environmental Health at Lok Nayak Hospital has been set up in 1998 to address the growing concerns and hazards related to environment and health.

Apart from training and teaching the centre is collaborating in its research activities with many national and international organizations on occupational and environmental health. The ongoing projects include study on malignancies such as bladder cancers study, musculo-skeletal study and needle-stick injury in health care workers study.

Association working in the field of Occupational Health Indian Association of Occupational Health (IAOH)

IAOH, started in 1948, has a membership of over 2,000 members, most of them are industrial physicians, medical teachers and research workers. Since its inception the association is holding annual national conferences periodic and international meetings. The association publishes a quarterly journal entitled Indian Journal of Occupational and Environmental Medicine.

IAOH holds annual conference in which research articles are invited which is then published in the form of proceedings of the conference. Analysis of the abstracts published in such proceedings during last three years (Table 3) shows that occupational health services in various occupational settings were widely discussed in all the three conferences^{25–27}. This may be attributed to the increased awareness among owners about safe workplace and healthy workforce as well as legislative compulsion to have appropriate occupational health services. Ergonomics problems and prevention of injuries/accidents were the next common topics discussed.

Topics that Have Attracted Researchers in Recent Years

As evidenced from the research activities, following topics have attracted researchers:

Asbestos and asbestos related diseases

Asbestos is a silent killer and there is a lot of controversy

whether to ban asbestos use in country or not. Most of the developed nations have either banned or restricted the use of asbestos. However in India, it is still used mainly in the cement industry. The research is being carried out in various institute regarding:

- a) Permissible levels of asbestos fibres in the workplace: This is important, as the studies carried out by National Institute of Occupational Health have shown that there was high prevalence of asbestosis in asbestos mining and milling, asbestos textile and asbestos cement industries^{11–13}.
- b) Examine the scientific evidence which justifies the banning of asbestos in India.

Pesticide poisoning

Agriculture being the principle occupation in the country exposes a considerable proportion of population to this occupational related hazard. One such hazard is the pesticide exposure. Not only the farmers are exposed females and children are exposed to harmful effects of pesticides. Researchers are working on the various effects of pesticide exposures and risk assessment throughout the country. A recent study carried out in Southern India in school children exposed to endosulfan an organochlorine pesticide through aerial spray on cashew plantations showed evidence of delayed puberty and low levels of serum testosterone²⁸. Commenting on the study, Dr. Jim Burkhart, science editor for Environmental Health Perspectives in a press release says²⁹, “This is the first human study to ever measure the effects of endosulfan on the male reproductive system. Decades of spraying this pesticide, and only this pesticide, on the village provided a unique opportunity to analyze its impact. Although the sample size is somewhat limited, the results are quite compelling.”

Silica related diseases other than silicosis

About 3 million workers working in mines and various industries and about 7 million workers engaged in construction industry are exposed to silica dust are exposed to various kinds of dusts of which free silica is most important. Surveys in some of these industries have shown high prevalence (12–54%) silicosis^{5–9}. Free silica has been classified as carcinogen³⁰. Though many studies^{31–34} have been carried out on the pulmonary effects of silica exposure, the studies on extra-pulmonary effects of free silica exposure such as progressive systemic sclerosis, systemic lupus erythematosus, rheumatoid arthritis, dermatomyositis, glomerulonephritis and vasculitis are lacking.

Musculoskeletal disorders

Musculoskeletal impairments impact significantly on the population, the health care utilization and the cost for society. The workplace is a significant source of occupational injury, occupational illness and related disability. The ILO estimates that 40% of all costs related to work-related injuries and diseases are due to musculoskeletal disorders³⁵. Among these low back pain is the most common. The researchers are working on the ergonomic aspects of the low back pain and repetitive strain injuries^{3, 36–39}.

Measures to Improve Occupational Health Research

In the tenth five year plan (2002–2007), it has been recommended by an expert working group appointed by the planning commission, Government of India that occupational and environmental health should be given priority⁴⁰. The measures to improve occupational and environmental health research include following suggestions:

Creation of advanced research facilities

It was recommended that to create national facility for the analysis of toxic substances at nano-gram level to precisely quantify the exposure to various chemicals and to facilitate research facilities to examine the effects of toxicants at molecular level e.g. development of biomarkers, toxicogenomic studies etc.

Human resources development

Leading institutes in the country such as National Institute of Occupational Health, Industrial Toxicology Research Centre, All India Institute of Hygiene and Public Health, Centre for Occupational and Environmental Health and Central Labour Institute are to be given resources for training and educational programmes in occupational and environmental health. There was also proposal to review and revise the existing medical and engineering curricula and include occupational and environmental health.

Creation of environmental and occupational health cells

Environmental and occupational health cells with multi-disciplinary expertise need to be created in the Ministry of Health & Family Welfare and Ministry of Environment and Forests. This cell will coordinate with occupational and environmental health related issues, which require action by other ministries like Ministry of Labour, Ministry of Industries, Ministry of Mines etc. One such cell has already started functioning in Ministry of Environment.

Database development

Development of database and information system in environmental and occupational health which should include making a directory of the government institutions and universities/departments working on occupational and environmental related matters and linkages between them. Information can also be collected on the capabilities of these institutions for doing various types of activities.

National Strategy for Prevention and Control of Occupational Diseases

The argument that insistence on occupational health and safety may adversely affect the industrial growth and development is not always true. On the contrary, neglect of occupational health and safety of the workers may result in invisible burden to the economy, which, in some cases, may be substantial. Ill health of the workers results in reduced production due to inefficiency of the workers and sickness absenteeism. Moreover, the workers have to be paid sickness benefits and compensation. There is also increased expenditure either on the part of the factory management or the Government to meet the medical expenses for treatment. Further, it must be realized that most of the occupational diseases are incurable and, therefore, the best course of action in dealing with them is their prevention. The economic benefits and incurable nature of occupational diseases must be highlighted while proposing for the investment in occupational health and safety programmes.

At State and National level health of the workers as members of the community is primarily the concern of the Ministry of Health and the task of prevention is vested with the Ministry of Labour. Therefore, inter-ministerial co-operation is very essential for the prevention of industrial diseases.

The strategy for prevention and control of occupational hazards should have the following components:

1. Development of database and information system in occupational health
2. Recognition, evaluation and control of hazards
3. Evaluation of effectiveness of the control strategy (periodic medical and environmental monitoring)
4. Management of cases of occupational diseases
5. Creation of awareness in workers, trade unions and management

Development of database and information system in occupational health

Several International Conferences held in India and abroad

have emphasized that database on Occupational Health at National level is not available in India. The first requirement, however, is to collect data and information on research already conducted or status done or all institutions involved in various activities related to this sector. There is an evident data gap. Therefore, the first activity would necessarily be:

- a) Compilation of information and making a Directory of the Government Institutions and Universities/Departments working on Occupation related matters and linkages between them. Information can also be collected on the capabilities of these Institutions for doing various types of activities.
- b) Compilation of available information regarding epidemiological surveys and related studies to prepare a National Occupational Health profile, which would help in preparation of a National Occupational Health Plan. It is proposed that Ministry of Health straightaway may initiate action on this.

Identification of source of hazard and developing appropriate technology for control/elimination of hazard

The ultimate success of any prevention programme lies in the elimination of the hazard. Appropriate technology should be developed for the elimination of the hazard. Joint effort by the entrepreneurs, machinery manufacturers, Factory Inspectorate, Central Labour Institute, National Institute of Occupational Health etc. will help in identifying appropriate technology for the elimination/control of hazard. NIOH has already developed some technology for the prevention of occupational hazard in slate-pencil industry, tobacco cultivators, agate workers, stone quarries, sand grinding etc. The success of control technology will be determined by (1) initial cost (2) cost of maintenance and running and (3) acceptability to the workers. A control technology usually increases the cost of production. Our experience in slate-pencil and agate industry has shown that a control technology⁴¹⁾ adopted by only a few entrepreneurs initially is given up by them because the cost of production is higher for those who adopt the control techniques.

Medical and Environmental surveillance

This has the following purposes: (1) Early detection of occupational morbidity (2) Evaluation of the success of control strategy and (3) Compliance of law. Under the amended Factories Act and Mines Act, the pre-employment and periodical medical examination and environmental monitoring is mandatory in the factories and mines having hazardous processes. However, compliance of law is generally not satisfactory for lack of infrastructure and trained

manpower. Appropriate steps, such as training of factory inspector, medical inspector of factories, mine inspector, staff of industrial hygiene laboratories of State Government, provision of equipment/supplies, are necessary for the periodic medical and environmental monitoring.

Management of occupational diseases

Special skill is required in diagnosis, treatment and post-illness management of the cases of occupational diseases. Before allowing the worker to resume his work after sickness, it is essential to consider the work environment adversely affecting the existing medical condition and also the physical demand of the work. Training of physicians working in ESIS, District Hospitals and PHCs is, therefore, essential. In the Annexure, the objectives, action and agencies responsible for the prevention and control of occupational diseases are summarized. For the successful implementation of occupational health programme, the need for co-ordination between various Ministries and Departments cannot be over emphasized.

Creation of Awareness and Health Education

In India, a large section of the workers are employed in unorganized sectors. The working populations being largely illiterate are unaware of the hazards associated with their occupation. Similarly, the owners are also unaware about the hazards resulting from improper workplace. This results in poor implementation of control measures and enforcement of laws. Thus, awareness and health education programme should be carried out for the workers, supervisors and owners/management of the factories/mines engaged in hazardous process. Health education programmes should include advice on smoking, avoidance of drinking, eating and smoking at workplace etc. Possible economic benefits resulting from prevention programmes must be ascertained before the management, trade unions and policy makers.

References

- 1) Office of the Registrar General, Ministry of Home Affairs, Government of India; Created on 30th January 2002 <http://mha.nic.in>.
- 2) Leigh J, Macaskill P, Kuosma E, Mandryk J (1999) Global burden of disease and injuries due to occupational factors. *Epidemiol* **10**, 626–31.
- 3) Mohan D, Patel R (1992) Design of safer agricultural equipment: Application of ergonomics and epidemiology. *Int J Ind Ergonomics* **10**, 301–9.
- 4) Industrial Accidents Statistics (2002) Industrial Safety Chronicle, 22–3.
- 5) Saiyed HN, Parikh DJ, Ghodasara NB, Sharma YK, Patel GC, Chatterjee SK, Chatterjee BB (1985) Silicosis in slate pencil workers: I. an environmental and medical study. *Am J Ind Med* **8**, 127–33.
- 6) National Institute of Occupational Health (1988) Study of Respiratory Morbidity in Agate Workers. National Institute of Occupational Health, Ahmedabad, 1–21.
- 7) National Institute of Occupational Health (1987) Pilot survey of stone quarry workers in Jakhlaun area of Lalitpur district (U.P.). National Institute of Occupational Health, Ahmedabad, 37–51.
- 8) Saiyed HN, Ghodasara NB, Sathwara NG, Patel GC, Parikh GC, Kashyap SK (1995) Dustiness, silicosis and tuberculosis in small scale pottery workers. *Indian J Med Res* **102**, 138–42.
- 9) National Institute of Occupational Health (1986) Evaluation of health hazards in quartz crushing industry and evaluation of dust control measures. National Institute of Occupational Health, Ahmedabad, 1–22.
- 10) Saiyed HN, Gangopadhyay PK, Mukherjee AK, Chattopadhyay BP, Kashyap SK (1995) Report on ICMR-IDRC Study of Pneumoconiosis in Underground coal miners in India, Kolkata, 1–113.
- 11) National Institute of Occupational Health (1990) Prevalence of asbestosis in asbestos miners. National Institute of Occupational Health, Ahmedabad, 9–18.
- 12) Dave SK (1993) Asbestosis—Epidemiology, clinical manifestations, diagnosis and treatment. *Indian J Clin Practice* **3**, 40–9.
- 13) National Institute of Occupational Health (1981) Environmental cum medical survey in asbestos cement factory. National Institute of Occupational Health, Ahmedabad, 47–74.
- 14) Parikh JR (1992) Byssinosis in developing countries. *Brit J Ind Med* **49**, 217–9.
- 15) Chattopadhyay BP, Saiyed HN, Alam J (2000) Reversibility of airway obstruction in chronic bronchitis and byssinotic subjects. *Indian J Occup Environ Med* **4**, 64.
- 16) Chattopadhyay BP, Saiyed HN, Alam J, Roy SK, Thakur S, Dasgupta TK (1999) Inquiry into occurrence of byssinosis in jute mill workers. *J Occup Health* **41**, 225–31.
- 17) Ameen S, Musthapas, Ahmad I, Ansari FA, Baig MA, Rahman Q (2003) Alterations in cellular and biochemical markers of pulmonary toxicity in rat lung exposed to carpet dusts. *Inhal Toxicol* **15**, 1119–31.
- 18) Abidi P, Afaq F, Arif JM, Lohani M, Rahman Q (1999)

- Chrysothile mediated imbalance in the glutathione redox system in the development of pulmonary injury. *Toxicol Lett* **106**, 31–9.
- 19) Sahu P, Saxena AK (1994) Enhanced translocation of particles from lungs by jaggery. *Environ Health Perspect* **102** (suppl. 5), 211–4.
 - 20) Husain R, Adhami VM, Seth PK (1994) Behavioural, neurochemical and neuromorphological effects of deltamethrin in adult rats. *J Toxicol Environ Health* **48**, 515–26.
 - 21) Kumar R, Agarwal AK, Seth PK (1996) Oxidant stress mediated neurotoxicity of cadmium. *Toxicol Lett* **89**, 65–9.
 - 22) Husain R, Malaviya M, Seth PK, Husain R (1994) Effect of deltamethrin on regional brain polyamines and behaviour in young rats. *Pharmacol Toxicol* **74**, 211–5.
 - 23) Shukla A, Shukla GS, Srimal RC (1996) Cadmium-induced alterations in blood-brain barrier permeability and its possible correlation with decreased microvessel antioxidant potential in rat. *Hum Exp Toxicol* **15**, 400–5.
 - 24) Seth PK, Saidi NF, Agrawal AK, Anand M (1986) Neurotoxicity of endosulfan in young and adult rats. *Neurotoxicology* **7**, 623–35.
 - 25) Indian Association of Occupational Health (2001) Abstract book of 51st Annual conference of Indian Association of Occupational Health (IAOH), Delhi.
 - 26) Indian Association of Occupational Health (2002) Abstract book of 52nd Annual conference of Indian Association of Occupational Health (IAOH), Goa.
 - 27) Indian Association of Occupational Health (2003) Abstract book of 53rd Annual conference of Indian Association of Occupational Health (IAOH), Bangalore.
 - 28) Saiyed HN, Dewan A, Bhatnagar VK, Shenoy U, Shenoy R, Rajmohan H, Patel KG, Kashyap R, Kulkarni PK, Rajan B, Lakkad BC (2003) Effect of Endosulfan on male reproductive development. *Environ Health Perspect* **111**, 1958–62.
 - 29) Young Males Exposed to Pesticide Endosulfan See Delay in Sexual Maturation Study in Environmental Health Perspectives Also Finds Interference with Sex Hormone Synthesis, <http://ehp.niehs.nih.gov/press/120103.html> (16th January 2004).
 - 30) International Agency for Research on Cancer (IARC) (1997) IARC monographs on the evaluation of carcinogenic risks to humans, Vol. 68: Silica, some silicates, coal dust and para-aramid fibrils. World Health Organization, IARC, Lyon, France.
 - 31) Hotz P, Gonzalez-Lorenzo J, Siles E, Trujillano G, Lauwerys R, Bernard A (1995) Subclinical signs of kidney dysfunction following short exposure to silica in the absence of silicosis. *Nephron* **70**, 438–42.
 - 32) Dracon M, Noël C, Wallaert BP, Dequiedt P, Lelièvre G, Tacquet A (1990) Rapidly progressive glomerulonephritis in silicotic coal miners. *Nephrologie* **11**, 61–5.
 - 33) Masson C, Audran M, Pascaretti C, Chevaller A, Subra JF, Tuchais E, Kahn M-F (1997) Silica-associated systemic erythematosus lupus or mineral dust lupus? *Lupus* **6**, 1–3.
 - 34) Hausteil UF, Anderegg U (1998) Silica induced scleroderma—clinical and experimental aspects. *J Rheumatol* **25**, 1917–26.
 - 35) Rajgopal T (2000) Musculoskeletal disorders. *Indian J Occup Environ Med* **4**, 2–3.
 - 36) Tiwari RR, Pathak MC, Zodpey SP (2003) Low back pain among cotton textile workers. *Indian J Occup Environ Med* **7**, 27–9.
 - 37) Bakhtiar CS, Rao V, Suneetha S (2003) Attitude alters the risk for development of RSI in software professionals. *Indian J Occup Environ Med* **7**, 32–4.
 - 38) Nag PK, Pradhan CK (1992) Workman—A biomechanical human model for ergonomics application. *Indian J Physiol Allied Sci* **46**, 165.
 - 39) Nag PK, Pradhan CK (1992) Ergonomics in the hoeing operation. *Int J Ind Ergonomics* **10**, 341.
 - 40) Government of India (2001) Report of the working group on Environmental and Occupational Health for the Tenth Five Year Plan. TYFP Working Group Sr. No. 36/2001.
 - 41) Ghodasara NB, Rathod RA, Sathawara NG, Saiyed HN, Parikh DJ, Kashyap SK (1992) Environmental dust hazards and its control in small-scale slate pencil industry. *Indian J Environ Protect* **12**, 50.