Data Base on Health effects of Occupational Exposure to Pesticides

ENVIS Centre
on
Occupational and Environmental Health
Website: envisnioh.org

National Institute of Occupational Health
(Indian Council of Medical Research)
Ahmedabad

Working Team

Dr. Sunil Kumar	Dy. Director (Sr. Grade) and Coordinator ENVIS Centre
Dr. (Mrs.) Aruna Dewan	ICMR Consultant, Ex-Dy. Director (Sr. Grade) and Coordinator ENVIS Centre
Ms. Shruti Patel	Senior Technical Assistant

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National Institute of Occupational Health
Meghaninagar, Ahmedabad

PREFACE

Environmental Information System (ENVIS) – NIOH Centre, Ahmedabad started functioning to document information in the form of reports, research publication of studies on occupational and environmental health and to conduct awareness programme and prepare national database on various pollutants with an objective to respond the users queries.

It is my pleasure that ENVIS - NIOH Centre is bringing out the national database on "Occupational Exposure to Pesticide and Health". No doubt that the pesticides are essential for controlling the insects and pests in the environment so as to protect human health and agricultural output. However, one has to realize that there are various forms and magnitudes of toxicity have been observed with the use of these substances. So it is but natural to use them judicially. Hope this bibliography and abstract of the articles would be useful to the researchers, scientists and scholars.

We are thankful to Dr. D. Bandopadhyay, Ex. Project Director (EI), and Dr. S.P. Sharma Project Director (EI), Ministry of Environment & Forest for providing grants from the ENVIS programme of Government of India and their constant support for the ENVIS-NIOH center. The efforts of the staff involved in compilation of this document are also highly acknowledged and appreciated.

Dr. S. K. Dave
Officer-In-Charge
National Institute of Occupational Health

July 2007
Ahmedabad

BACKGROUND

Pesticides/insecticides are used to protect crops from the ravages of pests and diseases and in the vector control program. Guided by commercial motives, farmers are using more and more pesticides to protect their crops. A large number of agricultural workers along with family members and pesticide factory workers and/or applicators are being exposed to various pesticides. The general population is exposed to pesticides through the food chain, The US Environmental Protection Agency, defines a ***pesticide*** as "***any substance or mixture of substances intended for preventing, destroying, repelling, or lessening the damage of any pest***".

Today synthetic chemical contamination is pervasive and global. United Nations Environment Protection agency reported that nine of the twelve most unwanted persistent organic pollutants are pesticides used in agriculture crops and for public health vector control programme. Some pesticides are considered too hazardous for sale to the general public and are designated restricted use pesticides. The list of pesticides / pesticides formulations banned as well as restricted use in India is given in table1-2 [(cibre.nic.in/list_pest_bann_htm) searched on7-6-07).

The present database is prepared on the basis of the available data on occupational exposure to pesticides and human health from India. The data were collected through searching various databases such as Pub Med, Medline, Toxline and other websites such as Goggle and consulting various journals. We have arranged the data year wise from recent one to older one. We are thankful to Dr. SK Dave, Officer In Charge, NIOH and Dr. D. Bandopadhyay, and Dr. SP Sharma Project Director (EI), Ministry of Environment & Forest for encouragement and suggestion.

Dr. Sunil Kumar,
Dy. Director (Sr. Grade) & Coordinator ENVIS Centre,
NIOH, Ahmedabad

1. Kaiser Jamil[1]*,G. Prabhavathy Das[2], Abjal Pasha Shaik[2], Sunita S. Dharmi[2] and Sudha Murthy[1]

Epidemiological studies of pesticide exposed individuals and their clinical implications

Current science, February 2007, Vol. 92, no. 3, 10

1 Indo American Cancer Hospital and Research Centre, Banjara Hills, Hyderabad 500 034, India

2 Department of Genetics, Bhagwan Mahavir Medical Research Center, 10-1-1, Mahavir Marg, A. C. Guards, Hyderabad 500 004, India

*For correspondence. (e-mail: kaiser.jamil@gmail.com)

Epidemiological studies were conducted in pesticide exposed agricultural workers along with an equal number of age- and sex-matched controls. All the 200 exposed volunteers were suffering from fever, nausea, headache and other abnormal symptoms and visited the hospital for general health check-up. These cases were taken up for more detailed studies. Five (2.5%) showed decrease in RBC, haemoglobin, and increase in WBC with a large number of immature cells. These volunteers were further diagnosed as Philadelphia negative Chronic Myeloid Leukaemia (CML) cases based on clinical and pathological examinations. In similar environs, about 100 children (aged between 1 and 17 years) were studied for the above parameters. About 3% of the exposed children showed signs of mental retardation and delayed milestones; these were compared with healthy children (age- and sex-matched) from pristine environment. It is therefore concluded that clinical evaluations supported by occupational epidemiology could determine CML in exposed individuals (adults).

Keywords: Chronic myeloid leukaemia, hematological and neurological parameters, occupational exposure, pesticides.

2. Singh VK, Jyoti , Reddy MM, Kesavachandran C, Rastogi SK Siddiqui MK

Biomonitoring of organochlorines, glutathione, lipid peroxidation and cholinesterase activity among pesticide sprayers in mango orchards

Clin Chim Acta. 2007 Feb;377(1-2):268-72

Analytical Toxicology Section, Industrial Toxicology Research Centre P.O. Box 80, M.G. Marg, Lucknow-226001, India.

BACKGROUND: Pesticide sprayers in mango orchards of Malihabad, Lucknow (India) are generally exposed to organophosphate (OP) and pyrethroid pesticides. We determined the pesticide exposure levels along with their biochemical and clinical effects in 31 sprayers, compared with 18 controls. METHODS: Assay of acetyl and butyrylcholinesterases (AChE, BChE respectively) as an indirect measurement of OP exposure and levels of malondialdehyde (MDA) and glutathione (GSH) were estimated in blood samples to determine their impact on redox potential. Organochlorines were estimated by GLC-ECD. RESULTS: Significantly inhibited AChE, BChE activities and higher MDA level were found among sprayers compared to controls ($p<0.05$). Mean of total organochlorines were surprisingly higher (97.65+/-13.38 ppb) in sprayers than in those of controls (20.42+/-3.56 ppb) ($p<0.05$). Respiratory morbidity (32.4%), ocular problems (8.8%), gastrointestinal (17.6%) and skin problems (23.5%) were found in sprayers. There was significant correlation

between AChE and GSH (r=0.29, p<0.05) and AChE with MDA (r=-0.34, p<0.05). CONCLUSION: Results indicated the significantly enhanced lipid peroxidation in sprayers correlated with cholinesterases inhibition. A small sample size limits the significance of this study. However, it paves the way for a larger Indian study with extended practical significance.
Keywords: Pesticide sprayers; Organochlorines; Glutathione; Lipid- peroxidation; Cholinesterase

3. Bhatnagar VK, Kashyap R, Saiyed HN

Residues of organochlorine pesticides in human blood in Ahmedabad, India

Asian J. of Chemistry 2006, Vol. 18, No. 2, 1583-1585

National Institute of Occupational Health, (Indian Council of Medical Research), Meghaninagar, Ahmedabad 380 016, India
Email:vijai_bhatnagar@yahoo.com

Three studies on the estimation of residues of organochlorine pesticides in the general population of Ahmedabad at different intervals were carried out. Observed trend for these contaminants is descending which may be due to restrictions imposed on the use of these chemicals. However, these levels are still higher than the studies originating from other developing countries.
Key words: Residues, DDT, HCH, Human blood

4. Chandrasekharan Nair Kesavachandran*, Subhodh Kumar Rastogi, Neeraj Mathur, Mohammad Kaleem Javed Siddiqui, Vipul Kumar Singh, Vipin Bihari, Ram Shankar Bharti

Health Status Among Pesticide Applicators at a Mango Plantation in India

Journal of Pesticide Safety Education 2006,Volume 8

*corresponding author
Scientist, Epidemiology Section, Industrial Toxicology
Research Centre, Lucknow, India. email: kesavachandran@rediffmail.com.

Observations of mango plantation workers applying chemicals showed many were mixing pesticides without the appropriate personal protective equipment. Personal hygiene was lacking in that many applicators commonly ate and drank without previously washing their hands. Medical evaluation of thirty-four of these workers at a free health clinic shows pesticide exposure may be linked to health problems. Respiratory, gastrointestinal, ocular and dermal problems were observed; biochemical analysis shows decreased glutathione levels and increased levels of malondialdehyde thereby suggesting significant pesticide exposure. Our study clearly indicates that growers and workers applying pesticides in mango plantations need additional training on how to properly and safely use pesticides.
Keywords: health, occupational, safety, PPE, exposure, pesticide, medical, monitoring

5. Chitra GA, Muraleedharan VR, Swaminathan T, Veeraraghavan D

Use of pesticides and its impact on health of farmers in South India
International Journal of Occupational and Environmental Health
Jul-Sep 2006. Vol. 12, Iss. 3; p. 228

A study of the health effects of acute pesticide toxicity among the cotton growers of India, by Mancini et al., is a positive step to fill this research gap.6 Specific studies dealing with the agricultural practices of Indian farmers regarding pesticide use and its health impacts are needed to inform policy decisions to bring about changes in agricultural practices. The interview questionnaire was designed to elicit land ownership, the plantation where the farmer was currently working, exposure to pesticides, the use of pesticides, the commonly used pesticides, precautions taken, the farmer's source of information about pesticides, and signs and symptoms of illnesses related to pesticide exposure. Some signs, such as tremors, skin lesions, and wheezing, which can be chronic, were observed at the time of the interview.

6. Kallidass Subramaniam and RD. Jebakumar Solomon

Organochlorine pesticides BHC and DDE in human blood in and around madurai, india
Indian Journal of Clinical Biochemistry, 2006 / 21 (2) 169-172
Department of Molecular Microbiology, School of Biotechnology
Madurai Kamaraj University, Madurai - 625 021, India.

In this study blood samples are taken from two groups of people, one that has direct exposure to pesticides (agriculturists & public health workers) the second group, which has indirect exposure to pesticides through food chain. The objective of our investigation is to analyze the blood of the patients with minimum health complaints and skin diseases for the residue of the banned organochlorine pesticides DDE and BHC using Gas Chromatography. High concentrations of both BHC & DDE were observed in the serum samples of the people who had direct exposure to the pesticides, namely agriculturalists and public health workers with few exceptions. The pesticide residue concentration in serum ranges from 0.006 to 0.130 ppm for BHC and 0.002 to 0.033 ppm for DDE. Significance of this study reveals that the presence of these banned pesticides in human serum.

KEY WORDS
BHC, DDE, Gas chromatography, Human serum, Organochlorine pesticide,

7. Sailaja N, Chandrasekhar M, Rekhadevi PV, Mahboob M, Rahman MF, Vuyyuri SB, Danadevi K, Hussain SA, Grover P

Genotoxic evaluation of workers employed in pesticide production
Mutat Res. 2006 Oct 10;609(1):74-80
Toxicology Unit, Biology Division, Indian Institute of Chemical Technology, Hyderabad 500007, Andhra Pradesh, India.

Pesticides are widely used throughout the world in agriculture to protect crops and in public health to control diseases. Nevertheless exposure to pesticides can represent a potential risk to humans. Pesticide manufacturing unit workers are prone to possible occupational pesticide exposure. Therefore, this study was performed to

evaluate the genotoxic effect of pesticide exposure in these workers. In the present investigation 54 pesticide workers and an equal number of control subjects were assessed for genome damage in blood lymphocytes utilizing the chromosomal aberration analysis and the buccal epithelial cell by adopting the micronucleus test. The results suggested that pesticide workers had a significantly increased frequency of chromosomal aberrations when compared with controls (mean+/-S.D., 8.43+/-2.36 versus 3.32+/-1.26; P<0.05). Similarly, the pesticides exposed workers showed a significant increase in micronucleated cells compared with controls (1.24+/-0.72 versus 0.32+/-0.26; P<0.05). Analysis of variance revealed that occupational exposure to pesticides had a significant effect on frequency of micronuclei (P<0.05), whereas smoking, age, gender and alcohol consumption had no significant effect on genetic damage (P>0.05). However, no association was found between years of exposure, smoking, age, gender, alcohol consumption and higher levels of genetic damage as assessed by the chromosomal aberration assay (P>0.05). Our findings indicate that occupational exposure to pesticides could cause genome damage in somatic cells.

8. Bawaskar HS, Joshi SR

Organophosphorus poisoning in agricultural India--status in 2005
J Assoc Physicians India. 2005 May;53:422-4

Abstract not available

9. Cherian MA, Roshini C, Visalakshi J, Jeyaseelan L, Cherian AM

Biochemical and clinical profile after organophosphorus poisoning--a placebo-controlled trial using pralidoxime
J. Assoc. Physicians India, 2005 May, 53:427-31
Dept. of Biochemistry, Christian Medical College Hospital, Vellore 632 004, Tamil Nadu, India.

BACKGROUND: Organophosphorus (OP) compounds are the most common suicidal poison in developing countries and mortality continues to be high. METHODS: A study was done to see butyryl cholinesterase (BuChE) profile after OP poisoning in pralidoxime (P2AM) and placebo treated cases. Highest recommended dose of P2AM was used to study the reactivation of cholinesterase. Clinical outcomes like, correlation of BuChE and severity of poisoning, mortality and complications like Type I and II paralysis, need for ventilation and ICU stay were also studied. RESULTS: Twenty-one cases of moderate and severe poisoning with OP compounds were included in the study. Mean BuChE levels came up gradually over 6-7 days, some taking up to two weeks. There was no. difference between the treatment and placebo groups. BuChE levels did not correlate with severity of poisoning nor did it correlate with Type I or II paralysis, need for ventilation, ICU stay or mortality. CONCLUSIONS: Treatment with P2AM does not make any difference in BuChE reactivation or complications of moderate and severe OP poisoning. We have not been using P2AM for OP poisoning in our medical ICU with good patient outcomes.

10. Das DK, Dey TK

Agricultural practices and personal hygiene among agricultural workers in a rural area of Howrah district, West Bengal
Indian J Public Health. 2005 Oct-Dec;49(4):252-3
R.G. Kar Medical College and Hospital, Kolkata.
dilip_shampa@hotmail.com

The study attempted to assess agricultural practices and personal hygiene among 100 agricultural workers in a rural area of West Bengal in 1999. 69% of the study population was marginal farmer with less than 2 acres of land. Organophosphorus group of pesticides were most commonly used pesticides (68%); spraying was irregular in nature (98%), through semiautomatic sprayer (99%) and only 5% used any special dress while spraying pesticides. 40% of workers used to store pesticides either in living room or in food storage area. 88% of them did not take any food during work with pesticides, only 37% used to take regular bath after working with pesticides but regular hand washing was practiced by all of them.

11. Edward Broughton

The Bhopal disaster and its aftermath: a review
Environ Health. 2005; 4: 6
Published online 2005 May 10. doi: 10.1186/1476-069X-4-6.
Columbia University, Mailman School of Public Health, 600 W 168th St. New York, NY 10032 USA
Edward Broughton: eib6@columbia.edu

On December 3 1984, more than 40 tons of methyl isocyanate gas leaked from a pesticide plant in Bhopal, India, immediately killing at least 3,800 people and causing significant morbidity and premature death for many thousands more. The company involved in what became the worst industrial accident in history immediately tried to dissociate itself from legal responsibility. Eventually it reached a settlement with the Indian Government through mediation of that country's Supreme Court and accepted moral responsibility. It paid $470 million in compensation, a relatively small amount of based on significant underestimations of the long-term health consequences of exposure and the number of people exposed. The disaster indicated a need for enforceable international standards for environmental safety, preventative strategies to avoid similar accidents and industrial disaster preparedness.

Since the disaster, India has experienced rapid industrialization. While some positive changes in government policy and behavior of a few industries have taken place, major threats to the environment from rapid and poorly regulated industrial growth remain. Widespread environmental degradation with significant adverse human health consequences continues to occur throughout India.

December 2004 marked the twentieth anniversary of the massive toxic gas leak from Union Carbide Corporation's chemical plant in Bhopal in the state of Madhya Pradesh, India that killed more than 3,800 people. This review examines the health effects of exposure to the disaster, the legal response, the lessons learned and whether or not these are put into practice in India in terms of industrial development, environmental management and public health.

12. Kerger Heinz, Dodidou Petroula; Passani-Kruppa Daniela, Gruttner Joachim, Birmelin Monika; Volz Alexander, Waschke Klaus F

Excessive methaemoglobinaemia and multi-organ failure following 4-DMAP antidote therapy

Resuscitation 2005,vol.66,n2,pp.231-235

This report describes the clinical history of a patient intoxicated with methyl isocyanate (MIC), a toxic agent first receiving attention in 1984 after a mass accident in a pesticide plant in Bhopal, India, and treated with the cyanide-specific antidote 4-DMAP. The numerous clinical conditions requiring 39-day intensive care treatment included ARDS, renal and hepatic failure, haemolysis, bone marrow depression, septic encephalopathy and critical illness polyneuropathy. The most outstanding condition, however, was a methaemoglobinemia of 86.7%, which was predominantly related to the use of 4-DMAP, although uptake of MIC may have been a significant contributing factor. Since significant cyanide intoxication could be excluded clinically and by laboratory testing in the initial phase of emergency treatment, most of the clinical effects were due to the side-effects of the antidote therapy. Due to intensive therapy, the patient survived without any neurological or organ deficit. This case shows that antidotes should be used cautiously in cases where uncertainties about the nature of the underlying toxic agent exist. This may prevent severe side-effects associated with antidote therapy, e.g. 4-DMAP. if there is-as in our case-a mismatch between the toxic agent and the antidote.

Keywords

Multiple organ failure ; Toxicity ; Cyanides ; Treatment ; Antidote ; Intensive care

Author Keywords

Methyl isocyanate ; Cyanide ; 4-Dimethyl amino phenol ; Toxicity ; Methaemoglobin ; Multiple organ failure ;

13. Mancini F, Van Bruggen AH, Jiggins JL, Ambatipudi AC, Murphy H

Acute pesticide poisoning among female and male cotton growers in India

International Journal of Occupational and Environmental Health

Jul-Sep 2005. Vol. 11, Iss. 3; p. 221, 12 pgs

A season-long assessment of acute pesticide poisoning among farmers was conducted in three villages in India. Fifty female cotton growers reported the adverse effects experienced after exposures to pesticides by themselves and by their male relatives (n = 47). The study documented the serious consequences of pesticide use for the health of farmers, particularly women field helpers. Typically female tasks such as mixing concentrated chemicals and refilling spraying tanks were as hazardous as direct pesticide application. Of 323 reported events, 83.6% were associated with signs and symptoms of mild to severe poisoning, and 10% of the pesticide application sessions were associated with three or more neurotoxic/systemic signs and symptoms typical of poisoning by organophosphates, which were used in 47% of the applications. Although in 6% of the spray sessions the workers' neurotoxic effects were extremely serious, none sought medical care.

Low-income marginal farmers were more often subjected to severe poisoning than were landlords.

14. McKnight RH, Spiller HA

Green tobacco sickness in children and adolescents

Public Health Rep. 2005 Nov-Dec;120(6):602-5

Southeast Center for Agricultural Health and Injury Prevention, College of Public Health, University of Kentucky, Lexington, USA. rmcknig@uky.edu

Tobacco (Nicotiana tabacum) is cultivated in more than 100 countries, and in 2004, some 5.73 million metric tons dry weight of tobacco were grown worldwide. The top five tobacco producers forecast for 2004 are China (2.01 million metric tons; 35.1%), Brazil (757 thousand metric tons; 13.2%), India (598 thousand metric tons; 10.4%), United States (358 thousand metric tons; 6.2%), and Malawi (138 thousand metric tons; 2.4%). Together, these five countries account for two-thirds of worldwide tobacco production. Tobacco farming presents several hazards to those who cultivate and harvest the plant. Although some of these hazards, such as pesticide exposure and musculoskeletal trauma, are faced by workers in other types of agricultural production, tobacco production presents some unique hazards, most notably acute nicotine poisoning, a condition also known as green tobacco sickness (GTS). GTS is an occupational poisoning that can affect workers who cultivate and harvest tobacco. It occurs when workers absorb nicotine through the skin as they come into contact with leaves of the mature tobacco plant. GTS is characterized largely by nausea, vomiting, headache, muscle weakness, and dizziness. Historically, children have played a role in agricultural production in the United States, and they continue to do so today. This includes tobacco farming. The North American Guidelines for Children's Agricultural Tasks, a set of injury prevention guidelines prepared by the National Children's Center for Rural and Agricultural Health and Safety, lists GTS as one of several hazards children face when working on tobacco farms. Children 17 years of age and younger who work on U.S. tobacco farms come from three main groups: members of farm families, migrant youth laborers (primarily Latinos), and other hired local children. All three groups are at risk for GTS. Beyond the U.S., tobacco production using child labor is an emerging topic of concern in developing nations. An international movement, advocated by the Eliminating Child Labor in Tobacco Foundation, is underway to restrict child labor in tobacco production. GTS is a unique occupational poisoning associated with tobacco farming. We suspect that many public health practitioners, clinicians, advocates, and researchers are unaware of GTS among children and adolescents. In this article, we provide an overview of GTS among young people who work in tobacco, summarize reports documenting pediatric GTS cases, explain GTS etiology, and present three case studies of pediatric GTS in Kentucky. In addition, we discuss the need for expanded surveillance and prevention of GTS, both in the United States and globally.

15. Siddiqui MK, Anand M, Mehrotra PK, Sarangi R, Mathur N

Biomonitoring of organochlorines in women with benign and malignant breast disease

Environ Res. 2005 Jun;98(2):250-7

Analytical Toxicology, Industrial Toxicology Research Centre, P.O. Box No. 80, M.G. Marg, Lucknow 226 001, India. mkjs@rediffmail.com

Established risk factors for breast cancer explain breast cancer risk only partially. Organochlorines are considered to be a possible cause for hormone-dependent cancers. A hospital-based case-control study, the first from India, was conducted among 50 women undergoing surgery for breast disease to examine the association between organochlorine exposure and breast cancer risk. Blood, tumor, and surrounding adipose tissue of the breast were collected from the subjects with benign (control) and malignant breast (study) lesions and analyzed to determine organochlorine insecticides using a gas-liquid chromatograph equipped with an electron capture detector. The alpha, beta, gamma, and delta isomers of hexachlorocyclohexane (HCH), p,p'-dichlorodiphenyltrichloroethane (DDT), o,p'-DDT, p,p-dichlorodiphenyldichloroethylene, and p,p'-dichlorodiphenyldichloroethane were frequently detected in three specimens. Total HCH and total DDT levels were higher in the blood of the study group (25 cases) than in those of the controls (25 cases) with only gamma-HCH being significantly different ($P<0.05$). However, both total HCH and total DDT were higher in the tumor tissues of the controls than in those of the study group; gamma-HCH was significantly different ($P<0.05$). The level of total HCH (alpha-HCH was significantly different, $P<0.05$) was higher in the breast adipose tissue of the study group, whereas total DDT was higher in the breast adipose tissue of the control group. The distribution of known confounders of breast cancer including age, body mass index, age at menarche and menopause, duration of breast feeding, and family history related to breast disease did not differ significantly between benign and malignant groups. This pilot study with limited statistical power does not support a positive association between exposure to organochlorines and risk of breast cancer but paves the way for a larger Indian study with greater statistical power encompassing different regions of the country to enable statistically sound conclusions.

16. Srinivas Rao Ch, Venkateswarlu V, Surender T, Eddleston M, Buckley NA

Pesticide poisoning in south India: opportunities for prevention and improved medical management

Trop Med Int Health. 2005 Jun;10(6):581-8

University College of Pharmaceutical Sciences, Kakatiya University, Warangal, India. chennamanenir@yahoo.com

OBJECTIVE: Warangal district in Andhra Pradesh, southern India, records >1000 pesticide poisoning cases each year and hundreds of deaths. We aimed to describe their frequency and distribution, and to assess quality of management and subsequent outcomes from pesticide poisoning in one large hospital in the district.
METHODS: We reviewed data on all patients admitted with pesticide poisoning to a district government hospital for the years 1997 to 2002. For 2002, details of the

particular pesticide ingested and management were abstracted from the medical files.
FINDINGS: During these 6 years, 8040 patients were admitted to the hospital with pesticide poisoning. The overall case fatality ratio was 22.6%. More detailed data from 2002 revealed that two-thirds of the patients were <30 years old, 57% were male and 96% had intentionally poisoned themselves. Two compounds, monocrotophos and endosulfan, accounted for the majority of deaths with known pesticides in 2002. Low fixed-dose regimens were used in the majority of cases for the most commonly used antidotes (atropine and pralidoxime). Inappropriate antidotes were also used in some patients. CONCLUSIONS: It is likely that these findings reflect the situation in many rural hospitals of the Asia Pacific region. Even without an increase in resources, there appear to be significant opportunities for reducing mortality by better medical management and further restrictions on the most toxic pesticides.

17. Srivastava HC, Kumar GP, Hassan A, Dabhi M, Pant CS, Yadav RS

Evaluation of possible health effects of pyrethroid insecticides, bifenthrin 10% WP, and deltamethrin 25% WG, on spraymen exposed in a field trial in India

Bull Environ Contam Toxicol. 2005 Sep;75(3):413-20

Malaria Research Center, Indian Council of Medical Research, Civil Hospital, Nadiad 387001, Gujarat, India.

Abstract not available

18. Bhatnagar VK, Kashyap R, Zaidi SSA, Kulkarni PK, Saiyed HN

Levels of DDT, HCH, and HCB Residues in human blood in Ahmedabad, India

Bull. Environ. Contam. Toxicol. (2004) 72:261-265

Division of Pesticide Toxicology, National Institute of Occupational Health, Indian Council of Medical Research, Meghaninagar, Ahmedabad 380 016, India

Abstract not available

19. Dewan A, Bhatnagar VK, Mathur ML, Chakma T, Kashyap R, Sadhu HG, Sinha SN, Saiyed HN

Repeated episodes of endosulfan poisoning

J. Toxicol Clin Toxicol, 2004;42(4):363-9

National Institute of Occupational Health, (Indian Council of Medical Research), Ahmedabad, India. dewanaruna@yahoo.com

INTRODUCTION: A number of families in a rural area of Jabalpur District (Madhya Pradesh), India, were affected by repeated episodes of convulsive illness over a period of three weeks. The aim of this investigation was to determine the cause of the illness. METHODS: The investigation included a house-to-house survey, interviews of affected families, discussions with treating physicians, and examination of hospital records. Endosulfan poisoning was suspected as many villagers were using empty pesticide containers for food storage. To confirm this, our team

collected blood and food samples, which were transported to the laboratory and analyzed with GC-ECD. RESULTS: Thirty-six persons of all age groups had illness of varying severity over a period of three weeks. In the first week, due to superstitions and lack of treatment, three children died. In the second week, symptomatic treatment of affected persons in a district hospital led to recovery but recurrence of convulsive episodes occurred after the return home. In the third week, 10 people were again hospitalized in a teaching hospital. Investigations carried out in this hospital ruled out infective etiology but no facilities were available for chemical analysis. All persons responded to symptomatic treatment. The blood and food samples analyzed by our team showed presence of endosulfan, which was confirmed by GCMS. One of the food items (Laddu) prepared from wheat flour was found to contain 676 ppm of alpha-endosulfan.
CONCLUSIONS: Contamination of wheat grains or flour with endosulfan and its consumption over a period of time was the most likely cause of repeated episodes of convulsions, but the exact reason for this contamination could not be determined. This report highlights the unsafe disposal of pesticide containers by illiterate farm workers, superstitions leading to delay in treatment, and susceptibility of children to endosulfan.

20. Dhara VR

Assessing exposure to toxic gases in Bhopal

The Journal of the American Medical Association Jan 28 2004. Vol. 291, Iss. 4; p. 422

Abstract not available

21. Lal CS, Kumar V, Ranjan A, Das VN, Kumar N, Kishore K, Bhattacharya SK

Evaluation of cholinesterase level in an endemic population exposed to malathion suspension formulation as a vector control measure

Mem Inst Oswaldo Cruz 2004 Mar 99(2):219-21

Rajendra Memorial Research Institute of Medical Sciences, (Indian Council of Medical Research), Patna 800 007, India. drcslal@sify.com

The manuscript describes a study on the blood cholinesterase (ChE) level in an exposed population at different interval of time after spraying with malathion suspension (SRES) use for kala-azar vector control in an endemic area of Bihar, India. The toxicity of a 5% malathion formulation in the form of a slow release emulsified suspension (SRES) was assessed by measuring serum ChE levels in spraymen and in the exposed population. The study showed a significant decrease in ChE levels in the spraymen ($p < 0.01$) after one week of spraying and in exposed population one week and one month after of spraying ($p < 0.01$), but was still within the normal range of ChE concentration, one year after spraying, the ChE concentration in the exposed population was the same as prior to spraying ($p > 0.01$). On no occasion was the decrease in ChE level alarming. A parallel examination of the clinical status also showed the absence of any over toxicity or any behavioural changes in the exposed population. Hence, it may be concluded that 5% malathion slow release formulation, SRES, is a safe insecticide for use as a vector control measure in endemic areas of kala-azar in Bihar, India so long as good

personal protection for spraymen is provided to minimize absorption and it can substitute the presently used traditional DDT spray.

22. Saiyed HN, Tiwari RR

Occupational health research in India
Ind Health, 2004 Apr,42(2):141-8
National Institute of Occupational Health, Meghani Nagar, Ahmedabad-380016, Gujarat, India.

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.

23. Singh S, Ranjit A, Parthasarathy S, Sharma N, Bambery P

Organo-phosphate induced delayed neuropathy: report of two cases.
Neurol India. 2004 Dec;52(4):525-6

Organophosphates are the most common cause of acute poisoning in India.[1] Organophosphate induced delayed neuropathy (OPIDN) is common following exposure to OPC's, which have weak cholinergic activity, little insecticidal activity and are of use in chemical warfare.[2] The presently used organophosphates have potent cholinergic activity and are being widely used as insecticides. However OPIDN is distinctly uncommon following exposure to these OPC's.[3]

A 35-year-old farmer consumed about 200 ml of dichlorvos with a suicidal intent. He was treated with atropine and pralidoxime and required assisted ventilation for 7 days. Four days after his discharge, he developed weakness of all the four limbs and fever. Neurological examination revealed generalized hypotonia with power 3/5 in proximal muscles and 5/5 in distal muscles of upper limbs and 3/5 and 4/5 in lower limbs respectively. Sensory examination was normal. However there was complete areflexia and plantars were mute. Hematological, biochemical and CSF examinations did not reveal significant abnormalities. Nerve conduction revealed normal distal latency (right median 3.2 ms, 7.3 ms wrist elbow), (ulnar 2.9 ms, 7.4 ms wrist below elbow), (peroneal 2.3 ms, 2.0 ms ankle fibular head); amplitude (11.0 mv, 8.3 mV wrist elbow; 5.9, 6.3 mV; 2.3, 2.0 mV) and conduction velocity (54 ms, 51 ms, 37 ms) respectively. However F-waves were absent. Sural nerve was not

stimulable. Sensory nerve conduction in the right ulnar and median nerves was peak latency 2.6, 2.7 ms; amplitude 14 mV, 38 mV; conduction velocity 51 ms and 62 ms respectively. These findings were considered to be consistent with mild polyradiculoneuropathy with mild peripheral neuropathy. The nerve conduction was repeated 5 days later and it revealed decreased amplitude (1.4 mV and 1.1 mV); distal latency (7.5 ms) and conduction velocity (43 ms) in the right peroneal nerve. The right sural nerve was not stimulable. However in the median and ulnar nerves, amplitude, distal latency and conduction velocity were normal. EMG of right vastus lateralis revealed normal insertional activity, minimal spontaneous activity, a few polyphasic MUP's with increased duration and amplitude with decreased recruitment and discrete pattern and less than normal interference consistent with neurogenic EMG. Repetitive nerve stimulation (RNS) did not reveal increment-decrement phenomenon. He was followed up for 6 months during which he recovered completely and the nerve conduction done at 6 months was normal except F- waves were absent (right median nerve distal latency 4.2 ms,8.7 ms; amplitude 12.6 uV, 9.7 mV; conduction velocity 12.6 ms; right ulnar nerve distal latency 7.0,15.5 ms; conduction velocity 47 ms and amplitude 4.1,4.7 mV).

A 19-year-old female had ingested 200-300 ml of monocrotophos with a suicidal intent 23 days ago and was treated with atropine and pralidoxime (total 3 gm). For the next 3 weeks, she continued to remain in altered sensorium and was brought to the institute. On examination her pulse was 100/min and BP 130/70 mmHg. Pupils were 3 mm in size with normal reaction to light. Neurological examination revealed spontaneous eye opening and movements, generalized hypotonia, areflexia and power grade 0-1 in all the four limbs. Nerve conduction revealed absent F waves but normal latency (3.2 ms, 7.4 ms wrist elbow), amplitude (4.0 m V, 2.3 m V and conduction velocity (57 ms) in right median motor nerve. The sensory median conduction revealed normal peak latency (2.9 ms), amplitude (12 uV) and conduction velocity (55 ms). However the peroneal nerve was not stimulable. The impression was predominant distal motor neuropathy more marked in the lower limbs than the upper limbs. EMG of right vastus lateralis revealed normal insertional activity but minimal spontaneous activity, a few polyphasic MUP's with increased duration and amplitude with decreased recruitment and discrete pattern with less than normal interference as in first case. RNS could not be carried out. Her altered sensorium was thought to be due to hypoxic brain damage. However MRI of brain was normal. She was treated with antibiotics and became afebrile after about 2 weeks. Her neurological status had not changed at discharge and she did not return for follow up.

Organophosphate induced delayed neuropathy is a well-recognized complication of organophosphate poisoning.[1],[3] The later appears 2-4 weeks after poisoning and leads to motor paralysis affecting the distal muscles of limbs, minimal sensory involvement and calf pain which precedes its onset. It has been reported following poisoning with compounds like TOCP, mipafox, leptophos, chlorophos etc which have weak cholinergic activity and are not being used as insecticides at present.[2] Senanayake and Jhonson reported 10 cases of OPIDN following poisoning with methomidaphos.[4] All these cases had acute cholinergic crisis preceding its development. Das and Jena[5] have reported a young female who developed OPIDN following phorate ingestion. Both our patients had acute cholinergic crisis and 2-3 weeks later developed OPIDN.

In patients reported by Senanayake and Jhonson, 50% inhibition of neuropathy target esterase (NTE) was found.[4] However we have not been able to estimate this in our patients. NTE is present in abundance in the axons of nervous system and > 70% of its phosphorylation and ageing leads to development of neuropathy in experimental studies.[2]

References

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24. Bhatnagar VK

Status of pesticide residues in human tissues in India
A Review article
Symposium on risk assessment of pesticide residues in water and food (2003) H1-H9

Sponsored by International Life Sciences Institute-India, New Delhi and ILSI Risk Science Institute, Washington DC
Co-Sponsored by Indian Council of Medical Research, New Delhi and Indian Toxicology Research Centre, Lucknow

This article is a review on available data on presence of pesticide residues in human tissues (adipose tissue, blood and breast milk) in general population of the country. Findings suggest that residues of pesticides in biologic samples are present in detectable amounts and the potential health risk to man and the environment remains. There is wide variation in the data, which may be related to the local use pattern. An improved National Monitoring Program on residues of persistent pesticides including PCBs, dioxins and furans based on human epidemiological rationale would submit for more consistent data on trends over time, regional variability and in our knowledge on contribution of such exposure resulting adverse health outcomes.

25. Bhatnagar VK*, Zaidi SSA, Kashyap R, Karnik AB, Kulkarni PK, Venkaish K[1], Shah MP and Saiyed HN

Pesticides residues in formulators and their relevance to certain biological indices
Toxicol. Int.(2003) Vol. 10, No. 1, pp 47-50

*National Institute of Occupational Health, Meghaninagar, Ahmedabad 380 016, India
[1] National Institute of Nutrition, Hyderabad – 500007, India

The study on the biological monitoring of the residues of persistent pesticides in formulators engaged in formulation of various pesticides in an industrial setting was

conducted. Total hexachlorocyclohexane (HCH) and its residues were significantly higher ($p<0.005$) in formulators. β-HCH was the chief contaminant and it accounts for about 93% of the total HCH content. A total of four residues of DDT (pp'-DDE, pp'-DDT, op'-DDT and pp'-DDD) were also detected. However, significant elevation ($p<0.01$) was noticed in the level of pp'-DDE and total DDT in formulators. The pp'-DDE contributed about 73% of the total DDT content. On comparison with the levels of various organochlorine insecticides detected in this study, a significant positive correlation was found between α-HCH and IgM ($r=0.526$, $p<0.005$) and total HCH and IgM ($r=0.401$, $p< 0.05$). These findings merit surveillance insight reflective of industrial exposure and may be regarded as an aid towards understanding of the environmental problems resulting from pesticide formulation practices in industrial settings.

Key words: Formulators, pesticide residues DDT, HCH, IgM

26. Jyotsna A. Patil*, Arun J. Patil* and Sanjay P. Govindwar **

Biochemical Effects of Various Pesticides on Sprayers of Grape Gardens

Indian Journal of Clinical Biochemistry, 2003, 18 (2) 16-22

* Department of Biochemistry, BLDEAS Shri B.M. Patil Medical College, Bijapur, ** Department of Biochemistry, Shivaji University, Kolhapur

Running Title: Biochemical effects of pesticides

Author for Correspondence:
Dr. S. P. Govindwar Reader,
Department of Biochemistry, Shivaji University, Kolhapur- 416 004
Email: spgovindwar@rediffmail.com

A total of 85 healthy male pesticide sprayers in grape garden exposed to different class of pesticides for 3 to 10 years were compared with 75 controls matched for age with respect to serum cholinesterase, serum total protein, albumin, AST, ALT, hematological parameters such as Hb, Hct, RBC and serum lipid peroxidation. Serum lipid peroxidation was estimated in the form of thiobarbituric acid reactive substances (TBARS) produced. Significant decrease was observed in serum cholinesterase, serum total proteins, albumin and hematological parameters viz. Hb, Hct and RBC. Significant increase in lipid peroxidation, AST, ALT, was observed in exposed group when compared with control. These results suggest that the long term exposure of various pesticides on sprayers of grape garden affect liver, heme biosynthesis and decrease serum cholinesterase.

KEY WORDS
Aspartate aminotransferase, Alanine aminotransferase, Acetyl cholinesterase, hemoglobin, hematocrit, red blood cell, lipid peroxidation.

27. Mathews R, Reis C, Iacopino V

Child labor. A matter of health and human rights

Journal of Ambulatory Care Management Apr-Jun 2003. Vol. 26, Iss. 2; p. 181, 2 pgs

Despite the existence of laws in India that prohibit the labor of children under age 14, 70 to 115 million children between the ages of 5 and 14 are estimated to be part of India's labor force. Child labor in the agriculture sector accounts for 80% of child laborers in India and 70% of working children globally. From May 2001 to July 2001,

Physicians for Human Rights (PHR) investigated the health experiences of 100 children in hybrid cottonseed production in rural Andhra Pradesh. Eighty-eight percent of the survey participants were girls, ages 7 to 14. PHR found that children worked on average 12 hours a day, were frequently exposed to pesticides, and were not provided with safety equipment, not even shoes or water to wash their hands and clothes. Children reported having frequent headaches and dizziness and skin and eye irritations after pesticide spraying. All 100 children reported that they were unable to go to school during the hybrid cottonseed season due to work demands. Ninety-four children reported to PHR that they would rather be in school. In addition, a majority of child workers interviewed by PHR reported physical and/or verbal abuse by their employers. Moreover, PHR interviews with representatives of multinational and national companies revealed knowledge of child labor practices for up to 10 years. Child labor is a significant health and human rights problem for children in India. The progressive elimination of child labor practices will require the support of a wide cross-section of civil society. Key words: Andhra Pradesh, child labor, cottonseed, health, hybrid, India

CHILD LABOR is a worldwide problem. The International Labor Organization estimates that there are 250 million children between the ages of 5 and 14 working in developing countries. Most of these children do not have access to education. The often repetitious work in which they engage frequently endangers their health and safety and adversely affects their physical and mental development.

India has the largest number of working children. Approximately 70 to 115 million Indian children between the ages of 5 and 14 are estimated to be part of India's labor force; this approximation does not include children who engage in paid or unpaid domestic labor and is made despite the existence of laws in India that prohibit the labor of children under age 14 in most industrial sectors, especially those deemed hazardous. India's labor laws regulate working conditions for children employed in nonprohibited industries, but these provisions are often not enforced and monitoring is poor. Most of India's child laborers work long hours for low wages, often to pay off family debts. Such employment in debt servitude is forbidden by Indian and international law, however, an estimated 15 million children in India and millions more worldwide are subject to this practice of debt bondage. Campaigns against and subsequent bans of child labor in the carpet, beedi (cigarette), textile, and other industries may have contributed to shifting the child labor underground, which may place children at increased risk for adverse health effects.

Child labor in the agriculture sector accounts for 80% of child laborers in India and 70% of working children globally. From May 2001 to July 2001, Physicians for Human Rights (PHR) investigated the health experiences of children in hybrid cottonseed production in rural Andhra Pradesh, a state on the southeastern coast of India. PHR studied the nature and scope of the labor practices, work conditions, employment arrangements, exposure to harmful agents, education status, access to health care, and socioeconomic status of the family through interviews with 100 children in the hybrid cottonseed fields.

Eighty-eight percent of the survey participants were girls, ages 7 to 14 years old. On average, these children worked 12 hours a day, earning 18 rupees a day (38 cents). Eighty-eight percent were working to pay off a family loan or advance. They were frequently exposed to pesticides while they worked and were not provided with

protective equipment by their employer. Children reported having frequent headaches, dizziness, and skin and eye irritations after pesticide spraying. A few reported experiencing fainting spells and convulsions.

Boys were employed expressly for taking on extra tasks that were deemed dangerous, such as mixing and spraying the pesticides. None of the boys interviewed by PHR were provided with proper protection or training on safe handling of the extremely hazardous pesticides used in the cottonseed fields. In fact, almost all the children worked barefoot and are likely to have been in constant direct contact with these toxic chemicals. None had regular access to water to wash themselves or their clothes. A local physician interviewed by PHR indicated that he had seen many cases of pesticide poisoning in the area and most of them were children or adults who work in the fields.

All of the 100 children who participated in the PHR study reported that they could not go to school during the cottonseed season, from May to February, due to work demands. Most of the children reported dropping out of school completely or never having attended. Ninety-four children told PHR investigators that they would rather go to school than be working. A 13-year-old girl, who told PHR she has been working since the age of eight, stated: "Whenever I see children of my age who are going to school, I get a feeling that I am missing something and feel bad about myself. My future would have been better if I had joined in school and had tried to study." In addition, a majority of child workers interviewed by PHR reported physical and/or verbal abuse by their employers.

All the children in the PHR study were working in fields that were producing hybrid cottonseed for major multinational and national seed companies. Representatives of the involved companies acknowledged to PHR researchers that they have known for up to 10 years about the child labor employed in making their hybrid cottonseed. Although representatives of the multinational corporations indicated their intention to remedy the problem of child labor, little has changed in practice.

PHR's study is a snapshot of a range of experiences reported by children working in the agricultural industry in India. Such practices are harmful to children and may displace opportunities for educational development. State and nonstate actors must ensure through monitoring and accountability measures an immediate end to harmful practices such as bonded labor and pesticide spraying while workers are in the field. The progressive elimination of all child labor practices will require the concentrated efforts of wide cross-section of civil society including state representatives, employers and farmers, community organizations, parents and children, human rights organizations, health professionals, educators, and the support of the public. For more information on PHR's child labor project, visit www.phrusa.org or contact Rahel Mathews at phrusa@phrusa.org.

28. Saiyed HN, Dewan A, Bhatnagar VK, Shenoy U, Shenoy R, Rajmohan H, Patel K, Kashyap R, Kulkarni PK, Rajan B, Lakkad BC

Effect of endosulfan on male reproductive development

Environ Health Perspect. 2003 Dec; 111(16):1958-62

National Institute of Occupational Health (Indian Council of Medical Research), Meghani Nagar, Ahmedabad, India. saiyedhn@yahoo.com

There is experimental evidence of adverse effects of endosulfan on the male reproductive system, but there are no human data. Therefore, we undertook a study to examine the relationship between environmental endosulfan exposure and reproductive development in male children and adolescents. The study population was composed of 117 male schoolchildren (10-19 years of age) of a village situated at the foothills of cashew plantations, where endosulfan had been aerially sprayed for more than 20 years, and 90 comparable controls with no such exposure history. The study parameters included recording of clinical history, physical examination, sexual maturity rating (SMR) according to Tanner stages, and estimation of serum levels of testosterone, luteinizing hormone (LH), follicle-stimulating hormone, and endosulfan residues (70 study and 47 control subjects). Mean +/- SE serum endosulfan levels in the study group (7.47 +/- 1.19 ppb) were significantly higher ($p < 0.001$) than in controls (1.37 +/- 0.40 ppb). Multiple regression analysis showed that SMR scoring for development of pubic hair, testes, penis, and serum testosterone level was positively related to age and negatively related to aerial exposure to endosulfan (AEE; $p < 0.01$). Serum LH levels were significantly positively related to AEE after controlling for age ($p < 0.01$). The prevalence of congenital abnormalities related to testicular descent (congenital hydrocele, undescended testis, and congenital inguinal hernia) among study and controls subjects was 5.1% and 1.1%, respectively, but the differences were statistically nonsignificant. Our study results suggest that endosulfan exposure in male children may delay sexual maturity and interfere with sex hormone synthesis. Our study is limited by small sample size and nonparticipation.

29. Sanghi R, Pillai MK, Jayalekshmi TR, Nair A

Organochlorine and organophosphorus pesticide residues in breast milk from Bhopal, Madhya Pradesh, India

Hum Exp Toxicol 2003 Feb:22(2):73-6

Facility of Ecological and Analytical Testing, 302 Southern Laboratories, Indian Institute of Technology, Kanpur-208016, India. rsanghi@iitk.ac.in

HCH isomers, endosulfan, malathion, chlorpyrifos, and methyl-parathion were monitored in human milk samples from Bhopal, Madhya Pradesh. The endosulfan concentrations were highest and exceeded the sigma-HCH, chlorpyrifos, and malathion concentrations by 3.5-, 1.5-, and 8.4-fold, respectively. Through breast milk, infants consumed 8.6 times more endosulfan and 4.1 times more malathion than the average daily intake levels recommended by the World Health Organization. A correlation analysis (r values) between mothers' age and the content of the chemicals accumulated in breast milk indicated a substantial degree of correlation for malathion ($r = 0.5$). The other chemicals showed low to negligible correlation with donor age.

30. Bhatnagar VK, Karnik AB, Suthar AM, Zaidi SSA, Kashyap R, Shah MP, Kulkarni PK, Saiyed HN

Biological indices in formulators exposed to a combination of pesticides
Bull. Environ. Contam. Toxicol. (2002) 68:22-28
Division of Pesticide Toxicology, National Institute of Occupational Health, Indian Council of Medical Research, Meghaninagar, Ahmedabad 380 016, India

Abstract not available

31. Patil RR

An investigative report on circumstances leading to death among Indian cotton farmers
Int J Occup Med Environ Health 2002 15(4):405-7
Community Health Cell, Bangalore, India. rajanpatil@yahoo.com

Andhra Pradesh, a southern state of India has been in the news for cotton farmers' deaths/suicides since 1998. The occurrence of 12 deaths among the farmers in the years 2001-2002 clustering around September-October expedited the investigation. The objective of our investigation was to identify the circumstances leading to death of cotton farmers in Warangal district of Andhra Pradesh. Some of the broadly held hypotheses were also analyzed for their validity. The socioeconomic-political factors emerge as very strong determinants of deaths, given the occupational work environment.

32. Anand AC

Kerala pesticide tragedy
Natl Med J India. 2001 Mar-Apr;14(2):123-4.

Abstract not available

33. Chaudhuri RN

Occupational health problems among agricultural and plantation workers
J Indian Med Assoc. 2000 Aug;98(8):439-41, 445
Department of Occupational Health, All India Institute of Hygiene and Public Health, Calcutta.

Agricultural and plantation works are associated with a variety of unique occupational health hazards in the form of physical factors like extreme weather conditions, sunrays, etc; chemicaVtoxicological hazards in the form of pesticides/fertilisers, etc, including different forms of biological and mechanical hazards. As most of our rural people are engaged in varied types of agricultural activities, they are highly susceptible for suffering from numerous work related health disorders. There are very few data regarding the epidemiology of occupational health disorders among agricultural and plantation workers. Clinically well recognised group of occupationally acquired health problems may be respiratory, dermatological, traumatic, poisoning and neoplastic in nature. Prevalence of some specific zoonotic diseases and behavioural health problems are also found to be more among them. There is lack of attention for prevention and control of these occupational health problems. An adequately developed comprehensive occupational health care

programme having all the components of preventive, curative and rehabilitative aspects can only promote and maintain the highest degree of physical, mental and social well-being in all types of agricultural and plantation workers of rural India.

34. Singh S, Sharma N

Neurological syndromes following organophosphate poisoning
Neurol India. 2000 Dec;48(4):308-13
Department of Internal Medicine, Postgraduate Institute of Medical Education and Research, Chandigarh, 160012, India.

Organophosphorous compounds, the anticholinesterases, produce significant morbidity and mortality in India. Although exact estimates are not available, hospital based statistics suggest that nearly half of the admissions to emergency with acute poisoning are due to organophosphates. Following accidental or suicidal exposure, these anticholinesterases lead to three well defined neurological syndromes i.e. initial life threatening acute cholinergic crisis which often requires management in intensive care unit, intermediate syndrome in which cranial nerve palsies, proximal muscle weakness and respiratory muscle weakness are common and patients often require respiratory support and delayed organophosphate induced polyneuropathy. In addition to these three classical neurological syndromes following acute exposure and in some following low dose chronic exposure, several neurobehavioural changes have been observed and these have been termed together as 'chronic organophosphate induced neuropsychiatric disorders' (COPIND). Organo-phosphate compounds produce significant pesticide related illness in developing countries. There is, thus, a need to determine exact extent of the problem and to develop appropriate strategies to manage these cases with available resources in these countries.

35. Zaidi SSA, Bhatnagar VK, Gandhi SJ, Shah MP, Kulkarni PK, Saiyed HN

Assessment of thyroid function in pesticide formulators
Human & Experimental Toxicology (2000) 19, 497-501
Department of Biochemistry, National Institute of Occupational Health, Meghani Nagar, Ahmedabad, Gujarat 380 016, India

Thirty male pesticide formulators exposed to the dust and liquid formulation of endosulfan, quinalphos, chlorpyriphos, monocrotophos, lindane, parathion, phorate, and fenvalerate and 20 comparable control subjects from the same area of study were examined for the evaluation of thyroid function tests. The level of TSH was elevated (about 28%) in pesticide formulators as compared to a control group, but the increase was statistically insignificant. Based on the individual TSH measurement, 3 of 30 formulators had isolated elevated levels of TSH and seem to have acquired sub-clinical hypothyroidism; five had TSH values slightly elevated to the upper boarder line (4.03,uIU/ml); and the majority of formulators (N= 22) had TSH values in the normal range varying from 1.29 to 3.9 pIU/ml. Total T_3 was suppressed significantly ($P < 0.01$) in formulators, while marginal decrease (about 7%) was noticed in T_4 level. This study indicated thyroid function impairment in few pesticide formulators.
Key Words: thyroid hormone • endocrine disruptors • radioimmunoassay • hypothyroidism • hyperthyroidism • pesticides • formulators

36. Chugh SN, Dhawan R, Agrawal N, Mahajan SK

Endosulfan poisoning in Northern India: a report of 18 cases
Int J Clin Pharmacol Ther. 1998 Sep;36(9):474-7
Department of Medicine II, Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India

Eighteen cases of endosulfan poisoning by accidental overexposure during spray, admitted between October 1995 to September 1997, were observed and analyzed. These accounted for approximately one third of the total number of poisoning cases admitted in our unit during this period. Nausea, vomiting abdominal discomfort, tonic and clonic convulsions, confusion, disorientation, and muscular twitchings were cardinal manifestations. None of the patients succumbed to their illness. Analysis of various incriminating factors revealed that accidental overexposure was due to failure to adhere to the instructions for spray either due to ignorance or due to illiteracy. All the patients avoided preventive measures and developed toxicity both due to inhalation and absorption through skin. Endosulfan (a chlordiene derivative) poisoning is gaining up momentum in this part of world and has become an important matter for public health in India.

37. Dua VK, Pant CS, Sharma VP, Pathak GK

HCH and DDT in surface extractable skin lipid as a measure of human exposure in India
Bull Environ Contam Toxicol 1998 Feb:60(2):238-44
Malaria Research Centre (Field Station), Section III, BHEL, Ranipur, Hardwar, India.

Abstract not available

38. Dua VK, Pant CS, Sharma VP, Pathak GK

Determination of HCH and DDT in finger-prick whole blood dried on filter paper and its field application for monitoring concentrations in blood
Bull Environ Contam Toxicol. 1996 Jan;56(1):50-7
Malaria Research Centre, Hardwar, India.

Abstract not available

39. Joshi PL, Bhattacharya M, Yadava RL, Chand B, Narasimham MV, Nigam DK, Jain CL

A community-based study on the effect of hexachlorocyclo-hexane (HCH) exposure in spraymen and general population
J Commun Dis 1996 Sep:28(3):189-98
Regional Office for Health and Family Welfare, Lucknow.

The study was carried out in Allahabad district, (Uttar Pradesh) with 260 spraymen as test subjects and 50 persons as controls from a sprayed and unsprayed village respectively. Majority of the spraymen (44%) had worked for 3-4 years (seasons) and 31% had worked in the programme for 5-10 years. The spraymen were relatively healthy with no complaints in 77% whereas the figures were 76% for the Community living in the sprayed village, and 50% for the Community in the unsprayed village. A

comparison of the biochemical parameters revealed lowered Cholesterol more than 150 mg % in 38% of the spraymen and 58% had altered A:G ratio. Other biochemical estimations were not significantly different from the control population. The mean residue of Alpha, Beta and Gamma Isomers and the total Alpha, Beta and Gamma isomers were 0.0317, 0.2254, 0.0288 and 0.2859 mg/1 respectively; the corresponding mean values in the control population were 0.0211, 0.1112, 0.0197 and 0.1520 mg/1 respectively. The values in spraymen were twice those of the general population. A significant association ($p < .05$) was observed between their length of exposure and the levels of Cholesterol and HCH isomers in blood of spraymen. No significant morbidity was evident in spraymen due to HCH exposure.

40. Gupta BN, Mathur N, Rastogi SK, Srivastava AK, Chandra H, Pangtey BS, Mahendra PN, Bharti RS

Socio-economic, environmental and health aspects of farm workers engaged in mango plantations

Biomed Environ Sci. 1995 Dec;8(4):301-9

Epidemiology Division, Industrial Toxicology Research Centre, Lucknow, India.

A cross-sectional survey of 489 male subjects in the age group 15 to 65 years engaged directly or indirectly in mango cultivation along with 208 control subjects was carried out to find their socio-economic, environmental and health conditions. The conditions like high illiteracy rate (49.5%), poverty (PCI less than Rs 100 per month, 52.2%), poor housing (mud houses, 66.7%) unsafe water supply (78.6%) were prevailing in the surveyed population. The high respiratory morbidity may be attributed to high prevalence of smoking and prolonged inhalation of organic dusts during farming operation associated with illiteracy and poor socio-economic status. Gastrointestinal disorders were related to poor hygienic conditions, smoking and consumption of contaminated water. The symptoms pertaining to CNS, skin and eyes were found to be associated with exposure to pesticides.

41. Srivastava AK, Gupta BN, Bihari V, Mathur N, Pangtey BS, Bharti RS

Chronic effects of hexachlorocyclohexane exposure: clinical, hematologic and electrocardiographic studies

Vet Hum Toxicol. 1995 Aug;37(4):302-5

Epidemiology Division, Industrial Toxicology Research Centre, Lucknow, India.

Twenty-six farm workers handling about 4 kg of commercial grade hexachlorocyclohexane (HCH)/y for 2-5 y and 21 control subjects were studied for chronic effects in clinical, hematological and cardiac variables. No clinically apparent morbidity was detected, but changes in hemoglobin and electrocardiograms were early effects of HCH exposure.

42. Srivastava AK, Gupta BN, Bihari V, Mathur N, Pangtey BS, Bharti RS, Godbole MM

Organochlorine pesticide exposure and thyroid function: a study in human subjects

J Environ Pathol Toxicol Oncol 1995: 14(2):107-10

Epidemiology Division, Industrial Toxicology Research Centre, Lucknow, India

We examined the serum levels of thyroxine and thyroid stimulating hormone in 103 rural subjects with respect to blood levels of organochlorine pesticide and occupation. We found that 24.3% of study subjects had depleted thyroxine levels in association with significantly lower organochlorine pesticide residues in blood. Sex, nutritional status, thyromegaly, or handling of pesticides in the course of work were not found to be factors contributing to depleted thyroxine levels.

43. Kashyap R, Iyer LR, Singh MM, Kashyap SK

Assessment of location-specific human exposure to dichloro-diphenyl trichloroethane and benzenehexachloride in Gujarat state, India

Int Arch Occup Environ Health. 1994;65(6):381-4 National Institute of Occupational Health, Ahmedabad, India

On the basis of the use of insecticides in agriculture and vector control programmes, two locations were selected in Gujarat state, India. In location 1 the insecticides are used in both agriculture and vector control programmes while in location 2 they are used only in agriculture. Raw food commodities, water, soil and blood samples were collected from the people residing in these locations, and analysed for total dichloro-diphenyl trichloroethane and total benzenehexachloride residues. Residue levels were significantly lower in location 2 than in location 1

44. Agarwal SB

A clinical, biochemical, neurobehavioral, and sociopsychological study of 190 patients admitted to hospital as a result of acute organophosphorus poisoning

Environ Res 1993 Jul 62(1):63-70

Department of Medicine, B. J. Medical College, Asarwa, Ahmedabad, India

To study acute organophosphorus (OP) poisoning cases, 190 OP-intoxicated cases admitted to Civil Hospital, Ahmedabad, were investigated in depth. The group consisted of subjects ranging from 11 to 60 years of age, with the maximum number of cases in the age group 21-30 years and a male-to-female ratio of 2.1:1. Most of the subjects (71.61%) were partially educated, 24.2% of the cases were illiterate, and only 4.2% of the cases were highly educated. Socioeconomically, 21.1% of the subjects were of low economic status, 52.6% were low middle class, 16.8% were upper middle class, and only 9.5% were upper class. With regard to marital status of the subjects, 98 cases were married and 92 were unmarried. About 67.4% of the cases had the intention of committing suicide, 16.8% of the cases were the result of occupational exposure, and 15.8% of the cases were from accidental poisoning. Social and domestic problems (37.5%), marital friction (15.6%), financial stress (15.6%), love affairs (14.1%), job problems (10.9%), chronic illness (4.7%), and failure in examination (1.6%) were observed as the precipitating factors. Muscarinic

manifestations such as vomiting (96.8%), nausea (82.1%), miosis (64.2%), excessive salivation (61.1%), and blurred vision (54.7%) and CNS manifestations such as giddiness (93.7%), headache (84.2%), disturbances of consciousness (44.2%), and typical pungent odor from mouth and clothes (77.9%) were the main presenting symptoms. Cardiac manifestations such as sinus tachycardia (25.3%), sinus bradycardia (6.3%), and depression of ST segments with T-wave inversion (6.3%) were observed electrocardiographically, with hypertension (10.5%) and muscular twitching in some (2.1%) cases. Biochemical changes such as albuminuria (12.6%) and azotemia (18.9%) with inhibition of acetylcholinesterase enzyme activity in blood were recorded in 78.9% of the cases. About 89.5% of the cases recovered completely, 4.2% of the cases absconded after partial recovery, and 6.3% of the cases died. The mortality rate (6.3%) depended on various factors such as the organophosphorus compound consumed, the amount ingested, the time interval for hospitalization, and the general health of the patient. Chances of recovery were higher when the patient was hospitalized at the earliest indication.

45. Kashyap R, Iyer LR, Singh MM, Kashyap SK

Evaluation of human exposure to the persistent insecticides DDT and HCH in Ahmedabad, India

J Anal Toxicol. 1993 Jul-Aug;17(4):211-4

Forensic Science Laboratory, Ahmedabad, India.

Concentrations of two organochlorine insecticides, DDT and HCH, in 21 human adipose tissue samples (from cadavers) and 20 venous blood samples collected in Ahmedabad, India were determined. None of the cases had any history of occupational exposure to organochlorine insecticides. Residue concentrations of DDT and HCH in these samples indicated considerable exposure of the general population to these chemicals. Samples from males had comparatively higher concentrations of these insecticide residues than females. The mean residue concentrations of total DDT and HCH in the blood serum of males was 213.83 and 70.051 ppb, respectively, whereas females had DDT and HCH concentrations of 177.38 and 65.44 ppb, respectively. Total DDT and HCH in adipose tissue was 3.967 and 4.054 ppm in males, and 3.538 and 3.144 ppm in females, respectively. Residue concentrations reported here are lower than those reported earlier.

46. Shoeb A. Khan[1] and Sharique A. Ali[2]

Assessment of certain hematological responses of factory workers exposed to pesticides

Bulletin of Environmental Contamination and Toxicology, Vol.51, (5); November 1993, pgs. 740-747

1. Department of Pathology and Microbiology, Jawaharlal Nehru Hospital, Bhopal, India
2. Physiology, Biochemistry Laboratory, P.G. Zoology Department, Saifia Postgraduate College of Science and Education, 462 001 Bhopal, India

Abstract not available

47. Varma DR

The Bhopal accident and methyl isocyanate toxicity
J Toxicol Environ Health. 1993 Dec;40(4):513-29
Department of Pharmacology and Therapeutics, McGill University, Montreal, Canada.

The Bhopal accident, the world's worst industrial disaster, in which nearly 40 metric tons of methyl isocyanate (MIC) was released from the Union Carbide pesticide plant, occurred nearly 10 yr ago during the night of December 2 and 3, 1984. Over 3000 people residing in areas adjacent to the plant died of pulmonary edema within 3 d of the accident. Follow-up studies revealed pulmonary, ophthalmic, reproductive, immunologic, neurological, and hematologic toxicity among the survivors. Despite high reactivity, MIC can traverse cell membranes and reach distant organs, perhaps as a reversible conjugate with glutathione, which may explain some of the systemic effects of MIC. MIC can be degraded as a result of pyrolysis and interaction with water, but none of the breakdown products can duplicate the toxicity observed in Bhopal and in animal models. MIC may be the most toxic of all isocyanates because of its very high vapor pressure relative to other isocyanates and because of its ability to exert toxic effects on numerous organ systems.

48. Bhatnagar VK, Patel JS, Variya MR, Venkaiah K, Shah MP, Kashyap SK

Levels of organochlorine insecticides in human blood from Ahmedabad (Rural), India
Bull. Environ. Contam. Toxicol. 1992 48:302-307
Division of Pesticide Toxicology, National Institute of Occupational Health, Indian Council of Medical Research, Meghaninagar, Ahmedabad 380 016, India

Abstract not available

49. Chand B, Sankaranarayan T, Yadava RL, Narasimham MV

Residues of DDT and its metabolite in blood of exposed factory workers and their correlation with ill health symptoms
J Commun Dis. 1991 Dec;23(4):245-7
National Malaria Eradication Programme, Delhi.

The residue levels of DDE, op1--DDT and pp1--DDT of the factory workers exposed to DDT formulations having temporary clinical symptoms and of those without any such symptoms did not show any significant difference in their values suggestive of no direct correlation between insecticide residues and ill health symptoms. The average residue values of DDT (mg/litre) and its metabolite DDE (mg/litre) in exposed workers were 0.8634 +/- 0.1529 and 0.2106 +/- 0.0458 respectively while in unexposed control subjects 0.0826 +/- 0.0238 and 0.0278 +/- 0.0040. Total DDT residue in blood in exposed workers is more than 10 times higher than the same in unexposed control.

50. Rupa DS, Reddy PP, Reddi OS

Clastogenic effect of pesticides in peripheral lymphocytes of cotton-field workers

Mutat Res. 1991 Nov;261(3):177-80

Environmental Toxicology Program, University of California, Riverside 92521.

We studied clastogenic effects in peripheral lymphocytes of cotton-field workers who were exposed to different pesticides. All the cells were grown in RPMI 1640 medium for 48 and 72 h. The type of aberrations observed in the exposed group are gaps, breaks, dicentrics, exchanges, rings and polyploidy. The frequency of total chromosomal aberrations increased significantly in male pesticide applicators when compared to controls. A significant decrease in mitotic index was observed in the exposed group as compared to the control group. The 48-h cultures showed high incidence of chromosomal aberrations and low mitotic index when compared to 72-h cultures. The difference in chromosomal aberrations between 48- and 72-h cultures was not significant. 24 out of 26 individuals showed ill health effects such as severe giddiness and nervous disorders.

51. Rupa DS, Reddy PP, Reddi OS

Reproductive performance in population exposed to pesticides in cotton fields in India

Environ Res. 1991 Aug;55(2):123-8

Environmental Toxicology Program, University of California, Riverside 92521.

Data on reproductive histories were collected from 1016 couples in which the males were directly exposed to pesticides. For comparison data were collected from 1020 couples who were not exposed to pesticides and belong to the same socioeconomic group and age range. Statistical analysis revealed a significant decrease in fertile males and a significant increase in abortions among the wives of these exposed males when compared to the control group. The frequency of live births decreased significantly and still births, neonatal deaths, and congenital defects showed a significant increase in the offspring of exposed males when compared to the offspring of control group. Smokers exposed to pesticides showed a higher effect than nonsmokers exposed to pesticides. Eighty percent males in the exposed group showed ill health effects such as severe giddiness, nervous, skin, and eye disorders.

52. Rupa DS, Reddy PP, Sreemannarayana K, Reddi OS

Frequency of sister chromatid exchange in peripheral lymphocytes of male pesticide applicators

Environ Mol Mutagen. 1991;18(2):136-8

Environmental Toxicology Program, University of California, Riverside 92521.

In the present study 61 male pesticide applicators who worked in cotton fields and regularly sprayed pesticides such as DDT, BHC, endosulfan, malathion, methyl parathion, phosphamidon, dimethoate, monocrotophos, quinalphos fenvelrate, and cypermethrin were analyzed for sister chromatid exchanges, mitotic index, and cell cycle kinetics in peripheral lymphocytes. Subjects who handled pesticides were non-smokers and teetotalers and the data were compared with the matched control group. Statistical analysis revealed that the frequency of sister chromatid exchanges

was significantly higher among the pesticide applicators at all the durations of exposure when compared to controls. Subjects exposed to pesticides also showed cell cycle delay and decrease in mitotic index when compared to the control group.

53. Yadava RL, Rao CK, Thapar BR, Narasimham MV

Blood Cholinesterase monitoring in spraymen involved in malathion spraying--a health protection measure

J Commun Dis. 1991 Mar;23(1):55-8

National Malaria Eradication Programme, Delhi.

The blood Cholinesterase (ChE) level of malathion in spraymen is continuously monitored through a "built-in warning system" existing under NMEP since the introduction of malathion spraying. The data available from the States of Maharashtra, Punjab and Gujarat revealed that, in spraymen of Punjab, the ChE level in 1988 and 1989 remained normal in about 99.8 per cent spray personnel, and in 1 out of 381 workers, the ChE level fell to 62.5 per cent during 1989. In Gujarat and Maharashtra, the normal level of ChE was maintained in nearly 88 and 98.4 per cent of spray personnel respectively during the spraying period. The ChE level fell to 62.5 per cent in 11.9 per cent of spray staff in Gujarat during 1987 and in 1.5 and 1.6 per cent persons during 1988 and 1989 respectively in Maharashtra. Only in three cases (0.07 per cent) out of 4,100 in Maharashtra showed depression in ChE to 50 per cent in 1988. In none of the above mentioned cases, there was any parasympathetic overstimulation or uneasiness, etc, even then they were withdrawn from spray and were given rest and where needed medical care.

54. Rastogi SK, Gupta BN, Husain T, Mathur N, Garg N

Study of respiratory impairment among pesticide sprayers in Mango plantations

Am J Ind Med 1989 16(5):529-38

Epidemiology Division, Industrial Toxicology Research Centre, Lucknow, India.

Pulmonary function studies were conducted on 489 pesticide workers engaged in spraying operations on mango plantations. These workers were exposed to a variety of organochlorine and organophosphorus pesticides. A reference group consisting of 208 controls, belonging to the same socioeconomic stratum, was taken from the same area for purposes of comparison. The results of the study showed 36.5 and 41.5% prevalence of respiratory impairment in the exposed workers and in the controls, respectively. The most common pulmonary impairment among the exposed subjects (18.8%) and controls (16.9%) was of the restrictive type, followed by mixed ventilatory defect. Bronchial obstruction affected 2.5 and 3.7% of the exposed and control populations, respectively. In a comparison of the prevalence of total respiratory impairment in the pesticide workers and the controls, the nonsmokers did not show any significant difference in this study. The prevalence rate of respiratory impairment showed an increasing trend in different exposure groups (p less than 0.05), thereby clearly indicating a dose effect. The study revealed that occupational exposure to pesticides had a direct bearing on the respiratory impairment identified in the exposed workers.

55. Rupa DS, Reddy PP, Reddi OS

Analysis of sister-chromatid exchanges, cell kinetics and mitotic index in lymphocytes of smoking pesticide sprayers

Mutat Res. 1989 Jun;223(2):253-8

Institute of Genetics, Osmania University, Andhra Pradesh, India.

Whole blood of 50 smokers who were exposed to pesticides was set up in RPMI 1640 medium, and observed for sister-chromatid exchanges (SCEs), cell kinetics (CK) and mitotic index (MI). As controls, blood samples were collected from 20 non-smokers (control I) and 27 smokers (control II) who were not exposed to pesticides. A significant increase in SCEs was observed as the duration of exposure increased. The frequency of M1 metaphases increased significantly whereas M2 and M3+ metaphases decreased in the exposed group. The mitotic index increased in control II and in the exposed population while it showed a decrease at 11-25 years' exposure.

56. Rupa DS, Reddy PP, Reddi OS

Chromosomal aberrations in peripheral lymphocytes of cotton field workers exposed to pesticides

Environ Res. 1989 Jun;49(1):1-6

Institute of Genetics, Osmania University, Andhra Pradesh, India.

Fifty-two pesticide sprayers in cotton fields were selected for the analysis of chromosomal aberrations in peripheral lymphocytes. Twenty-five samples were collected from healthy males who were not exposed to pesticides. Statistical analysis revealed that there was a significant increase in chromosomal aberrations in the exposed population compared to controls. Total chromosomal aberrations increased irrespective of duration of exposure.

57. Rupa DS, Reddy PP, Reddi OS

Frequencies of chromosomal aberrations in smokers exposed to pesticides in cotton fields

Mutat Res. 1989 Jan;222(1):37-41

Institute of Genetics, Osmania University, Begumpet, Andhra Pradesh, India.

Blood samples were collected from 50 smokers who were exposed to the pesticides DDT, BHC, endosulfan, malathion, methyl parathion, monocrotophos, quinolphos, dimethoate, phosphomidon, cypermethrin and fenvelrate. Samples were also collected from 20 non-smokers (control I) and 27 smokers (control II) who were unexposed to pesticides. Control II showed a significant increase in chromosomal aberrations when compared to control I. There was a significant increase in total chromosomal aberrations in smokers exposed to pesticides when compared to unexposed populations.

58. Rupa DS, Reddy PP, Reddi OS

Genotoxic effect of benzene hexachloride in cultured human lymphocytes

Hum Genet. 1989 Oct;83(3):271-3

Institute of Genetics, Osmania University, Hyderabad, India.

Chromosomal aberrations, sister chromatid exchanges, mitotic index and cell kinetics were observed in human peripheral lymphocytes after treatment with four different concentrations (0.0125, 0.025, 0.05 and 0.1 microgram/ml) of benzene hexachloride (BHC), an organochlorine pesticide. Cells were treated with BHC for 24, 48 and 72 h. There was a dose-dependent increase in the frequency of chromosomal aberrations and sister chromatid exchanges. A significant decrease in mitotic index was observed at all concentrations and times of exposure. BHC did not show a significant effect on cell kinetics.

59. Chattopadhyay P, Karnik AB, Thakore KN, Lakkad BC, Nigam SK, Kashyap SK

Health effects among workers involved in the manufacture of hexachlorocyclohexane

J Soc Occup Med. 1988 Autumn;38(3):77-81

Forty-five male workers exposed to hexachlorocyclohexane (HCH) during its manufacture were studied and compared with 22 matched controls. Twenty-one of the exposed workers worked in packaging and manual transport of HCH. Twenty-four other exposed workers were plant operators. Exposure was mainly through skin. Results indicate that the neurological symptoms reported were due to recent exposure to HCH and were related to the intensity of exposure.

An increase in leucine aminopeptidase, ornithine carbamyl transaminase, 5'nucleotides and immunoglobulin M levels among the exposed workers is suggestive of some degree of liver damage. A significant increase in total blood HCH and its α, ß and γisomers was also observed in these workers. In spite of pronounced exposure to the α, ß and γisomers of HCH, signs of severe health impairment were not observed. Further biological monitoring needs to be carried out among such workers exposed to HCH.

60. Jani JP, Patel JS, Shah MP, Gupta SK and Kashyap SK

Levels of organochlorine pesticides in human milk in Ahmedabad, India

Int Arch Occup Environ Health 1988;60(2):111-3

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

Concentrations of organochlorine compounds, i.e., alpha HCH, gamma HCH, beta HCH, p,p'-DDE, p,p'-DDT, o,p'-DDT; p,p'-DDD and PCBs were determined in 50 human milk samples collected in Ahmedabad, India during 1981–1982. The mothers' ages ranged from 18 to 30 years (mean 24 years), and they were nursing their first or second child. All 50 samples contained alpha-HCH, gamma HCH, beta HCH, p,p'-DDE, and p,p'-DDT in a concentration of 17.51, 1.62, 205.48, 244.71, and 53.43,

respectively (median μg/kg: whole-milk basis). o,p'-DDT was found in 48 samples whereas p,p'DDD was detected in 44 samples. The concentration of o,p'-DDT and p,p'-DDD was 53.43 and 5.13 μg/kg (median), expressed on a whole-milk basis. PCBs were absent in all samples.
Key words: Human milk-DDE-DDT-HCH-PCBs

61. Misra UK, Bhargava SK, Nag D, Kidwai MM, Lal MM

Occupational phosphine exposure in Indian workers
Toxicol Lett. 1988 Sep;42(3):257-63
Department of Neurology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, India.

To evaluate the health effects of occupational phosphine exposure, 22 workers engaged in fumigation of stored grains were subjected to a clinical and environmental study. These workers were used to placing aluminum phosphide tablets on the stacks of grains and covering it with a gas-proof plastic cover. The mean age of the workers was 48 years (range 24-60) and mean duration of exposure 11.1 years (range 0.5-29). After fumigation they reported minor symptoms, which included cough (18.2%), dyspnoea (31.8%), tightness around the chest (27.3%), headache (31.8%), giddiness, numbness and lethargy (13.6% each), anorexia and epigastric pain (18.2% each). The abnormal physical signs included bilateral diffuse rhonchi and absent ankle reflex each occurring in one worker. Motor nerve conduction velocity of median and peroneal nerves, and sensory conduction velocity of median and sural nerves were normal. Phosphine concentration in the work environment ranged from 0.17 to 2.11 ppm. Occupational phosphine exposure in the workers was associated with mild to moderate symptoms, which were transient. However, to assess the chronic effects, long-term follow-up is recommended.

62. Misra UK, Nag D, Khan WA, Ray PK

A study of nerve conduction velocity, late responses and neuromuscular synapse functions in organophosphate workers in India
Arch Toxicol. 1988;61(6):496-500
Department of Neurology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, India.

To study the effect of occupational organophosphate exposure on neuromuscular function, 24 workers exposed to fenthion [0,0-dimethyl-0(4-methyl mercapto-3 methyl phenyl)phosphorothioate], whose mean age was 31.7 years (range 22-50) and mean duration of exposure to fenthion 8.5 years (range 1-19) were subjected to detailed clinical and neurophysiological evaluation after spraying. The neurophysiological tests included motor and sensory nerve conduction velocity; F response, H reflex and electromyographic neuromuscular synapse testing. Fenthion exposure was monitored by serum acetyl cholinesterase (AchE) levels. The observations were repeated after withdrawing the workers from fenthion exposure for 3 weeks to study the reversibility of the observed changes. There was no clinical evidence of peripheral neuropathy or muscle weakness. However, peroneal motor conduction velocity (p less than 0.05) terminal motor latency of median (p less than 0.1), and peroneal nerve (p less than 0.05); F minimal latency and H reflex latency (p less than 0.01) were significantly affected. Twenty-nine per cent of workers had repetitive

muscle activity. Serum AchE levels also showed significant changes (p less than 0.01). The clinical significance of these subtle neurophysiological changes requires further investigation and follow-up.

63. Rupa DS, Rita P, Reddy PP, Reddi OS

Screening of chromosomal aberrations and sister chromatid exchanges in peripheral lymphocytes of vegetable garden workers
Hum Toxicol. 1988 Jul;7(4):333-6
Institute of Genetics and Hospital for Genetic Diseases, Osmania University, Andhra Pradesh, India.

1. Twenty-five male workers occupationally exposed to DDT, BHC malathion, parathion, dimethoate, fenitrothion, urea and gromor were selected as subjects for the analysis of chromosomal aberrations and sister chromatid exchanges (SCE) in peripheral lymphocytes. 2. Blood samples were collected from 30 normal healthy males from the same age group and socioeconomic class for the control. 3. The frequency of chromosomal aberrations and SCEs increased significantly irrespective of the duration of exposure to pesticides, when compared to controls.

64. Misra UK[1], Nag D[2], Khan WA [3] and Ray PK[3]

A study of nerve conduction velocity, late responses and neuromuscular synapse functions in organophosphate workers in India
Archives of Toxicology, 1988, 61(6), pp 496-500
1 Department of Neurology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, P. O. Box No. 375, 226001 Lucknow, India
2 Department of Neurology, K. G.'s Medical College, 226003 Lucknow, India
3 Industrial Toxicology Research Centre, M. G. Marg, P. O. Box No. 80, 226001- U. P Lucknow, India

To study the effect of occupational organophosphate exposure on neuromuscular function, 24 workers exposed to fenthion [0,0-dimethyl-0(4-methyl mercapto-3 methyl phenyl phosphorothioate], whose mean age was 31.7 years (range 22–50) and mean duration of exposure to fenthion 8.5 years (range 1–19) were subjected to detailed clinical and neurophysiological evaluation after spraying. The neurophysiological tests included motor and sensory nerve conduction velocity; F response, H reflex and electromyographic neuromuscular synapse testing. Fenthion exposure was monitored by serum acetyl cholinesterase (AchE) levels. The observations were repeated after withdrawing the workers from fenthion exposure for 3 weeks to study the reversibility of the observed changes. There was no clinical evidence of peripheral neuropathy or muscle weakness. However, peroneal motor conduction velocity (p<0.05) terminal motor latency of median (p<0.1), and peroneal nerve (p<0.05); F minimal latency and H reflex latency (p<0.01) were significantly affected. Twenty-nine per cent of workers had repetitive muscle activity. Serum AchE levels also showed significant changes (p<0.01). The clinical significance of these subtle neurophysiological changes requires further investigation and follow-up.
Key words: Organophosphate-Occupational exposure-Neurotoxicity-Nerve conduction-Neuromuscular synapse function-Late responses

65. Rita P, Reddy PP, Reddy SV

Monitoring of workers occupationally exposed to pesticides in grape gardens of Andhra Pradesh

Environ Res. 1987 Oct;44(1):1-5

Institute of Genetics, Osmania University, Begumpet, Andhra Pradesh, India.

Studies were undertaken to investigate the effect of pesticides on workers employed in grape gardens of Andhra Pradesh. The data obtained on the reproductive performance showed an increase in the incidence of abortions and stillbirths. Out of 12 employed couples in grape gardens, 2 were found to be sterile. Cytogenetic studies revealed a significant increase in chromatid breaks and gaps in chromosomes of peripheral blood in workers exposed to pesticides. In addition, a high frequency of satellite associations was recorded in these workers.

66. Kashyap SK

Health surveillance and biological monitoring of pesticide formulators in India

Toxicol Lett. 1986 Oct;33(1-3):107-14

Results of health survey and biological monitoring in pesticide formulators exposed to a combination of pesticides, an organophosphorus (OP) insecticide (phorate) and a persistent chlorinated insecticide (technical hexachlorocyclohexane; HCH; BHC) are reported. Exposure of 160 workers to a combination of pesticides (malathion, parathion, DDT and HCH) resulted in 73% of the workers showing toxic signs and symptoms. Formulators showed marked inhibition of whole blood, plasma and red blood cell cholinesterase (ChE) activity and slightly higher concentrations of DDT and HCH in serum. An interesting observation was that over 25% of the formulators showed ECG aberrations. The ECG changes were not related to whole blood ChE activity. Exposure to the chlorinated insecticide HCH in 19 workers engaged in the manufacture of technical HCH resulted in toxic signs and symptoms in over 90% of the subjects. The HCH concentrations in serum showed a ten-fold increase. Changes in the liver enzymes ornithine carbamyl transferase (OCT), gamma-glutamyl transpeptidase (GGTP), leucine aminopeptidase (LAP) and in immunoglobulin M(IgM) showed possible effects on liver and humoral immunity. ECG monitoring showed evidence of cardiac effects. Exposure of 40 formulators to a highly toxic OP insecticide (phorate) showed that over 60% of the workers suffered from toxic effects in spite of using a complete set of protective clothing. A marked and progressive inhibition in whole blood and plasma ChE activity was found during the two weeks of exposure to phorate. An appreciable recovery in ChE activity was observed 10 days after cessation of exposure. These surveys have established the need to practice and develop biological monitoring techniques to assess exposure and predict health risks in workers occupationally exposed to pesticides.

67. Misra UK, Nag D, Misra NK, Mehra MK, Ray PK

Some observations on the macula of pesticide workers

Hum Toxicol. 1985 Mar;4(2):135-45

To study the retinal changes in occupationally exposed pesticide workers, 79 subjects exposed to an organophosphate, fenthion, and 18 exposed to an

organochlorine pesticide DDT [1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane], were subjected to a detailed study, including history taking, physical examination and ophthalmic evaluation. Fluorescein angiography was performed in selected cases. Serum cholinesterase level in 22 workers and serum DDT residue in 17 workers of the respective groups were also estimated. Fifteen workers (19%), who were exposed to fenthion had macular changes (P less than 0.01). The macular lesions were characterized by perifoveal irregularity of pigmentation and areas of hypopigmentation of 1/8-1/3 disc diameter. Mean age of the subjects having macular involvement was 30.6 years and mean duration of exposure 7.9 years. The symptoms reported by them were diminution of vision (8), dislike for bright light, flash of light, black dots in front of the eyes (2 each) and visual blurring (1). Paracentral scotoma and constriction of peripheral field were present in three workers each. Fluorescein angiography suggested pigment epithelium defect. Other causes of macular involvement in these workers were excluded; a possible role of pesticides in the genesis of these macular changes is suggested.

68. Siddiqui MK, Saxena MC

Placenta and milk as excretory routes of lipophilic pesticides in women
Hum Toxicol. 1985 May;4(3):249-54

Age, diet and ethnic-dependent excretion of chlorinated pesticides through placenta and milk was studied in women from the general population around Lucknow in India by using gas-liquid chromatography equipped with an electron-capture detector (3H+). Pesticidal contaminants in both placenta and milk were 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane (p,p'-DDT), its metabolites 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene (p,p'-DDE) and 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane (p,p'-DDD), alpha, beta, gamma - isomers of benzene hexachloride (BHC) and aldrin. The study revealed higher excretion of pesticides through the placentas of older and non-vegetarian women than younger and vegetarian women. There was higher excretion of total DDT in rural than in urban women while a reverse trend was found in the case of total BHC in two ethnic groups. Similarly, age and dietary habits influenced the excretion of these pesticides in milk. Women undergoing premature delivery and stillbirths were found to excrete more DDT in their milk than those undergoing full-term normal delivery.

69. Balarajan R, Acheson ED

Soft tissue sarcomas in agriculture and forestry workers
J Epidemiol Community Health. 1984 Jun;38(2):113-6

The National Cancer Register maintained by the Office of Population Censuses and Surveys (OPCS) was used to investigate the relative risks of soft tissue sarcomas among farmers, agricultural workers, and related occupational groups. The relative risk for the group as a whole was 1.15 (95% confidence limits 0.83-1.59). One of the four subgroups (which comprises farmers, farm managers, and market gardeners) experienced a relative risk of 1.7 which just achieves significance at the 5% level (95% confidence limits 1.00-2.88). The risks in the other three subgroups were respectively 1.0 (agricultural workers, 003), 0.7 (gardeners and groundsmen, 005), and 1.0 (foresters and woodmen, 006). No attempt has been made in this study to determine exposure to phenoxy herbicides in cases or controls. The significance of these findings is discussed.

70. Bhatnagar VK, Saigal S, Singh SP, Khemani LD, Malviya AN
Survey amongst workers in pesticide factories
Toxicol Lett. 1982 Feb;10(2-3):129-32

Blood samples of 75 pesticide factory workers in Agra Division, India, were analyzed for biochemical parameters of clinical importance. About 75% of the subjects had significantly low levels of serum cholinesterase activity. Several subjects had below average blood sugar and urea values. The majority had elevated levels of serum cholesterol, phospholipid and SGOT activity. 52 workers reported general toxic symptoms. A correlation between the clinical manifestations and blood biochemical parameters has been attempted.

71. Siddiqui MK[1], Saxena MC[1], Mishra UK [2], Krishna Murti CR [1] and Nag D[2]Long-term occupational exposure to DDTInternational Archives of Occupational and Environmental Health
June 1981, 48 (3) ,P 301-308
DOI:10.1007/BF00405618Industrial Toxicology Research Centre, Post Box No. 80, 226001 Lucknow, India
(2) Department of Neurology, King George's Medical College, Lucknow

Blood serum of twenty workers occupationally exposed to DDT for an average duration of 14 years was analysed for organochlorine pesticides by gas-liquid chromatography with an electron capture detector. Significant levels of BHC, p,p′-DDT, p,p′-DDD and p,p′-DDE were detected. A higher incidence of total DDT equivalent, about 10 times, was observed in DDT exposed workers when compared with a comparable sample of unexposed persons from the general population. Levels of DDT in serum of occupationally exposed workers were more than the permitted level of 200 ppb. The daily intake was computed to be about 10 mg/man/day as against 0.25 mg/man/day the acceptable daily intake. Abnormal nerve conduction was encountered in a few cases of DDT sprayers. No significant correlation was observed between the total DDT equivalent in serum and duration of occupational exposure in workers. Levels of BHC in controls was 2.3 times the level in exposed workers, possibly due to induction of hepatic drug metabolising enzymes by high levels of DDT in the latter group. Findings are discussed in the light of existing knowledge of the bio-chemical effects evoked due to residual intoxication of DDT during occupational exposure.
Key words DDT-BHC- Nerve conduction - Hepatic microsomal drug metabolising enzymes -Accepted daily intake

72. Siddiqui MK, Saxena MC, Krishna Murti CR
Storage of DDT and BHC in adipose tissue of Indian males
Int J Environ Anal Chem. 1981;10(3-4):197-204

Adipose tissue of 50 human subjects (10 to 60 years old) were taken from autopsy cases and analysed by gas-liquid chromatography equipped with an electron capture detector (3H +) for determination of storage levels of BHC (benzene hexa chloride), DDT (dichlorodiphenyl trichloroethane) and its metabolites DDE and DDD in human body fat. The data is reported according to age (length of exposure), dietetic habits and area of residence of the subjects. The results show relatively moderate

exposure to DDT and BHC. Levels of residues were slightly higher in non-vegetarian and rural residents than those of their counterpart vegetarian and urban inhabitants. The study suggests that DDT levels in human adipose show a decreasing trend as compared to earlier report of Dale et al. of highest body burden of pesticides being present in indians.

73. Bhatnagar VK, Sharma RP, Malviya AN

Effects of pesticidal stress amongst pesticide factory workers in Agra, India
Public Health (London) (1980) 94:375-378

Abstract not available

74. Blok AC & Mann AH

Organophosphorus insecticide exposure of spraying under field conditions on rice in India. II Azodrin (Monocrotophos) [Sh sub no 3308 A3162/11 Box 77 Vol 2])
The Hague, Shell International Research Maatschappi, BV Report *Series Tox 77-006 1977*

The effects of monocrotophos on workers involved in its application to rice fields in India was assessed in field conditions. Five workers were involved in the application of the pesticide on 6 consecutive days, working 7 h/day. A 40% water soluble solution of monocrotophos was diluted to 0.06% and applied from a knapsack sprayer containing 10 L of formulation. On the first day of spraying, the formulation was accidentally made up at 0.12%; all other days used the correct dilution. Workers applied an average of 66 g monocrotophos/day. Workers did not use protective clothing; their normal clothing exposed the arms, legs and feet. Clean clothes were worn for each day's work, and the workers washed their hands before meals. Workers were trained in common sense ways of avoiding contamination, such as avoiding direct contact with formulation and spray mix, giving attention to the containers to ensure they were not leaking, and avoiding spraying against the wind or upwind of other workers. All workers were normal farmhands, aged between 17 and 40 years, and described as healthy and fit, with normal nutritional status. They had not had contact with pesticides for 2 weeks prior to the trial. Five pre-test blood samples were taken from the workers applying monocrotophos, and also from 5 workers not involved in pesticide applications to act as controls, to determine plasma and erythrocyte ChE levels. Samples were taken regularly throughout the trial, and for two days at the end of the trial. It was recognised that there were practical difficulties with the sampling and testing methods, due to the uncontrolled field conditions. No clinical signs of exposure were seen during the trial. Plasma ChE appeared to be inhibited on the evening of the first day, and morning of the second day. Control workers also had some depression of ChE, so there may have been a problem with the testing method at these times. No inhibition of plasma or erythrocyte ChE was seen for the rest of the trial. Therefore it appears that there is little effect from applying monocrotophos from a knapsack spray without protective clothing, however the quality of the assay method may obscure any real effects.

75. Nayak NJ, Shingatgeri MK, Rao RR, Marathe MR & Gangoli SD

Toxicological, residual and biological evaluation of NUVACRON 40 (monocrotophos) by aerial application under Indian field conditions Ciba-Geigy of India Ltd. Bombay [CG sub no 10662 Box 38 Vol 6]) 1975

Monocrotophos (Nuvacron 40, 40% w/v) was diluted in water (400 mL/8.5L) and applied aerially at 8.5L/acre to a 10-acre plot using a helicopter flying at 2 to 3 metres, and spraying approximately a 40 m swath. There was approximately 2 kg of monocrotophos applied overall. Workers, cattle and fowls were exposed, with the domestic animals being tethered along footpaths at the edges of the sprayed plot, while workers continued to work in the plot during spraying. Only light clothing was worn, and men remover their shirts. The only protective clothing used was a rubber finger glove to protect the blood sampling site. Blood was taken from each volunteer 1 to 2 days before spraying, and then between 1 and 3 h after spraying. Samples were also taken 24, 48 and 72 h after the application of the monocrotophos. No abnormal clinical signs were noted in the volunteers. There were no changes in ChE activity, erythrocyte or leucocyte counts or Hct values, either before or after spraying.

Table-1 List of pesticides / pesticides formulations banned in India*

A.	**Pesticides Banned for manufacture, import and use (25 Nos.)**
1	Aldrin
2	Benzene Hexachloride
3	Calcium Cyanide
4	Chlordane
5	Copper Acetoarsenite
6	CIbromochloropropane
7	Endrin
8	Ethyl Mercury Chloride
9	Ethyl Parathion
10	Heptachlor
11	Menazone
12	Nitrofen
13	Paraquat Dimethyl Sulphate
14	Pentachloro Nitrobenzene
15	Pentachlorophenol
16	Phenyl Mercury Acetate
17	Sodium Methane Arsonate
18	Tetradifon
19	Toxafen
20	Aldicarb
21	Chlorobenzilate
22	Dieldrine
23	Maleic Hydrazide
24	Ethylene Dibromide
25	TCA (Trichloro acetic acid)
B.	**Pesticide / Pesticide formulations banned for use but their manufacture is allowed for export (2 Nos.)**
26	Nicotin Sulfate
27	Captafol 80% Powder
C.	**Pesticide formulations banned for import, manufacture and use (4 Nos)**
1	Methomyl 24% L
2	Methomyl 12.5% L
3	Phosphamidon 85% SL
4	Carbofuron 50% SP
D.	**Pesticide Withdrawn (7 Nos)**
1	Dalapon
2	Ferbam
3	Formothion
4	Nickel Chloride
5	Paradichlorobenzene (PDCB)
6	Simazine
7	Warfarin

* Adapted from cibre.nic.in/list_pest_bann_htm

Table –2 Pesticides restricted for use in India*

S.No.	Name of Pesticides
1	Aluminium Phosphide
2	DDT
3	Lindane
4	Methyl Bromide
5	Methyl Parathion
6	Sodium Cyanide
7	Methoxy Ethyl Merciru Chloride (MEMC)
8	Monocrotophos(ban for use on vegetables)

* Adapted from cibre.nic.in/list_pest_bann_htm

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