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Assessment of Certain Hematological Responses of Factory Workers Exposed to Pesticides

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Exposure to pesticides in the recent years has increased manifold due to their intense application and as such the risks of occupational hazards have also multiplied tremendously. Interestingly the greater part of the data regarding the effect of pesticides concentrated on aquatic organisms (Reddy and Rao, 1989), birds (Perry, 1990) and other laboratory mammals (Dikshith et al., 1978). Comparatively there are few hematological, biochemical or risk assessment studies of pesticide on exposed human beings (WHO, 1986; Ingermann, 1989; Nair et al., 1992). Most of these environmental hazard studies which have been done on human beings, deal with residue levels of pesticides either in blood, serum or adipose tissue following occupational or accidental exposures. As factory workers who work in pesticide plants where pesticides of different nature are manufactured, formulated or packed, run a great risk of direct exposure, assessment of their occupational risks involving the damage to hematological or biochemical factors is of paramount importance.

The present study was undertaken to explore the effects of pesticides on the hematological responses of workers exposed for varying durations in one of the factories of Bhopal where organochlorine and organophosphorus pesticides are manufactured and formulated on a very large scale. Needless to say, private chemical factories in developing countries have poor working conditions and if environmental legislations and laws are followed they are only on paper. Bhopal gas disaster is a living example of the extent of precautions followed in factories. It must be mentioned that in the past whatever hematological studies have been done, particularly on the human subjects exposed accidentally or occupationally to pesticides the results are at variance. Davignon et al. (1965) reported that there was no change in red blood cells and hemoglobin concentration after pesticide exposure, whereas Namba et al. (1971), Sandifer et al. (1972) and Morgan and Lin (1978) reported significantly lowered values values of hemoglobin in workers following pesticide

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exposure. Similarly Desi et al. (1986) also reported some changes in hematological factors of pesticide exposed workers, however, all such studies regarding the effects of pesticide exposure on factory workers are of European countries and reports on the status of Indian pesticide factory workers are wanting, who work in more rigorous environmental conditions and have comparative low socio-economic and health status.

MATERIAL AND METHODS

The present study was conducted in one of the major pesticide manufacturing and formulating factories of Bhopal, where the working conditions were considerably substandard and the workers did not use masks, gloves, gumboots or any protective apparel. It was observed that they worked in stuffy rooms without proper ventilation, and only tied a cloth around their mouth, working on an average for 10 to 12 hours in hot and humid conditions. The temperature of their working place ranged from 24-40°C. The products manufactured by the factory were benzene hexachloride, malathion, parathion and carbaryl. The workers handled the pesticides by way of manual mixing and packing them in plastic bags and also stacking the pesticide bags for loading. Almost all the workers were exposed to the pesticides through skin as well as by inhalation. After their work very few pesticide workers (10-15%) used to take shower and change their clothes, whereas others used to change their clothes after 3-4 days. Information regarding the concentration of pesticides in air or on skin could not be obtained. A total number of 41 human subjects were studied for a period of two years. The subjects were studied after three, six and nine to twelve months of pesticide exposure. A group comprising eleven workers who left their job were also studied as withdrawal group. All the workers were males and ranged between 25-40 years of age and belonged to low income group. The subjects in each group were compared with an external group of control subjects of the same age and socio-economic status having no previous history of occupational contact with pesticides.

Various blood samples from all the subjects, exposed as well as controls, were taken in vials containing dried ethylene diamine tetra acetic acid as anticoagulant and brought to laboratory for analyzing the hemoglobin (Hb), total leucocyte count (TLC), differential leucocyte count (DLC) and erythrocyte sedimentation rate (ESR). The equipment used for estimation was SEAC computerisod analyser (Miles India Ltd.). Total white blood cell count was done using WBC diluting fluid and the enumeration was done using Neubauer counting chamber. DLC was done using Leishman's stained blood films while ESR was measured using Westerngreen method.

RESULTS AND DISCUSSION

Fig. 1 shows the changes in levels of Hb and ESR in the factory workers occupationally exposed to organochlorine and organophos-

phorus pesticides along with well matched control human subjects without any pesticide exposure. In the 3 months exposed workers it was observed that there was a significant decrease in the average Hb values, the level decreased from a control value of 15.9 g/dl to 12.46 g/dl (Fig. 1). The 6 and 9-12 months exposed groups also exhibited considerable lower values of Hb from that of unexposed controls, the deviation being 26.6% and 34.4% respectively. Thus there was a clear cut exposure dependent decrease of Hb values in the pesticides exposed factory workers which was statistically significant ($P < 0.001$).

ESR was also found to be significantly affected, the response increasing exposure dependently being minimum in the 3 months exposed group and maximum in the 9-12 months group. Percentagewise the 3 months exposed group exhibited an increase of 21.42% from the controls, whereas the 6 and 9-12 months pesticide exposed groups registered further elevation in the ESR values. Percentagewise the increase being 109.7% and 217.2% respectively ($P < 0.001$). Interestingly, studies of Hb and ESR from withdrawal group indicated that within 3 months of the cessation of exposure, ESR values in all the factory workers became normal whereas Hb levels fell slightly short to that of normal and were found to be quite similar to that of 3 months exposed group (Fig. 1 & 2; $P < 0.001$).

Another important hematological factor TLC was also seriously affected by the pesticide exposure in almost all the groups of workers studied. In the 3 months exposed workers, TLC increased by 15.66% whereas in the 6 and 9 to 12 months group the percentwise increase was 30.29% and 44.2% respectively (Fig. 4). DLC of the occupationally exposed workers also exhibited significant deviations from the normal values, the changes being nonspecific. The percentages of polymorph and eosinophil were found to be markedly elevated in almost all the three exposed groups from control values. Percentagewise the increase in polymorph was found to be 3.14% after three months exposure, 15.6% after six months and 37.36% in 9 to 12 months exposed group, eosinophils showed an elevation of 5.10% in the group studied after three months of exposure, 87.18% in six months exposed group and the maximum exposed group showed an elevation of 110.24% (Fig. 3, 5).

On the other hand lymphocytes decreased in all the three differently exposed groups, the percentage of lymphocytes in three months exposed group decreased from control values of 41.26% ± 0.9402 to 38.65% ± 1.3388 in the exposed human subjects, exhibiting a deviation of 6.44%. In the six and nine to twelve months exposure groups the lymphocyte percentage further showed a fall of 29.48% and 66.72% respectively (Fig. 6). The percentages of basophils and monocytes were found to be unaffected in all the three groups. Analysis of blood from workers who had left their jobs further confirmed the fact that the pesticide exposure induced deviations in hematological parameters was time related and cessation of exposure or its withdrawal

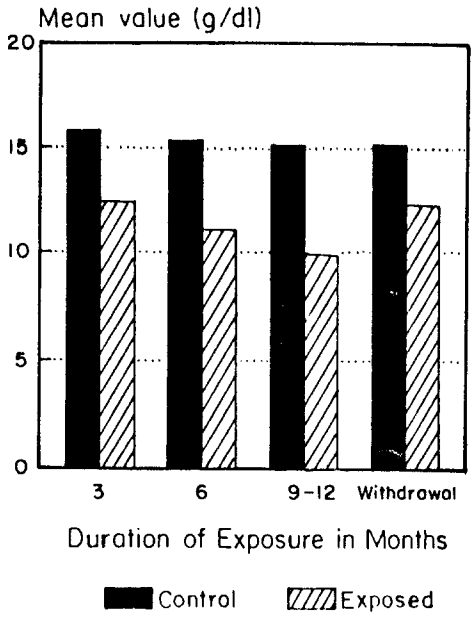

Figure 1 - Hemoglobin levels of Control and Exposed Subjects

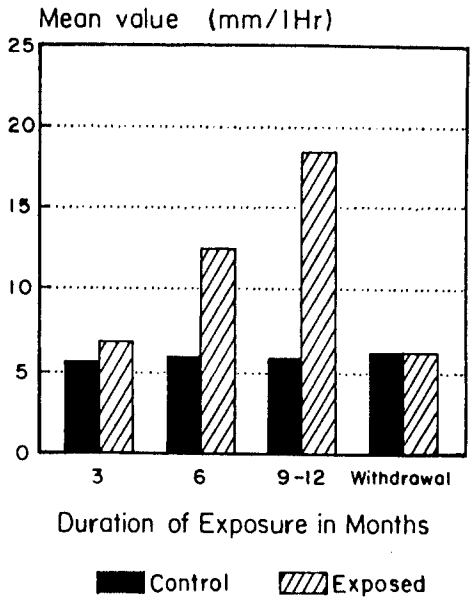

Figure 2-Erythrocyte Sedimentation Rate in Control and Exposed Subjects

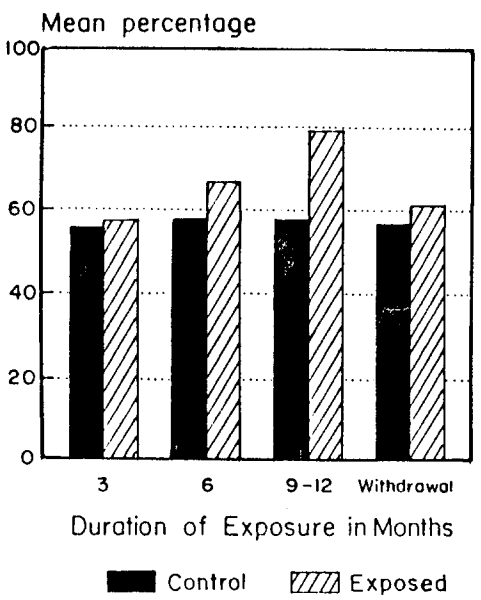

Figure 3 - Percentage of Polymorph in Control and Exposed Subjects

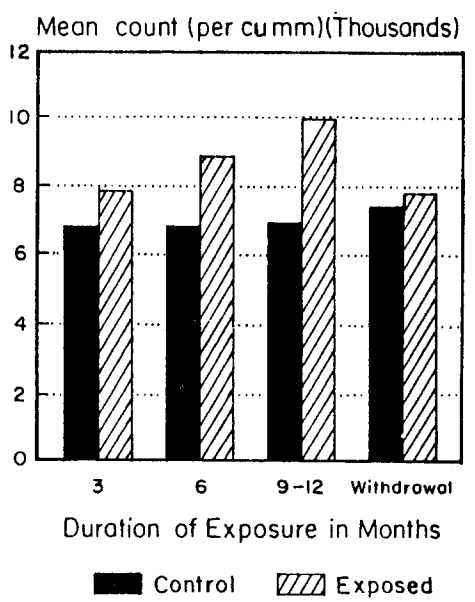

Figure 4 - Total Leucocyte Counts of Control and Exposed Subjects

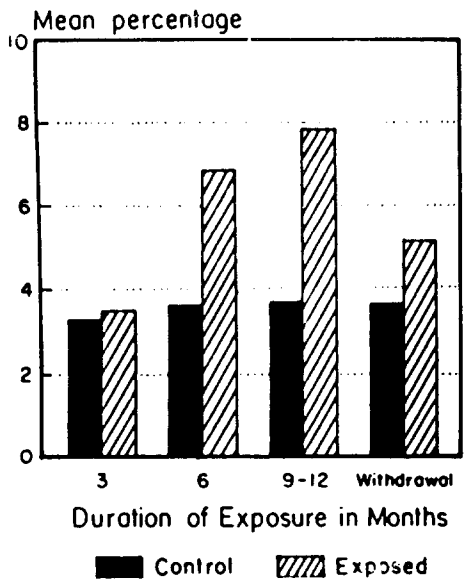

Figure 5 - Percentage of Eosinophil in Control and Exposed Subjects

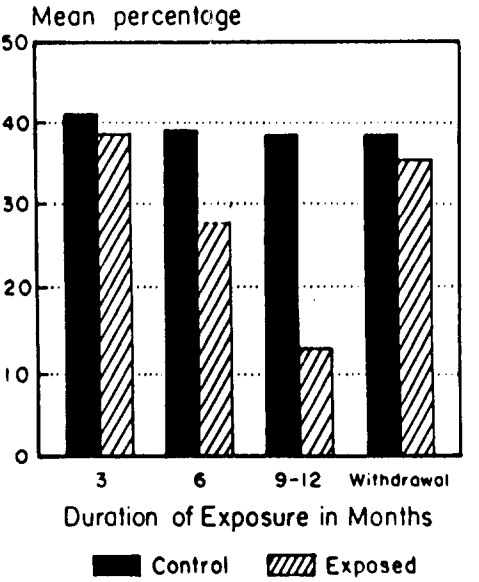

Figure 6 - Percentage of Lymphocytes in Control and Exposed Subjects

resulted in achieving normal levels of hematological factors within three months.

It has been argued that environmental levels of pesticides may not reflect the amount ingested, inhaled or absorbed, while blood samples show only specific time levels (Davis, 1980). In contrast to the earlier reports of Davignon et al. (1965) and Christopher (1969) who reported that pesticide exposure is without any hematological effects in human beings, in the present study a significant reversible decrease in hemoglobin levels resulted in response to duration dependent pesticide exposure.

The results of the present study are highly significant in relation to the fact that few such studies have been conducted on Indian subjects which have quite different geographical, racial and socio-economic status. The only detailed study carried on Indian factory workers is of Bhatnagar (1980) who reported a similar decrease in hemoglobin levels in human subjects exposed to mixture of organochlorinee and organophosphorus pesticides. These workers found that hemoglobin values decreased from a control level of 14.48 ± 0.75 to 11.0 ± 3.05 ($P < 0.001$) in male workers. In the present study also the decrease is statistically significant, however, it is much greater than that reported by Bhatnagar (1980). The present findings also corroborate those of Morgan and Lin (1978) and Desi et al. (1986) who have reported that following pesticide exposure, Hb levels decrease significantly.

In the present study ESR of human factory workers exposed to mixed organochlorine and organophosphorus pesticides showed marked increase ranging from 21.42 to 217%. This increase in ESR was found to be directly proportional to duration of exposure and the values returned to normal after cessation of pesticide exposure. It may be mentioned that this is the first report indicating the increase in ESR on exposure to pesticides as there are no studies reported in the literature. These data are highly significant in relation to health and disease conditions, as any increase in ESR is always associated with tuberculosis, rheumatic fever, myocardial infarction and other inflammatory and arthritic conditions. Thus the present data show that the tremendous increase in ESR is a matter of serious concern in human subjects working in the pesticide factories. Even a short exposure of three months duration had increased the ESR by 21.42%, whereas the increase was 217.2% in the maximally exposed group.

In the present study, an important component of hematological factors was total and differential white cell counting. The data clearly demonstrate that WBC increased between 15.56% being minimum in the three months exposed group and maximum in one year exposed factory workers. The increase in total WBC in all the three exposed groups of varying durations is similar to that reported by Sandifer et al. (1972) who found that WBC elevated significantly in 120 workers exposed to pesticide for a period averaging twelve years. Similarly Namba et al. (1971) found that in moderate or severe poisoning cases of organophosphate pesticides leucocytosis occurred with a WBC count of upto 20,000 per cu mm with an increased number of neutrophils. In the present study, distinct leucocytosis has occurred in all the three groups with significant deviation in the white cell count. The data of the present study regarding the differential white cell count revealed that maximum elevation occurred in eosinophils (110.24%) followed by polymorphs (37.36%), whereas the lymphocytes decreased by 66.72% in the group exposed for maximum period (Fig. 3,5,6). While the monocyte and basophil percentages were unaffected. These data are also supported by the observations of Namba et al. (1971) who reported that there is a neutrophil increase followed by decrease in lymphocytes and monocytes in moderate or severe organophosphate pesticide poisoning cases. Morgan and Lin (1978) also suspected hematoxic effects in human subjects exposed to mixed pesticides with positive correlation between pesticides and WBC count. The data of the present study regarding the significant elevation of WBC and statistically significant variations in differential count are also supported by the recent findings of Desi et al. (1986) who found green house workers, who were engaged in spraying pesticides had their lymphocytes increased significantly. Similarly Ingermann (1989) reported that exposure of human red blood cells to pesticides results in hemolysis and the membrane transport is affected considerably. Thus it may be concluded that in the factory workers exposed to pesticides there are significant hematoxic changes which need to be further elucidated

in different geographical and socio-economic groups so that serious after effects of pesticide contamination may be monitored and eliminated.

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