
Original Article

EFFECT OF RESPIRABLE TEXTILE PARTICULATE MATTER ON ANIMAL MODEL: RAT

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Abstract: Industries operating the machines in enclosed spaces creates a new microenvironment. Such an environment is much more dangerous for human health in factories handling the synthetic and natural fibers. Person exposed to cotton or flax dust may develop a series of acute and chronic symptoms categorized as the response to single or multiple exposures, to relatively high cotton dust concentration which results into mill fever and later into byssinosis. Cotton textile industry is the single largest industry employing lacs of workers, but the powerloom sector of this industry is operating with adverse working conditions without any research or innovation. In present contribution, rats were exposed to cotton dust in powerloom sectors for several days and a significant increase in spleen size was observed. Histologic observations showed hypertrophy of red pulp, congestion of venous sinuses, blood clots in trabecular artery and vein, few lymphatic nodules with germinating center, reduced or atrophied white pulp, increased reticulum cells and macrophages number. Hemosiderin was seen in reticulum cells. Bone marrow showed increased erythroblasts, reticulocytes, myelocytes, megakaryoblasts and megakaryocytes. The hematological profile revealed increased hematocrit, red and white cells count. Decreased platelets count, hemoglobin gram percentage, mean corpuscular hemoglobin concentration and anisocytosis and pikilocytosis of RBCS. Serum protein profile showed increase α and θ-globulins and decreased total proteins and albumin level. The experimental data indicate that respirable particulate matter induces several significant structural and functional alterations in the body of rats. Our findings for spleen, bone marrow and peripheral blood provide evidence of extrapulmonary activity of inhaled particles in the textile environment.

Key words: Textile environment, Spleen, Bone marrow, Blood, Endotoxin,

INTRODUCTION

Occupational hazards among people exposed to various types of organic dusts are known for centuries. Industrialization has led to operating of machines in enclosed spaces and handling of natural and synthetic fibers on such machines in these conditions creates a new microenvironment which is seen to affect the health of exposed workers. Persons exposed to cotton or flax dust may develop series of acute and chronic symptoms categorized as the response to either single or multiple exposures, mill fever may occur following first exposure to relatively high cotton dust concentration [1,2]. Chest tightness and air way obstruction is reported by Merchant et al. [2] which can result into byssinosis. Textile industry in India holds the international repute of being the third largest producer of textile only next to USA and Japan. Powerloom sector is an important but unorganized part of the textile industry and is well dispersed throughout the country.

Several lacs of workers are employed in power loom centers but very little attention has been focused on their health, safety and welfare [3]. It is the only sector of the textile that is operating without research or innovation. The working environment is adverse with extremely hot, humid and moisture laden
conditions. The high noise, vibrations, inadequate illumination, and ventilation, musty odour, high cotton dust and associated endotoxin(s) concentration, faulty workplace layout, long hours of work (10-12 hours/day) etc. together lead to physical, physiological and psychological stresses on workers, and experimental animals [4]. The cotton dust fibers are respirable size (5<um) [5], usually contaminated with Gram negative bacteria, Gram positive bacteria and allergic fungal spores. Helander and Lounatamma [6] reported that gram negative bacteria liberate endotoxins.

An animal model has been developed in laboratory taking rat as an experimental animal with the view that it will mimic physiological reactions of human to cotton dust inhalation. The animals were stressed in powerloom conditions and their effects on physiologic responses on animal mobility, behavior, blood composition, pulmonary, cardiovascular and other systemic responses were studied.

**MATERIALS AND METHODS**

**Experimental animals:** Adult male albino rats (*Rattus norvegicus*) weighing about 220-250 gms were used. The rats were kept in metallic cages with enough space for free movement and kept in animal house which has sufficient ventilation and light. The temperature of the room was maintained at 25 °C ± 2 °C. The cages were cleaned everyday and the husk beds replaced after cleaning. The animals were fed standard pellet feed and water *ad libitum*. All experimentation was done using INSA- ethical guidelines for use of animals in scientific research.

The rats were divided in to 5 groups and treated as follows: Group 1: Animals of this group wee kept as control. Group II rats were exposed to cotton dust in powerloom sectors for 1, 2, and 3 days, for a period of 6 h/day. Group III rats were exposed to cotton dust in powerloom sectors of 6 h/day for 15 days. Group IV rats were exposed to cotton dust in powerloom sectors, 6 h/day for 30 days. Group V rats were exposed to cotton dust in powerloom sectors for a period of 6 h/day, 30 days and 15 days recovery following exposure (To study the effect of recovery). All the rats were sacrificed on scheduled day by cervical dislocation. The spleen was weighed and then used for further study.

**Histopathologic study:** The spleen of all animals were dissected out, washed and fixed in neutral buffered formalin, washed with water and paraffin blocks were prepared. 5 to 6 um serially sections were stained with Trichrome staining technique and observed under light microscope.

**Bone Marrow study:** The femur bone was dissected and bone marrow flushed out with phosphate buffered saline (PBS). Fixed in methanol plus acetic acid (3: 1) mixture, smeared on glass slides, dried, stained with Wright’s’s stain and cell counted under oil immersion at 100 x of microscope.

**Hematological study** The blood from the rats of all 4 sets and controls was collected in glass bulbs pre-coated with K2EDTA after sacrificing the rats. Complete blood count (CBC) and differential cell count (DCC) was done on automatic cell counter model Symexk-4500, Serial No. 42076 (Mfd. By TOA Medical Electronics company Ltd. Japan.)

**Total protein:** Total protein of spleen was estimated by Lowry et al. [7] method.

**RESULTS AND DISCUSSION**

The rats were exposed to cotton dust and associated endotoxin(s) in powerloom sector. The study shows that the organ weight of spleen was increased significantly in all groups and the maximum elevation was observed in group II animals. The Increase was also significantly high in group III and IV animals (Data not presented here).

The spleen is markedly enlargement in all animals of group IV. The histologic observations of the spleen showed hypertrophy of the red pulp, congestion of venous sinuses with blood and yellowish brown fluid. Trabecular vein and artery showed blood clot containing granulocytes, few lymphatic nodules were observed with germinal center in group II, while the size of lymphatic nodules in group III and IV rats was decreased, hence showed reduced or atrophied while pulp. The number of macrophages and reticulum cells increased from group II and IV rats. Hemosiderin, lies within the cytoplasm of reticulum cells, with maximum, siderin in group II rat spleen followed by set-III and IV rats (Figs. 1 to 4). The bone marrow smear showed increased number of erythroblasts, reticulocytes, myleocytes, megakaryocyte and megakaryoblasts (Figs. 11-18).

The hematological profile showed increased Red cell count, white cell count and decreased platelets count. Hematocrit was increased in groups I, II and III and
Figs. 1 to 4 are the histological sections of spleen.

was approximately near normal in group IV rats. Anisocytosis and poikilocytosis of red blood cells were observed in all groups (Figs. 5-10). Hemoglobin was increased in groups I and IV but decreased in groups II and III rats. Mean corpuscular Hemoglobin was decreased in groups II, III and IV rats.

Tracheal and bronchoalveolar lavages showed significantly high thrombocytosis [4]. Complete blood count indicated erythropoiesis, myelopoesis with defective and also immature red blood cells and white blood cells released into the circulation indicating hypoxic stress [4]. Respiratory insufficiency due to
stress on respiratory system and cardiovascular system either due to cotton dust and/or associated endotoxin(s). Noise and vibrations and other workplace hazards have been shown by various researchers [5,9-13]. Alteration in Liver function and histophysiological study of liver showed progressive liver damage with hemosiderin accumulation has been reported [14].

The serum protein profile shows increased β and γ-globulins and decreased total proteins and albumin in rats exposed to cotton dust and associated endotoxins. This may be due to the pseudo immune reaction as reported by Edwards and Jones [15]. The experimental data of present study indicate that respirable particulate matter induced several significant alterations in the body of rat. There was frequent and prolonged hypoxic period after exposure to textile environment indicating severe respiratory stress. Our findings for spleen, bone marrow and peripheral blood provide evidence of extra pulmonary activity of inhaled particles. Our previous work has suggested that the respirable dust particles in textile environment also affect the liver kidneys and adrenals [16]. These ambient air particles exert significant effects on hematologic parameters after inhalation. The red blood and splenic cells changes in rat associated with these respirable particles were also intriguing. Recent work has showed similar significant association with changes in cells and lungs in humans after exposure to these respirable particles in textile environment[17].

It is unclear whether these extra pulmonary responses are triggered by the reaction of the lung, or respirable particles in textile environment become extra-pulmonary to directly exert splenic and hematologic effect. The exact mechanism and clinical impact of these observations are unclear, but studies indicate that red cell and splenic parameters may provide a sensitive indicator of physiologic response to the cotton dust and associated endotoxin.

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