



# Evaluation of Occupational Exposure to Nitrosamine, Carbon Black and Dust in Rubber Processing Industry

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**R**ubber processing industry uses a wide range of chemicals, including chemical compounds recognized as carcinogenic to humans. Nitrosamines are one of the suspected compounds found to be associated with increased risks of esophagus, pharynx, bladder, lung, stomach, and gastric cancer as well as leukemia.<sup>1</sup> Rubber workers had an increased risk of nose bleeding, eye and throat burning, hoarseness, cough, nausea, and headache.<sup>2</sup> The accelerators used for the vulcanization release free secondary amines that can react with nitrosating agents to produce N-nitrosamines. Carbon black has been widely used as a filling material to create the necessary properties of the final rubber product. The International Agency for Research on Cancer (IARC) classifies carbon black as a “possible human carcinogen” (Group 2B).<sup>3</sup> Handling raw materials can increase the amount of airborne dust particulates. Mixing, extruding, calendaring, and vulcanizing (curing) rubber exposes workers to these inhalable dust particulates. Rubber workers lose their pulmonary function after 10 years of exposure to an average level of 2.0 mg/m<sup>3</sup> respirable dust. The objective of this study was to measure the concentration of nitrosamines, carbon black, and dust in a rubber processing industry in Thailand, and to assess the health risk following the exposure.

In a cross-sectional study conducted between January 2017 and April 2017, all 50 workers of a rubber processing industry were studied. The study group was workers who worked in the vulcanization process unit (n=10). A comparison group, included workers who worked in office (n=40), was also studied. Participants were also asked about symptoms occurring during work. Ambient concentration of N-nitrosamines including NDMA, NDEA, NDBA, NPIP, NPYR, MNOR, and NDPhA were measured in the breathing zones of 10 and 14 workers from the study and comparison groups, respectively. Ambient air samples were collected by ThermoSorb/N<sup>TM</sup> tube (Thermedics Inc, Woburn, MA, USA) by a sampling pump (Gillian, USA) with an air flow rate of 1 L/min for approximately six hours and then analyzed by GC-TEA according to NIOSH method 2522. Airborne carbon black, total dust, and respirable dust were sampled and analyzed according to the NIOSH method 5000, 0500, and 0600, respectively. Samples were collected in the breathing zones of workers by a PVC 37-mm dia. filter (Zefon, 5 µm) at a flow rate of 1 L/min for carbon black and total dust, and 2.5 L/min for respirable dust with a GilAir5 pump (Gillian, USA) for approximately six hours.

Seven different nitrosamines were examined in 24 samples. No airborne nitrosamine was detected in samples collected

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**Table 1:** The median (IQR) of carbon black, total dust, and respirable dust concentration (mg/m<sup>3</sup>) in the studied rubber processing industry

Substance	Group	Morning	Afternoon	TWA-8h
Carbon black	Study group	2.41 (1.68 to 3.15)	2.84 (2.38 to 3.30)	2.63 (2.51 to 2.76)
	Comparison group	0.81 (0.00 to 1.59)	0.00 (0.00 to 1.61)*	0.40 (0.00 to 1.60)
Total dust	Study group	3.67 (1.66, 4.99)	3.63 (0.83 to 6.76)	3.65 (1.25 to 5.83)
	Comparison group	1.63 (0.81 to 2.84)	1.59 (0.81 to 2.44)	1.42 (1.10 to 2.70)
Respirable dust	Study group	1.10 (0.99 to 1.33)	0.98 (0.65 to 1.34)	1.15 (0.82 to 1.22)
	Comparison group	0.33 (0.33 to 0.66)	0.65 (0.00 to 0.65)	0.50 (0.17 to 0.65)

\*Significantly (p<0.05) different from the study group

from the study and comparison groups. Airborne nitrosamines levels were very low because they are light sensitive.<sup>4</sup> The concentrations (TWA-8h) of carbon black, total dust, and respirable dust in the study group were more than two times higher than those in the comparison group (Table 1). The median concentrations of carbon black, total dust, and respirable dust were lower than the recommended level set by OSHA. The carbon black concentrations were higher in the study group compared with that in the comparison group, perhaps because the vulcanization area uses carbon black that can increase the amount of airborne particulates. Carbon black was also found in areas where the comparison group worked in, probably because they used a photocopy machine that contains dry toner and it generally emits carbon black.<sup>5</sup> In addition, the studied rubber processing industry installed a local exhaust ventilation system in the vulcanization process unit for removing pollutants that could reduce the nitrosamine and carbon black concentrations. The total dust and respirable dust were also higher in the study group compared with those in the comparison group because the doors and windows in the vulcanization area were opened and dust could enter the area from the outside. Furthermore, the vulcaniza-

tion process mixed some raw materials that could spread dust in the area.

The symptoms occurring during work and their frequencies were consistent with earlier reports that show inhalation of carbon black can cause cough, and nose and throat irritation. Skin contact with carbon black can cause eye and skin irritation. Nitrosamines can also cause nose bleeding, eye and throat burning, hoarseness, cough, nausea, and headache.<sup>2</sup> Although the average concentration of nitrosamines, carbon black, and dust were below the permissible exposure limit and threshold limit value, the study group had an increased risk of developing all studied symptoms. Therefore, regularly check of the local exhaust ventilation system in the vulcanization area and use of proper personal protective equipment during work are strongly recommended.

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**Conflicts of Interest:** None declared.

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