CHAPTER 14

THE CARCINOGENIC RISK OF OCCUPATIONAL EXPOSURE TO QUARTZ DUST: BIOMONITORING RESULTS

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Abstract: This study utilized biomonitoring to evaluate the genotoxic potential of quartz dust in the ambient air at the workplace in coal mines, quarries, and stone processing facilities. The data suggest that quartz dust is genotoxic, and is an important contributor to the genotoxicity of complex mixtures of fibrogenic respirable airborne particles in ambient air in these workplaces. In areas of quarrying and stone processing, the respirable dust particle concentration was between 0.18 – 2.16 mg/m³, and quartz made up 30% of the dust. In coal mines the average concentration of respirable dust was 2.68 mg/m³; quartz made up only 3% of the dust or less. The frequency of chromosomal aberrations increased significantly in exposed groups, compared to the controls. The results indicate a significant increase in chromosomal aberrations (%AB.C.) among workers who were occupationally exposed to dust containing quartz (during the earliest period of exposure, about 30% of the highest acceptable exposure. The results show a non-linear dose-response for chromosomal aberrations at high exposure levels.

Key words: quartz, genotoxicity, carcinogenicity, chromosomal aberrations, biomonitoring, highest acceptable exposure (HAE), coal mines, stone processing

1. INTRODUCTION

The increasing exposure of humans to genotoxic contaminants in the environment is a complex public health problem. According to an IARC/WHO Monograph (IARC/WHO, 1997), crystalline silica and
cristobalite are classified as Group 1 substances, i.e., substances that are carcinogenic to humans. Exposure to these substances has been linked to pulmonary disease and other types of malignant cancers. Research is needed to determine the emission, distribution and fate of genotoxicants in the environment, as well as human exposures to these compounds (Lewtas, 1990, Hunter, et al., 1997).

In the Czech Republic, more information is needed regarding the carcinogenic risk of quartz dust among workers in tunneling, metallurgy, and the ceramic industry. The present study evaluated selected biomarkers of exposure and effect among occupationally exposed workers (miners of black coal, and workers in quarrying and stone processing). The goal of this study was to assess the carcinogenic risk of quartz dust.

2. METHODS

2.1 Cytogenetic analysis of lymphocytes in peripheral blood

Cytogenetic methods were used to evaluate health effects among workers with lengthy occupational exposures. Cytogenetic analysis (CA) of structural chromosomal aberrations was conducted using cultures of peripheral blood lymphocytes. A modified conventional method (Hungerford, 1965) was used with short-term cultures for 52 hrs. All cells were in first division. CA of chromosomal aberrations was used for the groups of workers (miners, stonecutters) exposed to dust particles containing quartz. These workers were exposed to between 30% and 85-95% of the highest acceptable exposure (HAE). The matching control group was composed of individuals living in the same region who were not occupationally exposed. Every group (exposed and unexposed) included 25 cases, to give a total of 150 persons.

2.2 Urine collection and 1-hydroxypyrene determination

1-Hydroxypyrene (1-OH-P) is generally accepted as an indicator of human exposure to PAHs. Approximately 150 ml of post-shift urine was collected from the occupationally exposed individuals, and stored at -20°C in the dark within 24 hours of collection. In this study, this metabolite was detected in urine samples after enzymatic hydrolysis of the urine samples, followed by high performance liquid chromatography (HPLC) with fluorescence detection. Creatinine was also measured, and 1-OH-P was presented as a ratio to creatinine.