Relationships between respiratory diseases and quartz-rich dust in Idaho, U.S.A.

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Abstract

Quartz—one of the most abundant minerals in the Earth’s crust—has been deemed a human carcinogen by the International Agency for Research on Cancer (IARC), with the main threat to humans being lung cancer through inhalation of dust particles. Currently, the United States Environmental Protection Agency (EPA) has required communities to monitor PM\textsubscript{10} (particulate matter less than 10 micrometers in diameter) levels, with the concern that higher levels of PM\textsubscript{10} have been linked to increased respiratory disease rates. This hypothesis can be tested by an analysis of mortality data for groups that have received high lifelong exposures to quartz-rich PM\textsubscript{10} (e.g., farmers). Idaho is a very dusty state with a large agricultural community and can serve as a model to test this hypothesis.

A database was constructed of PM\textsubscript{10} levels statewide and of all the deaths attributed to respiratory diseases in Idaho from 1969 to 1994. For the Moscow, Idaho, PM\textsubscript{10} samples, quartz composed approximately 10\% of the PM\textsubscript{10}, with the remainder being 30\% feldspar and 60\% Mount St. Helens volcanic ash. The PM\textsubscript{2.5} samples contained no detectable mineral matter. Statewide, the quartz component for the PM\textsubscript{10} samples ranged from 7 to 16\%. Analysis of the database indicates that Idaho residents, in general, have below-average lung cancer rates when compared to the U.S. population and that Idaho farmers are at no greater risk of dying from lung cancer than non-farmers. These conclusions are based upon age- and smoking-adjusted standard mortality ratios (SMRs). No correlations or trends between PM\textsubscript{10} levels and respiratory diseases could be found in the general population. Data for chronic obstructive pulmonary diseases (COPDs) are more difficult to interpret because of fewer deaths and the inability to compensate for the effect of smoking in the induction of these diseases; however, it appears that Idaho has a higher rate of COPDs when compared to the U.S. populations and that farmers have a higher rate of COPDs than non-farmers.

Introduction

This project was initiated in response to two regulatory developments: (1) an International Agency for Research on Cancer (IARC) ruling to upgrade quartz from a Group 2A to a Group 1 human carcinogen (IARC 1997) and (2) an EPA requirement that communities monitor PM\textsubscript{10} (EPA 1986) and a possible modification of EPA guidelines to include PM\textsubscript{2.5} (EPA 1996). To determine whether inhalation of large amounts of quartz-rich dust in rural settings increases the risk of lung cancer, we developed a project to: (1) characterize the amount and mineralogical compositions of PM\textsubscript{10} in Idaho, especially with respect to quartz content, (2) build an epidemiological database of respiratory diseases and occupations in Idaho, concentrating on lung cancer rates and farmers, and (3) determine if any relationships exist between PM\textsubscript{10} amounts, compositions, and respiratory diseases.

Most people associate silicosis with inhalation of quartz. Silicosis is a debilitating disease of the lung caused by inhalation of large amounts of quartz over a long period of time, as may occur in an occupational setting. Silicosis and other types of pneumoconiosis (e.g., asbestosis, black lung) fiberize portions of the lung, resulting in decreased O\textsubscript{2}-CO\textsubscript{2} exchange and, in some cases, death by heart failure. Silicosis is a rare disease and is not a form of cancer. In the U.S., only 135 people died of silicosis in 1988, whereas 133,284 died of lung cancer (Feinleid 1991). In Idaho, an average of one person per year dies of silicosis (Norton 1996). Silicosis historically has been a disease associated with mining operations. Attention in America was drawn to this disease in the early 1900s regarding the granite workers of the northeast (Davis et al. 1983; Ross et al. 1993; Russel 1941). For reviews of the human lung function and silicosis, see U.S. EPA (1995), Goldsmith (1994), Ross et al. (1993), and Skinner et al. (1988).

Because of the association between silicosis and quartz dust, quartz became a suspected human carcinogen. Consequently, over the past 20 years many epidemiological studies have focused on the carcinogenicity of quartz (e.g., Frazier and Sundin 1986; Hnizdo and Sluis-Cremer 1991) in conjunction with animal studies (e.g., Dagel et al. 1986; Spiehoff et al. 1992; Wagner et al. 1980) and in vitro studies (e.g., Saffiotti et al. 1993). IARC (1997), Goldsmith (1994), and Ross et al. (1993) provide good overviews of this research. IARC has five classi-