1. PUBLIC HEALTH STATEMENT FOR SILICA

This Public Health Statement summarizes the Agency for Toxic Substances and Disease Registry’s (ATSDR) findings on silica, including chemical characteristics, exposure risks, possible health effects from exposure, and ways to limit exposure.

Silica is a naturally occurring compound and is widespread in the environment. It is of particular concern in areas adjacent to crystalline silica mining, processing, and transporting facilities.

If you are exposed to silica, many factors determine whether you’ll be harmed. These include how much you are exposed to (dose), how long you are exposed (duration), how often you are exposed (frequency), and how you are exposed (route of exposure). You must also consider the other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

WHAT IS SILICA?

Silica is another name for the chemical compound composed of silicon and oxygen with the chemical formula SiO₂, or silicon dioxide. There are many forms of silica. All silica forms are identical in chemical composition, but have different atom arrangements. Silica compounds can be divided into two groups, crystalline (or c-silica) and amorphous silica (a-silica or non-crystalline silica). c-Silica compounds have structures with repeating patterns of silicon and oxygen. a-Silica chemical structures are more randomly linked when compared to c-silica. All forms of silica are odorless solids composed of silicon and oxygen atoms. Silica particles become suspended in air and form non-explosive dusts. Silica may combine with other metallic elements and oxides to form silicates.

Silica is abundant in the environment and has many uses. Over 95% of the earth’s crust is made of silica-containing minerals and c-silica. Quartz is one form of c-silica commonly found in the environment. Approximately 12% of the earth’s crust by volume is quartz. Other less common forms of c-silica, including tridymite and cristobalite, are found in rocks and soils. Silica sand and gravel are used for building and construction, hydraulic fracturing, ceramics, and abrasives. Silica sand melts to glass and has been used throughout history to make glass. Crystal quartz forms of silica are used in jewelry, electronics, and the optical component industry. Some gemstones, such as amethyst, tiger's eye, agate, carnelian, chalcedony, and onyx are forms of silica.
Kieselguhr or diatomaceous earth, silica gel, and precipitated silica are forms of a-silica. a-Silica compounds have uses as fillers, insulators, absorption agents, scourers, catalyst supports, packing material, and filtration. Diatomaceous earth and silica gel are also used as carriers for pesticides to control insects, mites, and ticks.

WHAT HAPPENS TO SILICA WHEN IT ENTERS THE ENVIRONMENT?

Silica is a naturally occurring compound that is abundant in the environment. Quartz is an important component of soils and rocks and may be found on every part of every continent. It is the major component (90–95%) of all sand and silt fractions in soil. Silica is also naturally occurring in other less common forms, including cristobalite, tridymite, diatomite, agate, amethyst, chalcedony, and flint. Silica does not break down in the environment, although it may change forms (e.g., lightning strikes or burning of agricultural wastes containing silica) or undergo transport by natural processes (e.g., weathering) and human activities (e.g., brick and ceramics manufacturing). As part of the natural movement of silica between earth and organisms, silica particles are carried by wind and water currents, and settle out of water into sediment. Dissolved silica is extracted by certain species of microscopic marine organisms, such as diatoms and radiolarians, to form their structures and shells, and some forms of silica accumulate in plants or crops (e.g., rice and wheat).

HOW MIGHT I BE EXPOSED TO SILICA?

You may be exposed to silica compounds from the air, indoor dust, food, water, soil, and various consumer products. Silica compounds can be released into the environment by natural, industrial, and farming activities.

Silica is a common air contaminant. The primary nonwork-related silica exposure route is thought to be inhalation of c-silica during the use of commercial products containing quartz. Silica is found in many commercial products.

c-Silica is emitted as a component of particulate emissions into the environment. Residents near quarries or sand and gravel operations or drilling involving fracking may be exposed to elevated levels of respirable c-silica. Local meteorological conditions, such as wind and rain, especially in deserts and areas near recent volcanic eruptions and mine dumps, are expected to influence the location and spread of silica-containing dust.
1. PUBLIC HEALTH STATEMENT

People may be exposed to silica through their diet. a-Silica compounds are used as pesticides that are applied to crops and are used near food handling and preparation areas. Silica is used in food packaging; therefore, food is expected to be an important source of exposure to silica for most people.

Human exposure to c-silica that have the potential to impact human health occurs mainly in industrial and occupational settings. c-Silica is used throughout industry and is recognized as an important occupational hazard. People who work where silica is mined or used are exposed to higher levels of these substances than the general population. Workplace exposure also occurs for people with jobs that require frequent handling or use of silica substances, such as ceramic manufacturing, construction, and foundries. Industrial hygiene practices, such as engineering controls, tailored work practices, respirators, and worker training, are used to minimize potential silica health hazards.

HOW CAN SILICA ENTER AND LEAVE MY BODY?

The most important route of exposure to c-silica and a-silica is through air containing these compounds. Only very small particles of silica, less than 5 microns, are more likely to be deposited in the lungs. Small amounts of silica compounds deposited in the lungs may be coughed up and swallowed. Once in your body, silica compounds remain for long periods of time in the lungs and tissues surrounding the lungs. Some silica is distributed to the kidneys and the lymphatic system, an important part of the immune system. Silica compounds are not broken down by the body. Small amounts of silica compounds leave the body in the urine.

HOW CAN SILICA AFFECT MY HEALTH?

Health effects of c-silica and a-silica in people are found in workers exposed for long periods of time (typically ≥10 years) or with extremely heavy exposure over a short period of time (acute silicosis). There is no evidence that breathing small amounts of silica compounds found in the environment causes any health effects in humans. No health effects are shown to occur in humans from eating food or drinking water contaminated with c-silica or a-silica or from exposure of the skin to these compounds.

Crystalline Silica. Many studies have examined the health effects of c-silica in workers. Results of these studies show that potential effects of long-term occupational exposure to c-silica might include silicosis (a lung disease), chronic obstructive pulmonary disease (COPD), lung cancer, increased risk of tuberculosis, effects on the kidney, and autoimmune diseases. Of these, silicosis and lung cancer pose the greatest risks to human health.
1. PUBLIC HEALTH STATEMENT

Silicosis is a progressive, irreversible lung disease. No other chemical, including a-silica, can cause silicosis. Silicosis is classified as several different types (simple silicosis, progressive massive fibrosis [PMF], acute silicosis, and accelerated silicosis). All types of silicosis can cause death due to failure of the respiratory system. The time from first exposure to c-silica to the development of silicosis may be as short as a few weeks for acute silicosis or as long as 20 or more years for simple silicosis and PMF. The severity of silicosis may continue to slowly increase over decades even after exposure has been stopped. The current number of silicosis cases in the United States is not known; however, it has been estimated that during the period of 1987–1997, approximately 3,600–7,300 new silicosis cases were diagnosed yearly in workers in the United States.

Several government agencies have classified c-silica as a lung carcinogen in humans. Results of studies indicate that c-silica can cause lung cancer in workers, with increased risks in smokers. However, conflicting results regarding the association between inhalation of respirable c-silica and lung cancer, as well as adverse effects to the kidney and autoimmune diseases, have been reported. Despite inconsistent results, available evidence supports an association between occupational exposure to c-silica and increased risks for these effects. Available data in humans and laboratory animals are not sufficient to demonstrate a causal relationship between oral exposure to c-silica and any adverse effect outcome. Adverse effects of dermal exposure to c-silica have not been reported.

Some studies have shown harmful effects to the kidneys and associations with autoimmune diseases. These could have been caused by exposure to c-silica or could occur spontaneously or could have developed from exposure to other chemicals or mixtures of chemicals. Some studies examining the relationship between c-silica exposure and kidney effects and autoimmune diseases show an association between c-silica exposure and kidney and autoimmune diseases, while others do not show an association. Therefore, it is difficult to interpret the results of these studies. Compared to silicosis, kidney and autoimmune diseases are observed in a small number of workers.

Amorphous Silica. Compared to the large number of studies on c-silica, few studies have studied the effects of breathing a-silica, with most data obtained from animal studies. In workers, lung fibrosis (thickened, stiffened tissue of the lungs due to damage and scarring) has been reported in a-silica workers, although it is possible that these workers were also exposed to c-silica at the same time. Animal studies show reversible damage to the lung. Other than lung effects, no other effects associated with inhaled a-silica have been established.
1. PUBLIC HEALTH STATEMENT

For more information on health effects of c-silica and a-silica, see Chapters 2 and 3.

HOW CAN SILICA AFFECT CHILDREN?

This section discusses potential health effects of c-silica and a-silica exposure in humans from when they’re first conceived to 18 years of age.

Health effects of c-silica and a-silica have been shown only to occur in people working in silica industries, most typically following prolonged exposure. Exposures to children during sensitive developmental windows of time periods may put them at increased or decreased risk of health effects from exposure to hazardous substances. Based on available scientific evidence, it is not known with certainty, if children, when similarly exposed to silica, will have the same health effects as adults.

HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO SILICA?

If your doctor finds that you have been exposed to significant amounts of c-silica or a-silica, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate. You may also contact the state or local health department with health concerns.

To date, exposure to c-silica and a-silica at levels that produce health effects has not been reported in workers who have been exposed for a prolonged period of time in silica industries. There are no known human health effects that occur from exposure to any silica compound at levels typically found in general non-workplace environments. Several regulations and recommendations are in place to protect workers from adverse effects from exposure to silica.

ARE THERE MEDICAL TESTS TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO SILICA?

There are no known medical tests to determine if you have been exposed to c-silica or a-silica. For workers exposed to silica compounds, periodic x-rays and tests for lung function are recommended to look for abnormalities. Workers should also be evaluated for tuberculosis, kidney function, and autoimmune diseases.

***DRAFT FOR PUBLIC COMMENT***
WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but are not enforceable by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed as “not-to-exceed” levels; that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value usually based on levels that affect animals; levels are then adjusted to help protect humans. Sometimes these not-to-exceed levels differ among federal organizations. Different organizations use different exposure times (e.g., an 8-hour workday or a 24-hour day), different animal studies, or emphasize some factors over others, depending on their mission.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that issued the regulation or recommendation.

The Department of Energy (DOE), NIOSH, and OSHA have set limits for exposure to c-silica levels air in occupational settings. For a-silica, DOE, NIOSH, and OSHA have set limits of levels in air in occupational settings. EPA has not recommended guidelines for c-silica or a-silica in water.

WHERE CAN I GET MORE INFORMATION?

If you have any questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below. You may also contact your doctor if experiencing adverse health effects or for medical concerns or questions. ATSDR can also provide publicly available information regarding medical specialists with expertise and experience recognizing, evaluating, treating, and managing patients exposed to hazardous substances.

- Call the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636) or
1. PUBLIC HEALTH STATEMENT

- Write to:
  Agency for Toxic Substances and Disease Registry
  Division of Toxicology and Human Health Sciences
  1600 Clifton Road NE
  Mailstop F-57
  Atlanta, GA 30329-4027

Toxicological profiles and other information are available on ATSDR’s web site: