

## Executive summary

SBU has systematically reviewed the epidemiological evidence exploring how exposure to chemical substances in the workplace correlates with heart disease, pulmonary heart disease, stroke and high blood pressure.

### Conclusions

- ▶ **Heart disease:** There is evidence that workplace exposure to silica dust, engine exhaust or welding fumes, all of which are common workplace exposures in Sweden today, is associated with heart disease. An association was also seen for workplace exposure to arsenic, benzopyrenes, lead, dynamite, carbon disulphide, carbon monoxide, metalworking fluids, and occupational exposure to tobacco smoke. Working with the electrolytic production of aluminium or the production of paper when the sulphate pulping process is used is associated with heart disease. An association was also found between heart disease and exposure to compounds which are no longer permitted in Swedish work environments, such as phenoxy acids containing TCDD (dioxin) or asbestos.
- ▶ **Pulmonary heart disease (cor pulmonale):** There is evidence that workplace exposure to silica dust or asbestos is associated with pulmonary heart disease.
- ▶ **Stroke:** There is evidence that workplace exposure to lead, carbon disulphide, phenoxy acids containing TCDD, as well as working in an environment where aluminium is being electrolytically produced, is associated with stroke
- ▶ **High blood pressure:** There is evidence that workplace exposure to asbestos or lead is associated with high blood pressure.



THE PHOTO SHOWS SILICA DUST, A COMPONENT IN CONCRETE.

- ▶ There is insufficient evidence to establish if there is any difference between how vulnerable men and women are to chemical exposure in the workplace.

### Background and Aims

In 2011, the Swedish government tasked SBU with reviewing the available evidence on how working environments impact health, particularly with respect to where women work. The aim of this report was to systematically review the scientific literature on correlation between occupational exposure to chemicals and cardiovascular disease. This report is a supplement to the report “Occupational Exposures and Cardiovascular Disease”, that was published by SBU in 2015.

The term *cardiovascular disease* is a broad term which we have broken down into four main categories to reflect the outcomes reported in the literature.

*Heart disease:* There are about 30 000 confirmed heart attacks in Sweden each year. There is an additional unknown number of people who have heart attacks but do not seek medical attention. The risk of suffering a heart attack increases with age.

*Pulmonary heart disease (cor pulmonale)* is associated with a change in the structure and function of the right ventricle of the heart, and is primarily caused by disease in the respiratory system. This is thought to be the result of chronically increased pressure in the diseased lungs that places too much strain on the heart.

*Stroke:* In Sweden, more than 25 000 people have a stroke each year. Acute stroke is the somatic illness that is responsible for the highest number of hospital days.

*High blood pressure:* Nearly a third of European adults have high blood pressure. The proportion of people with high blood pressure increases with age.

## Methods

The systematic review is built upon a literature search in two international databases that contain original research articles from the fields of medicine and occupational health and safety. The last search was done in January, 2017.

The review was produced using SBU's method for systematic evaluation. The internationally developed GRADE system was used to describe the body of evidence for each result. Studies published in a peer reviewed journal between 1970 and 2016 were included in the review if they focused on exposure to chemicals in the workplace. Studies also needed to focus on working populations whose working conditions were relevant for previous or current working conditions in Sweden. Cohort studies were only included if a minimum of 50 people were in the exposed group. Case-control studies were only included if they reported a minimum of 50 cases. No limitations were placed on dosage (for instance minimum exposure limits were not set) or other aspects of exposure such as duration or frequency.

Many studies have been published that investigate various chemical exposures outside of the context of the work environment; these studies were not included in this review. Neither does this review consider the evidence presented in case studies, nor experimental studies.

## A detailed analysis of exposure levels was not conducted

This report does not provide answers regarding the levels of exposure that are harmful. For example, we are unable to set exposure limits with the material we gathered. To establish what level of exposure is harmful would have required a broader assessment of

the evidence, considering not only epidemiological studies, but also experimental studies on humans and animal models, and the knowledge provided by general environmental and mechanistic studies.

## Results

We screened more than 8 000 abstracts. A total of 164 articles were identified that met our inclusion and quality criteria, several of which studied more than one chemical exposure, and occasionally multiple conditions. Overall, the included studies reflect more than forty different chemical exposures and several different cardiovascular conditions. The largest group of articles studied the association between lead exposure and high blood pressure (11 articles); followed by carbon disulphide and heart disease (10 articles).

We use the term cardiovascular disease as a general term in this systematic review. Of those articles that were included in our assessment, most studied heart disease. Nearly all of these were focused on ischemic heart disease, i.e. heart attacks. A few studies focused on pulmonary heart disease. Only a few studied other kinds of heart conditions, e.g. cardiac arrhythmias. We also included studies that focused on stroke or high blood pressure. Very few studies were identified that examined changes in blood pressure during pregnancy.

We found insufficient scientific evidence meeting our inclusion criteria for some chemical exposures found in working environments. In some cases, no evidence was found, in others too few studies could be included, and in others the available studies had methodological limitations.

## Limitations

SBU's expert group critically reviewed a large number of articles and identified some methodological challenges and potential sources of misinterpretation. This review excluded chemical exposures that occur outside of the workplace, meaning no conclusions could be drawn regarding associations between chemical exposures in the home or general environment and cardiovascular disease.

It is important to point out that the results presented in this report apply to populations and not individuals. The likelihood of developing cardiovascular disease varies between individuals who work in the same environments. Correlations within populations can give important clues, but can never replace an individual assessment.

**Figure 1** Summary of the results.

Chemical exposure	Cardiovascular disease			
	Heart disease	Pulmonary heart disease	Stroke	High blood pressure
Arsenic				
Asbestos				
Benzopyrene				
Lead				
Electrolytic aluminium production				
Phenoxy acids with TCDD				
Production of paper using the sulphate method				
Carbon disulphide				
Carbon monoxide				
Quarts and other crystalline silicon dioxides				
Engine exhaust				
Nitro-glycerine/dynamite				
Metalworking fluids				
Fumes from welding				
Tobacco smoke				
Other chemical exposures*	*	*	*	*

\* The scientific evidence was considered insufficient to draw any conclusions about the association between cardiovascular disease and several additional chemicals. For example, we found that there is insufficient evidence to establish whether there is an association between occupational exposure to mercury and the incidence of heart disease, stroke or high blood pressure.

□ = Indicates an association between exposure and condition.

■ = Indicates that there is insufficient evidence to draw any conclusions about the association between exposure and condition. Note that insufficient evidence does not indicate that the exposure is not harmful, rather that there is not enough information available to draw any conclusion.

□ = Indicates that no studies meeting our inclusion criteria were identified between exposure and cardiovascular disease. There was insufficient evidence to determine if any of the chemical exposures assessed were associated with changes in blood pressure during pregnancy.

### These results do not identify all chemical compounds that are associated with cardiovascular disease

The results presented are restricted to those chemical compounds for which the research community has conducted epidemiological studies exploring the possible associations between exposure and cardiovascular disease. It is important to point out that other compounds exist which have a documented association with cardiovascular disease. Some compounds were removed from the workplace after it was understood they constituted a health risk. Consequently, there have been little published data to be retrieved for these compounds in the period covered by our literature search.

We chose to limit our literature search to outcomes directly coupled to cardiovascular disease, excluding “all causes mortality.” We may have therefore missed those studies providing information on cardiovascular related deaths, if cardiovascular terms were not mentioned in the title or abstract of the article.

### Scientific Uncertainties

The effects of chemical exposures are less well studied for women than for men. Professions that are dominated by women that involve chemical exposures have not traditionally been the focus of this kind of research. Although a lot of research has been conducted on specific occupations, researchers do not always present their data separately for men and women,

or the studies do not include enough women to draw any reliable conclusions. More research is needed that focuses specifically on women who are subjected to chemical exposure in their workplaces.

Simultaneous exposure to multiple chemicals in the workplace is common. However, studies often only explore the correlation between a single chemical compound and employee health and safety. In addition, interactions between chemical and psychosocial or genetic factors have rarely been considered in relation to cardiovascular health risk.

There is insufficient evidence to determine whether older employees are more vulnerable to chemical exposures. It is also important to study whether any of the populations new to Sweden may have been subjected to other, potentially extensive, chemical exposures before arriving in Sweden.

Research is needed exploring the relationship between dose and response, including understanding how the exposure intensity and duration effects health.

In conclusion, research is also needed to determine whether the risks of chemical exposures in the workplace are currently being underestimated because those that become sick soon stop working, leaving only those who remain healthy to be employed, and subsequently studied.

### **Ethical and Social Considerations**

We have shown that chemical exposures in the workplace are associated with cardiovascular disease. This report may therefore serve as a foundation for the development of preventive measures. Decisions regarding which measures are appropriate creates an ethical dilemma when the cost of protecting individuals conflicts with other economic interests (for example profit margins).

Insufficient scientific evidence is not synonymous with lack of risk. Ethical issues are raised when deciding how to compensate individuals who have developed cardiovascular disease when there is insufficient scientific evidence. SBU can offer no guidance in this situation. Rather the question will require additional information from other sources, and that the decision makers involved carefully consider the circumstances surrounding each individual case.

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