RESEARCH BRIEF

# Occupational Exposure to Cr(VI)

## KEY FINDINGS

- Preliminary results showed higher chromium (Cr) levels in urinary samples when compared to the controls
- Workers in the chrome plating sector had the highest urinary and red blood cells' Cr levels and exhaled breath condensate (EBC)
- Chrome platers had the highest exposure and the welders the lowest, but all exposed groups showed significantly higher exposure than the control group
- Air measurements showed the 90th percentile (P90) of inhalable Cr(VI) levels below the BOELV of 5 µg/m$^3$ in welding and chrome plating, whereas in other surface treatment the P90 was above the transient BOELV of 10 µg/m$^3$
- HBM data, together with air and dermal monitoring data, helped to identify the role of different exposure routes in the total exposure of Cr(VI) in the occupational settings
- Information provided by different (bio)markers can be complementary to assess occupational exposure.
- A multicenter study using HBM in the assessment of occupational exposure and associated health risks in occupational settings provides a model that can greatly improve risk assessment

## HBM4EU WORK ON OCCUPATIONAL EXPOSURE TO CHEMICALS

Occupational exposure to chemicals, in many instances, may be several times higher than environmental exposures experienced by the general population. Human biomonitoring (HBM) provides a valuable tool for understanding exposure to chemicals in the workplace and ensuring safety at work.

A typical challenge in undertaking occupational biomonitoring studies is the low number of workers that can be recruited in national studies. In addition, the studies are usually performed by different research groups in individual countries and consequently these are usually not aligned with respect to sampling, data collection or analytical methodologies. This hampers the comparison of the findings and the use of the data in regulatory risk assessment throughout Europe.

Combining results from national surveys that have used harmonized study designs and methodologies can greatly improve the usefulness of the information collected from occupational studies and deliver added value at a European level.

Within HBM4EU (www.hbm4eu.eu), three targeted occupational studies have been implemented, focusing on priority substances identified within the project. The first one is targeted on hexavalent chromium [Cr(VI)] exposure, which began in 2018. Sample and data collection have been completed across eight countries, with data analysis and reporting of the results currently ongoing.

The two further occupational studies, focussed on exposure to diisocyanates and chemical exposure in E-waste handling, have been planned, with sample and data collection expected to start at the end of 2020.

Further information on the design of the Hexavalent Chromium study can be found at: Santonen et al (2019) Setting up a collaborative European human biological monitoring study on occupational exposure to hexavalent chromium. Environ Res., Jul 10;177:108583. doi: 10.1016/j.envres.2019.108583

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This research brief was produced by the European Environment Agency together with Dr Tiina Santonen, Finnish Institute of Occupational Health (Finland), in collaboration with experts from INRS (FR), INSA and ESTeSL (PT), IOM and HSL (UK), KuLeuven (BE), NIOM (PL), ISS and DPH (IT) and RUMC (NL).

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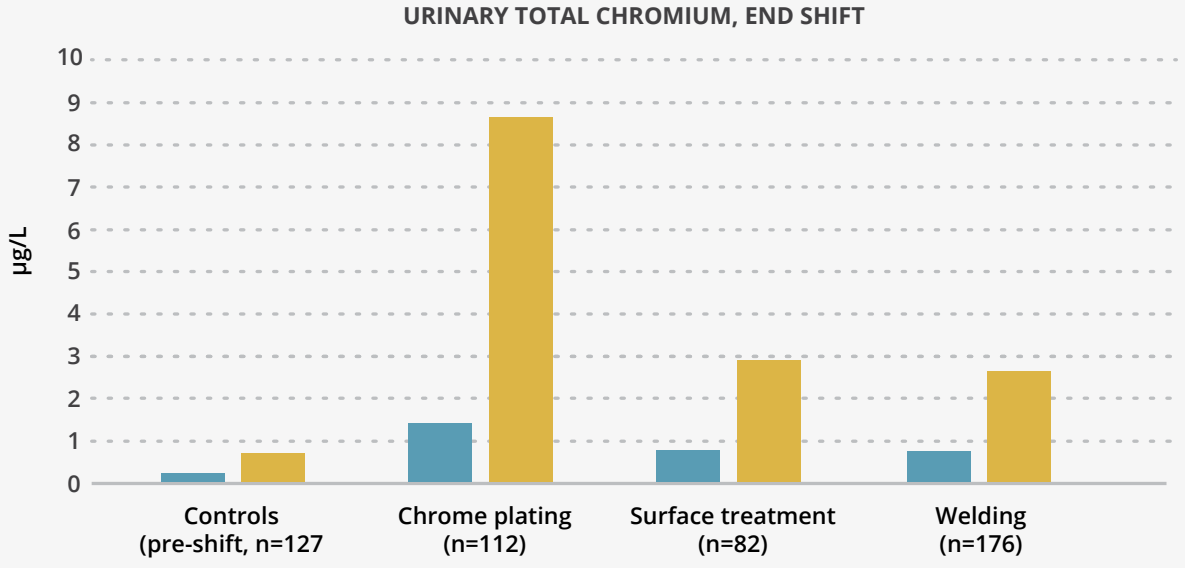
## HBM4EU CHROMATE STUDY BRINGS NEW INFORMATION ON THE OCCUPATIONAL EXPOSURE TO HEXAVALENT CHROMIUM (CR VI)

Cr(VI) is a carcinogen to which people may be exposed in the workplace. Although Cr(VI) compounds are subject to authorisation under Regulation (EC 1907/2006) concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), these compounds are still widely used in different applications, especially in surface treatment of different metallic objects. In addition, workers may be exposed to Cr(VI) formed during hot processes, such as welding.

There is a binding occupational limit value (BOELV) set in 2017 under EU Directive 2004/37/EC[1] for Cr(VI) to control occupational exposures in all processes. It is, however, unclear how well workplaces perform relative to this exposure level. This was studied in the HBM4EU chromate study focusing in occupational exposure to Cr(VI) in surface treatment activities and welding in eight different countries in Europe. This study included approximately 40 companies and in total of almost 580 workers and control subjects (not occupationally exposed to hexavalent chromium).

According to preliminary results of this study all workers showed higher chromium (Cr) levels in urinary samples when compared to the controls. Among the sectors covered by the study, workers in the Cr plating sector had the highest urinary Cr levels (Figure 1). A similar trend is reflected in the results of the analysis of red blood cells and exhaled breath condensate (EBC); i.e. chrome platers had the highest exposure and the welders the lowest but all exposed groups showed significantly higher exposure than controls.

**Figure 1:** Urinary chromium (U-Cr) levels in controls and exposed workers (GM=geometric mean, P90=90$^{th}$ percentile)




[1] Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (Sixth individual Directive within the meaning of Article 16(1) of Council Directive 89/391/EEC) (codified version). The binding limit value for hexavalent chromium given in this directive is 0.010 mg Cr(VI)/m3 for a period of 5 years after the date of transposition of the directive; after that period a limit of 0.005 mg Cr(VI)/m3 will apply. For welding or plasma-cutting processes or similar work processes that generate fumes, BOELV is 0.025 mg Cr(VI)/m3 until 5 years after the transposition date and after that period 0.005 mg Cr(VI)/m3.

In the air measurements, the 90th percentile (P90) of inhalable Cr(VI) levels was below the BOELV of 5 µg/m$^3$ in welding and chrome plating, whereas in other surface treatment the P90 was above the transient BOELV of 10 µg/m$^3$.
More frequent use of RPE may explain why other surface treatment workers showed, however, lower exposure in biomonitoring studies. Hand wipe samples showed significant dermal contamination in all worker groups suggesting the role of dermal exposure and hand-to-mouth contact in the exposure of the workers to total Cr.

The results from urinary total Cr measurements (U-Cr) allowed to distinguish exposed workers from controls and demonstrated an increase over the shift for all sectors, despite the lack of specificity. Correlation between U-Cr and Cr(VI) air levels was seen in chrome platers and welders and between U-Cr and wipe samples in chrome platers.

Overall, HBM data, together with air and dermal monitoring data, helped to identify the role of different exposure routes in the total exposure of Cr(VI) in the occupational settings under investigation. In addition, it showed how information provided by different (bio)markers can be complementary to assess occupational exposure.

In order to conclude whether recent regulations have already had a favourable impact on Cr(VI) exposure, further evaluation and comparison to earlier data need to be performed. However, the data suggests that greater focus on the control of exposures is still needed in these sectors. Wider use of the new methods applied in this study may help in the control of Cr(VI) exposures at workplaces in future.

## HBM4EU MULTICENTER STUDIES IN ADVANCING OCCUPATIONAL EXPOSURE ASSESSMENT

The design of a multicenter study using HBM in the assessment of occupational exposure and associated health risks in occupational settings provides a model that can greatly improve risk assessment. The higher number of companies, which covered the spectrum of microsized to large companies and inclusion of several countries from different parts of Europe will enhance the power of the study and the usability of the data in regulatory risk assessment and decision making in EU. Collection of detailed contextual information, biomonitoring data can be linked to different conditions and different risk management measures allowing to identify the best practices at the workplaces.

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