Trends in Occupational Exposure to Styrene

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Introduction

Styrene is used to make a variety of products including plastics, resins, fibre glass, paints, and rubber. Inhaled styrene is rapidly absorbed. Repeated exposure to styrene can lead to irritation of the nose and throat, wheezing and coughing, dermatitis and “Styrene sickness”.(1) In 2019 IARC classified styrene as 'probably carcinogenic to humans' (Group 2A). Around 85% of the absorbed amount is metabolised to mandelic acid. The analysis of end of shift urine samples for mandelic acid is a well-established biological monitoring technique.

Methods

We have been monitoring styrene exposure for many years. Since 1996 over 3000 results for mandelic acid concentration in urine have been collected in the HSE’s biological monitoring database. Mandelic acid is measured using HPLC-UV and we participate in proficiency testing. The detection limit is 0.1 mmol/L and the coefficient of variation is 10.4%.

Results

The results for each year are expressed as the 90th percentile value which indicates achievable exposure levels. (2, 3) . The German DFG (German Research Foundation) set a biological tolerance value of 600 mg/g creatinine for mandelic acid plus phenylglyoxylic acid which is equivalent to an exposure for 8 h at 20 ppm. If only mandelic is considered the equivalent would be 400 mg/g creatinine, which is 300 mmol/mol creatinine. (4) As styrene is a carcinogen the exposure should be as low as reasonably practicable (ALARP). Figure 1 shows the relationship between sample number, P90 and the BAT-equivalent value from 1996 to 2022. In recent years, the trend line for P90 drops below the BAT-equivalent value indicating continuous improvement of working practices. From the data we have collected we can see that fibreglass related occupations, particularly boat building and repairs, have elevated exposures to styrene (figure 2).

Conclusions

Over time we see an increase in the number of samples being submitted for analysis and a decrease in the P90 for mandelic acid in urine. This trend shows that biological monitoring is a valuable tool in the assessment of control measures and can stimulate reductions in exposure to styrene in an occupational setting.

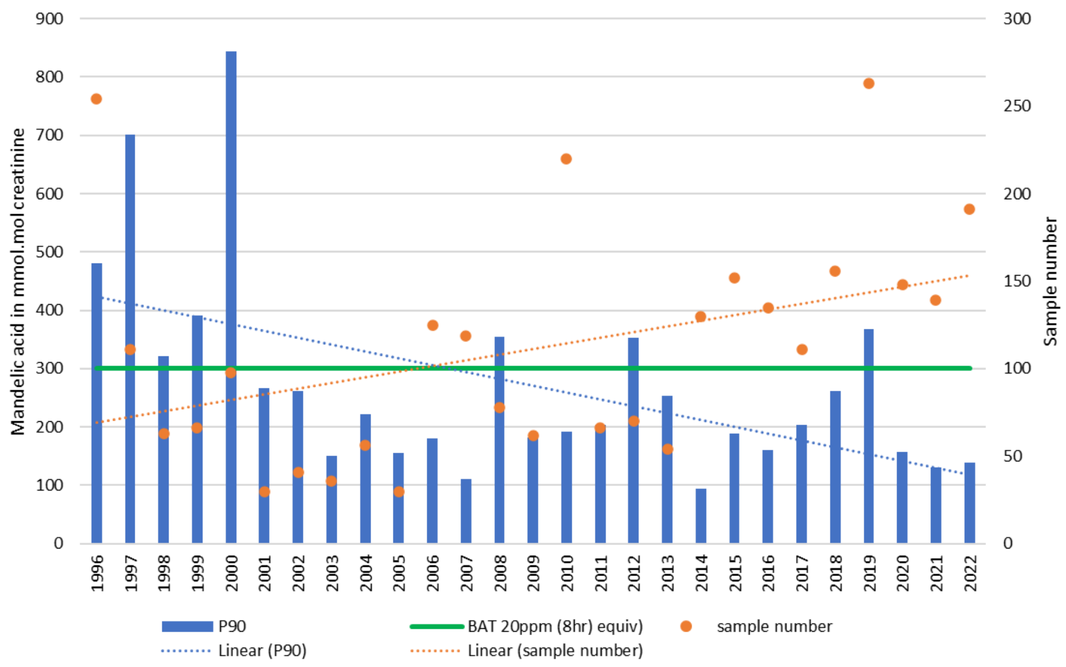

Figure 1: P90 of mandelic acid in urine and the number of samples each year.

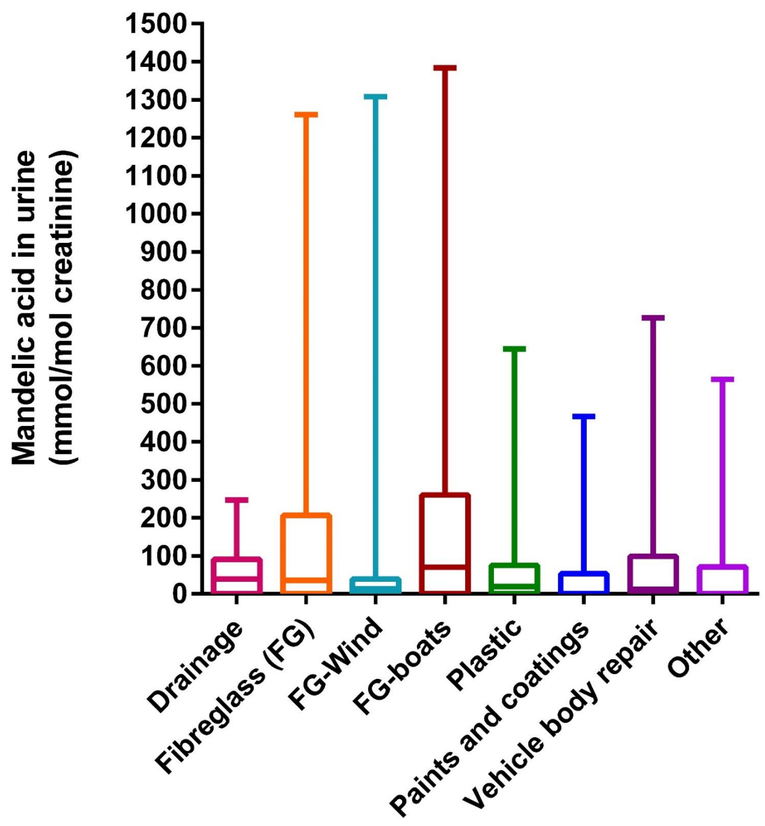

Figure 2: Concentration of mandelic acid in urine for different sectors using styrene. The centre line denotes the median value, the box contains the 25th to 75th percentiles and the whisker marks the 5th and 95th percentiles, and values beyond these upper and lower bounds are considered outliers.

References:
(1) International Programme on Chemical Safety (IPCS). Styrene. Poisons Information Monograph. PIM 509. 1996, WHO: Geneva.
(2) Cocker, John, and Kate Jones. "Biological monitoring without limits." *Annals of Work Exposures and Health* 61.4 (2017): 401-405.
(3) Morton, Jackie, et al. "Biological monitoring: evidence for reductions in occupational exposure and risk." *Frontiers in Toxicology* 4 (2022).
(4) Styrene, Addendum [BAT Value Documentation, 1998b], *Biological Exposure Values for Occupational Toxicants and Carcinogens*, Vol. 3 (1998)

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