

# Metals and oxidative stress parameters levels in the blood of welders in Latvia

I. Martinsone<sup>1</sup>, M.-A. Bake<sup>1</sup>, N. Rusakova<sup>1,2</sup>, L. Larmane<sup>2</sup>, A. Silova<sup>2</sup>

<sup>1</sup>Riga Stradins University, Laboratory of Hygiene and Occupational Diseases | <sup>2</sup>Rigas Stradins university, Laboratory of Biochemistry

Dzirciema str. 16, Riga, Latvia, LV – 1007, e-mail: inese.martinsone@rsu.lv

An employee who performs gas cutting and welding is subjected to a series of harmful factors. Welding fume consisting of various metal salts and oxides is released in work environment air; the presence of substances having especially adverse human health effects – cadmium, nickel, chromium (VI) – is possible. As from laboratory experience, many of assessed welders' work places have no appropriate ventilation systems, employees use respirators which do not prevent inhaling the welding fume therefore it is possible for various occupational diseases to develop. Summing up scientific literature on the impact of metals contained in the welding fumes on welders' health, levels of metals in bio-environments and causes of their changes as well as possible health disorders, one must conclude that this problem is not sufficiently researched in Latvia.

## Purpose

Determination of metal levels and biochemical indices in the blood of workers employed in metal processing might indicate early work environment risk factor-induced changes in the body and so it might be possible to assess the impact of work environment.

## Material and methods

Subjects of the study were 94 welders from different metalworking enterprises. The control group was 54 workers from the electric power supply industry, free of exposure to welding fumes and hazardous dusts. The work histories of the subjects were assessed through a structured questionnaire including questions on previous and current jobs, working conditions, habits (alcohol consumption; smoking habits, including duration), and data on age and dietary habits. The blood samples were collected by venipuncture in lithium heparin vacutainers. Whole blood was digested in a closed system with a microwave apparatus MARS 5, CEM. The concentration of metals (Mn, Zn, Cu) in the blood samples was analyzed by atomic absorption spectrophotometry (AAS) with electrothermal atomization in a graphite furnace, and Zeeman background correction Varian SpectraAA 220 Z. The amount of oxidative stress parameters (Cu, Zn-superoxide dismutase (SOD), glutathione peroxidase (GPx), lipid peroxides) in blood were determined by means of a clinical chemistry analyzer using standard testing systems of Randox Laboratories Ltd. Statistical result processing was performed by using SPSS 16.0 computer program.

## Results

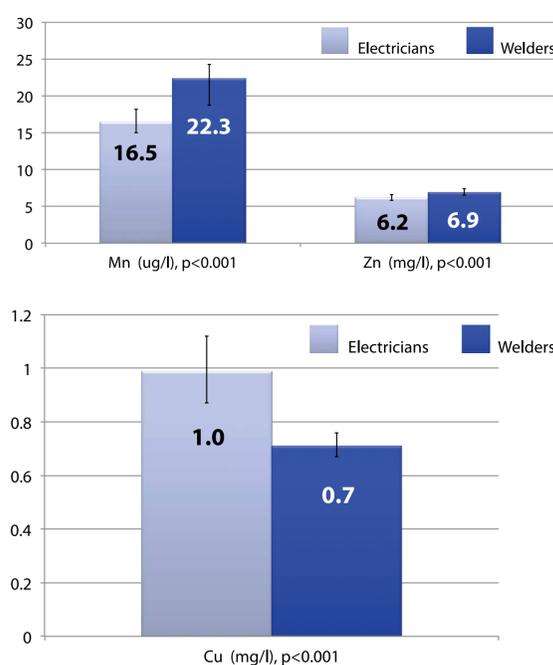
Figure 1 gives an overview of the determined metal concentrations in blood for welders and electricians. Comparing the results of welder (exposed) group to the results of electrician (control) group for **manganese (Mn)** concentration median in blood, it is 22.30 µg/l (95% CI 18.70 – 24.30), but for the electrician (control) group – 16.50 µg/l (95% CI 14.99 – 18.14). Processing the obtained results by means of Mann-Whitney U test, a statistically valid difference ( $z=4.37$ ;  $p < 0.001$ ) can be observed between groups, the level of Mn in blood for the exposed group being considerably higher.

## Results

**Table 1.**  
Characteristics of welder and control (electricians) groups

	Control group (n = 54)		Welder group (n = 94)	
	n	Mean ± SD	n	Mean ± SD
Age (years)	54	47.6 ± 11.0	94	41.3 ± 14.1
Smoking habits				
Current smokers	18	33.3	55	58.5
Ex - smokers	13	24.1	17	18.1
Non - smokers	23	42.6	22	23.4

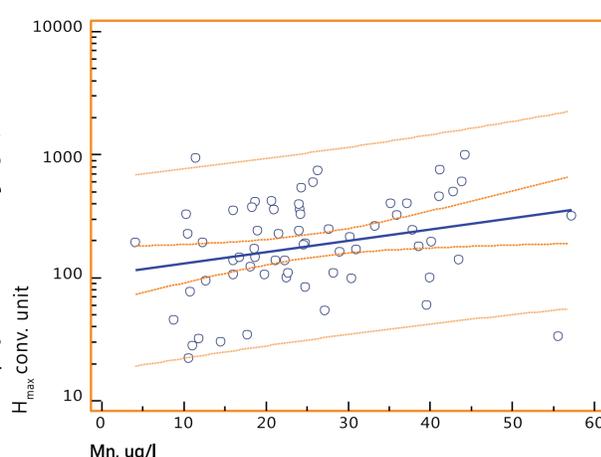
**Figure 1.**  
Concentration of metals in the blood of welders and electricians



**Table 2.**  
Biochemical indices in the blood of welders and electricians

Group	N	Indices	Median	IQR (Q <sub>3</sub> - Q <sub>1</sub> )	95% CI
Welders	96	Cu, Zn - SOD, U/g Hb	1341.5	1161.0 - 1558.5	1276.3 - 1391.5
	97	GPx, U/L	6466.0	5510.3 - 7475.5	6036.0 - 6725.0
	70	H <sub>max</sub> - amount of lipid peroxides, cond. unit	190.0	100.0 - 357.0	141.3 - 240.3
Electricians	54	Cu, Zn - SOD, U/g Hb	1279.0	1163.0 - 1404.0	1238.9 - 1354.78
	54	GPx, U/L	6215.0	5346.0 - 7348.0	5747.8 - 6777.4
	45	H <sub>max</sub> - amount of lipid peroxides, cond. unit	228.0	92.3 - 323.8	125.7 - 275.8

**Figure 2.**  
Changes in the amount of lipid peroxide (H<sub>max</sub>) depending on the changes of manganese level in the blood of welder group



## Results

Concentration median for **copper (Cu)** in blood for the exposed group is 0.71 mg/l (95% CI 0.66 – 0.75) while for control group – 0.99 mg/l (95% CI 0.86 – 1.11). Processing the obtained results by means of Mann-Whitney U test, a statistically valid difference ( $z = 4.23$ ;  $p < 0.001$ ) can be observed between the groups. The level of Cu for the exposed group is considerably lower. Concentration median for **zinc (Zn)** in blood for the exposed group is 6.90 mg/l (95% CI 6.51 – 7.39) while for control group – 6.20 mg/l (95% CI 5.82 – 6.60). Processing the obtained results by means of Mann-Whitney U test, a statistically valid difference ( $z = 3.78$ ;  $p < 0.001$ ) can be observed between the groups. The level of Zn for the exposed group is considerably higher. When welding fume enters into the lungs, it becomes the source of chronic irritation. Activation of macrophages and leucocytes is followed by phagocytosis, thus causing the discharge of protease, inflammation agents and active oxygen radicals. Determination of Cu, Zn-superoxide dismutase, reduced glutathione and the total level of antioxidants as well as determination of plasma chemiluminescence (HCL) was performed in the blood of welders and electricians. The obtained results are summarized in Table 2. Comparing the obtained results from both groups, none of found indices show statistically valid difference. By performing Spearman's rank correlation test, a positive weak ( $r=0.318$ ), statistically valid ( $p < 0.001$ ) correlation was found between the amount of lipid peroxides and the level of manganese in the blood of welder group (Fig. 2); it means that by increasing the concentration of manganese the increase of "oxidative stress" is observed in the body. Negative weak ( $r=-0.321$ ), statistically valid ( $p < 0.001$ ) correlation is obtained between the amount of lipid peroxides and zinc-copper correlation in the blood of welder group. Such correlations are not observed in the electrician group.

## Conclusion

Concentrations of manganese and zinc in blood of welders have higher statistical validity than for the electrician (control) group, while level of copper in blood is statistically lower. It must be noted that copper concentration is lower not only in comparison to the control group but also to the reference levels of other countries and indicates of probable clinical changes in organism. Results of study indicate of considerable impact of the work environment air on the mutual balance of metals existing in organism. Copper concentration in blood of welders is clinically low; in order to find a cause for the reduced concentration in welder group additional research is necessary by determining copper concentration in cells and in ceruloplasmin serum. It is possible to have an early assessment of work environment impact on organism of employee when using monitoring of metals and complex of biological indices.

## Acknowledgements

This study was supported by the Ministry of Education and Science of Latvia grant (RSU-ZP08-3/) and Riga Stradins University and Europe Social Fund grant (2009/0147/1DP/1.1.2.1.2/09/IPIA/VIAA/009).