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Lead and its compounds (except lead arsenate, lead chromate and alkyl lead compounds) – Addendum for re-evaluation of the BAR

Assessment Values in Biological Material – Translation of the German version from 2020

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Abstract

In 2019 the German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area has re-evaluated the biological reference value (BAR) for lead [7439-92-1] in blood for women and has also evaluated a BAR for lead in blood for men.

The last representative survey of blood lead in the German adult population was performed in 1998/1999. However, the blood lead levels (BLLs) in young adults (aged 20–29 years) continuously analysed since 1997 in the German Environmental Specimen Bank (ESB) showed a distinct decline in the BLLs, which reached a plateau in 2010. The BLLs of 2626 women and 2310 men determined in the 2010–2019 period yielded 95th percentiles of 21.8 µg/l for young women and 26.1 µg/l for young men, respectively. The results are in good accordance with other international studies on BLLs in young adults. Due to the accumulation of lead over the life course, elderly adults have higher body and blood lead concentrations than young adults. Using the age-specific data of the German Environmental Survey of 1998/1999, the BLLs data from the ESB were adapted to the working population. Thus, a BAR of 30 µg lead/l blood for women and a BAR of 40 µg lead/l blood for men were established. Sampling time is not restricted because of the long biological persistence of lead in the body.

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BAR for women (2019)	**30 µg lead/l blood** Sampling time: not fixed
BAR for men (2019)	**40 µg lead/l blood** Sampling time: not fixed
MAK value	–
Absorption through the skin	–
Carcinogenicity (2006)	Category 2

Re-evaluation

For lead and its inorganic compounds, a biological reference value (BAR) of 70 µg/l blood for women was established in 2012 (translated in Bolt 2019). To this end, the data for blood lead levels from the last German Environmental Survey of the adult population conducted in 1998 were used. However, evidence suggests that the population's exposure to lead has continued to decrease significantly ever since, necessitating an update of the reference value. As no new representative surveys of exposure of the German adult population to lead have been conducted since 1998, only the data obtained for the human samples of the ESB are currently available for a BAR re-evaluation.

For the ESB, at least 120 blood and urine samples from young adults (aged 19–29 years) are collected every year at each of the four locations Münster, Greifswald, Halle/Saale and Ulm. Among others, blood lead levels are determined by real-time monitoring (Göen et al. 2018). Currently, ESB BLLs have been evaluated with regard to the temporal trend and possible influencing factors. Last year, the Human Biomonitoring Commission used this data to update the reference values for BLLs in women and men (Lermen et al. 2021; UBA 2019 a).

For Münster, data are available covering the period between 1981 and 2019, while data from the other sites were not fully integrated until 1997. For all four sites, there was a significant and distinct decrease in blood lead levels among young adults (Lermen et al. 2021). However, blood lead concentrations remained at almost the same level from around 2010 onwards. Therefore, the data covering the period between 2010 and 2019 were summarized and used for descriptive statistics and for the analysis of influencing factors.

The main results of the descriptive statistics of BLLs for the 2010–2019 period as well as the key influencing factors are presented in Table 1. As in the evaluation of the 1998 German Environmental Survey, BLLs in women and men differ significantly. The median BLL in young men is about 20% higher than in women of the same age. The evaluation also revealed that blood lead levels are significantly higher among smokers than among non-smokers. Depending on gender, the BLLs differ by a factor of 1.34 (♀) and 1.19 (♂), respectively. The effect of alcohol intake on BLLs was also assessed, with people who consume alcohol tending to have higher BLLs. However, the effect is moderate, with a 5 to 10% increase in lead concentration. Disregarding the influencing factors, a 95th percentile of 21.8 µg lead/l blood was determined for women aged 20–29 years and 26.1 µg lead/l blood for men aged 20–29 years.

Tab. 1 Statistical evaluation of the data on blood lead concentration [µg/l] of the Environmental Specimen Bank for Human Tissues in German young adults aged 20–29 covering the 2010–2019 period (Lermen et al. 2021)

Collective	n	50th p	AM (± SD)	GM (95% CI)	95th p	Min	Max	Mann-Whitney test
♀ total	2626	10.2	11.6 (± 6.2)	10.5 (10.3–10.7)	21.8	2.8	103.1	p < 0.001
♂ total	2310	12.4	13.9 (± 7.0)	12.7 (12.4–13.0)	26.1	3.0	98.5	
♀								
non-smokers	2345	9.9	11.3 (± 5.8)	10.3 (10–10.5)	21.2	2.8	71.9	p < 0.001
smokers	265	13.3	14.5 (± 8.3)	13.1 (12.1–14.1)	24.7	4.2	103.1	
♀, non-smokers								
no alcohol intake	205	8.8	11.1 (± 8.0)	9.6 (8.5–10.7)	25.6	2.9	71.9	p = 0.001
alcohol intake	2140	10.1	11.3 (± 5.5)	10.3 (10.1–10.6)	21.1	2.8	66.9	
♂								
non-smokers	1930	12.1	13.5 (± 6.9)	12.3 (12–12.6)	24.4	3.0	98.5	p < 0.001
smokers	363	14.4	16.4 (± 7.4)	15 (14.3–15.8)	30.4	5.6	55.4	
♂, non-smokers								
no alcohol intake	132	11.1	12.5 (± 8.0)	10.9 (9.5–12.3)	23.3	3.5	61.9	p = 0.002
alcohol intake	1798	12.2	13.5 (± 6.8)	12.4 (12.1–12.7)	24.5	3.0	98.5	
Total	**4936**	**11.2**	**12.7 (± 6.7)**	**11.5 (11.3–11.7)**	**23.6**	**2.8**	**103.1**	

AM: arithmetic mean; GM: geometric mean; Mann-Whitney test: result of group comparison (non-parametric test); Max: maximum; Min: minimum; SD: standard deviation; 50th p: median; 95th p: 95th percentile; 95% CI: 95% confidence interval

Re-evaluation of the BAR

The 95th percentiles from the evaluation of the ESB data covering the period between 2010 and 2019 can be used as a basis for the evaluation of a BAR for lead in blood. It should be noted that young adults tend to have lower blood lead levels than older adults. This is due to the storage of absorbed lead in the bone matrix and inefficient remobilization and associated slower elimination (Klotz and Göen 2017). Based on the evaluation of the last environmental survey for the adult population, differentiated by age, the blood lead levels in young adults aged 20–29 years are 1.25 times lower than those in the total population at the 95th percentile. Taking this factor into account, a 95th percentile of 27.3 µg lead/l blood for women and 32.6 µg/l blood for men would be expected in the general population. A calculation using the full distribution, age profile and time course of the data covering the 2010–2015 period yielded estimates of 31.0 µg lead/l blood for women and 39.5 µg lead/l blood for men (UBA 2019 b). Taking these values into account,

a BAR of 30 µg lead/l blood for women and a BAR of 40 µg lead/l blood for men

are established. There are no restrictions as to the sampling time.

Although a significant difference between smokers and non-smokers was found in the gender-differentiated evaluation of the ESB data, smokers were clearly underrepresented. As the difference is relatively small, no differentiation between smokers and non-smokers was made in the BAR derivation.

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