

Benchmark Dose of Lead Inducing Anemia at the Workplace

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Abstract

To estimate the critical dose of lead inducing anemia in humans, the effects of lead on hemoglobin (Hb) and hematocrit (Hct) levels, and red blood cell (RBC) count were examined in 388 male lead-exposed workers with blood lead (BPb) levels of 0.05~5.5 (mean 1.3) $\mu\text{mol/L}$, by using the benchmark dose (BMD) approach. The BPb level was significantly related to Hb (regression coefficient $\beta=-0.276$), RBC ($\beta=-11.35$), and Hct ($\beta=-0.563$) among the workers ($p<0.001$) when controlling for age and working status. The average BPb levels were significantly higher in the workers with anemia (1.85 $\mu\text{mol/L}$), based on the WHO criteria, than in those without anemia (1.26 $\mu\text{mol/L}$). The benchmark dose levels of BPb (i.e., lower 95% confidence limits of BMD), calculated from the *K*-power model set at an abnormal probability of 5% in unexposed workers and an excess risk of 5% in exposed workers, were estimated to be 0.94 $\mu\text{mol/L}$ (19.5 $\mu\text{g/dl}$) for Hb, 0.94 $\mu\text{mol/L}$ (19.4 $\mu\text{g/dl}$) for RBC, and 1.43 $\mu\text{mol/L}$ (29.6 $\mu\text{g/dl}$) for Hct. These findings suggest that reduction in hematopoietic indicators may be initiated at BPbs below the level currently considered no effect.

Key words: Benchmark dose, Lead, Hemoglobin, Hematocrit, Red blood cell

Table Benchmark doses (BMD, $\mu\text{mol/L}$) and the lower 95% confidence limits of BMD (BMDL, $\mu\text{mol/L}$) of blood lead concentrations, set at the P_0 of 5% when controlling for age and working status, in 388 lead-exposed workers*

| | <i>K</i> value | BMD (BMR=0.05) | BMDL | BMD (BMR=0.1) | BMDL |
|----------------------|----------------|-------------------|------|------------------|------|
| Hemoglobin | 1.012 | 1.38 | 0.94 | 2.30 | 1.57 |
| Hematocrit | 1.012 | 2.12 | 1.43 | 3.52 | 2.38 |
| Red blood cell count | 1 | 1.39 | 0.94 | 2.32 | 1.57 |

* P_0 and BMR indicate an abnormal probability in unexposed workers and an excess risk in exposed workers, respectively (see Figure 1). Cutoff values of hemoglobin (137 g/L), hematocrit (40.0%), and red blood cell count ($432 \times 10^4 / \mu\text{l}$) were calculated from the *K*-power model of the BMD approach.