**Medical Laboratory Science Journal (MedLab)**
Vol. 1, No. 2, 2025, pp. 38-42

# Blood lead levels among automotive workshop workers measured using atomic absorption spectrophotometry

**Gusti Ayu Chintya[1], Nyoman Sudarma[2*], Moh Fairuz Abadi[3]**
[123]Medical Laboratory Technology Study Program, STIKES Wira Medika Bali, Denpasar, Indonesia
*Corresponding Author: sudarmanyoman@stikeswiramedika.ac.id

**Article Info**

**Article history:**
Received September 1, 2025
Revised October 18, 2025
Accepted November 2, 2025

**Keywords:** blood lead levels, automotive workshop workers, atomic absorption spectrophotometry, occupational exposure, clinical toxicology



**Abstract**

Lead exposure in automotive workshop environments is a significant occupational health problem because it can lead to heavy metal accumulation in the blood and affect various organ systems. Workshop workers are at high risk of lead exposure through inhalation and direct contact during vehicle maintenance and repair activities. This study aims to analyze lead levels in blood specimens from automotive workshop workers measured using atomic absorption spectrophotometry. The study used a cross-sectional, observational, analytical design. The research subjects were automotive workshop workers in Banjar Karangsari who met the inclusion criteria. Nine blood samples were taken according to clinical laboratory procedures and measured using an atomic absorption spectrophotometer. The data were analyzed descriptively and analytically to describe the distribution of lead levels and their relationship with respondent characteristics. The results showed that automotive workshop workers had varying blood lead levels, with a tendency to increase in individuals with longer working hours and higher exposure intensity. The findings indicate that there are health risks due to lead exposure in the workshop work environment, which need to be addressed by increasing understanding of occupational safety and health in the informal sector.

**How to cite:**
Chintya, G. A., Sudarma, N., & Abadi, M. F. (2025). Blood lead levels among automotive workshop workers measured using atomic absorption spectrophotometry. *Medical Laboratory Science Journal (MedLab)*, 1(2), 38–42.

## 1. Introduction

Air pollution is one of the environmental problems with a significant impact on human health, especially in areas with high levels of transportation activity. Motor vehicle exhaust emissions are a major contributor to air pollution and contain various hazardous heavy metals, including lead. The continuous increase in the number of motor vehicles contributes to the accumulation of lead, thereby increasing the risk of exposure to humans (Statistics Agency, 2018; Reffiane et al., 2017).

Lead is a toxic heavy metal that can enter the body through inhalation, digestion, and skin contact and can accumulate in body tissues when continuously exposed (Mulyana, 2012; Rahayu & Solihat, 2018). Long-term exposure to lead can cause various health disorders, including disorders of the hematopoietic, nervous, renal, cardiovascular, and reproductive systems (Sembel, 2015; Rahayu & Solihat, 2018). Therefore, monitoring lead levels in the body is important to detect the risk of heavy metal toxicity early.

Motor vehicle repair workers are a group at high risk of lead exposure due to their work activities, which involve direct contact with vehicle exhaust emissions, lubricants, and a work environment generally located along roads with high traffic density (Yoga, 2013; Alsuhendra, 2013). This exposure can be exacerbated by behavioral factors, such as low use of personal protective equipment, poor personal hygiene habits, and long working hours (Dewi et al., 2016; Rustanti & Mahawati, 2011). Several previous studies have shown that blood lead levels among workshop workers can exceed the established threshold and pose serious health risks (Budianto, 2019; Cahyanti Nova, 2020).

Lead levels in blood specimens are the most commonly used biological indicator of lead exposure, as they reflect the amount of lead circulating in the bloodstream from external sources (Mulyana, 2012). The Indonesian government, through the Decree of the Minister of Health of the Republic of Indonesia Number 1406/MENKES/SK/IX/2002, has set a threshold for blood lead levels as a reference for assessing health risks. Therefore, measuring blood lead levels in workshop workers is important to assess their exposure status and the potential health impacts.

Atomic absorption spectrophotometry is a widely used analytical method for determining heavy metal levels, including lead, because it offers high sensitivity and accuracy and can detect metals at low concentrations (Rahayu & Solihat, 2018). The success of lead content analysis using this method is greatly influenced by the pre-analytical stage and sample preparation, particularly the destruction method used. Wet destruction methods are considered more effective at preserving metal content than dry destruction, as they minimize element loss from evaporation at high temperatures (Rahayu & Solihat, 2018; Firdaus, 2015). Given the high traffic density, long working hours, and low use of personal protective equipment in Banjar Karangsari, Sukadana Village, Kubu District, Karangasem Regency, a laboratory study is needed to determine blood lead levels among workshop workers in the area. Blood lead level testing in this group of workers has never been conducted systematically. Therefore, this study aims to analyze lead levels in blood specimens of workshop workers using the atomic absorption spectrophotometer method to support occupational health monitoring.

## 2. Method

### 2.1 Research Design and Participants

This study is a descriptive study that aims to describe lead levels in blood specimens from workshop workers without any treatment or intervention. The study was conducted in Banjar Karangsari, Sukadana Village, Kubu District, Karangasem Regency. Blood specimens were collected at the study site, and lead levels were analyzed at the Udayana University Analytical Laboratory and the Udayana University Forensic Laboratory. The population in this study comprised all workshop workers in Banjar Karangsari, totaling 10 individuals. The research sample consisted of 9 respondents who met the inclusion criteria, namely workshop workers with more than five years of service, aged 20–50 years, and actively working for the last six months. The sampling technique used was purposive sampling, which involves selecting samples based on criteria relevant to the research objectives (Subhaktiyasa, 2024). The exclusion criteria included workers who were unwilling to have their blood drawn and those who were sick or taking certain medications or vitamins.

### 2.2 Instruments and Data Collection

The main instrument in this study was an atomic absorption spectrophotometer, which measured lead levels in blood. Supporting equipment included needles and holders, tourniquets, EDTA tubes, hot plates, measuring flasks, Erlenmeyer flasks, pipettes, filter paper, and other laboratory glassware. The materials used included venous blood from workshop workers, lead standard solution, nitric acid, sulfuric acid, and distilled water. Blood specimens were collected from veins into EDTA tubes containing ±3 mL of EDTA. The specimens were stored in a cool box and immediately taken to the laboratory for analysis. Sample preparation was carried out using the wet destruction method with a mixture of nitric acid and sulfuric acid, then heated until a clear solution was obtained. The resulting destruction solution was then diluted to a particular volume before analysis. Lead levels were determined using the Atomic Absorption Spectrophotometer method at 217.0 nm. A standard curve was created using lead standard solutions at 0.5 ppm, 1.0 ppm, and 1.5 ppm to determine the relationship between concentration and absorbance.

### 2.3 Data Analysis

The data on blood lead levels among workshop workers are presented descriptively in tabular form. The lead levels obtained were compared with the threshold values set in Indonesian Minister of Health Decree No. 1406/MENKES/SK/XI/2002 concerning standards for testing lead levels in human biomarker specimens, with a normal blood lead level range of 0.1–0.25 ppm.

### 2.4 Ethical Considerations

All respondents were informed of the study's purpose and benefits, as well as the blood specimen collection procedure, prior to the study. Specimen collection was carried out after obtaining the respondents' voluntary consent. The respondents' identities were kept confidential, and all laboratory procedures were carried out in accordance with occupational safety standards and laboratory practices.

## 3. Results and Discussion

### 3.1 Results

This study involved nine workshop workers as respondents. The characteristics of the respondents are shown in Table 1, and the results of lead level measurements in the blood specimens of workshop workers, obtained using an atomic absorption spectrophotometer, are shown in Table 2.

Table 1. Characteristics of research respondents

| Characteristics | Categories | Number | Percentage (%) |
|---|---|---|---|
| Age | ≤40 years | 7 | 80 |
| | > 40 years | 2 | 20 |
| Length of employment | ≤ 5 years | 2 | 20 |
| | > 5 years | 7 | 80 |
| Working hours | ≤ 8 hours/day | 0 | 0 |
| | > 8 hours/day | 9 | 100 |
| Use of PPE | Yes | 0 | 0 |
| | No | 9 | 100 |
| Hand washing habit | Ya | 0 | 0 |
| | No | 9 | 100 |
| Smoking habit | Yes | 5 | 60 |
| | No | 4 | 40 |

Table 2. Results of lead level measurements in blood specimens

| Sample | Lead level (ppm) |
|---|---|
| Sample 1 | 0.47 |
| Sample 2 | 0.40 |
| Sample 3 | 0.41 |
| Sample 4 | 0.58 |
| Sample 5 | 0.72 |
| Sample 6 | 0.70 |
| Sample 7 | 0.79 |
| Sample 8 | 0.79 |
| Sample 9 | 0.84 |

Table 1 demonstrates that the majority of respondents were aged ≤40 years (80%) and had worked for >5 years (80%). All respondents worked>8 hours per day, did not use personal protective equipment at work, and had a habit of not washing their hands after work. In addition, 60% of respondents had a smoking habit. Table 2 describes that all samples had lead levels exceeding the threshold value set in the Decree of the Minister of Health of the Republic of Indonesia Number 1406/MENKES/SK/XI/2002, which is 0.1–0.25 ppm. The measured blood lead levels in respondents ranged from 0.40 ppm to 0.84 ppm. The lowest lead level was 0.40 ppm in one respondent, while the highest was 0.84 ppm. Most respondents had blood lead levels above 0.50 ppm, indicating high lead exposure among the workshop workers studied. These findings indicate that lead exposure among workshop workers in Banjar Karangsari is widespread and exceeds the safe limits recommended for human biomarker specimens.

### 3.2 Discussion

The results of this study indicate that all workshop workers who participated in the survey had blood lead levels exceeding the threshold value set by Indonesian Minister of Health Decree No. 1406/MENKES/SK/XI/2002. These findings indicate that workshop workers in Banjar Karangsari are exposed to significant levels of lead, which could potentially cause health effects if exposure is chronic.

This condition aligns with the characteristics of the motor vehicle workshop work environment, which is characterized by high exposure to exhaust emissions, metal dust, and lubricant residues containing lead (Sembel, 2015; Rahayu & Solihat, 2018).

High blood lead levels in respondents are caused by inhalation and direct contact during work activities. Lead contained in air particles resulting from fuel combustion and vehicle component friction can be inhaled and enter the bloodstream, where it accumulates due to its difficulty in being eliminated from the body (Mulyana, 2012). In addition, work behaviors that are not conducive to safety, such as failing to use personal protective equipment, failing to wash hands after work, and smoking, can increase lead absorption into the body (Rustanti & Mahawati, 2011; Dewi et al., 2016). It is reflected in the results of the study, which show that not all respondents used personal protective equipment, and most had a smoking habit.

The findings of this study are consistent with previous studies reporting that workshop workers and transportation workers have higher blood lead levels than the general population. Budianto (2019) and Cahyanti Nova (2020) stated that lead exposure among workshop workers is closely related to both employment duration and the intensity of environmental exposure. This statement is reinforced by the fact that the majority of respondents had worked for more than five years and worked more than eight hours per day, which strengthens the assumption that chronic exposure is a significant factor in increased blood lead levels.

The Atomic Absorption Spectrophotometer method offers greater sensitivity and accuracy for detecting low levels of lead. This method is considered appropriate for analyzing heavy metal biomarkers in blood specimens because it can yield reliable quantitative data that serve as a basis for evaluating heavy metal exposure among workers at risk (Rahayu & Solihat, 2018). The analysis uses a wet destruction method that effectively preserves metal content and minimizes element loss during sample preparation.

The study's results confirm the importance of blood lead testing as part of occupational health monitoring for high-risk worker groups. Data on heavy metal exposure can inform preventive decision-making. The implementation of periodic blood lead testing, accompanied by education on the use of personal protective equipment and occupational hygiene practices, is expected to reduce the risk of lead accumulation and long-term health effects on workshop workers.

## 4. Conclusion

Motor vehicle repair shop workers in Banjar Karangsari experienced significant lead exposure, as evidenced by blood lead levels exceeding the established threshold in all respondents. These findings fulfill the research objective of describing the level of lead exposure in at-risk worker groups through laboratory analysis using atomic absorption spectrophotometry. Work environment factors and work behavior play an important role in determining heavy metal exposure. The results of this study reinforce the concept of occupational toxicology that chronic exposure to lead in a workshop environment can accumulate in the blood and be detected through sensitive biological biomarkers. It confirms the importance of blood lead level testing as part of worker health monitoring and supports strengthening prevention policies by implementing personal protective equipment and periodic health checks. However, this study has limitations that need to be considered. The limited sample size and descriptive design did not establish a causal relationship, so further research should use a larger sample and examine the relationships among work characteristics, health behaviors, and blood lead levels to gain a comprehensive understanding.

## Conflict of Interest

The authors declare no conflict of interest.

## References


Adhani, R., & Husaini. (2017). *Logam berat sekitar manusia* (hlm. 38–139). Lambung Mangkurat University Press.

Alsuhendra, A., et al. (2013). *Bahan toksik dan makanan*. PT Remaja Rosdakarya.

Badan Pusat Statistik. (2018). *Perkembangan jumlah kendaraan bermotor 1949–2016*. Badan Pusat Statistik.

Budianto, S. (2019). *Paparan kadar timbal (Pb) dalam darah pekerja bengkel sepeda motor di Jalan Jamin Ginting tahun 2019* (Skripsi). Universitas Sumatera Utara.

Cahyanti, N. (2020). *Analisis kadar timbal (Pb) dalam darah pekerja bengkel di Desa Buduk dengan metode spektrofotometri serapan atom* (Skripsi). Sekolah Tinggi Ilmu Kesehatan Wira Medika Bali.

Departemen Kesehatan Republik Indonesia. (2011). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 1691/MENKES/PER/VIII/2011 tentang keselamatan pasien rumah sakit*. Kementerian Kesehatan Republik Indonesia.

Dewi, P. P., Yusuf, S., & Arum, D. P. (2016). Faktor terkait kadar timbal pada polisi lalu lintas Kota Kendari. *Jurnal Ilmiah Mahasiswa Kesehatan Masyarakat Unsyiah, 1*(2), 1–7.

Firdaus, N. (2015). *Hubungan karakteristik responden dan kadar timbal (Pb) dalam darah dengan kelelahan kerja pada operator SPBU* (Skripsi). Universitas Jember.

Hasan, W., Matondang, A. R., Syahrin, A., & Wahyuni, C. U. (2012). Pengaruh jenis kelamin dan kebiasaan merokok terhadap kadar timbal darah. *Jurnal Kesehatan Masyarakat Nasional, 8*(4), 166–167.

Kementerian Kesehatan Republik Indonesia. (2002). *Keputusan Menteri Kesehatan Republik Indonesia Nomor 1406/MENKES/SK/XI/2002 tentang standar pemeriksaan kadar timah hitam pada spesimen biomarker*. Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan Republik Indonesia. (2012). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 37 Tahun 2012 tentang pelayanan laboratorium puskesmas*. Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan Republik Indonesia. (2013). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 43 Tahun 2013 tentang penyelenggaraan laboratorium klinik yang baik*. Kementerian Kesehatan Republik Indonesia.

Mulyana. (2012). *Efek dan biomarker pajanan timbal*. PT Prodia Widyahusada.

Notoatmodjo, S. (2012). *Metodologi penelitian kesehatan* (hlm. 50). Rineka Cipta.

Palar, H. (2012). *Pencemaran dan toksikologi logam berat*. Rineka Cipta.

Rahmadani, P. (2018). *Analisis paparan dan kadar timbal (Pb) dalam darah pekerja bengkel kendaraan bermotor roda dua di Kota Medan tahun 2017* (Skripsi). Universitas Sumatera Utara.

Rahayu, M., & Solihat, M. F. (2018). *Bahan ajar teknologi laboratorium medis (TLM): Toksikologi klinik* (hlm. 270–289). BPPPSDMK Kementerian Kesehatan Republik Indonesia.

Reffiane, F., Mohammad, N. A., & Santoso, B. (2017). Dampak kandungan timbal (Pb) dalam udara terhadap anak sekolah dasar. *Majalah Ilmiah Pendidikan Dasar, 1*(2), 96.

Rustanti, I., & Mahawati, E. (2011). Faktor-faktor yang berhubungan dengan kadar timbal (Pb) dalam darah pada sopir angkutan umum jurusan Karang Ayu–Penggaron di Kota Semarang. *Jurnal VISIKES, 10*(1), 60–61.

Saftro, A. S. M. (2012). *Darah*. Pustaka Pelajar.

Sastroasmoro, S., & Ismael, S. (2011). *Dasar-dasar metodologi penelitian klinis*. CV Sagung Seto.

Sembel, D. T. (2015). *Toksikologi lingkungan: Dampak pencemaran dari berbagai bahan kimia dalam kehidupan sehari-hari* (hlm. 105–111). Andi Offset.

Soerdarto. (2013). *Lingkungan dan kesehatan*. CV Sagung Seto.

Subhaktiyasa, P. G. (2024). *Menentukan populasi dan sampel : Pendekatan metodologi penelitian kuantitatif dan kualitatif.* Jurnal Ilmiah Profesi Pendidikan, 9(4), 2721–2731. https://doi.org/10.29303/jipp.v9i4.2657

Yoga, A. J. (2013). *Perencanaan sistem inventory motor pada CV Surya Jaya Jepara*.