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## Original article:

# Elevated Blood Lead Level Alters the Liver and Kidney Function Tests of Spray Painters

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**Abstract:**

**Background:** The color pigments contain the lead and earlier lead was added in color paints, due to its anticorrosive properties.

**Aims and Objectives:**To perceive the present scenario of blood lead level and its effects on liver and kidney function test of spray painters.

**Material and Methods:** 42 spray painters and 50 control subjects were included from Western Maharashtra, India. Blood lead level was estimated using lead Care II blood lead analyzer and liver and kidney function tests were measured by standard methods

**Results:** Blood lead level (P<0.001, 458%), serum alanine transaminase (P<0.001, 50.50 %), serum aspartate transaminase (P<0.001, 25.70%), serum bilirubin (P<0.05, 24.53%), serum alkaline phosphatase (P<0.05, 30.60%), blood urea (P<0.01, 14.63%), serum creatinine (P<0.001, 23.47%), serum uric acid (P<0.001, 21.99%) and albumin/globulin ratio (P<0.001, 11.51%) were significantly increased while serum total protein (P<0.001, -9.24 %), albumin (P<0.05, -3.46%) were significantly decreased in spray painters as compared to healthy control subjects**.**

**Conclusions:**Increased blood lead level clearly indicates the more absorption of lead in spray painters of Western Maharashtra, which may impair the liver and kidney function tests. Therefore, it is very indispensable to reduce the lead absorption by using protective measures such as apron, mask, and goggles. Also the regular monitoring of blood lead level, liver, and kidney function tests may prevent the sever health hazards caused by lead.

**Key Words:**Alanine Transaminase, Aspartate Transaminase, Alkaline Phosphatase, Bilirubin, BloodLead Level, Blood Urea, Spray Painters

## Introduction:

Lead is an everywhere, multipurpose metal that has been used since ancient times due to its superb properties such as it is soft, silvery grey metal, highly resistant to corrosion, pliable, having high density, low elasticity, high thermal expansion, low melting point, melting at 327.5°C, easy workability, easily recycled, excellent antifriction metal, and inexpensive. It has become widely dispersed and mobilized in the environment; therefore, the human exposure and uptake of this element have consequently elevated since the last 20 decades (1). Elevated blood lead level affects almost all systems, it is

not sparing single organs or systems. Mainly it alters the normal function of liver, kidney, gut, myocardium, immune system, peripheral, and central nervous. Even at low blood lead levels it affects the heme synthesis and other biochemical processes (2-4). The first occupational exposure lead poisoning cases were reported in 370 BC (5). In the 19th and 20th centuries, it becomes more common when workers were exposed to lead via various industrial activities such as smelting, painting, plumbing, and printing. Lead enters our body mostly through the respiratory and gastrointestinal (GI) tracts. Around 30 to 40 % of inhaled lead is absorbed into the blood stream (6). Blood lead level < 10µg/dl is considered as normal in case of an adult, however in case of children even below10 µg/dl reduces intellectual quotient, impairs hearing, and decreases growth. Blood lead level is the principal marker of lead exposure. More than 95% of blood lead is present in the erythrocytes and seems to be in dynamic equilibrium with plasma lead (7). During increased absorption, it is distributed to the liver and kidneys and then accumulate in the bones and mostly damage all the organs including liver and kidney (8).

Earlier lead was added in paints, for fast drying, enhance durability, maintain a fresh appearance, and prevent corrosion. Mainly lead chromate [PbCrO4 (chrome yellow)] and lead carbonate [PbCO3 (white lead)] was used in paints (9).

To produce yellow, orange, red and green paints the Lead chromates are mainly used and for painting the vehicles the lead carbonate is used, however, it is widely replaced by Titanium oxide and Barium –Zinc Sulfur combinations. For corrosion protection in various industries mainly red lead i.e. lead oxide with 4 oxygens and bright orange color and blue lead i.e. lead sulfate with lead oxide, zinc oxide, and carbon are used in color pigments. An exterior primer the lead flakes and as a drier in paints the lead oleate is commonly used (9).

Less lead contains paints that are white, blue, and brown-red, while green, orange, red, and yellow paints contain more lead (10). The yellow paints have the highest lead concentrations (200,000 ppm) as compared to others and next highest amount of lead were present in yellow-derivative paints i.e. green and brown (11).

In many oil-based paints the lead content was observed to be high up to 140,000 ppm. Lead levels of 83.87 % of the enamel paints were observed to be > 1000 ppm and 61.3% of samples had >5000 ppm reported by Toxics Link in India(9).

Forty percent lead was added in all paints before the 1960s. However, the addition of lead in paints was banned in USA 1976 and in India 1984. Now day's household paints contain less than 0.06% lead (600ppm). In Western Maharashtra the automobile body repair shops are generally small-sized and few workers are mainly involved in repairing and painting the damaged vehicle body. During the spray painting lot of lead contain paint disseminated in the workplace. The spray painters are not using any protective measures, like breathing masks, apron, goggles during painting the vehicle, and mainly this works is conducted in an open place.

Increased environmental lead levels enhance the absorption of lead in spray painters mainly through the inhalation of fine lead dust or through the skin. Also it may be through contamination of food with lead dust and such food taken at the workplace by the workers (12).

Increased blood lead level alters the normal functions of all organs, both in adults and children. Lead mainly affects the nervous system, it causes weakness in fingers, wrists or ankles, increases blood pressure, and anemia. At high levels lead exposure, it severely damages the kidneys, brain and affects the cardiovascular and reproduction system, haem synthesis, acceleration of skeletal maturation; alteration of hormone levels, and immunity. Lead induces oxidative stress and alters the antioxidant status (13).

Therefore, we have intended this study to know the blood lead levels of spray painters and its effects on mainly liver and kidney function tests.

**Material and Methods:**

For this interventional study 42 spray painters and 50 normal healthy subjects were included from Western Maharashtra, India (95 % Confidence Interval (CI) and 90% power of

study). Study and control group subjects taking drugs for major illnesses were excluded from the study. The age range of the subjects under study was 20 to 50 years and age-matched control subjects were selected from the same area. Before the biological specimen collection, written consent was obtained from both the groups. This research study was carried out at Krishna Institute of Medical Sciences "Deemed To Be University" Karad and research protocol was accepted by the institutional ethical committee (Ref. No. KIMSDU/IEC/03/2016, Dated 8/11/2016, Protocol No. 2016-2017/07) and maximum care was taken throughout the experimental procedure as per 1964 Helsinki declaration (14). Blood samples from study and control group subjects were collected into CBC tubes.

The blood lead level was measured by using a blood lead analyzer (Lead Care II, Magellan Diagnostics Company, USA). This blood lead analyzer is based on an electrochemical technique called Anodic Stripping Voltammetry (ASV) to determine the amount of lead in a blood sample. The blood was mixed with lead care treatment reagent [0.34 M - dilute hydrochloric acid solution in water], which lyses the red blood cells and release the lead. A negative potential was applied to the sensor to accumulate lead atoms on the test electrode. The potential is rapidly reversed releasing the lead ions. The current produced was directly proportional to the amount of lead in the sample (15).

Liver and kidney function tests were estimated by using EM360 – Transasia fully automated biochemistry analyzer. Serum ALT and AST transaminases activity were estimated by the UV-kinetic method using M/S Accurex Biomedical reagents (16). Serum total protein was estimated by the Biuret method (17)and serum albumin concentration was measured by the BCG method (18). Serum total bilirubin was estimated by diazo method (19). Serum alkaline phosphatase (ALP) was measured byusing a 2-Amino-2-Methyl-1-Propanol (AMP) method (20). Blood urea was measured by Glutamate Dehydrogenase (GLDH) method (21). Serum uric acid was measured by Uricase -Peroxidase (POD) method (22). Serum creatinine was estimated by Jaffes method (23).

**Statistical Analysis:**

Statistical comparison between blood lead levels, liver and kidney function tests of healthy controls and spray painters were done by Student's t-test using Instat GraphPad software.

**Results:**

Blood lead level (P<0.001, 458%), serum alanine transaminase (P<0.001, 50.50 %), serum aspartate transaminase (P<0.001, 25.70%), serum bilirubin (P<0.05, 24.53%), serum alkaline phosphatase (P<0.05, 30.60%), blood urea (P<0.01, 14.63%), serum creatinine (P<0.001, 23.47%) and serum uric acid (P<0.001, 21.99%) and albumin/globulin ratio (P<0.001, 11.51%) were significantly increased while serum total protein (P<0.001, -9.24 %), albumin (P<0.05, -3.46%) were significantly decreased in spray painters as compared to healthy control subjects.

**Table1. Blood Lead Levels and Liver and Kidney Function Tests of Spray Paintersand Normal Healthy Control Subjects**

| | Biochemical Parameters | Control Group (N= 50) | Spray Painters (N= 42) |
|---|---|---|---|
| **A** | Blood Lead (µg/dl) | 5.46 ± 2.58 (3.3 – 11.9) | 30.5±12.2 *** (12.8-63) |
| **B.Liver Function Tests** | | | |
| 1. | AST (U/L) | 27.5± 8.04 (16 - 49) | 34.57±11.6*** (19-56) |
| 2. | ALT (U/L) | 28.87 ± 9.1 (10 - 44) | 43.45±7.57*** (24 - 56) |
| 3. | Total Proteins (gm/dl) | 8.12 ± 0.69 (6.7 – 9.5) | 7.37 ± 0.39*** (6.4 - 8.4) |
| 4. | Albumin (gm/dl) | 4.62 ± 0.38 (3.8 - 5.2) | 4.46 ± 0.23* (4.1 - 4.9) |
| 5. | Globulin (gm/dl) | 3.5 ± 0.7 (1.9- 4.8) | 2.9 ± 0.39*** (2.2 - 4.09) |
| 6. | Albumin/Globulin Ratio | 1.39 ± 0.41 (0.84 - 2.58) | 1.55 ± 0.24*** (1.04 - 2.18) |
| 7. | Bilirubin (mg/dl) | 0.53 ± 0.2 (0.2 -1.0) | 0.66 ± 0.33* (0.35 - 1.8) |

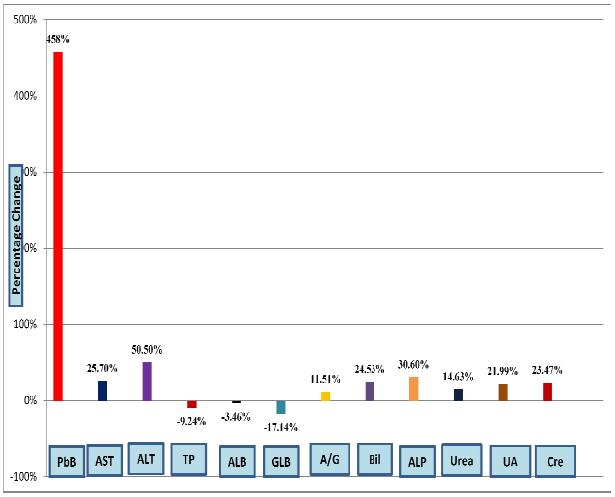
| | | | |
|---|---|---|---|
| 8. | ALP (IU/L) | 63.4±21.08 (32-113) | 74.5±18.9* (38-122) |
| **C. Kidney Function Tests** | | | |
| 1. | Urea (mg/dl) | 20.5 ± 4.78 (15-35) | 23.5 ± 5.33** (15-36) |
| 2. | Uric acid (mg/dl) | 5.41 ± 1.03 (3.1 - 8) | 6.6 ± 2*** (3.7 - 12) |
| 3. | Creatinine (mg/dl) | 0.98 ± 0.17 (0.3 - 1.3) | 1.21± 0.26*** (0.7 -1.5) |

AST- Aspartate Transaminase, ALT- Alanine Transaminase, ALP- Alkaline Phosphatase

Figures indicate Mean ± SD values and those in parenthesis are the minimum to maximum range of values of the specific group.

*P< 0.05, ** P< 0.01, *** P< 0.001, #Non-significant as compared with controls [Student's t-test].

**Figure 1: Percentage Change of Blood lead Levels, Liver and Kidney Function Tests of Spray Painters (SP) with Respect to Control Subjects**




**PbB-** Blood lead**, ALT**-Alanine Transaminase, **AST**-Aspartate Transaminase, **TP**- Total Proteins,**Alb**-Albumin,

**Glb**-Globulin, **A/G**-Albumin /Globulin Ratio, **TBil**-Total Bilirubin, **ALP**-Alkaline Phosphatase,

**BUL**-Blood Urea Level, **Creat**-Creatinine,**UA**-Uric Acid.

**Discussion:**

Blood lead (PbB) level was found to be significantly elevated (p<0.001, 458%) in spray painters as compared to healthy control subjects, indicating increased absorption of lead in spray painters. The majority of spray painters were mostly painting large vehicles such as buses, trucks, tractors and they were doing painting work constantly more than 12 hours. For painting these vehicles mainly red, brown, yellow, green, orange, and red oxides colors were used and these paints contain more lead concentrations (10). The highest lead levels (200,000 ppm) present in yellow paints as compared to others and the next highest amount of lead were present in yellow-derivative paints such as green and brown (11).

Spray painters were not using any safety measures, while spraying the paints; they were not using any breathing masks, apron, goggle, chewing tobacco during work without washing hands, etc. As automobile paints sprayed the metal present in paints dispersed and suspended more time in the environment, which enhance the absorption of lead mainly through respiration and skin.

Alanine transaminase (P<0.001, 50.50 %), aspartate transaminase (P<0.001, 25.70%) and serum alkaline phosphatase (P<0.05, 30.60%) levels were significantly elevated in spray painters as compared to healthy control subjects, indicates the small change in liver functions. An elevated level of these transaminases in spray painters suggests necrosis of the hepatic cell by lead or solvent used for painting and these might induce hepatocellular injury. An elevated level of transaminase liver enzymes than controls in the chronic lead-exposed workers was reported in the previous study [24]. Elevated alkaline phosphatase levels may be a sign of space-occupying lesions in the liver.

A little decreased serum total proteins (P<0.001, -9.24%), albumin (P<0.05, -3.46%) and slightly increased albumin/globulin ratio (P<0.001, 11.51%) were found in spray painters as compared to healthy control subjects. Declined level of serum total proteins and albumin may be due to the elevated blood lead level in spray painters. An elevated blood lead level reduces the synthesis of plasma proteins mainly albumin

was reported in several previous studies (25, 26). Therefore, regular estimation of total protein is useful to know the impairment of liver functions in lead exposure workers.

Serum total bilirubin level ($p<0.05$, 24.53%) significantly elevated in spray painters as compared to the healthy control subjects, which may be due to the elevated blood lead level. Serum bilirubin level was significantly increased in lead-exposed populations were reported in earlier studies (27-33). Serum bilirubin levels ranging from 1.5 to 2.5 mg/dl were common in lead poisoning cases. Increased Lead level in red blood cell causes hemolysis and resulting hemolytic jaundice and increased serum unconjugated bilirubin is well documented in previous studies (27-33). In *vitro* study, the administrations of a large dose of lead creates morphological changes and destruction of red cells and increases the rate of breakdown of RBC (34). From the previous study (25)and the present study it can be speculated that the slightly increased serum bilirubin level in spray painters as compared to healthy control group might be due to elevated blood lead level.

The blood urea level ($P<0.01$, 14.63%), serum creatinine ($P<0.001$, 23.47%) and serum uric acid ($P<0.001$, 21.99%) were significantly elevated in spray painters as compared to the healthy control group, which might be due to high blood lead level and these results are also consistent with earlier reports in the literature (35, 36). The previous study showed that the increased re-absorption of uric acid from the renal tubular cells results in gout which is a metabolic complication of lead-induced renal impairment (37). More lead exposure results in the impairment of renal functions reported in earlier study (38).

In spray painters the alterations of liver and kidney function tests, might be due to elevated blood lead levels. Therefore, it is very essential to guard these spray painters against the health hazards of occupational lead exposure by giving the training for appropriate use and application of personal protection devices. Also these spray painters should be screen regularly to know their blood lead levels.

**Conclusiones:**

Elevated blood lead level in spray painters of Western Maharashtra (India), indicating the more absorption of lead, which alters the liver and kidney function tests.

**Recomendaciones:**

The regular monitoring of blood lead level, liver and kidney function tests may prevent the severe health hazards caused by lead.

**Study limitations:**

Sample size of this study is small.

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