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# Correlation of TSB and Urea with Pb, Na and Mg in Workers of Fuel Station

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**Abstract**

Petrol, manufactured from crude oil, is a primary pathway of exposure to polycyclic aromatic hydrocarbons (PAHs). Among hazardous substances related to fuel-associated occupational exposure, benzene, being a natural component of crude oil and a byproduct from petrol refining, is classified as having one of the highest risks. The aim of this study was to compare serum levels of total serum bilirubin (TSB), urea, sodium (Na), magnesium (Mg), and lead (Pb) between fuel station workers and a control group of non-exposed individuals.

In this study, a total of 60 male fuel station workers and 30 male controls were recruited from Al-Najaf City, Iraq. Serum levels of urea, TSB, Na, and Mg were measured using spectrophotometric methods with commercially available diagnostic kits. Serum lead (Pb) concentrations were measured with flame atomic absorption spectrophotometry.

The results show that serum TSB and Pb levels were significantly higher among fuel station workers than in controls ($p < 0.001$, each). Conversely, serum levels of urea ($p < 0.001$) and sodium ($p = 0.021$) were significantly lower in the workers' group. No statistically significant difference was observed in serum magnesium levels between the two groups.

Correlation analysis in the workers' group showed a statistically significant negative correlation between urea and TSB ($r = -0.446$) and a statistically significant positive correlation between urea and Pb ($r = 0.578$). In addition, TSB correlated significantly and positively with Pb ($r = 0.538$, $p < 0.01$) and negatively with Na ($r = -0.264$, $p < 0.05$). Pb levels were negatively correlated with Na levels ($r = -0.360$, $p < 0.01$).

***Keywords:*** Liver, Kidney, Workers of Fuel Station, Pb, Na, TSB, Urea.

## علاقة البيليروبين الكلي بالدم واليوريا مع الرصاص والصوديوم والمغنيسيوم لدى عمال محطات الوقود

**الخلاصة:**

يُعد البترول، المشتق من الزيوت الخام، مصدرًا مهمًا للهيدروكربونات العطرية متعددة الحلقات، حيث يُعد البنزين مكونًا طبيعيًا للنفط الخام ومنتجًا ثانويًا لتكرير البترول. تهدف هذه الدراسة إلى مقارنة مستويات البيليروبين الكلي في المصل (TSB) واليوريا والصوديوم (Na)

والمغنيسيوم (Mg) والرصاص (Pb) في مصل الدم لدى عمال محطات الوقود مقابل مجموعة ضابطة من غير العمال. شارك في هذه الدراسة ستون عاملًا و30 ضابطًا من محطات الوقود في مدينة النجف بالعراق. تم قياس مستويات اليوريا و TSBوالصوديوم والمغنيسيوم في مصل الدم باستخدام مطياف ضوئي باستخدام أدوات متوفرة تجاريًا، بينما تم تحديد مستويات الرصاص باستخدام مطياف الامتصاص الذري باللهب.
أظهرت النتائج تركيزات مصل الدم من TSB والرصاص أعلى بكثير لدى العمال (p < 0.001) مقارنة بمجموعة الضابطة. وعلى العكس من ذلك، كانت تركيزات اليوريا في مصل الدم (p < 0.001) والصوديوم (p = 0.021) أقل بكثير لدى العمال. لم يتم ملاحظة أي فرق كبير في مستويات المغنيسيوم في المصل بين المجموعتين.
وُجد ارتباطٌ ذو دلالة إحصائية بين اليوريا و (r=-0.446) TSBوالرصاص (r=0.578) في مجموعة العمال. توجد لدى مجموعة العمال ارتباطٌ ذو دلالة إحصائية بين TSB والرصاص (r=0.538**) والصوديوم (r=-264*) في مجموعة العمال، يوجد ارتباطٌ ذو دلالة إحصائية بين الرصاص والصوديوم .(r=-0.360**).

## 1. Introduction

Fuel stations are attendants to numerous risks. The environment of fuel stations exposes gas hazards, which should be considered harmful to the health status of these workers. Among the risks are contact with fuels and other Chemical products, remaining close to fuel pumps, noise, heat, cold, risk of being run over, and repetitive performed functions [1].

There are chemical products to which these workers are exposed, such as aromatic hydrocarbons, benzene, toluene and xylene (BTX) components of gasoline and chemical solvents [2]. The Chemical agent benzene, which poses a high risk to human health, even in small amounts, is a colourless, volatile, soluble, flammable liquid with high carcinogenic potential.

It is present in the air through cigarette smoke, gasoline and emissions from automotive engines, gas stations, and chemical industries, among others [3]. Automobiles are considered to be the main source of benzene. Therefore, we note the continuous exposure of individuals working at gas stations work hours [4].

Gasoline is an Ignitable liquid that may or may not be employed to initiate or propagate the spread of a fire. The American Society for Testing and Materials (ASTM) has a classification scheme for ignitable liquids including compositional carbon ranges and common peaks observed for each [5].

All frequently used ignitable liquids possess similar chemical properties but differ in the boiling point ranges of their components, These differences affect volatility and can cause different components of each ignitable liquid to evaporate at various rates from the sample [6]. Ignitable liquids employed to initiate fires include gasoline, diesel fuels, charcoal lighter fluids, paint thinners and alcohols [7].

Gasoline primarily consists of hydrocarbons, as well as additives and blending agents that are added to improve the performance and stability of gasoline [8].

ASTM guidelines note that commercial gasoline is a medium-range distillate derived from petroleum typically containing a mixture of hundreds of hydrocarbons ranging from C4 to C12 and containing as many as thousands of hydrocarbons have been reported to be detected in gasoline [9]. Gasoline components include various aliphatic (straight-chain) hydrocarbons, paraffin, olefins, benzenes and aromatic hydrocarbons including toluene, xylene and a large number of volatile compounds with boiling points <80°C [10].

Over 300 different hydrocarbon molecules used in gasoline were observed to have boiling points ranging from 40°C to 190°C, showing that many components are highly volatile. Further classifications of the individual include the length of the carbon chain backbone, the extent of branching, and the isotopes of carbon atoms [4].

Gasoline is used in the world has been used for several purposes, such as a cleaner solvent, automotive fuel, ingredients in paints and various other applications. It is a mixture of petroleum hydrocarbons with a variety of volatile organic compounds [11].

The routes of exposure to gasoline components include inhalation [12]. There are different gasoline vapour exposure scenarios that humans can experience. The public can be exposed to gasoline components (e.g. benzene) via inhalation of the air that is emitted from various sources such as industrial activities, traffic, and via releases during refueling [13].

The benzene urinary biomarker, S-phenylmercuric acid was found to occur in higher concentrations in the urine of those people who worked partly outdoors [14]. An investigation in 2004-2006 suggested that exposures to elevated VOCs air pollution particularly benzene and ethylbenzene in urban villages a cancer risk. Other non-cancer neurological and respiratory effects have also been attributed to BTX levels that exceeded the United States Environmental Protection Agency benchmarking [15]. Traffic police officers and municipal employees are examples of people occupationally exposed to gasoline during their daily tasks, especially near heavy traffic. In contrast, petrol station attendants were found to exceed the exposure levels of these two other professions [16].

## 2. Materials and Methods

**A. Patients:** Blood samples were collected from 60 male workers employed at fuel filling stations. The participants had an average age of 36.45 ± 7.10 years. Informed consent was obtained from all participants, and the questionnaires were accurately completed. Only candidates who met the inclusion criteria were enrolled in the study. Samples were collected from fuel stations located in Najaf City, Iraq.

**B. Controls:** A control group consisting of thirty healthy adults was selected, with an age range comparable to that of the workers (35.00 ± 8.04 years).

**C. Exclusion Criteria:** Participants with chronic hypertension, diabetes mellitus, autoimmune diseases, or renal disorders were excluded from the study.

### 2.1. Measurements:

Five milliliters of venous blood were collected from each patient and control. The samples were left at room temperature until they completely clot, after which they were centrifuged at 3000 rpm for 5 minutes. The serum was then separated and transferred into three new disposable tubes, which were stored at -20 ºC until analysis. The serum lead (Pb) level was measured using flame atomic absorption spectrophotometry. Serum levels of total serum bilirubin (TSB), urea, sodium (Na), and magnesium (Mg) were analyzed using a spectrophotometric kit provided by Elabscience Co., USA.

### 2.2. Statistical Analysis

The distribution types of the variable results were assessed using the Kolmogorov-Smirnov test. Normally distributed parameters were presented as mean ± standard deviation. A pooled t-test was used to compare the patient and control groups. Pearson's correlation coefficients (r) were calculated to evaluate the relationships between parameters. A difference between groups was considered statistically significant when $p < 0.05$. All statistical analyses were conducted using SPSS Statistics version 21 (2013), IBM-USA, while the figures were created using Microsoft Excel 2010.

## 3. Results and Discussion

### 3.1. Comparison between workers and control

The comparison between workers and the control group is cited in Table (1).

**Table (1):** Comparison between workers and control group

| Parameter | Control | workers | F | df | p-value |
|---|---|---|---|---|---|
| Age (years) | 35±8.04 | 36.45±7.10 | 0.598 | 1/88 | 0.361 |
| Weight (Kg) | 77.17±12.01 | 76.50±10.61 | 3.17 | 1/88 | 0.511 |
| Height (cm) | 170.53±7.87 | 164.37±18.09 | 4.66 | 1/88 | 0.055 |
| BMI | 26.11±2.73 | 28.01±2.01 | 0.674 | 1/88 | 0.279 |
| TSB (mg/dl) | 0.60±0.28 | 0.70 ± 0.20 | 49.804 | 1/88 | <0.001 |
| Urea (mg/dl) | 35 ±1.80 | 32 ±6.72 | 43.741 | 1/88 | <0.001 |
| Na (mM) | 144±2.82 | 140±5.66 | 18.511 | 1/88 | 0.021 |
| Mg (mg/dl) | 2.28±0.23 | 2.11±0.27 | 0.185 | 1/88 | 0.588 |
| Pb (µg/l) | 77.97±8.26 | 136.82±17.97 | 295.654 | 1/88 | <0.001 |

Results are expressed as mean±standard deviation for normally distributed data. Binomial data were expressed as ratios and analyzed by the Chi-squared test. BMI: body mass index.

Significant differences ($p < 0.001$) were observed in total serum bilirubin (TSB) levels between workers (0.76 ± 0.10 mg/dl) and the control group (0.60 ± 0.60 mg/dl). A longitudinal study found a notable negative correlation between baseline bilirubin levels, the incidence of coronary heart disease, and cardiovascular disease mortality [17].

Another study showed a negative correlation between total bilirubin levels and the risk of cardiovascular diseases (CVD), independent of other risk factors [18]. Incorporating total bilirubin into the standard panel of established risk factors did not lead to a significant enhancement in predicting cardiovascular disease (CVD) risk. A large prospective study conducted in Korea found that higher baseline bilirubin levels within the normal range were linked to a reduced risk of lung cancer. Conversely, both smoking and low bilirubin levels have been cumulatively associated with an increased risk of lung cancer [19]. Additionally, bilirubin levels showed a negative correlation with smoking history, duration, and intensity, indicating a potential role of inhaled tobacco in the development of lung function decline associated with oxidative stress [20].

There are significant differences ($p<0.001$) in the level of Urea between workers (33 ±2.72 mg/dl) and the control group (36 ±1.80 mg/dl), indicates that the difference observed is very unlikely to have occurred by chance, suggesting strong evidence against the null hypothesis.

There are significant differences (0.021) in the level of Na between workers (140±5.66 mM) and the control group (144±2.82 mM). When workers have increased total body sodium, an excessive amount of fluid is retained in the interstitial space, causing the animal to appear overhydrated, regardless of the plasma sodium levels. Animals that are overhydrated may show signs such as a gelatinous subcutaneous layer, peripheral or ventral pitting edema, chemosis, or an increased watery nasal discharge [21].

Pb is the most prevalent environmental nephrotoxin, and exposure can induce oxidative stress in tubular and glomerular cells, resulting in the formation of free radicals. This may contribute to cellular apoptosis and subsequent alterations in renal structure and function [22]. Acute Pb toxicity, characterized by blood Pb levels exceeding 80–100 μg/dL, has been associated with proximal tubular injury. This damage may arise from cytoplasmic, mitochondrial, and intranuclear inclusion bodies formed by Pb-protein complexes. Clinical manifestations include glucosuria, aminoaciduria, phosphaturia, and Fanconi syndrome [23]. Chronic Pb poisoning (blood Pb level > 60 μg/dL) has been reported to cause Pb nephropathy, which is characterized by glomerular sclerosis, tubular atrophy, tubulointerstitial fibrosis, and finally reduced *glomerular filtration rate* [24]. In addition, chronic low Pb exposure (blood Pb level < 5-10 mg/dL) has been reported to potentially contribute to the development of Chronic Kidney Disease and the progression of established [25].

### 3.2. Correlations Study

Table (2) presents the correlation coefficients and highlights the statistically significant relationships between the investigated parameters.

**Table (2):** Correlations between workers and control group

| | Age | BMI | Urea | TSB | Pb | Na | Mg | weight | higher |
|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | -0.091 | -0.123 | 0.042 | 0.040 | -0.162 | -0.079 | -0.072 | 0.023 |
| BMI | -0.091 | 1 | -0.118 | 0.060 | 0.071 | -0.005 | -0.273** | 0.292** | -0.625** |
| Urea | -0.123 | -0.118 | 1 | -0.446** | -0.578** | 0.183 | -0.078 | -0.003 | 0.118 |
| TSB | 0.042 | 0.060 | -0.446** | 1 | 0.538** | -0.264* | 0.114 | 0.027 | -0.029 |
| Pb | 0.040 | 0.071 | -0.578** | 0.538** | 1 | -0.360** | -0.049 | -0.134 | -0.185 |
| Na | -0.162 | -0.005 | 0.183 | -0.264* | -.0360** | 1 | -0.085 | 0.066 | 0.045 |
| Mg | -0.079 | -0.273** | -0.078 | 0.114 | -0.049 | -0.085 | 1 | 0.000 | 0.239* |
| weight | -0.072 | 0.292** | -0.003 | 0.027 | -0.134 | 0.066 | 0.000 | 1 | 0.543** |
| Higher | 0.023 | -0.625** | 0.118 | -0.029 | -0.185 | 0.045 | 0.239* | 0.543** | 1 |

**Correlation is significant at the 0.05 level (2-tailed).*
***Correlation is significant at the 0.01 level (2-tailed).*

There is significant correlation between BMI with Mg (r =-0.273), weight (r =0.292) and higher (r =-0.625) in workers group.

Magnesium is the second most abundant (after potassium) intracellular cation and is the fourth most abundant cation of the human body. Approximately half of the magnesium is found in the bones and half in the soft tissue. <1% of the total body magnesium is found in the blood Normal serum magnesium level is 1.5–2.3 mg/dl or 0.62–0.95 mmol/L [26]. Magnesium exists in the serum in the three states. Evidence that magnesium is directly involved in body weight regulation is lacking. The mechanisms for an inverse association between magnesium intake and abdominal obesity are unclear. The objective of this study was to evaluate the correlation of serum magnesium with anthropometric parameters. They found that consuming less than the estimated average requirement for magnesium was associated with a significantly higher BMI [27].

There is a significant correlation between Urea and TSB (r = -0.446), as shown in Figure (1), and between Urea and Pb (r = 0.578), as shown in Figure (2), in the workers' group.

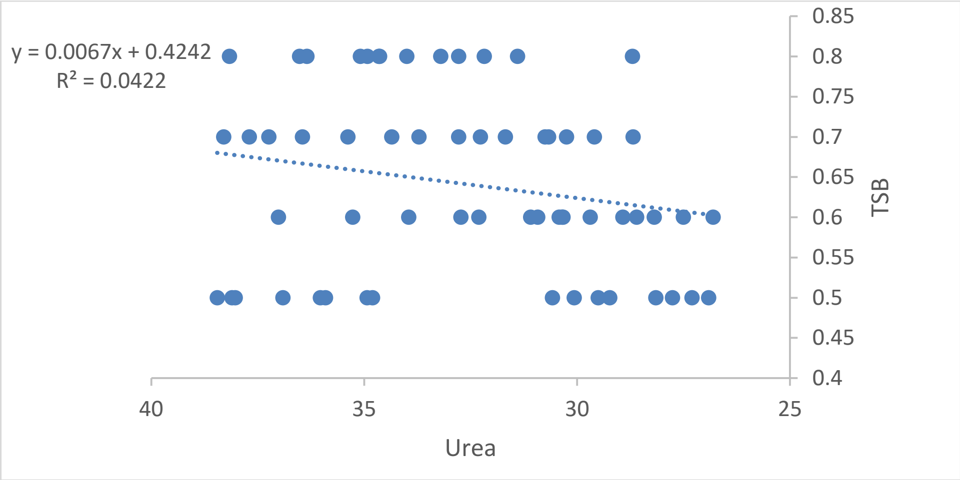


**Fig. (1):** Correlation between Urea & TSB in workers.

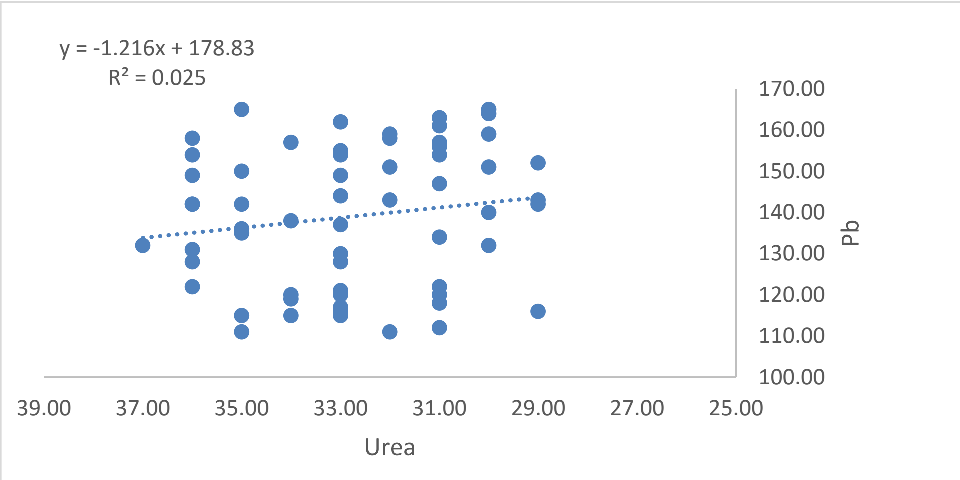


**Fig. (2):** Correlation between Urea & Pb in workers

Urea, commonly referred to as blood urea nitrogen (BUN) when measured in the blood, is a product of protein metabolism. BUN is considered a non-protein nitrogenous (NPN) waste product. Amino acids derived from the breakdown of protein are delaminated to produce ammonia [28].

There is a significant correlation between TSB and Pb (r = 0.538**), as shown in Figure (3), and between TSB and Na (r = -0.264*), as shown in Figure (4), in the workers' group.

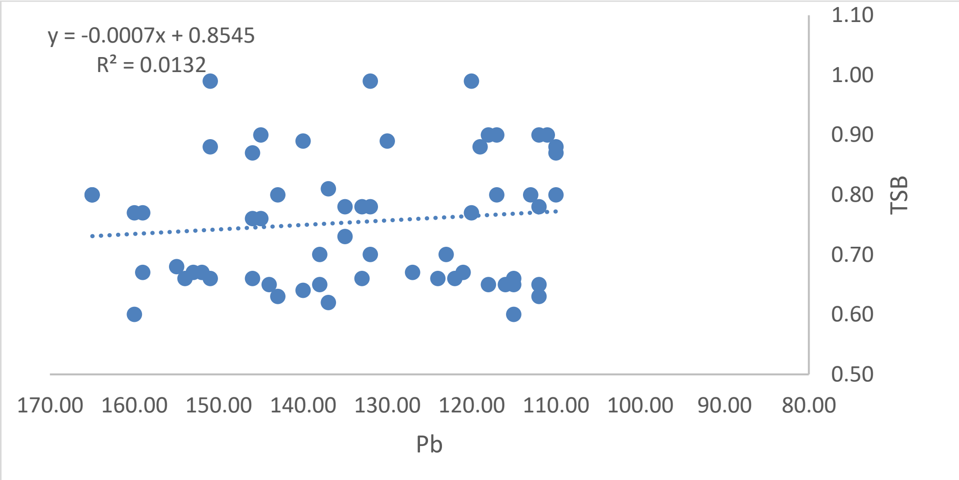


**Fig. (3):** Correlation between Pb & TSB in workers.

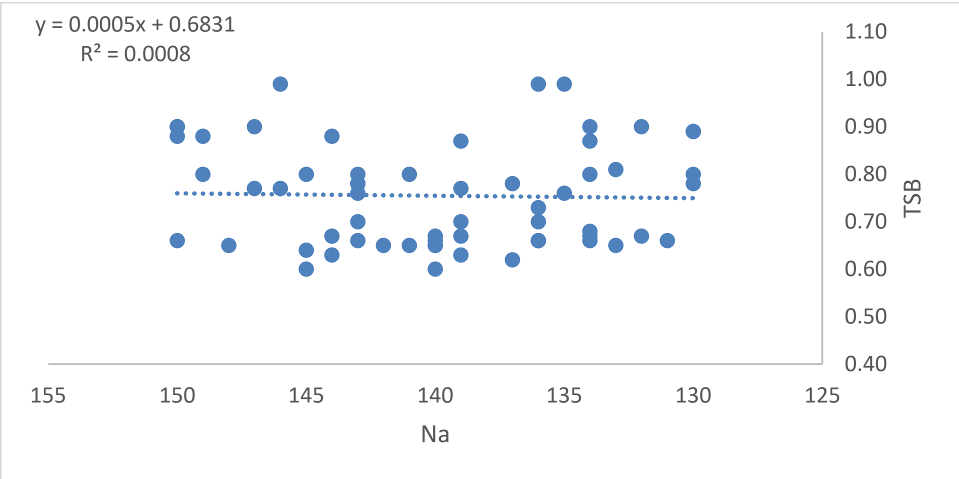


**Fig. (4):** Correlation between Na & TSB in workers.

Serum bilirubin has long been acknowledged as an indicator of liver dysfunction. Recent data strongly indicates that slightly increased serum total bilirubin concentration can be a potent biological protective marker. Heavy metal poisoning is caused by the accumulation of certain metals in the body due to exposure to food, water, industrial chemicals, or other sources. While your body needs small amounts of some heavy metals to function normally such as zinc, copper, chromium, iron, and manganese toxic amounts are harmful [29].

There is a significant negative correlation between Pb and Na (r = -0.360**), as shown in Figure (5), in the workers' group.

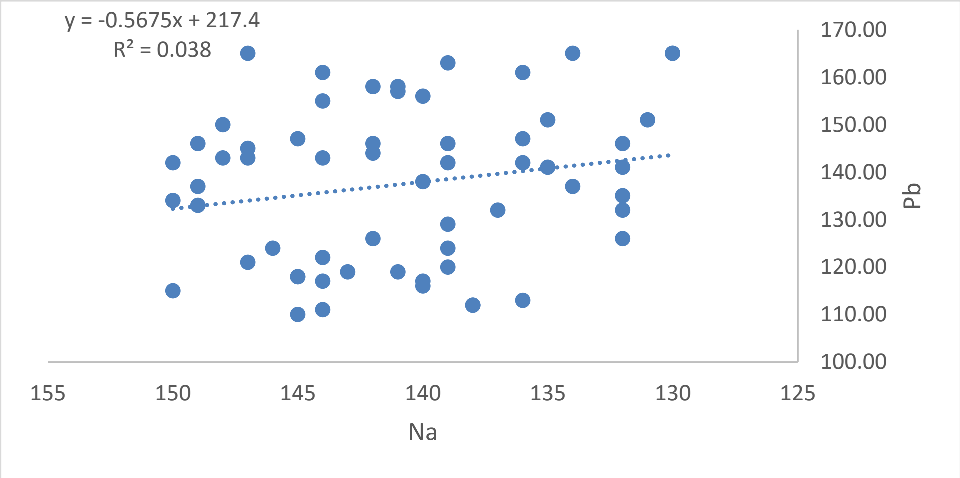


**Fig. (5):** Correlation between Na & Pb in workers.

A heavy metals panel is a group of tests that detects and measures specific potentially toxic metals in the blood, urine or, more rarely, in the hair or other body tissue or fluid. A laboratory may offer several different heavy metals panels as well as individual tests for metals. In hypernatremia, the level of sodium in the blood is too high. Hypernatremia involves dehydration, which can have many causes, including not drinking enough fluids, diarrhoea, kidney dysfunction, and diuretics [30]. There is a significant correlation between weight with higher (r =0.543**) in the worker's group. A positive correlation is a relationship between two variables in which both variables move in the same direction. Therefore, when one variable increases as the other variable increases or one variable decreases while the other decreases [31].

## 4. Conclusions

The current study shows a potential role of increased pollution in the health of workers' groups. The increase in serum TSB and Pb were associated with the workers in comparison with the control groups. Serum Na was increased with the control as compared with workers. While the reduction of Urea level was related to the workers, the estimate of parameters is important for workers to monitor their liver and kidney health of these workers.

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