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Biochemical Effects of Lead Toxicity on Serum Total Protein, Albumin and Globulin Levels in Occupationally Exposed Workers in Major Sudanese Cities

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***Abstract*- Exposure to air lead pollution represents a major potential health hazard for occupationally exposed workers. A total of 100 traffic policemen and petrol station workers (exposed group) was compared with 50 unexposed groups (control) with respect to lead toxicity on serum total protein, albumin and globulin levels. Blood lead concentration was determined by using atomic absorption spectrometer. Biochemical parameters were measured in serum using standard methods. Mean blood lead concentration in exposed group was found to be (32.2 µg /dl) compared to control (12.4µg/dl). Significant decrease in total protein, albumin and globulin levels was observed in exposed group in comparison to control. Result suggests that prolonged exposure to air lead pollution causes many severe health problems.**

***Keywords*- albumin, biochemical effects, globulin, lead pollution, total protein, traffic police**

I. INTRODUCTION

Metallic compounds on land and water pose potential health hazards to living things[14]. Lead dispersion in ambient air, in many foods, in drinking water, and in dust[15]. Its continued release into the environment as an exhaust emission product, as well as its widespread industrial use, has made lead a serious threat to human health[16]. Lead may be deposited in the red blood corpuscles, soft tissues of children mainly in the kidney region, but the greater concerning matter is that 70 to 90% of this lead is deposited in bones. This is the most hazardous because the half-life of lead in the bones is 28 years, whereas lead in the blood and kidneys remains only up to two to four weeks[11]. Lead poisoning is a medical condition also known as saturnism or plumbism which caused by occupational or environmental exposure to sources of lead[23]. Lead poisoning prevalence in the general adult population is unclear and especially children are at risk for impaired neurological development upon chronic exposure[4].

Even at low doses of developmental stages, lead exposure resulted in embryonic toxicity, behavioral alteration, learning/memory deficit[6]. Consistently, Gargouri *et al.*[9] studied the effect of lead acetate exposure in drinking water to mothers during gestation, from the 5th day of gestation to day 14 postpartum, revealing that caused lead deposition was found in the brain and cerebellum of newborns as well as cerebellum tissue damages and significant decrease in weight, protein content of these tissues, oxidative stress and changes in antioxidant enzyme activities in brain tissues were also recorded, lead acetate has been found to induce biochemical and histological abnormalities in blood, kidney, liver and brain tissues[21].

Albumin is the main protein in blood and is made by the liver; its normal range is 3.4 - 5.4 g/dl. It can be used as a supplementary test for hepatic biosynthetic functions. Increased albumin may be due to dehydration or improper use of protein whereas decreased levels are common in infections, liver diseases, ulcers and some kidney diseases[27]. Decreased levels of albumin affect the transportation of serum ions such as thyroid hormones. Globulin is one type of protective antibody produced by immune system that helps identify and fight infections. Increased globulin levels may be due to chronic inflammation, kidney infection, stress, liver diseases and parasite infestations[17] whereas decreased globulin may be due to anaemia, low hydrochloric acid and depressed immune systems[27]. The estimation of total proteins in the body is helpful in differentiating between a normal and damaged liver function as the majority of plasma proteins like albumins and globulins that are produced in the liver. Normal range of total protein is 6.0 to 8.3 g/dl. Total protein is often reduced slightly but the albumin to globulin ratio shows a sharp decline during hepatocellular injury[26].

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El-Nahal[8] concluded that many chelating agents are currently used to manage lead toxicity and the most common are nonspecific and have some adverse effects in humans, but pectins are both specific and effective in complexion with lead, and these compounds may be considered as nutritional products that could be used to decrease lead intestinal absorption, prevention of lead accumulation, and amelioration of lead toxicity. Traffic policemen and petrol station workers are more likely affected by air lead pollution[24]. Therefore, the objective of this study is to determine blood lead concentrations in traffic policemen and petrol station workers in main Sudanese cities and to estimate some biochemical parameters related to lead poisoning such as total protein, albumin and globulin.

II. Materials And Methods

Study area and sample size:

This study was conducted in different cities of Sudan (Abohamad, Marwy, Portsudan, kassalla, Wadmadany, Kostey, Gabalmarah, Alobed, Aldalang and Khartoum state). The samples size is 150 subjects (100 exposed taken from both petrol station workers and traffic policemen and 50 unexposed samples (control).

Study design:

A case – control study was conducted.

Sample collection:

A total of 150 blood samples were collected from petrol stations and traffic policemen. Four ml of venous blood was taken from each exposed and control groups, then kept in clean heparanized container and stored in a refrigerator bending analyses.

Lead extraction:

Lead was extracted from blood used NIOSH method, where two ml of blood was taken, then one ml of deionized water was added, half ml of ammonium pyrrolidine dithiocarbonate and half ml of triton was added, 0.75ml of methyl isobutyl ketene was added. The mixture was then rotated in centrifuge; the top layer which contains lead was observed[20].

Lead concentration determination:

Lead concentration was estimated by an atomic absorption spectrometer.

The biochemical measurements:

Determination of serum total protein:

The serum total protein concentration was determined using biuret reagent method as described by Cannon[5]. In which, in alkaline medium, the copper reacts with the peptide bonds of proteins to form the characteristic pink to purple biuret complex. Sodium Potassium tartarate prevents copper hydroxide precipitation, and potassium iodide prevents the autoreduction of copper.

$$\text{Protein } Cu^{2+} \xrightarrow{\text{Alkaline pH}} \text{Cu – protein coplex}$$

The color intensity is directly proportional to protein concentration. It is determined by measuring the increase in the absorbance at 546 nm.

Determination of serum albumin:

The serum albumin concentration was determined using modified bromocresol green colorimetric method as described by Doumas[7].Measurement of albumin is based on its binding to the indicator dye bromocresol green (BCG) in pH 4.1 to form a blue – green colored complex. The intensity of the blue – green colorist directly proportional to the concentration of albumin in the sample. It is determined by monitoring the increase in absorbance at 623 nm.

$$\text{Albumin + BCG} \xrightarrow{\text{pH 4.1}} \text{Albumin – BCG complex}$$

Globulin:

The globulin values were calculated by subtracting the values of albumin from the corresponding values of total protein[1].

Statistical analysis: T.test was applied for analysis of data, used statistical package for social science (SPSS).

III. Result And Descusion

The blood lead level in petrol station workers and traffic policemen (exposed group) and control (unexposed group) in different cities in Sudan is shown in figure (1). The mean blood lead level in exposed group was found to be 32.2 µg/dl while in control the mean was 12.4 µg/dl. The differences of serum lead concentrations between the two groups under study were found to be significant (P<0.001).

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The obtained result in this study agreed with those obtained by Zuhir[28] which was found the blood lead level ranged between 20 µg/dl to 88 µg/dl, and the mean was 33.5 µg/dl compared to other countries such as USA (10 µg/dl) and Germany (15 µg/dl), the biological standard of blood lead concentration ranged from 7 µg/dl to 22 µg/dl that set by NIOSH[20], therefore, there is a high level of blood lead in population of different cities in Sudan due to exposure of leaded gasoline.

Comparison between blood protein (total protein, albumin and globulin) concentration in petrol station workers and traffic policemen and control samples in different cities in Sudan is shown in table (1) and figures (2, 3 and 4). A student t. test in the present study exhibited a significant decrease in mean total protein (from 7.210 to 5.354), mean albumin (from 4.806 to 3.480) and mean globulin (from 2.404 to 1.862) in control group in comparison to exposed group, respectively. The differences of blood protein (total protein, albumin and globulin) sample concentrations between the two groups were found to be significant ($P<0.001$).

Analyses of blood protein among these exposed groups have strengthened the earlier findings of lowered levels of these parameters in health due to lead toxicity in experimental human and animal studies. A significant decrease in serum globulin level has also been reported in *Hymenolepis nana* mouse model treated with lead prior infection[2]. These results agreed with the study that conducted by Shalan *et al.*[25] who attributed this reduction to hepatic DNA and RNA disorders that caused by lead intoxication. Our results are also supported by a study of Mikhail *et al.*[19], who observed remarkable decrease in serum albumin and total protein levels, as well as a reversed albumin/globulin ratio in lead tank welders. However, on the other hand, Al-Neamy *et al.*[3] reported unchanged albumin and total protein levels in industrial workers exposed to lead. Ibrahim *et al.*[13] evaluated the effect of different doses of lead acetate on plasma protein profile and found that there was a significant reduction in total soluble protein and albumin, while plasma globulin value was insignificantly changed. Pachathundikandi and Varghese[22] reported that protein loss in lead toxicity might decrease the level of specific proteins such as albumin, hormones, hormone and metal binding proteins, drug binding proteins, enzymes etc. and thereby disturb the homeostasis and rate of metabolic activities. Mc-Lntire and Angle[18] attributed that the alterations in total soluble protein values were correlated with the changed albumin levels and these may be due to inhibition of albumin biosynthesis through specific enzymes in cell processes.

It was stated by Gourrier *et al.*[10] that serum total protein levels is a rough measure of protein status but reflects major functional changes in kidney and liver functions, and kidney is one of the main targets of lead poisoning and chronic poisoning can lead to kidney failure, while acute poisoning can lead to tubulopathy with Toni-Debre Fanconi syndrome.

IV. Conclusion And Recommendation

The results of this study revealed a prevalence of elevated blood lead level among lactated gasoline exposed, and it was found to be higher than the limit permitted by the World Health Organization. It was obvious decrease in serum total protein, albumin and globulin in traffic policemen and gasoline exposed professionals in comparison to control samples , Therefore, it is important to recognize that in addition to further future researches, good health promotion and protection measures should be taken for traffic policemen and gasoline exposed workers.

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REFERENCES

[1] Abdel – Fattah, S.A.; EL – Sanhoury, M.H.; EL.Mednay, N.M. and Abdel – Azeem, F. 2008. Thyroid Activity, some blood constituents, organs morphology and performance of broiler chicks fed Supplemental Organic Acid. International Journal of poultry science 7 (3), 215 – 222, ISSN 1682 – 8356.

[2] Agrawal, R. and Johri, G..N. 1990. Serum protein changes in lead exposed mice infected with *Hymenolepisnana*. J. Hyg. Epidemiol. Microbiol. Immunol. 34, 387-390.

[3] Al-Neamy, F.R.M., Almehdi, A.M., Alwash, R., Pasha, M.A.H., Ibrahim, A., Bener, A. 2001. Occupational lead exposure and amino acid profiles and liver function tests in industrial workers. Int J Environ Health Res. 11(2),181–188.

[4] Cairney, S., Maruff, P., Burns, C.B., Currie, J., Currie, B.J. 2004. Neurological cerebellum of newborn rats. Food Chem Toxicol. (7), 2303-10.

[5] Cannon, D.C., Olifzky, I. and inkpen, J.A. 1974. Protein. Cli – chem. Principle and technics,zed. Cannon and winkelman editors. New York, PP. 407 – 421.

[6] Chen, J., Chen, Y., Liu, W., Bai, C., Liu, X., Liu, K., Li, R., Zhu, J.H. and Huang, C. 2012. Developmental lead acetate exposure induces embryonic toxicity and memory deficit in adult zebrafish. Neurotoxicol Teratol. pii: S0892 0362(12)00149-3. (ahead of print). evaluation, and treatment. Altern Med Rev; 11, 2-22.

[7] Doumas, B.T., Waston, W.A. and Bigg,h.G., 1971. Albumin standard and the measurement of serum albumin with bromocresol green. Cli- chem. U.S. 31, 87 – 96.

[8] El-Nahal, D.M. 2010. Effect of using pectin on lead toxicity. The Journal of American Science, 6(12), 541-554.

[9] Gargouri, M., Ghorbel-Koubaa, F., Bonenfant- Magné, M., Magné, C., Dauvergne, X., Ksouri, R., Krichen, Y., Abdelly, C. and El Feki, A. 2012. Spirulina or dandelion-enriched diet of mothers alleviates lead-induced damages in brain andcerebellum of newborn rats. Food Chem Toxicol. 50 (7), 2303-10.

[10] Gourrier, E., Lamour, C., Feldmann, D. and Bensman, A. (1991). Early tubular involvements in lead poisoning in children. Arch. Fr. Pediatr. 48, 685-689.

[11] Haque, M.M. 2005. Effects of calcium carbonate, potassium iodide and zinc sulfate in lead induced toxicities in mice. MS Thesis, Department of Pharmacology, BAU, Mymensingh.

[12] Hassan, R.A., Amin, D.M., Rahmy, N.A., Hatem, M.E. and Dessouky, M.I. 2012. Clinicopathological, histopathological and immunolog1ical studies on animals exposed to lead and cadmium under experimental conditions, New York Science Journal, 5(12), 120-136.

[13] Ibrahim, N.M., Eweis, E.A., El-Beltagi, H.S. and Yasmin, E. Abdel-Mobdy, Y.E. 2012. Effect of lead acetate toxicity on experimental male albino rat. Asian Pac J Trop Biomed, 2(1), 41–46.

[14] Kalaiselvi, A., Aadhinath, G., Reddy, G.A. and Ramalingam, V. 2015. Ameliorating Effect of Ginger Extract (*Zingiber officinale* Roscoe) on Liver Marker Enzymes, Lipid Profile in Aluminium chloride Induced Male Rats, International Journal of Pharmaceutical Sciences and Drug Research. 2015. 7(1), 52-58

[15] Khotimchenko, M., Kovalev, V. and Khotimchenko, Y. 2007. Equilibrium studies of sorption of lead(II) ions by different pectin compounds. J. of Hazardous Materials 149, 693–699.

[16] Kshirsagar, M., Jyotsna Patil1, Arun Patil1, Ganesh Ghanwat. 2015. Biochemical effects of lead exposure and toxicity on battery manufacturing workers of Western Maharashtra (India): with respect to liver and kidney function tests, Al Ameen J Med Sc i; 8(2), 107-114.

[17] Limdi, J.K. and Hyde, G.M. 2003. Evaluation of abnormal liver function tests. *Postgrad. Med. J.*, *79*, 307–312.

[18] Mc-Lntire, M.S. and Angle, C.R. 1972. Air lead: relation to lead in blood of black school children deficient in glucose-6-phosphate dehydrogenase. Science, 177, 520–522.

[19] Mikhail, T.H., El-Sawaf, H.A., Ibrahim, K.M., Awadallah, R., El-Dessoukey, E.A. 1980. Evaluation of the effect of lead exposure on the liver in Egyptian lead tank welders. Z Ernahrungswiss.19(1):50–6, http://dx.doi.org/10.1007/BF02021073.

[20] NIOSH (National Institute for Occupational Safety and Health). 1978. 'criteria for a recommended standard occupational exposure to Inorganic lead –Revised Criteria' Cincinnati, DHEW (NIOSH) publication No. 78, pp 158.

[21] Ozsoy SY, Ozsoy B, Ozyildiz Z. and Aytekin I. 2011. Protective effect of L- carnitine on experimental lead toxicity in rats: a clinical, histopathological and immunohistochemical study. Biotech. Histochem. 86 (6): 436-43.

[22] Pachathundikandi, S.K. and Varghese, E.T. 2006. Blood zinc protoporphyrin, serum total protein, and total cholesterol levels in automobile workshop workers in relation to lead toxicity: our experience, Indian Journal of Clinical Biochemistry, 21(2), 114-117.

[23] Patrick L. 2006. Lead Toxicity, a Review of the Literature. Part I: Exposure, Evaluation, and Treatment Alternative Medicine Review u Volume 11.

[24] Saeed, H.S.A., Abdellah, A.M., Abbas, A.A., ELgazali, N.A. and Adam, F.A. 2017. Effect of air lead pollution on blood bilirubin and lactate dehydrogenase levels among occupationally exposed workers in main Sudanese cities. IOSR Journal of Applied Chemistry (IOSR-JAC), 10(1): 32-37.

[25] Shalan, M.G., Mostafa, M.S., Hassouna, M.M., Hassap EL-Nabi, S.E. and ELrafaie, A. 2005. Amelioration of lead toxicity on rat liver with vitamin C and silymarin supplements Toxicology, 206, 1–15.

[26] Singh, A, Bhat, T.K. and Sharma, O.P. 2011. Clinical Biochemistry of Hepatotoxicity. Singh, J Clinic Toxico, S4:001. doi:10.4172/2161-0495.S4-001.

[27] Thapa, B.R. and Walia, A. 2007. Liver function tests and their interpretation. Indian J Pediatr 74, 663-671.

[28] Zuhir, O. 2007. Determination of Blood Lead Levels in Traffic- and Gasoline Exposed Professionals in Khartoum State- Sudan, M.Sc. thesis, O. I.U. Khartoum, Sudan, pp. 22-40.

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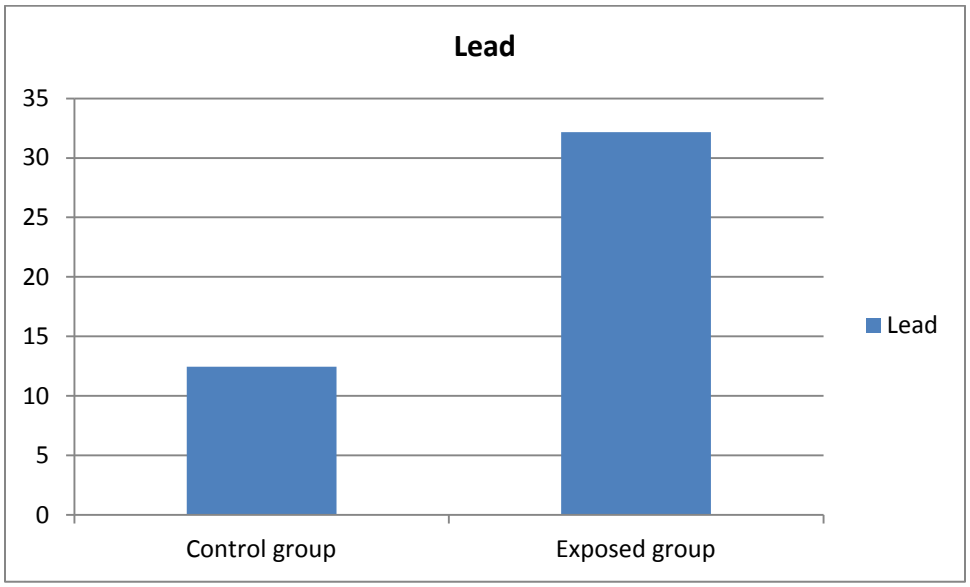

Fig (1): Comparison between blood lead level in petrol station and policemen (exposed group) and control group in different Sudanese cities.

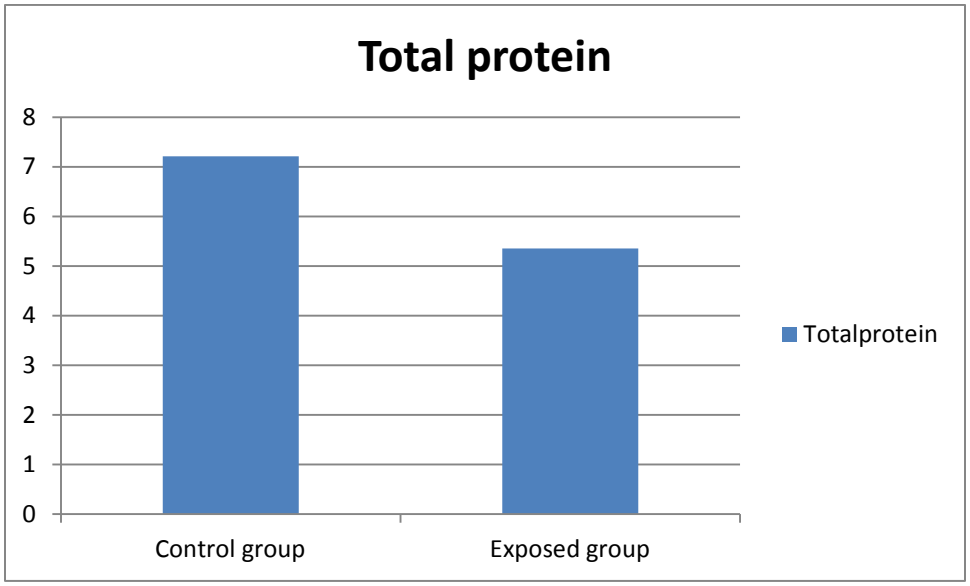

Fig. (2): shows correlation between blood protein (total protein) concentration for petrol station worker and traffic policemen (exposed group) and control group in different Sudanese cities.

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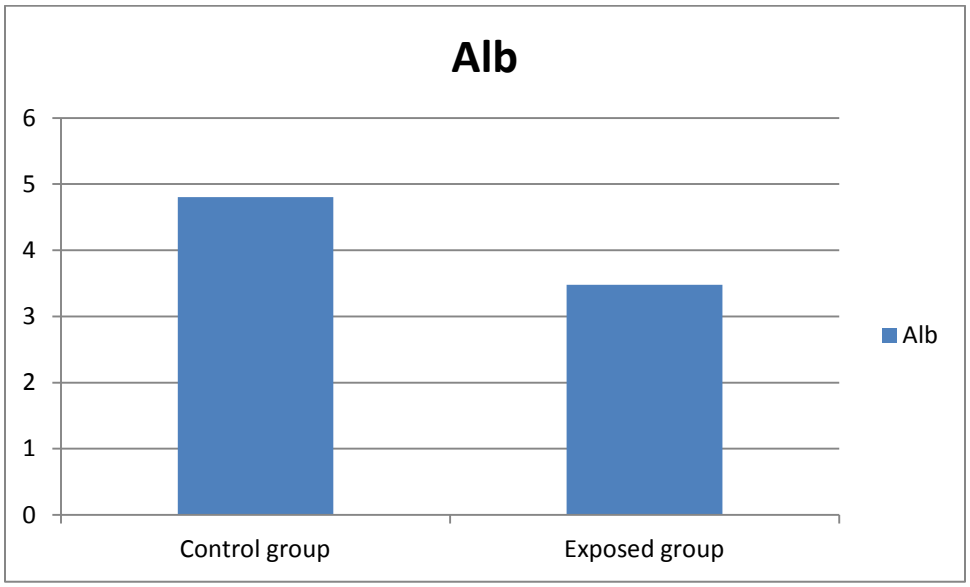

Fig. (3): shows correlation between Blood protein (albumin) concentration for petrol station worker, traffic policemen Exposed and control groups in different cities in Sudan.

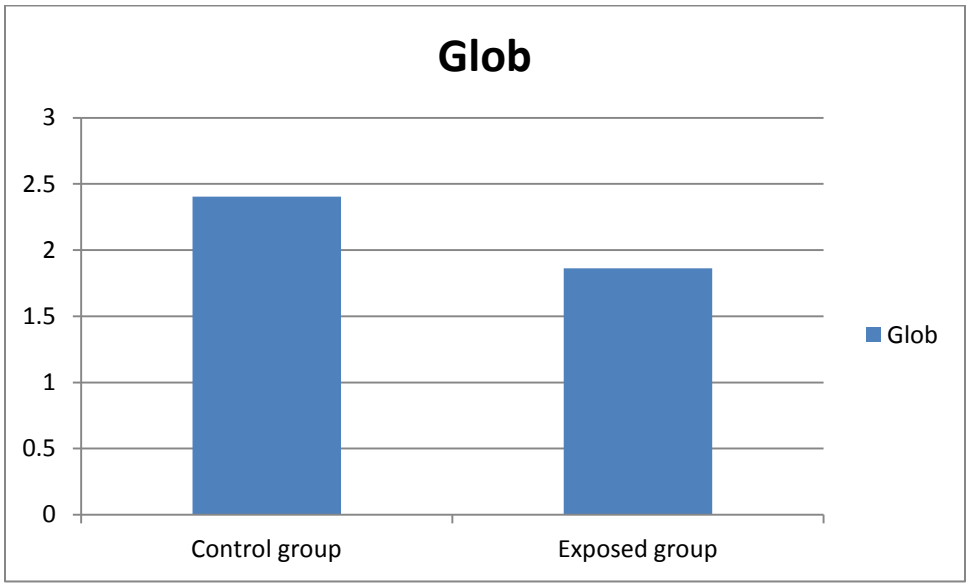

Fig. (4): shows correlation between Blood protein (globulin) concentration for petrol station worker, traffic policemen Exposed and control groups in different cities in Sudan.

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Table 1
shows correlation between Blood protein (total protein, albumin and globulin) concentration for petrol station worker, traffic policemen Exposed and control groups in different cities in Sudan.

Parameters(g/dl)	Exposed Mean	control mean	d.f	S.E+	Level of significant
Total protein	5.354	7.210	148	0.1376	***
Albumin	3.480	4.806	148	0.0988	***
Globulin	1.862	2.404	148	0.0775	***

***significant at 0.001 level of probability.