

# Investigation of Liver Enzymes, Kidney Functions and Some Heavy Metal Levels in Electrical Generator Workers

Ali Essam Ali, Huda Zuheir Majeed\*

Department of Biology, College of Science, Mustansiriyah University, 10052 Baghdad, IRAQ.

\*Correspondent contact: [hudazuheir@uomustansiriyah.edu.iq](mailto:hudazuheir@uomustansiriyah.edu.iq)

## Article Info

Received  
15/12/2022

Accepted  
15/01/2023

Published  
25/02/2023

## ABSTRACT

One of the most commonly health problems are Respiratory tract infections, almost (5-10) % of death cases reported in Centers for Disease Control and Prevention in the community and this increased over the years regardless of the country. As a substitute source of electricity many developing countries use electrical generators, but gases and materials rising from them will be inhaled from surrounding people especially for who work on them. This study aimed to detect and identify bacteria isolated from persons sputum suspected with Respiratory tract infections and collect blood to perform hematological, biochemical study and detection of some heavy metal for both workers and non-workers in electrical generators. Sputum samples were collected from electrical generators workers by 184 samples and from non-workers in electric generators by 50 samples, both were suspected had respiratory tract infection from the symptoms. All samples were cultured on blood agar and MacConkey and bacterial identification by utilizing a Vitek 2 system was done. Blood samples were also collected in order to perform biochemical, Hematological study and detection the level of some heavy metals in blood. Out of 184 samples, 27 samples (14.67 %) produced a significant growth of microbes, the predominant bacteria were *Klebsiella* spp. Statically, there were significant difference between workers and non-workers in Electrical generators at ( $p < 0.05$ ) for: Hematological parameters (WBC, Basophil and Eosinophil), all the liver enzymes, the Four heavy metals (Lead, Cadmium, Zinc and Copper). This study showed that Electrical generators had caused changes in blood parameters (WBC, Basophil and Eosinophil), all the liver enzymes and the Four heavy metals (Lead, Cadmium, Zinc and Copper). This effect most more studied and evaluated in generators workers.

**KEYWORDS:** Respiratory tract infection; Blood parameters; Electrical generators; Heavy metals.

## الخلاصة

أحد أكثر المشاكل الصحية شيوعاً هي التهابات القناة التنفسية، تقريباً (5-10) % من حالات الوفاة سجلت جراء هذه الالتهابات في مركز السيطرة على الأمراض ومنعها في المجتمع وهذا ازداد بمرور السنين بغض النظر عن البلد. المصدر البديل للكهرباء في العديد من البلدان النامية هو المولدات الكهربائية، لكن الغازات والمواد المنبعثة منها تستنشق من الأشخاص المحيطين خاصة العاملين عليها. هذه الدراسة هدفت إلى التحري وتشخيص البكتيريا المعزولة من قشع الأشخاص المشكوك بإصابتهم بالالتهابات التنفسية وجمع عينات من الدم لإنجاز دراسته دموية وبيوكيميائية والتحري عن بعض العناصر الثقيلة لكل من العاملين وغير العاملين بالمولدات الكهربائية. جمعت 184 عينة من قشع العاملين في المولدات الكهربائية و 50 عينة من قشع غير العاملين في المولدات الكهربائية. كلاهما شك بأصابته بالالتهابات التنفسية من وجود الأعراض. كل العينات زرعت على وسط اكار الدم والماكونكي وتم تشخيص البكتيريا باستخدام نظام الفايك 2. عينات الدم جمعت أيضاً لأجراء دراسته دموية وبيوكيميائية وتم التحري عن مستوى بعض العناصر الثقيلة. أظهرت 27 عينة (14.67) % نمواً بكتيريا معنوية للبكتيريا وكانت بكتيريا *Klebsiella* spp هي السائدة. احصائياً كان هناك فرق معنوي بين العاملين وغير العاملين في المولدات الكهربائية عند المستوى ( $p < 0.05$ ) لكل من المؤشرات الدموية وكل انزيمات الكبد والعناصر الثقيلة الأربعة (الرصاص، الكاديوم، الزنك والنحاس). أظهرت هذه الدراسة بأن المولدات الكهربائية سببت تغيرات في المؤشرات الدموية (كريات الدم البيض، الخلايا القاعدية والخلايا الحامضية) وكل انزيمات الكبد والعناصر الأربعة الثقيلة (الرصاص، الكاديوم، الزنك والنحاس). هذه التغيرات يجب ان تقيم وتدرس أكثر عند العاملين في المولدات الكهربائية.

## INTRODUCTION

Lower Respiratory Tract infections (LRTIs) are the most common infections in humans. It caused the death of about 2.74 million worldwide each year [1]. The commonest LRTIs include acute bronchitis, acute trachea bronchitis, chronic

bronchitis, and pneumonia, which represent 4.4% of all hospital admissions and are connected with high morbidity, mortality, and excessive health care costs [2].

The microbial etiology of LRTIs and their susceptibility profile to antibiotics varies in different geographic regions [3]. LRTIs could be

caused by Gram-positive bacteria such as *Staphylococcus aureus* and *Enterococcus* spp., and Gram-negative bacteria such as *Pseudomonas* spp., *Acinetobacter* spp., *Klebsiella pneumoniae*, and *Haemophilus influenzae* [4].

Electric generators were used widely in all places in Iraq due to shortage of electricity provided to people, they scattered between houses randomly. Diesel generators in turn produce some chemical pollutants to environment in gases and compounds emitted from them, leading to air pollution and harmful effects on the workers' health in generators in first degree, all the surrounding people, plant and animals [5]. The aim of this study was to detect and identify bacteria isolated from sputum of workers and non-workers in electrical generators suspected with LRTIs. In addition, to collect blood samples of both of them to perform hematological, biochemical study and detection of some heavy metals' levels.

## MATERIALS AND METHODOLOGIES

### Ethical Approval

Prior to initiate the study visit, each participant obtained informed constant and all participant were known about the study follows up before enrolling the study.

### Samples Collection

184 Sputum samples from workers in electric generators in Baghdad -Iraq (e.g., Palestine Street, Sader city, Ur, Baghdad Al-Jadeeda, Al-Binouk, Al-Ubaidy, Al-Shaab, Al-Qahira, Al-Shuala, Al-Alam, Al-Amin, Suleikh and Al-Thaliba), and 50 Sputum samples from non-workers in electrical generators were collected from men of all ages in the period from November 2021 until May 2022 who suspected had lower respiratory tract infection from their symptoms and visit hospitals and diagnosed by doctors.

Samples were collected in sterile containers and transported immediately to the laboratory at Mustansiriyah University- College of biology-Biology Dep. for further processing. Sputum specimens were subjected for Gram-staining and examined under light microscope. In microscopic examination, sputum smear containing <10 squamous epithelial cells and 25> leucocytes (or pus cells) for each low power field confirmed the reliability of the specimen, indicating that it was not contaminated with saliva [6].

All samples were cultured immediately on blood agar, MacConkey and Chocolate Agar were incubated at 37 °C for 24 hr. After incubation, each plate was examined, and bacterial identification was performed by utilizing a Vitek 2 (bioMerieux, France), according to the manufacturer's instructions.

### Blood sampling and Parameters detection:

Ten milliliters of blood from both workers and non-workers at electrical generators were drawn from each individual through a vein puncture with disposable syringes. Two milliliters were collected in an EDTA tube (in order to perform hematological assays item (2) mentioned below and eight milliliters in a gel tube, allowed to clot for (15-20) minutes at room temperature before being centrifuged for 10 minutes at 4000 rpm. The serum was used to perform biochemical assays item (1).

### 1. Biochemical assay

All biochemical tests of serum samples from both workers and non-workers at electrical generators were analyzed by clinical chemistry analyzer BS-230 Kits (Mindray,China) according to their instructions, and were measured by using colorimetric spectrophotometer . Liver Enzymes levels (Total Serum Bilirubin (TSB), Alanine aminotransferase (ALT), Aspartate Aminotransferase (AST) and Alkaline phosphatase (ALP) and kidney enzymes level (Blood urea, Serum Creatinine, Serum Total Protein and Serum Albumin) were estimated by technique according to company instructions of kits.

### 2. Hematological assays

Two ml of blood from both workers and non-workers in electric generators dispensed in EDTA anticoagulated labeled tubes for Complete blood count (CBC) which was done by AUTO Hematology analyzer BC-5000 device (Mindray,China). EDTA blood sample (10 µl) was placed in the aspirator of the instrument, the results were provided within 1 minute on device screen. The results involved total number of white blood cell (WBC), Neutrophils, Basophils, Eosinophils, Lymphocytes, Monocytes, Packed Cell Volume (PCV) and Haemoglobin (Hb).

### Detection of Heavy Metals

Atomic absorption spectrophotometer (Model AA646, Shimadzu Corporation, Kyoto, Japan) was used to evaluate the levels of heavy metals Copper

(Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb) concentrations in serum samples of the workers and non-workers in Electric generators according to [7].

### Statistical Analysis

The correlation was performed to test whether group variance was significant or not. Data were expressed as mean± Standard Deviation (SD) and statistical significances (two tailed tests) were carried out using SPSS program version 26.

## RESULTS AND DISCUSSION

From November 2021 until May 2022, A total of 184 Sputum samples from men workers in electrical generators were processed according to the standard microbiological methods. Information of workers include mean duration of work (9.2±1.1 years) and age (39.7±1.86 years).

The LRTIs were confirmed by microscopic examination, with more than 25 leukocytes per field and with the presence of microorganisms. Out of 184 Sputum samples of workers in electrical generators, 27 samples (14.67 %) resulted a significant growth of microorganisms on culture media, which included 25 isolates (92.59%) of Gram-negative bacteria and 2 isolates (7.41%) of Gram-positive bacteria. The predominant bacteria was *Klebsiella* spp. followed by other genus as shown at Table 1.

**Table 1.** Bacteria isolated from workers in generators.

Bacterial isolate	Gram Reaction	No. (%)
<i>Klebsiella pneumoniae</i>	-	11 (40.74)
<i>Klebsiella oxytoca</i>	-	2 (7.40)
<i>Burkholderia cepacia</i>	-	3 (11.11)
<i>Enterobacter cloacae</i>	-	2 (7.40)
<i>Enterobacter aerogenes</i>	-	1 (3.7)
<i>Serratia marcescens</i>	-	1 (3.7)
<i>Serratia ficaria</i>	-	1 (3.7)
<i>Stenotrophomonas malltophilia</i>	-	1 (3.7)
<i>Proteus mirabilis</i>	-	1 (3.7)
<i>Escherichia coli</i>	-	1 (3.7)
<i>Pseudomonas aeruginosa</i>	-	1 (3.7)
<i>Staphylococcus aureu</i>	+	1 (3.7)
<i>Enterococcus faecalis</i>	+	1 (3.7)
Total of Significant Bacterial growth		27 (14.67)
Total of non-Significant Bacterial growth		157(85.322)

The LRTIs in non-workers in electrical generators was confirmed by visiting hospitals and diagnosing by doctors in order to collect 27 bacterial isolates out from 50 sputum samples to use them as control for comparison as shown at Table 2.

**Table 2.** Bacteria isolated from non-workers in generators.

Bacterial isolate	Gram Reaction	No. (%)
<i>Klebsiella pneumoniae</i>	-	8 (29.63)
<i>Klebsiella oxytoca</i>	-	1 (3.7)
<i>Acinetobacter baumannii</i>	-	8 (29.63)
<i>Pseudomonas aeruginosa</i>	-	6 (22.22)
<i>Enterobacter cloacae</i>	-	1 (3.7)
<i>Serratia marcescens</i>	-	1 (3.7)
<i>Burkholderia cepacia</i>	-	1 (3.7)
<i>Proteus mirabilis</i>	-	1 (3.7)
Total of Significant Bacterial growth		27 (54)
Total of non-Significant Bacterial growth		23 (46)

The major microorganisms causing LRTI in the current study was *Klebsiella* spp., this observation is quite similar to a researcher [8] who found that (72.6%) of his isolates were Gram-negative bacteria, followed by (23.1%) of Gram-positive bacteria, also they found that the main causing pathogens were *K. pneumoniae* (27.4%), *E. coli* (17.9%), *P. aeruginosa* (10.3%), *Staphylococcus aureus* (12.0%), and *Streptococcus pneumoniae* (9.4%) respectively.

Results of this study was compatible with [9, 6, 10] who found in their studies on LRT infections that among pathogenic isolates, the Gram negative bacteria was higher than Gram Positive bacteria when it recorded (72.5%) compared with (24.5%) of Gram-positive bacteria.

Prevalence of LRTI in men may be due to some associated risk factors for respiratory tract infection e.g., smoking, alcohol consumption and aging [10]. Infections of Gram negative bacteria is more than Gram positive bacteria could be explained by : low permeability of the outer membrane coupled with the presence of membrane spanning efflux pump leading to antibiotics extrusion , acquiring resistance genes, randomly used antibiotics prescribed by unspecialized persons , wrong continuous use of antibiotics even for viral infections or slight sickness and some doctors don't had the enough knowledge to choose antibiotics, leading to overuse of antibiotics especially penicillins and cephalosporins [11].

Hematological tests results showed a significant difference at  $p < 0.05$  for WBC, Basophil and Eosinophil in workers in Electrical generators compared with non-workers, besides there were no significant difference for Neutrophils, lymphocytes, Monocytes, PCV and Hb as shown at Table 3.

**Table 3.** Comparison between complete blood counts for workers and non-workers in Electrical generators.

Parameters	Workers in Electrical generators No.=27	Non-workers in Electrical generators No.=27	P-value
	Mean $\pm$ SE		
WBC	13.2 $\pm$ 0.18	8.7 $\pm$ 0.49	0.025*
Neutrophils	70.2 $\pm$ 1.92	68.1 $\pm$ 1.7	0.493ns
Basophils	0.24 $\pm$ 0.02	0.78 $\pm$ 0.12	0.031*
Eosinophils	2.36 $\pm$ 0.28	3.58 $\pm$ 0.41	0.044*
Lymphocytes	21.7 $\pm$ 1.86	20.2 $\pm$ 1.62	0.622ns
Monocytes	5.6 $\pm$ 0.30	6.5 $\pm$ 0.46	0.117ns
PCV	49.8 $\pm$ 1.23	45.2 $\pm$ 0.77	0.352ns
Hb	16.3 $\pm$ 0.41	14.6 $\pm$ 0.26	0.367ns

\*p-value is significant at <0.05 (t-tailed) , ns : non-significant

The outcomes of this study were confirmed by an article of [12] who indicated that there was a significant elevation at ( $P \geq 0.01$ ) in the total leukocyte count of electrical generators workers compared with control. A significant leukocytosis appeared in lead exposed workers compared with non-exposed workers [13].

Electrical generators workers were exposed to occupational stresses due to excessive noise at work place, these physical and mental stressors may cause elevation stress hormones secretion (e.g., cortisol, corticosterone, adrenaline and noradrenaline). So, total white blood cells elevated in workers of mills perhaps due to long-time of exposure to occupational noise stress [14].

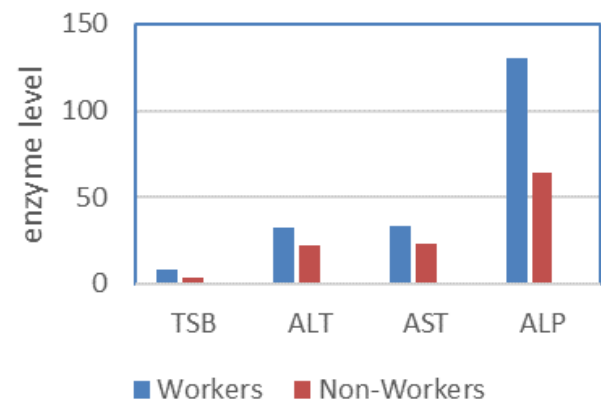
Concerning, differential leukocytes count, the statistical analysis of [12] showed that no significant elevation in percentages of neutrophils and lymphocytes count of electrical generators workers compared with control, this also found in this study.

These results could be explained by the inhalation of gaseous air pollutants which lead to different levels of toxicity depending of exposure duration and lead extent, finally leading to inflammation, [15] declared that the human hematopoietic system is so sensitive to environmental pollution because of rapid cell synthesis with resultant metabolic demands.

There was significant difference at ( $p < 0.05$ ) for all the liver enzyme (TSB, ALT, AST and ALP) in workers in Electrical generators compared with non-workers as shown at Figure 1.

The Complex compounds and many gases which were released from electrical power generators caused air pollution and human health hazards [16]. These effects could be noticed when there was

elevation of liver enzymes, just like found in this study.

**Figure 1.** Activity of liver enzymes in workers and non-workers in Electrical generators.

The present study was compatible with [12] who recorded a significant increment at ( $P \geq 0.01$ ) in serum aspartate aminotransferase (AST), alkaline phosphatase (ALP) and alanine aminotransferase catalase (ALT) for electrical generators workers compared to control.

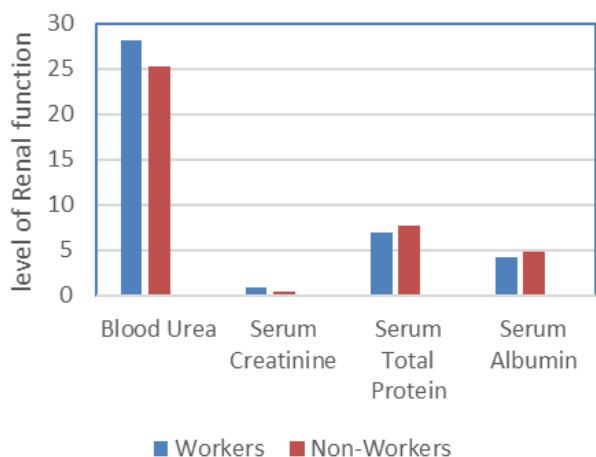
The results were compatible also with [17] who found serum alkaline phosphatase (ALP) and alanine aminotransferase catalase (ALT) were higher significantly in workers exposed to heavy metals at ( $P < 0.01$ ) compared with control group. The Researchers explained the (ALP) (ALT) elevation due to exposure to diesel components which had its toxic effect on the blood, on functions of liver, immunology and chromosomes with carcinogenesis risk development [12].

There was no significant difference at ( $p < 0.05$ ) for all Renal enzymes (including Blood urea, Serum Creatinine and Serum protein), except Serum Albumin which recorded a significant difference as shown at Figure 2.

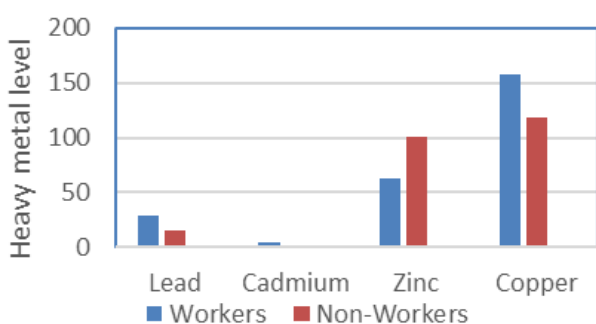
Researcher [12] also recorded a significant decrement at ( $P \geq 0.01$ ) in serum albumin for electrical generators workers compared with control, this was also found in the present study.

These results were compatible with [18] who studied the effect of chemical pollutants on some biochemical parameter in the workers of electric generators. Whereas, [19] recorded nonsignificant decrease in the average of albumin of workers in large private electrical generators compared with control.

The Four heavy metals (Lead, Cadimium, Zinc and Copper) recorded significant difference at ( $p < 0.05$ ) between workers and non-workers in electrical generators as shown at Figure 3.



**Figure 2.** Activity of renal function in workers and non-workers in Electrical generators.



**Figure 3.** Comparison effect of heavy metals in workers and non-workers in Electrical generators.

Electrical generators are well-known source of air pollutants release. Noise produced from so many different sources (e.g., automobiles, machines, household devices, industrial, commercial and residential generators) [20]. Most of the previous studies focused on noise pollution evaluation. There were few studies focused on the effect of the heavy metals produced by generators on their own workers.

Reference [21] found that the cadmium and copper values were higher in workers serum in private electrical generators compared with control, besides, elevated risk of the oxidative stress, eye irritation, respiratory allergies and breath shortness. In addition, the same researcher recorded high levels of Zinc in controls compared with generators workers, just like the current results, this could be explained by the role of zinc in the antioxidant defense system especially in generators workers who are under high oxidative stress, besides, zinc had its own properties as antioxidant defense system, it had the ability to stabilize macromolecules against excess production of Reactive Oxygen species.

Generally, many studies had proven that when heavy metals present under traces were toxic to humans. firstly, they combine with proteins and did not cause any poisoning, However, when concentration increase above the threshold level, they become a real health problem [22]. These toxic metals could interact with important cellular components by forming covalent and ionic bonding, furthermore, when it became at high levels, both essential and non-essential metals cause cell membrane damage, enzyme specificity alteration, cellular function disruption and DNA structure damage [23].

For example, lead that could be present in this air cause hemoglobin synthesis inhibition due to their effect on erythroblast growth and interference with hemoglobin production [24]. Other heavy metals like lead (Pb), cadmium (Cd) and mercury (Hg) cause pathophysiological issues that produce radicals like reactive oxygen species (ROS), hydroxyl radical (HO•), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), which cause the oxidant-antioxidant balance disruption leading to oxidative stress [22].

## CONCLUSIONS

Electrical generators had its own effects on environment and humans surrounding them, these effects on generators workers were confirmed in this study by elevation of blood parameters, all the liver enzymes. Elevation of some heavy metals above the normal values was observed ,which in turn , needs an expert solutions to deal with these changes in order not to reach undesired effects on human .

## ACKNOWLEDGMENT

The authors would like to thank Mustansiriyah University, Iraq ([www.uomustansiriyah.edu.iq](http://www.uomustansiriyah.edu.iq)) for its support of the current work by providing Instruments and Apparatuses. Special thanks to all members in the journal of science.

**Disclosure and Conflict of Interest:** The authors declare that they have no conflicts of interest.

**Author Contributions:** All authors contributed equally in writing original draft preparation, all authors have read and agreed to the published version of the manuscript.

**Informed Consent:** All patients gave their written informed consents before inclusion.

## REFERENCES

- [1] G. L. Collaborators. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of lower respiratory tract infections in 195 countries: A systematic analysis for the Global Burden of Disease Study. *Lancet Infect. Dis.* Vol. 17. 2015. pp:1133–1161.
- [2] J. Nowicki, M. T. Murray. “Bronchitis and Pneumonia. Textbook of Natural Medicine”; Elsevier: Amsterdam, The Netherlands, 2020. pp. :1196–1201.
- [3] B. Santella, V. Folliero, G.M. Pirofalo, E. Serretiello, C. Zannella, G. Moccia, E. Santoro, G. Sanna, O. Motta, F. De Caro. Sepsis—A Retrospective Cohort Study of Bloodstream Infections. *Antibiotics*, vol. 9.2020. pp: 851.
- [4] A. B. Gebre, T. A. Begashaw, M. D. Ormago. Bacterial profile and drug susceptibility among adult patients with community acquired lower respiratory tract infection at tertiary hospital, Southern Ethiopia. *BMC Infect. Dis.*, vol. 21. 2021. pp.: 440.
- [5] W. A. Mehdi. Study the effect of gases rising from electric generators on sera protein, iron, transferrin and other biochemical parameters. *Australian Journal of Basic and Applied Sciences*, vol. 8(3).2014. pp.: 521-526.
- [6] B. Santella, E. Serretiello, A. De Filippis, V. Folliero, D. Iervolino, F. Dell’Annunziata, R. Manente, F. Valitutti, E. Santoro, P. Pagliano, S. Singh, A. Sharma, V. Nag. Bacterial pathogens from lower respiratory tract infections: A study from Western Rajasthan. *J. Fam. Med. Prim. Care*, vol. 9. 2021. pp: 1407–1412.
- [7] [7] S. J. Haswell. Atomic Absorbtion Spectrometry, Theory, Design and applications. School of chemistry, The University of Hull, Elsevier. 1991.
- [8] [8] L. Luan, Y. Sun, S. Duan, P. Zhao, Z. Bao. Pathogenic bacterial profile and drug resistance analysis of community-acquired pneumonia in older outpatients with fever. *Journal of International Medical Research* . Vol. 46(11) .2018. pp. :4596–4604
- [9] [9] I. Regha, B. Sulekha. Bacteriological profile and antibiotic susceptibility patterns of lower respiratory tract infections in a tertiary care hospital, Central Kerala. *Int. J. Med. Microbiol. Trop. Dis.*, vol. 4.2018. pp.: 186–190.
- [10] S. Singh, A. Sharma, V. Nag. Bacterial pathogens from lower respiratory tract infections: A study from Western Rajasthan. *J. Fam. Med. Prim. Care*, vol. 9.2020. pp.:1407–1412.
- [11] Y.M. Wen. “Modern Medical Microbiology” [M]. Shanghai: Shanghai Medical University Press, 1999: pp.97111.5
- [12] D. M. S. AL-Maraashi, Z. M. M. AL-Hakkak. Study effect exposure of air pollutants on physiological blood parameters and liver functions in electric generators workers in Al - Najaf Al-Ashraf city. *Egypt. J. Chem.* Vol.65(2).2022. pp. : 259 – 264
- [13] Ó. Lorenzo, S. Urbé, S., M. J. Clague. Systematic analysis of myotubularins: heteromeric interactions, subcellular localisation and endosome related functions. *Journal of Cell Science.*, vol. 119(14).2006. pp.: 2953-2959.
- [14] D. Wankhar, R. Sheela Devi, I. Ashok. Emblica officinalis outcome on noise stress induced behavioral changes in Wistar albino rats. *Biomed Prev Nutr.*, vol.4(2).2014. pp.:219-24.
- [15] A.M.A. Almissari, H.A. Rashid, A.Q. Abd, R.A. Aldelaimy. The Effects of Lead exposure to workers in electric generator and car mending. *Diyala Journal for Pure Science.* Vol.8(4). 2014.
- [16] D. Gorman, A. Drewry, Y.L. Huang, C. Sames. The clinical toxicology of carbon monoxide. *Toxicology.* Vol. 187(1).2003. pp.: 25-38
- [17] S. H. Fadhil, K. F. A. AL-Kafour, A. F. Almehemdi. Determination the concentrations of some heavy metals and studying the blood variables for the diesel generators workers blood in Ramadi city. *Journal of university of Anbar for Pure science.* Vol. 7(1).2013.
- [18] I. Resan Ibraheem, F. Fateehallah, B. Furoon. Effect of the pollution produced by generators in some biochemical parameters in workers. *Journal of al-qadisiyah for pure science (quarterly).* Vol. 6(1). 2006. pp.: 30-39.
- [19] B. F. Abed, F. F. Karaam, L. A. Sagban. Pollution of plants by lead from power generators in Diwaniyah City-Iraq. *Journal of Alqadisiyah for Pure Science (quarterly).* Vol. 6(1).2006. pp.: 110-118
- [20] A. P. Azodo, S. B. Adejuyigbe. Examination of noise pollution from generators on the residents of Obantoko, Ogun State, Nigeria. *Asian J. Eng. Sci. Technol.* vol. 3(1). 2013. pp.: 31-41.
- [21] M. R. Al\_Saadi, F. S. Al-Fartusie, M. Z. Thani. Evaluation of lead, cadmium, copper and zinc levels and studying their toxic effect in sera of private electrical generator workers. In *Journal of Physics: Conference Series* 1853(1).2021. p. :012044. IOP Publishing
- [22] A.A. Fadhel, M. Johnson, K. Trieu, E. Koculi, and A.D. Campiglia., T alanta. Vol.164.2017. pp.: 209
- [23] M. J. Bruins, P. B. Soeters, N. E. Deutz. Endotoxemia affects organ protein metabolism differently during prolonged feeding in pigs. *J. Nutr.* Vol. 130.2000. pp.: 3003-3013.

### Cite this article

A. E. Ali and H. Z. . Majeed, “Investigation of Liver Enzymes, Kidney Functions and Some Heavy Metal Levels in Electrical Generator Workers”, *Al-Mustansiriyah Journal of Science*, vol. 33, no. 5, pp. 72–77, Feb. 2023.