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Occupational chemicals exposure and related hematological consequences among automobile garage workers in Benghazi, Libya.

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Highlights

- **Mobile repair garage workers are a high-risk group that is in direct contact with aromatic hydrocarbons and Petrochemicals compounds with no personal protection devices and with no protective guidelines.**
- **A comparative cross-sectional study to investigate the effect of chemicals on hematological parameters in which an exposed group of participants was compared with controls.**
- **There are hematological changes in some hematological parameters of the workers**

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ABSTRACT

Background: The automobile repair garage workers are exposed as part of their occupation to aromatic hydrocarbons, aliphatic hydrocarbons, and petrochemicals that have adverse effects on the heath of the human being. In Libya, there were no studies on the type and level of exposure to chemicals among automobile workers in different garage workplaces. Therefore, this field study was aimed to determine the consequences of occupational chemicals exposure on the hematological parameters of automobile workers.

Methods: In this comparative cross-sectional study, a total of 70 participants were enrolled, a number of 35 automobile repair garage workers filled out a questionnaire and gave blood samples for complete blood count (CBC) test and compared with an equal number of 35 control groups of the same sex and age group, gave also blood samples for CBC test. The data from the filled questionnaire were coded and the blood tests results were entered into the SPSS program (version 21). The data was presented by descriptive statistics. Meanwhile, the statistical analysis was done using the independent sample t-test. In addition, the proportions of categorical variables were compared using the Chi-square test.

Results: Our findings in comparison to control showed that there was no significant difference in the RBC count of all participants. Both petrochemicals and oils exposed groups had higher MCV levels with statistically significant differences of p=0.05 and p=0.006 respectively. Whereas, the MCHC was significantly increased in petrochemicals and oil exposed groups (p=0.027 and p=0.008 respectively), moreover, the total WBC counts were significantly reduced in paints exposed workers (p=0.04), while no significant changes in petrochemicals and oils exposed groups (p=0.450 and p=0.359 respectively). Additionally, both petroleum and oil exposed were anemic in comparison to the normal reference value of hemoglobin level.

Conclusion: Our results indicated that working in the garage changes some of the hematological parameters of the workers. Thus, suitable and actual safety guidelines should be implemented to prevent possible chemical exposure during routine work, and further study on the type of heavy metals causing these hematological changes should be conducted in further studies.

1. Introduction

The workers of automobile workshops are a class of labors susceptible to chemical toxicity as part of their routine work such as motor spray painting, vehicle assembly, welding, burning of petrol, cleaning, servicing, repairing of radiators, and general work (such as test driving) ranging in size from small engines to lightweight vehicles (Ishola *et al.*, 2017). The auto-repair workshops are considered as one of the main sources of environmental pollution as a result of random occupational activities of these workers. These occupational activities make the workers in this field exposed to environmental and health risks every single day more than the general population (Ataro *et al.*, 2019). The workers are frequently exposed to different types of hazards at garage workplace that can be divided into four types, mechanical hazards such as dust, smoke, and inhalation of fume, ergonomic hazards such as psychosocial hazards including stress and poor posture, physical hazards such as noise, fire, vibration, tools injuries, dirty environment and falling down (Amfo-Otu and Agyemang., 2017; Rongo *et al.*, 2004) and variable chemical hazards as a result of exposure to different emissions such as welding fumes, hydrocarbons, gases, dust, paints, solvents (Zalat and Shetta, 2012).

Protection against these types of hazards is needed. Therefore, the workers should use work practices, engineering controls, and personal protective devices (Reese and Eidson, 2006). In a large number of occupational surroundings, the ambient environment is considered as a sink of different types of contaminants that arose from different sources causing straight exposure to auto-repair workers (Tang *et al.*, 2009). The un-controlled exposure to petrochemicals containing the aromatic compounds in addition to heavy metals such as copper, lead, cadmium, chromium, vanadium, and

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nickel may thus cause adverse health consequences. Exposure to these aromatic compounds and heavy metals may suppress the bone marrow's activity leading to ineffective hematopoiesis. Also, they can accumulate in the tissues and/or organs as a result of chronic exposure and cause brain, and liver damage, cancer, birth defects, hormonal disorder, asthma, ulcers, skin irritation, and allergic dermatitis (Sharma *et al*., 2017).

However, the auto repair workers are also exposed to a huge number of other chemicals in the garage. One of these chemicals is mineral-based crankcase oil. The inhalation of vapors of used mineral-based crankcase oil for a few minutes can cause minor throat, nose, and eyes irritation. While, the ingestion of big quantities of used mineral-based crankcase oil can lead to diarrhea (ATSDR, 1997) and nervous system disturbance (tremors and headaches). Also, direct skin contact cause skin rash (Obinia and Afiukwaa, 2013). The oils are of different brands and each one contains a slightly different mixture of additives and oils. Thus, the health effects of these oils depend mainly on the characteristics of the chemicals found in the oil. Also, the final composition of the oil is may be affected by the types of engines is used. Therefore, the health effect after exposure to one batch of used mineral-based crankcase oil may be different from the exposure to another batch (Obinia and Afiukwaa, 2013).

2. Aim

There are no studies on the automobile-repair garage workers in Libya, Therefore, this field study was planned to estimate the consequences of occupational exposure to chemicals, solvents, and other factors on the hematological parameters of out-mobile garage workers in comparison to a group of unexposed volunteers as a control group in Benghazi, Libya.

3. Methodology

3.1. Study sample

For the purpose of the study, all the male garage workers who were assigned as full-time workers, working regular hours for a duration not less than one year were asked to share in the study (excluding warehouse, office workers, and workers on sick leave). While the control group was occupationally non-exposed people matching the exposed group in the sex and age.

3.2. Study design and study area

A comparative cross-sectional study was conducted among automobile garage workers and the control group. The study was conducted in Benghazi city (East Libya) from April to October 2019. The pre-structured questionnaire was pilot tested, written in English, translated in Arabic to avoid bias, then coded and entered in English. The questionnaire covers the socio-demographic and occupational characteristics of automobile garage workers including; Age, nationality, education level, body mass index (BMI), smoking status, working hours per day, working experience, job type, and symptoms suffered by workers. In addition to the worker's safety profile and chemicals exposure.

3.3. Data collection and hematological analysis

An approximately 20 randomly selected garages workshops in different areas in Benghazi city were visited and 35 auto-mobile workers participated in the study, filled the pre-structured questionnaire, and gave a blood sample. The questionnaire was first written in English language and then translated into the Arabic language to avoid the bias of not understanding the questions and miss explanations. Filling the questionnaire was done under supervising of the researchers to ensure that each worker is answering the questions by him selves and to give help and clarifications when it is needed. The interviewer-administered questionnaire included socio-demographic (age, nationality, education level, body mass index (BMI) and smoking status), working information (working hours, duration of the job, type of job, eating, drinking, and sleeping habits and, the satisfaction of participants about the level of garages' ventilation and hygiene frequency), the health status of the participants (chronic diseases and symptoms), the safety profile (accidents during work and wearing the personal protection devices by the participants) and the occupational chemical exposure of the participants. The participants were asked to do a complete blood count (CBC) test in the specified medical laboratory according to the area where the garage is located. Two medical laboratories were involved in the study, both using automatic CBC analyzers.

3.4. Data processing and analysis

The data in the collected questionnaire and the results of blood tests were entered in the SPSS software (version 21) and double-checked for accuracy. The data were summarized by descriptive statistics using Microsoft Excel 2010. In addition, the analysis was done using the independent sample t-test to compare the means of blood parameters of the automobile garage workers and the control group. The Chi-square test is used to correlate the symptoms of workers with the chemicals they use. A P value of <0.05 was considered statistically significant.

4. Results and discussion

4.1. Data analysis of questionnaire

4.1.1. Socio-demographic data and occupational characteristics of automobile workers

The results of this part were presented in Table 1. All the participants were male, this comes in accordance with several literatures concerning automobile repair garage workers of different jobs. The workers in automobile repair workshops are predominantly characterized by the male workforce (Ataro *et al*., 2019; Adu *et al*., 2018; Thangaraj and Shireen, 2017; Chauhan *et al*., 2014; Vyas *et al*., 2011). Almost all of the automobile repair workers (95.3 %) were belonging to the age group between 18-39 years old. This means that all of the participants were in young adulthood and the thirties of their life excluding the bias concerning the old age problems. But these findings were comparable with Chauhan *et al*. (2014), that majority of participants (17, 48.6%) and (16, 45.7%) fall in the age group (18-29 years) and (30-39 years) respectively, this study was done among welders in rural Delhi, India. Also, our results come in line with Amfo-Otu and Agyemang (2016), that the majority of auto mechanics in Ghana's informal sector were in the age group from (17-35) years. According to nationality, 78% of the participants were Libyans. Regarding the education level, 40 % of the participants were university graduates, 31.4 % completed high school education, and the rest 28.6 % were equally distributed between those who are still students and those with a secondary school degree. These findings differed from the findings of a similar study by Philip *et al*. (2014) done in an urban area of South India among automobile repair workers and services. In which, only (22.6%) of participants had a secondary school degree and the rest were illiterate. While similar results were reported by Thangaraj and Shireen (2017) study done among automobile mechanics working in an urban area of Bangalore finds out that (30.6%) of participants completed high school education and different results were reported for participants with secondary school education level (24.6%) and with higher education levels (1.3%).

An equal percentage of participants equivalent to (47.1%) each had normal and overweight BMI, and only (5.9%) were obese. These results were higher than the percentage of healthy (34.4%) and lower than the percentage of obese (59.4%) participants as stated in Kambris *et al*. (2019) study done among automotive repair industry workers in Dubai (UAE). Although, the percentage of obese is nearly comparable (6.3%) with the results of the current study. Whereas, these results were similar to Zalat and Shetta. (2012) findings, that the majority of workers had normal BMI. About a quarter (25%) of the participants were nonsmokers and an equal ratio of participants equivalent to (31.4%) was current

medium smoker and current heavy smoker respectively. Meanwhile, only (11.4%) of participants were the previous smoker. This is different from the findings of Kambris *et al*. (2019) in which approximately two-third participants (62.9%) were a non-smoker. Most of the participants 42.9 % work for 6-8 hours. While, the working experience of the rest was an approximately near to each other accounting (28.6 %, 31.4 %, 22.9 %, and 17.1 %) of the participants had experience of (1-2), (>2-5), (>5-10) and (>10-20) years respectively, which is different to the results of Philip *et al.* (2014) that three-quarters of the respondents had the experience of 10 years or more. In addition, the results of Zalat and Shetta (2012) work showed that (43.2%) of participants had experience of more than 10 years.

This study was identified six types of jobs of automobile repair workers in the visited garage workshops. Most of the participants were mechanics (51.4%). The rest were oil exchangers, welders, and painters in decreasing order; 17.1%, 11.4 %, and 8.6 % respectively, and equal distribution equivalent to (5.7 %) each were electricians and plumbers. In Vyas *et al* (2011) study, among the reviewed auto repair workers, one-third of participants (34%) were repairing workers (mechanics) and (11%) were painters, which is consistent with our results. While, the results were the opposite for the plumbers (11%), welders (5%), and electricians (1%). The percent of mechanics in this study were nearly comparable with the percent (57.1%) of car maintenance workers (mechanics) as stated by Amfo-Out and Agyemang. (2016). While, the results were different for welders (7.1%), electricians (14.3%), and sprayers (painters) (21.4%).

More than half of the participants (54.3%) suffer from muscular fatigue, and a half (51.45%) suffer from cough and breathing difficulty. While, the rest of the participants accounting (20%, 17.1 %, and 11.4%), were suffered from the following symptoms in decreasing orders; headache, dizziness, and nausea. This was slightly higher than the findings of Philip *et al.* (2014) in which (47, 44.3%) of participants suffered from muscle or bone pains. Also, only (19, 17.9%) of participants suffer from chronic cough or breathlessness. In Adu *et al.* (2018) study, the participants only asked about headaches and more than half (58.89%) suffered from headaches, which is opposite to our result. The muscular disorder was a common health problem among auto repair mechanics (26%) as stated in Thangaraj and Shireen (2017) study that is different from our results. Also, only 11.3% of participants suffer from chronic cough which is different from our results. Another study by Elenwo (2018) reported that among the studied occupational hazards of automobile mechanics in Nigeria, headaches and dizziness were common among (15%) and (13%) of automotive workers. Which were lower than the findings of the current study. In Kamal and Malik (2012) work, the painters and mechanics were asked if they had headaches and nausea. The results showed that more than half (56%) and nearly one-third (32%) of painters said they sometimes and often suffered from headaches respectively. There were (24%) and (16%) of painters who said they sometimes and often suffered from nausea respectively. Meanwhile, nearly one-third (31%) and only (3.5%) of mechanics suffered from headaches respectively. There were (6.9%) of mechanics who sometimes suffered from nausea. There was no statistically significant difference for both symptoms.

Table 1

The socio-demographic and occupational characteristics of automobile garage workers

Parameters	Variables	Frequency (n)	Percent (%)
Age (years)	18-29	17	48.6
	30-39	16	45.7
	40-64	2	5.7
Nationality	Libyan	26	78.8
	Non-Libyan	7	21.2
Education level	illiterate	0	0
	Primary education	0	0
	Secondary education	5	14.3
	High school	11	31.4
	Academic	14	40
	Still students	5	14.3
BMI (Kg/m^2)	18.5-24.9 (Normal)	16	47.1
	25-29.5 (Overweight)	16	47.1
	30 and Greater (Obese)	2	5.9
Smoking status	Nonsmoker	9	25.7
	Current medium smoker	11	31.4
	Current heavy smoker	11	31.4
	Previous smoker	4	11.4
Working hours per day	Less than 6 hours	13	37.1
	6-8 Hours	15	42.9
	More than 8 hours	7	20
Working experience	1- 2 years	10	28.6
	2-5 years	11	31.4
	5-10 years	8	22.9
	10-20	6	17.14
Type of job	Mechanics	18	51.4
	Painters	3	8.6
	Plumbers	2	5.7
	Welders	4	11.4
	Electricians	2	5.7
	Oil changers	6	17.1
Symptoms suffered by workers	No Symptoms	3	8.6
	Muscular Fatigue	19	54.3
	Headache	7	20
	Dizziness	6	17.1
	Nausea	4	11.4
	Breathing Difficulties and cough	18	51.4

4.1.2. The personal safety of the participants

The findings concerning the personal safety of workers were illustrated in Table 2. Nearly sixty percent of the participants (58.8 %) have had injuries during work in the garage, which come in accordance with Vyas *et al*. (2011) findings. This indicates that workers need a training program to minimize or avoid injuries during work. Further studies are needed to analyze the causes of injuries and the methods of prevention (Hunt *et al*., 2000). High injuries percent can be explained that only 6% of the participants were wearing the personal protection devices (PPEs) during the work in the garage and the rest do not wear the protection devices 94% at all. This goes in line with what was found by Kamal and Malik (2012), in which, almost all the participants in their work were found to be working without any proper personal protective equipment. However, this result is different from the results of Thangaraj and Shireen. (2017) that less than half (44%) of the workers used the PPE during work. Although, they had a high awareness Level about different PPEs. Therefore, Thangaraj and Shireen (2017) emphasize in their work on proper educational programs concerning occupational hazards and the use of proper protective equipment regardless of high awareness.

Table 2

The personal safety of the automobile repair workers

Characteristics	n	%
Accident during work		
Yes	20	58.8
No	14	41.2
Wearing protective device		
Yes	2	5.9
No	32	94.1

4.1.3. The occupational chemical exposure of the participants

The used chemicals and chemical users' workers were presented in Table 3. The participants during the work in the garage were exposed to a range of chemicals according to their answers to the last open question in the questionnaires. The chemicals used by participants in the garage workshop in decreasing order were as follows; More than three-quarters of participants (75.8%) used benzene, the same percent accounting (51.5%) each used (used oil) and car grease, (42.4%) used kerosene, (39.4%) used engine oil, (30.3%) used hydraulic oil, (15.2%) used gasoline, (12.1) exposed to welding fumes, (6.1%) used paints and finally equal percent representing (3%) each was exposed to naphtha and rust spray.

The workers were divided into three groups according to the nature of chemicals they were used and exposed to in the garage as follows; Petrochemicals users, oils users, and paint staffs' users. Nearly the majority of the participants 90.9 % were exposed to petrochemicals, 78.8 % were exposed to oils and the rest 24.2% were exposed to paints and their related products in the garage workshops. The contact with the chemicals is direct that could cause health consequences on long-term contact.

In this type of occupation, direct exposure to petroleum-related products generally results from routine distribution, transportation, improper handling and use, accidental leaching, and spills of these products. In addition to many other ways by which humans are exposed to these chemicals (Tang *et al*. 2009). Petroleum products consist of many types of solvents such as ethyl xylene, benzene, and toluene. The problem is that most of these solvents have already been established as carcinogens such as benzene (Sanders, 2000). Nevertheless, in the garage workshops, the contaminants are mainly included in petrochemicals, crude oil, kerosene oil, and predominantly the used gasoline engine oil that pollute the worker's body parts and workplaces. The smell of these chemicals is dominants causing severe nausea and headache, especially for spray painters. The volatile organic compounds (VOCs) gave smell and odors that arise from solvents used to help stabilize the dispersion and as tinting pigments (Kamal and Malik, 2012).

Table 3

The used chemicals and chemical users' workers

Parameters	Variables	n	%
Used chemicals	Benzene	25	75.8
	Kerosene	14	42.4
	Paints	2	6.1
	Welding fumes	4	12.1
	Engine oil	13	39.4
	Used oil	17	51.5
	Car grease	17	51.5
	Naphtha	1	3.0
	Hydrolytic oil	10	30.3
	Gasoline	5	15.2
	Tuner	6	18.2
	Rust Spray	1	3.0
Chemical users'	Petrochemicals users	30	90.9
	Oils users	26	78.8
	Paints stuff users	8	24.2

4.1.4. The correlation between the different chemical users' and the symptoms suffered.

Seventeen 17 (34.7%) of the petroleum users reported muscle fatigue as well as cough/breathlessness while 13 (31%) and 14(33.3%) of oils users had muscle fatigue and cough/ breathing difficulties respectively. Most paints users 8(66.7%) reported muscle fatigue and 3(25%) had cough/ breathing difficulties. However, there is no significant association between the symptoms of the participants and the chemicals they used during work in the garage except for the paint's users and the muscular fatigue (p=0.004). Moreover, cough and breathlessness could be attributed to the fact that the majority of participants in this study were smokers (74.3%) rather than chemicals exposure (Table 4).

Table 4

The correlation between the different chemical users and the symptoms.

Symptoms n (%)	Chemicals users' workers n (%)			P1	P2	P3
	Petrochemicals	Oils	Paint staffs			
No Symptoms	1 (2.0)	2 (4.8)	0 (0.0)	0.084	0.419	0.419
Muscular Fatigue	17 (34.7)	13 (31)	8 (66.7)	0.801	0.213	0.004*
Headache	5 (10.2)	6 (14.3)	0 (0.0)	0.121	0.518	0.1
Dizziness	5 (10.2)	4 (9.5)	0 (0.0)	0.681	0.533	0.134
Nausea	4 (8.2)	3 (7.1)	1 (8.3)	0.437	0.941	0.941
Cough and breathing difficulties	17 (34.7)	14 (33.3)	3 (25)	0.233	0.849	0.317

(P1= symptoms versus petrochemicals users, P2= symptoms versus oils users, P3= symptoms versus paint staff's users).
**Significant at p<0.05.*

4.2. Laboratory data analysis

The consequences of occupational chemicals exposure on the hematological parameters of automobile workers and different chemical users were summarized in Table 5. Auto repair workers who were exposed to petrochemicals, oil, and paints had no significant difference in RBC count compared to controls (p=0.641, 0.165, and 0.386 respectively). That is not compatible with (Kamal and Malik, 2012; Sajid and Ali, 2020; Adu *et al.,* 2018; Okoro *et al.,* 2006; lee *et al*., 2002) who found that mechanics had a significant reduction in RBC count when compared to controls. However, the results were in contrast with Getu *et al.* (2020) as they found that the mean RBC count was significantly higher in petroleum exposed workers as compared with the control group. The current study showed that both petrochemicals and oils exposed workers had lower hemoglobin levels that were statistically non-significant, (13.2) and (13) g/dL respectively, in comparison to control (13.65g/dL). Nevertheless, both were anemic in comparison to the normal range of the standard reference values of hemoglobin level. (Sajid and Ali, 2020; Ataro *et al*., 2018; Kamal and Malik, 2012; Okoro *et al*., 2006) found that the mean hemoglobin (Hb) values were significantly lower in workers who were exposed to petrochemicals. While Kamal and Malik. (2012) found that paints exposed workers (sprayers) had normal hemoglobin levels in comparison to control. However, a study by Adu *et al.* (2018) examine the sprayers and a study by (Getu *et al.,* 2020) examine petroleum exposed workers showed that they had significantly higher hemoglobin levels. Furthermore, in our finding both petrochemicals and oils exposed groups had a significant decrease in MCV levels (p=0.05 and 0.006 respectively) in comparison to controls while no effect had been found in sprayers. That was compatible with a study by Sajid Jabbar and Ali (2020) found significant reductions in MCV of exposed workers at petroleum stations. However, different outcomes by Adu *et al.*, 2018; Kamal and Malik, (2012) who found that MCV was increased in painters and reduced in both mechanics and sprayers.

Furthermore, our results revealed that the MCHC was significantly increased in petroleum and oil exposed groups compared to controls (p=0.027 and p=0.008 respectively), the MCH values had no significant difference in exposed groups compared to controls. In contrast to our study, other studies by Sajid Jabbar and Ali (2020); Abubakar *et al*. (2015); Okoro *et al*. (2006) examine the effect of petrochemicals inhalation on some hematological indices found MCHC were significantly decreased in test groups when compared with control. on the other side, different studies by (Getu *et al*., 2020; Zhang *et al.,* 2020; Harati *et al*., 2017) were consistent with our finding that MCHC concentration significantly increased in the petrochemicals-exposed group compared to the control group.

Our results showed that the total WBC counts were significantly reduced in paints exposed workers (p=0.04) in comparison to controls, while no significant changes in petrochemicals and oils exposed groups (p=0.450 and p=0.359). However, according to Adu *et al.* (2018); Okoro *et al*. (2006) the WBC counts were reduced in both mechanics, sprayers, and petroleum exposed workers. Also, the WBC count has reduced in petroleum exposed workers according to Sajid Jabbar and Ali (2020); D'Andrea and Reddy, (2016). While that is not compatible with Kamal and Malik's findings in which the WBC counts were increased in painters. However (Getu *et al*., 2020; Ataro *et al.,* 2018) reported a significant increase of WBC in garage workers and petrol filling workers compared with the non-exposed group.

Moreover, platelet counts were found to be slightly reduced in petroleum and oils exposed groups and painters (258, 253, and 249) (10^9/L) compared to controls 274(10^9/L). According to Harati *et al.* (2017) no significant differences were observed in the platelet count of painters compared to the control group. While according to Getu *et al*. (2020); Ataro *et al*. (2018) the platelet count was higher than healthy controls in garage workers and petrol filling workers respectively.

Additionally, all exposed automobile workers had non significantly higher lymphocytes percentages (LMP%) (35.26%, 36.51%, and 37% respectively) in comparison to control (34.44%), while they had non significantly lower granulocytes percentages [56.43%] in comparison to controls (58.47%). According to (Harati *et al.,* 2017) the mean lymphocyte and neutrophil levels increased in painting workers exposed to benzene, compared to the control group. Elderdery *et al.* (2015) found that more than (40%) of benzene-exposed workers showed neutropenia and (78%) showed lymphocytosis. Nevertheless, according to many types of research benzene is a hepatotoxic compound, causing a reduction in the total WBC, granulocyte, and lymphocyte counts in children exposed to petrochemicals containing benzene (Lee *et al*., 2002). Additionally, a study by Lan *et al.* (2004) showed that the decreases in WBCs, granulocytes, lymphocytes, significantly correlated with benzene exposure and were lower in those exposed to benzene compared to controls. However, a study by Pesatori *et al*. (2009) found there are no decline in WBC and lymphocytes related to benzene exposure. Chronic exposures of automobile workers to aromatic compounds like petrochemicals containing benzenes may have adversely affected hematopoiesis. The bone marrow's activity may be suppressed by petrochemical and heavy metals leading to ineffective hematopoiesis (Adu *et al.,* 2018). Although our study was not compatible with many studies that examine the effect of petrochemicals on hematological profile. However, our findings are indicative of the fact that the hemopoietic system may be affected by exposure to these petrochemicals.

Table 5

Comparison of average hematological parameters among control and chemicals users

Parameters	Control n=35	All exposed n=35	Petroleum product users	Oils users	Paint staffs' users	P1	P2	P3	P4
WBC (10^9/L)	9.19±2.42	8.45±2.5	8.7±2.6	8.5±2.6	7.4±2.184	0.450	0.359	0.043*	0.223
RBC (10^{12}/L)	4.79±0.44	4.72±0.51	4.73±0.54	4.61±0.511	4.65±0.210	0.641	0.165	0.386	0.533
HGB (g/dL)	13.65±2.9	13.24±2.72	13.2±2.8	13±0.59	14.3±1.18	0.527	0.477	0.538	0.543
HCT (%)	38.85±6.63	37.73±4.83	37.82±4.6	37.37±4.8	41.3±3.5	0.488	0.349	0.358	0.431
MCV (IL)	82.23±9.22	77.83±8.45	78.16±8.07	75.67±7.42	83.56±8.4	0.05*	0.006*	0.715	0.05*
MCH (pg)	28.87±2.56	28.23±2.64	28.3±2.61	27.75±2.43	29.12±3.4	0.465	0.104	0.861	0.321
MCHC (g/dL)	35.17±2.27	36.36±1.72	36.38±1.7	36.73±1.76	34.83±1.33	0.027*	0.008*	0.632	0.022*
LYM%	34.44±11.1	36.47±8.4	35.26±7.75	36.51±8.75	37±5.8	0.745	0.457	0.531	0.414
GRAN%	58.47±11.8	56.43±8.4	57.29±8.44	56.12±8.4	56.9±7.1	0.673	0.433	0.769	0.450
PLT (10^9/L)	274±87.07	262.70±80.07	258.9±84.28	253±72.88	249±61.7	0.492	0.342	0.450	0.582
MPV (fL)	9.10±1.3	9.29±0.8	9.16±0.83	9.07±0.90	9.01±0.53	0.663	0.509	0.592	0.508

(P1=control versus petroleum users, P2=control versus oil user, P3= control versus paints users, P4=control versus all users). Results are mean ± standard deviation) at 95% CI confident interval. Significant at p<0.05; WBC: white blood cell; RBC: red blood cell; Hb:hemoglobin; HCT: hematocrit; MCV: mean corpuscle volume; MCH: Mean cell hemoglobin ; MCMC: Mean cell hemoglobin concentration; LYM: lymphocytes; GRAN: granulocytes (neutrophils, eosinophils); PLT: platelet; MPV: Mean platelet volume. gm/dL = grams per deciliter, and pg/cell = picograms per cell, (fl) femtoliter.

**Significant at p<0.05.*

5. Conclusion

In conclusion, the automobile repair workers were exposed to a wide range of chemicals including petrochemicals, oils and paints, and its related products in the garage workshops. The results indicated that working in the garage changes some of the hematological parameters of the workers. Thus, suitable and actual safety guidelines should be implemented to prevent possible chemical exposure during routine work and further studies to recognize the type of anemia is needed and also the effect of heavy metals such as lead, chromium/chromates, platinum salts, nickel compounds, and copper, should be evaluated.

6. Limitations and Recommendations

This study has some limitations. First of all, neither the medical analysis Labs nor the auto-mobile workers were cooperative. Therefore, the sample size is small as it is difficult to convince people to participate and find control volunteers to meet the conditions. But this study is the first study to do among this type of job in Libya. The study should be done in a longer period of time in order to get an appropriate number of samples. Secondly, the complete blood count parameters of both the automobile garage workers and non-exposed people were measured and evaluated. But, the renal function test (RFT), the kidney function test (KFT), the lipid profiles were not measured and evaluated. Further studies including these blood tests in addition to CBC should be measured and evaluated. Also, the level of each chemical in the blood of automobile workers, heavy metals, and their health consequences should be measured and evaluated separately. At the country level, there should be safety guidelines for work in a garage that minimize exposure to chemical and their health effects.

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