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Atherogenic Index and Liver Function in Workers at Car Mechanics Workshops in Baghdad-Iraq

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Abstract
Workers in automotive repair shops are at risk of exposure to hazardous chemicals, which can have varying health consequences depending on the duration and intensity of exposure, and may ultimately contribute to environmental pollution. The objective of this study is to identify variations in the biochemical levels, including liver enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), lipid profile, and atherogenic indices (AIP) between workers in car mechanics workshops and occupationally unexposed participants in Baghdad. Blood samples were taken from 70 workers aged 18–50 at car mechanics workshops. The occupations included car maintenance (WI, n = 35), vehicle painting (WII, n = 35), and healthy males (C, n = 25) as the control group. All samples were analyzed for ALT, AST, total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) using commercially available kits. The atherogenic index of sera (AIP) was calculated from values of HDL and TG. The results of the present study revealed a statistically significant increase ($p < 0.05$) in ALT and AST levels among car maintenance and vehicle painting workers compared with the control group. Significant differences ($p < 0.05$) were also observed in HDL, LDL, TC, TG, and AIP between the workers and C groups. The study found that liver enzymes, lipid profiles, and indicators of atherogenicity were changed in workshop workers. The workers' exposure to environmental pollution in auto repair workshops was identified as a contributing factor to liver damage, dyslipidemia, and cardiovascular disease in these individuals.

Keywords: Mechanic's workers; Environmental pollution; Lipid profile; Liver function; Atherogenic index.

مؤشر تصلب الشرايين ووظائف الكبد لدى العاملين في ورش ميكانيكا السيارات في بغداد –العراق

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الخلاصة
يتعرض العاملون في ورش تصليح السيارات لخطر التعرض للمواد الكيميائية الخطرة، والتي يمكن أن يكون لها عواقب صحية متفاوتة اعتمادًا على مدة وشدة التعرض، وقد تساهم في النهاية في التلوث البيئي. الهدف من هذه الدراسة هو تحديد الاختلافات في المستويات الكيموحيوية، بما في ذلك إنزيمات الكبد ألانين

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أمينوترانسفيراز (ALT)، وأسبارتات أمينوترانسفيراز (AST)، وصورة الدهون، ومؤشرات تصلب الشرايين (AIP) بين العاملين في ورش ميكانيكا السيارات والمشاركين غير المعرضين مهنياً في بغداد. . تم أخذ عينات دم من 70 عاملاً تتراوح أعمارهم بين 18–50 عامًا في ورش ميكانيكا السيارات. وشملت المهن صيانة السيارات (WI، 35 = n)، وطلاء المركبات (WII، 35 = n)، والذكور الأصحاء (C، 25 = n) كمجموعة تحكم. تم تحليل جميع العينات لـ ALT، AST، والكوليسترول الكلي (TC)، والدهون الثلاثية (TG)، والبروتين الدهني منخفض الكثافة (LDL)، والبروتين الدهني عالي الكثافة (HDL)، والبروتين الدهني منخفض الكثافة جدًا (VLDL) باستخدام العدد المتاحة تجاريًا. تم حساب مؤشر تصلب الشرايين للأمصال (AIP) من قيم HDL وTG. كشفت نتائج الدراسة الحالية عن وجود زيادة ذات دلالة إحصائية (P <0.05) في مستويات ALT وAST بين العاملين في صيانة وطلاء المركبات مقارنة بالمجموعة الضابطة. كما لوحظت اختلافات كبيرة (P <0.05) في HDL، LDL، TC، TG، وAIP بين العمال ومجموعات C. وجدت الدراسة أن إنزيمات الكبد، وصورة الدهون، ومؤشرات تصلب الشرايين قد تغيرت لدى العاملين في الورشة. تم تحديد تعرض العمال للتلوث البيئي في ورش تصليح السيارات كعامل مساهم في تلف الكبد، واضطراب شحوم الدم، وأمراض القلب والأوعية الدموية لدى هؤلاء الأفراد.

1. Introduction

Workers at automotive repair shops often engage in tasks such as assembling motor cars, applying spray paint, igniting fuel, performing welding and soldering operations, and fixing radiators. These activities carry a risk of chemical toxicity [1]. This includes individuals working with small engines and light vehicles. Due to their professional activities, these workers encounter more significant health and environmental risks than the general population. However, these particular activities are the main contributors to toxic pollution, stemming from the irresponsible conduct of the occupational workforce [2].

Working in an automotive repair workshop exposes individuals to dust, air pollution, and various harmful chemicals. Studies have indicated that mechanics have higher concentrations of lead, cadmium, chromium, zinc, and copper in their bodies than those not consistently exposed to these substances [3]. Toxic substances can be found in many products used in workshops, including brake fluids, degreasers, greases, metal cleaners, benzene organic solvents, asbestos welding fumes, vehicle exhaust, and daily diet [4-6]. These harmful chemicals can enter the body through inhalation, skin contact, or accidental ingestion. Once inside the body, they can spread throughout, and cause effects that go beyond the initial point of contact [7,8]. This poses a significant risk to the health, particularly affecting organs involved in blood circulation, such as the liver [9].

The liver plays a crucial role in the body, performing essential functions such as storing and breaking down carbohydrates, processing hormones, managing waste and foreign substances, producing blood proteins, generating urea, regulating fat metabolism, and producing bile [10]. Aminotransferases, which include enzymes like alanine aminotransferase (ALT) and aspartate aminotransferase (AST), are frequently used to assess liver function [11, 12]. The liver is capable of processing metals and dispose of them in the bile via the intestines [13]. Approximately five percent of it is released as feces while 90 to 95% gets re-absorbed through circulation [14]. Liver damage, cell injury, and organ failure can occur due to chemical exposure [15, 16].

Injury to liver cells as well as damage to the liver can be indicated by elevated levels of AST and ALT [17]. Increased levels of AST in the blood are commonly observed in instances of acute damage to liver cells. Conversely, serum ALT is regarded as a dependable marker of liver cell damage since it is seen at low levels in organs other than the liver [18].

Vapors from petrol, diesel, and motor can adversely affect liver membrane and induce a rise in blood lipid concentrations due to their interference with lipid homeostasis, which is essential for maintaining the balance of lipids in the body. Increased levels of total cholesterol, triglycerides, LDL cholesterol, along with decreased levels of HDL cholesterol are contributing factors in the development of atherosclerosis and its related cardiovascular illnesses [19]. A lipid profile, also known as a lipid panel, consists of a series of blood tests to check for abnormalities in lipids like cholesterol and triglycerides. There could be several diseases like heart failure, digestive problems [20, 21], and other conditions that may be identified with the help of these findings. Typically, a lipid profile comprises tests performed together to determine the risk of heart disease. It gives details about the chances of experiencing a heart attack or stroke due to blocked blood vessels or atherosclerosis [22]. Researchers have discovered a connection between another ratio called the atherogenic index of plasma (AIP) and metabolic dysfunction-associated steatotic liver disease (MASLD) [23, 24].

The AIP assesses lipid profiles in the bloodstream. It has proven highly valuable in predicting dyslipidemia-related diseases like diabetes, atherosclerosis, and heart disease. The AIP is a useful predictor not only for cardiovascular disease but also for hyperuricemia [25]. Not only is AIP a useful predictor for heart disease, but it is a sensitive and potent indication that reflects the interaction between atherogenic and non-atherogenic lipoproteins; triglycerides are converted to the high-density lipoprotein/cholesterol ratio using a base-10 logarithmic scale (AIP = log10 (triglycerides/HDL cholesterol) [26]. AIP is a useful indication for determining the likelihood of developing cardiovascular illnesses and arteriosclerosis [27].
The AIP proves to be an indicator of atherosclerosis when compared to LDL cholesterol in a lipid profile. AIP eliminates uneven evaluation of various lipid components and makes basic estimation tasks easier [28]. Therefore, the aim of this study was to determine if long-term exposure to environmental contaminants at car mechanics workshops is linked with hepatic injury, dyslipidemia, and cardiovascular ailments in these individuals.

2. Materials and Methods

2.1 Subject

This retrospective cohort study included 70 male participants, categorized into two groups: car mechanics (WI, n=35) group and the vehicle painting (WII, n=35) group. A third group of healthy males (C, n=25) without automotive chemical exposures recruited from local communities served as the control group. The data collection from the private sector was conducted in Baghdad from September 2022 to January 2023.

The study included participants within the age range from 18-50 years, ensuring matching across the groups. The duration of exposure or years of work ranged between (10- 20) years. The anthropometric indices of all participants were obtained as weight and height were measured and body mass index (BMI) was calculated as body weight divided by height [29]. Exclusion criteria were pre-existing cardiovascular, hepatic, and renal diseases, diabetes, hypertension, substance abuse, and active inflammatory diseases. Additionally, individuals who consumed alcohol or smoked were excluded.

The groups were designed to examine associations between specific automotive chemical exposures and biomarkers of interest.

2.2 Chemicals

Ninety-five fasting blood samples (5ml each) were collected in gel tubes from all participants in this study, all of whom were individuals with various occupations in Baghdad. The samples were centrifuged at 2000xg for 10 min at room temperature to separate serum and red blood cells. Serums were used to estimate ALT, AST, and lipid profiles. Each participant's serum was divided into portions of 200 µl in Eppendorf tubes and stored in the freezer (-20 ° C) until use.
Liver biochemical markers such as ALT and AST are often examined in liver function tests [30]. The levels of these liver enzymes ALT and AST were measured by (Linear Chemicals, Spain), a commercially available kit. A professional testing company used a Hitachi 7600 automatic analyzer (Hitachi High-Technologies, Tokyo, Japan) for each individual's blood sample to perform biochemical analysis.
Total cholesterol (TC), triglycerides (TG), and high-density lipoprotein (HDL) were determined using the spectrophotometric method. In contrast, low-density lipoprotein (LDL) was calculated using the Friedewald equation [LDL cholesterol = total cholesterol (HDL cholesterol) – (triglyceride/5)] [31]. The atherogenic index of plasma (AIP) was calculated from values of HDL, TG, TC, and LDL [26].

2.3 Statistical analysis

Statistical analysis is very useful for gaining insights and supporting data interpretation. The means ± standard deviations of samples were calculated using SPSS-Statistics Version 22.0 and compared using a one-way ANOVA. The P values less than 0.05 were used to define statistical significance.

3. Results

This study comprises 70 Iraqi workers (W) from the private sector, matched with 25 healthy males serving as a control group (C). All participants were aged between 18-50 years. The study group (W) was further divided into two groups: the car mechanics (WI, n=35) group and the vehicle painting (WII, n=35) group.

Table 1: The mean ±SD of the Age, BMI**,** ALT, and AST in the studied groups.

PARAMETERS	C(N=25) MEAN ±SD	WI(N=35) MEAN ±SD	WII(N=35) MEAN ±SD	*P* VALUE	
AGE (YEARS)	29.96 ± 6.48	34.06 ± 8.68	32.66 ± 6.53	C&WI	0.348
				C&WII	0.092
				WI&WII	0.708
BMI(KG/M²)	23.03 ± 1.61	23.56 ± 3.74	24.79 ± 2.52	C&WI	0.270
				C&WII	0.290
				WI&WII	0.999
ALT(U/L)	28.78±6.49	39.22±6.68**	41.24±5.24**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.356
AST (U/L)	28.25±6.92	37.92±6.14**	38.97±6.65**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.781

Significant ****P*<0.05; highly significant*****P***<0.001; no significant** ***P***>**0.05**
(WI: Car mechanics, WII: Vehicle painting, and C: Control).

Table 1 presents the biochemical parameters and calculated indexes between all the studied groups. The data shows no statistically significant differences observed in terms of age and

BMI among all the groups examined (P>0.05). However, it revealed that the mean serum levels of ALT and AST significantly increased in the workers' group compared with the control group. As mentioned in Table (2), the results of the lipid profile parameters of the studied groups.

Table 2: The mean ±SD of the lipid profile parameters of mechanic workers and other groups.

PARAMETERS	C(N=25) MEAN ±SD	WI(N=35) MEAN ±SD	WII(N=35) MEAN ±SD	*P* VALUE	
TC MG/DL	159.27±6.29	184.36±10.99**	186.81±15.36**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.666
TG MG/DL	144.27±20.45	174.72±36.01**	190.18±38.20**	C&WI	0.002
				C&WII	0.000
				WI&WII	0.137
HDL-C MG/DL	47.38±3.86	36.55±3.37**	35.62±4.46**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.585
LDL-C MG/DL	83.03±7.62	112.85±12.12**	113.14±14.39**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.994
VLDL MG/DL	28.85±4.09	34.94±7.20**	38.03±7.64**	C&WI	0.002
				C&WII	0.000
				WI&WII	0.137

Significant ****P*<0.05; highly significant*****P***<0.001; no significant** ***P***>0.05**
(WI: Car mechanics, WII: Vehicle painting, and C: Control).

Table (3) summarizes the mean and standard deviation of the Atherogenic Index of serum (AIP), determined in all the studied groups.

Table 3: The mean ±SD of the AIP of mechanic workers and other groups.

PARAMETERS	C(N=25) MEAN ±SD	WI(N=35) MEAN ±SD	WII(N=35) MEAN ±SD	*P* VALUE	
AIP	0.51±0.12	0.67±0.11**	0.72±0.13**	C&WI	0.000
				C&WII	0.000
				WI&WII	0.226

Significant ****P*<0.05; highly significant*****P***<0.001; no significant** ***P***>0.05**
(WI: Car mechanics, WII: Vehicle painting, and C: Control).

4. Discussion

Table 1 demonstrates that the mean values of ALT and AST in WI (39.22±6.68 and 37.92±6.14 U/L**)** and WII (41.24±5.24 and 38.97±6.65 U/L) were significantly higher (P=0.000) compared to the C group (28.78±6.49 and 28.25±6.92 U/L) respectively. Numerous studies have shown that workshops are exposed to various chemicals that increase the activity of aminotransferases [32]. Elevated levels of transaminases have been reported in patients with severe liver injury. These findings suggest that liver enzymes may have been released into the bloodstream. Increased membrane permeability or necrosis of liver cell membrane leads to damaged liver cells and suggests liver organ dysfunction [33]. A previous study has shown that enzyme levels are increased in correlation with the number of damaged cells [34].

The results of the present study shown in Table (2) revealed a significant increase (P=0.000) in the concentration of TC, TG, HDL-C, LDL-C, and VLDL in the serum of the WI and WII compared to the C group. There have been different research findings regarding the relationship between various chemicals and lipid profiles. According to a study from Sulaimaniya (Iraq) [35] and Iran [36], there were no significant differences in lipid profile parameters between lead-exposed and non-exposed subjects. According to a study by Kasperczyk et al. [37], no significant association was observed between blood lead levels and lipid profiles, indicating a lack of correlation between the two variables. The total cholesterol level can rise because of lead intoxication, according to some studies. Subjects exposed to organic solvents had significantly higher blood triglyceride and total cholesterol levels. These workers are at higher risk of cardiovascular diseases because of exposure to different chemicals at work [38].

The elevated lipid profile in the present study is consistent with earlier research showing that exposure to gasoline vapor changes the average serum lipid profile and induces oxidative stress in rat hepatocytes [39]. It has been shown that the oxidation of LDL-C is a crucial step in the development of atherosclerosis [40].

Other chemicals present in the auto-mechanic environment, in addition, to lead exposure, have an impact on the amount of biochemical, which can result in abnormal liver, renal, and cardiovascular disorders, and maybe decrease in fertility because of the effect of the heavy metal on the male reproductive system [41].

For instance, a study from Pakistan revealed that the environment of a garage workshop had a considerable negative impact on the function of the liver and kidneys. Mechanics are more susceptible to hepatic dysfunctions due to exposure to hazardous levels of both total petroleum hydrocarbons and volatile organic compounds [42]. Additionally, it has been documented that exposure to hydrocarbons in a motor mechanic shop might harm the liver. Preliminary analysis showed that the mechanics had significantly higher levels of triglycerides, atherogenic risk index, and coronary risk index compared to the control group [43].

The results presented in Table (3) showed that the mean value of AIP has a significant increase (*P*=0.000) in WI (0.67±0.11) and WII (0.72±0.13) as compared with the mean value of AIP in the C group (0.51±0.12). In addition, no significant (*P*=0.226) between WI and WII.

The atherogenicity index (AIP), which is the logarithm of the molar ratio of triglycerides to high-density lipoprotein cholesterol (TG/HDL-C), showed a significant association with LDL-C particle size; AIP is a strong predictor of atherosclerosis and coronary heart disease [44].

In addition to visualizing lipid profiles, AIP can predict lipoprotein particle size. It has been associated with insulin resistance severity in lipid profiles, which partially explains its greater discriminatory power for metabolic dysfunction-associated steatotic liver disease (MASLD) [45].

Conclusion

Our research suggests that exposure to petrol, diesel, and automotive exhaust can harm liver function by causing hepatotoxicity. This impact is linked to the elevation of the lipid indices "TC, TG, LDL, and VLDL." It is commonly seen in mechanical engineering as opposed to controls. Exposure to petrol leads to an increase in oxidative stress within cells, which may overwhelm the body's antioxidant mechanisms. The impact is to notably elevate the levels of TG, LDL, and all other markers. Cholesterol. Elevated levels of AIP are associated with an increased susceptibility to atherosclerosis and cardiovascular disease. Regular surveillance and examinations of personnel in the workshop are essential for mitigating the enduring consequences of chemical exposure. Reducing detrimental exposures in workshops can mitigate adverse health effects.

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Authors Contributions

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

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