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Original Article

Platelet Count, Bleeding Time, and Coagulation Parameters Among Gasoline-Exposed Gas Station Workers in Zawia, Surman, and Sabratha, Libya

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Abstract

Background: Benzene is a common pollutant in gasoline station workplaces, where workers may be exposed through inhalation and dermal contact. Benzene is hematotoxic and can affect bone marrow function, but findings on platelet count and platelet function at low occupational exposure levels remain inconsistent. This study examined platelet count and function among gasoline station workers in Zawia, Surman, and Sabratha cities, Libya. **Materials and Methods:** A cross-sectional comparative study included 150 gasoline station workers and 60 control subjects. Venous blood samples were collected for complete blood count and coagulation testing. Platelet counts were measured using an automated haematology analyser (Sysmex XP-300). Bleeding time was measured using the Duke method, and Wright-stained peripheral blood smears were examined microscopically to assess platelet morphology and aggregation. **Results:** Overall, gasoline-exposed workers had platelet counts and bleeding times within reference ranges. Platelet count did not differ significantly between exposed workers and controls (p= 0.382), and bleeding time was also not significantly different (p= 0.196). Regional analysis showed a significant difference in platelet count among workers from the three cities, with lower values in Zawia than in Surman and Sabratha (p= 0.018). PT, PTT, and INR did not differ significantly between exposed and control groups, although regional differences were observed among exposed workers. **Conclusion:** Within the limitations of the cross-sectional design and the absence of direct benzene exposure measurements, occupational gasoline exposure was not associated with significant overall differences in platelet count, bleeding time, PT, PTT, or INR. The observed regional differences and the very limited use of personal protective equipment indicate the need for routine medical surveillance, exposure monitoring, and stronger occupational safety practices.

Keywords: gas station workers; benzene; platelet count; bleeding time; coagulation; occupational exposure.

Introduction

Benzene (C_6H_6) is a colourless, volatile, and highly flammable aromatic hydrocarbon found in gasoline, industrial solvents, and chemical manufacturing processes. Because of its high volatility, benzene readily evaporates into ambient air and can be inhaled by exposed workers. It is also present in emissions from gasoline service stations and motor vehicle exhaust (U.S. Environmental Protection Agency [EPA], 2016). Gasoline station attendants may be exposed to benzene during fuel dispensing, fuel handling, and contact with contaminated surfaces. Exposure occurs primarily by inhalation of fuel vapors and, to a lesser extent, by dermal contact. Chronic occupational exposure to benzene remains an important public health concern, particularly where workplace controls, training, and personal protective equipment are inadequate. Benzene is classified by the International Agency for Research on Cancer as a Group 1 carcinogen (IARC, 2018). Its most serious toxic effects involve the hematopoietic system, where it can suppress bone marrow activity and contribute to anaemia, leukopenia, thrombocytopenia, and other haematological abnormalities (Snyder, 2012). These effects are mediated in part by reactive metabolites, oxidative stress, DNA damage, and apoptosis of hematopoietic progenitor cells (Sun *et al.,* 2016; Wang *et al.,* 2012). Platelet alterations are clinically relevant because platelet count and function reflect both bone marrow thrombopoiesis and primary hemostasis. Previous occupational studies have reported reduced platelet counts among some benzene-exposed populations (Lan *et al.,* 2004; Rothman *et al.,* 1996), whereas other studies of low-level exposure have found no significant platelet reduction (Binsaleh *et al.,* 2024; Koh *et al.,* 2015). Additional studies suggest that benzene exposure may affect platelet indices or immune-mediated platelet parameters before measurable thrombocytopenia develops (Huang *et al.,* 2014). Benzene exposure may also influence inflammatory pathways. Occupational exposure has been associated with altered levels of inflammatory mediators, including tumor necrosis factor-alpha and interleukin-6, which

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may contribute to changes in platelet production or function (Guo *et al.,* 2020; Wang *et al.,* 2021). Given these mixed findings, further assessment of platelet-related parameters among chronically exposed gas station workers is warranted. The present study assessed platelet count, bleeding time, platelet morphology, and selected coagulation parameters among gas station workers in three Libyan cities.

Materials and Methods

Study Design

A cross-sectional comparative study was conducted to assess the association between occupational gasoline exposure and platelet-related haematological parameters.

Participants

The study included 150 male gasoline station workers aged 18-60 years from Zawia, Surman, and Sabratha who had worked for at least six months. The control group included 60 men with no known occupational exposure to gasoline or related pollutants and was selected to be broadly comparable by age.

Inclusion and Exclusion Criteria

Eligible participants were male gasoline station workers aged 18-60 years with at least six months of employment. Individuals with inherited blood disorders, chronic liver or kidney disease, acute infection, systemic illness, or current use of anticoagulant or antiplatelet medication were excluded.

Questionnaire

A structured questionnaire was administered through face-to-face interviews. It collected demographic characteristics, lifestyle factors, occupational history, duration of exposure, working hours, use of personal protective equipment, safety training, workplace practices, and health status. Symptoms commonly associated with benzene exposure, including drowsiness, headache, dizziness, and weakness, were also recorded.

Ethical Considerations

The study was approved by the Research Ethics Committee of the Medical Research Center in Zawia (NBC:018. H.24.38). Written informed consent was obtained from all participants before enrollment.

Blood Sampling and Laboratory Analysis

Five millilitres of venous blood were collected from each participant. Samples were divided into EDTA tubes for complete blood count and blood smear preparation, sodium citrate tubes for coagulation testing, and plain tubes for additional analyses not included in this manuscript. Platelet count was measured using a Sysmex XP-300 automated hematology analyzer within two hours of collection. Bleeding time was assessed at the collection site using the Duke method. Wright-stained peripheral blood smears were examined under light microscopy at 100x magnification to assess platelet count, morphology, and aggregation.

Statistical Analysis

Data were analyzed using SPSS version 27. Independent-samples t-tests were used to compare exposed workers and controls. One-way analysis of variance (ANOVA) was used to compare workers across the three cities. Statistical significance was set at $p < 0.05$.

Result

Demographic Characteristics

The study compared demographic characteristics and smoking status between gasoline station workers and the control group. The age distribution was generally concentrated among younger and middle-aged adults. The largest age category in the source table was 30-39 years, followed by participants younger than 30 years and those aged 40-49 years. Geographic distribution across Zawia, Surman, and Sabratha was approximately balanced. Smoking was common in both groups and was more frequent among gasoline station workers than among controls Table 1.

Table 1. Demographic and lifestyle characteristics of gas station workers and controls

Variable	Workers n	Workers %	Controls n	Controls %
Age group: <30 years	38	25.3	20	33.3
Age group: 30-39 years	54	36	17	28.3
Age group: 40-49 years	38	25.3	16	26.6
Age group: >=50 years	20	13.3	7	11.6
City: Zawia	50	33.3	20	33.3
City: Surman	50	33.3	20	33.3
City: Sabratha	50	33.3	20	33.3
Smoking: Yes	136	90.67	38	63.3
Smoking: No	14	9.33	22	36.6

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Occupational Exposure and Health Awareness

Among gasoline station workers, most participants reported either less than five years or five to ten years of work experience. Nearly all workers reported direct exposure to gasoline, but reported personal protective equipment (PPE) use and formal safety training were almost absent. Although most workers reported awareness of gasoline hazards, none indicated that workplace safety measures were adequately implemented. These findings indicate a substantial gap between hazard awareness and preventive practice Table 2.

Table 2. Occupational exposure and health awareness among gas station workers

Variable	n	%	Chi-square	*p* value
Years of experience: <5 years	62	41.3	90.705	<0.001
Years of experience: 5-10 years	70	46.6		
Years of experience: 11-15 years	13	8.6		
Years of experience: >15 years	5	3.3		
Use of PPE: Yes	3	2	141.107	<0.001
Use of PPE: No	147	98		
Symptoms during/after work: Yes	35	23.3	44.034	<0.001
Symptoms during/after work: No	115	76.66		
Direct exposure to gasoline: Yes	144	96	129.571	<0.001
Direct exposure to gasoline: No	6	4		
Recent platelet test: Yes	26	17.3	65.779	<0.001
Recent platelet test: No	124	82.6		
Abnormal platelet test results: Yes	4	2.66	137.242	<0.001
Abnormal platelet test results: No	146	97.33		
Awareness of gasoline hazards: Yes	147	98	141.107	<0.001
Awareness of gasoline hazards: No	3	2		
Received safety training: Yes	3	2	141.107	<0.001
Received safety training: No	147	98		
Adequate safety measures: Yes	0	0.0	145.027	<0.001
Adequate safety measures: No	150	100.0		

PPE = personal protective equipment.

Platelet Count and Bleeding Time

Mean platelet count among gasoline station workers was 231.92 x 10^3/uL (SD = 88.82), within the usual reference range of 150-400 x 10^3/uL. Mean bleeding time was 4.86 minutes (SD = 4.54), also within the reference range of 2-7 minutes. Platelet count did not differ significantly between gasoline station workers and controls (t = -0.88, *p* = 0.382). Bleeding time was also not significantly different between the two groups (t = 1.30, *p* = 0.196) Table 3.

Table 3. Platelet count and bleeding time among gas station workers and controls

Parameter	Group	n	Mean	SD	t-test	*p* value

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Platelet count (x10^3/uL)	Gasoline station workers	150	231.92	88.821	-0.88	0.382
Platelet count (x10^3/uL)	Controls	60	243.17	70.470		
Bleeding time (minutes)	Gasoline station workers	150	4.86	4.541	1.30	0.196
Bleeding time (minutes)	Controls	60	4.08	1.420		

Regional Differences in Platelet Parameters

One-way ANOVA showed a significant difference in platelet count across the three cities (F = 4.105, *p* = 0.018). Workers in Zawia had lower mean platelet counts than workers in Surman and Sabratha. Bleeding time did not differ significantly by city (F = 1.587, *p* = 0.208) as illustrated in Table 4.

Table 4. Regional differences in platelet count and bleeding time among gasoline station workers

Parameter	City	n	Mean	SD	F	*p* value
Platelet count (x10^3/uL)	Zawia	50	203.80	89.191	4.105	0.018
Platelet count (x10^3/uL)	Surman	50	240.62	88.373		
Platelet count (x10^3/uL)	Sabratha	50	251.34	83.401		
Bleeding time (minutes)	Zawia	50	5.78	7.152	1.587	0.208
Bleeding time (minutes)	Surman	50	4.52	2.565		
Bleeding time (minutes)	Sabratha	50	4.28	1.906		

Coagulation Parameters

The mean PT, PTT, and INR values among gasoline station workers were within conventional reference ranges. Between-group comparisons showed no statistically significant differences in PT (*p* = 0.206), PTT (*p* = 0.925), or INR (*p* = 0.935) between exposed workers and controls Table 5.

Table 5. Coagulation parameters among gas station workers and controls

Parameter	Group	n	Mean	SD	t-test	*p* value
Prothrombin time (seconds)	Gasoline station workers	150	12.12	1.581	1.267	0.206
Prothrombin time (seconds)	Controls	60	11.84	1.043		
Partial thromboplastin time (seconds)	Gasoline station workers	150	30.87	3.939	0.094	0.925
Partial thromboplastin time (seconds)	Controls	60	30.81	3.753		
International normalized ratio	Gasoline station workers	150	1.06	0.276	-0.081	0.935
International normalized ratio	Controls	60	1.06	0.256		

Regional Differences in Coagulation Parameters

Regional comparisons among gasoline station workers showed significant differences in PT, PTT, and INR. PT was higher in Zawia and Surman than in Sabratha. PTT was highest in Zawia, and INR was also higher in Zawia than in Surman and Sabratha (Table 6).

Table 6. Regional variations in coagulation parameters among gasoline station workers

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Parameter	City	n	Mean	SD	F	*p* value
Prothrombin time (seconds)	Zawia	50	12.51	1.163	9.232	<0.001
Prothrombin time (seconds)	Surman	50	12.48	2.121		
Prothrombin time (seconds)	Sabratha	50	11.38	0.949		
Partial thromboplastin time (seconds)	Zawia	50	33.57	3.225	22.838	<0.001
Partial thromboplastin time (seconds)	Surman	50	29.42	4.036		
Partial thromboplastin time (seconds)	Sabratha	50	29.62	3.050		
International normalized ratio	Zawia	50	1.33	0.265	68.306	<0.001
International normalized ratio	Surman	50	0.91	0.185		
International normalized ratio	Sabratha	50	0.94	0.126		

Peripheral Blood Smear Findings

Microscopic examination showed normal platelet count and morphology in most exposed workers. Thrombocytopenia was recorded in 8 exposed workers (5.3%), whereas all control participants had normal smear findings. The difference between groups was not statistically significant (chi-square = 3.33, *p* = 0.068) (Table 7).

Table 7. Peripheral blood smear findings

Finding/statistic	Workers n	Workers %	Controls n	Controls %
Normal platelet count and morphology	142	94.7	60	100.0
Thrombocytopenia	8	5.3	0	0.0
Chi-square	3.33			
p value	0.068			

Discussion

This study assessed platelet count, bleeding time, platelet morphology, and selected coagulation parameters among gasoline station workers chronically exposed to gasoline vapours. Overall, platelet counts and bleeding times among exposed workers remained within physiological reference ranges and did not differ significantly from controls. These findings suggest that, in this study population, occupational gasoline exposure was not associated with overt platelet count reduction or clinically detectable impairment of primary hemostasis. The findings are consistent with reports that low-level occupational benzene exposure may not always produce measurable thrombocytopenia (Binsaleh *et al.,* 2024; Koh *et al.,* 2015). They differ from studies in more heavily exposed populations in which platelet counts were significantly reduced (Lan *et al.,* 2004; Rothman *et al.,* 1996). Differences among studies may reflect variation in exposure intensity, duration, fuel composition, workplace controls, individual susceptibility, smoking, and analytical methods. Normal platelet counts do not exclude more subtle platelet changes. Benzene exposure may affect platelet indices, activation status, or immune-related platelet markers before it causes a measurable reduction in platelet number (Huang *et al.,* 2014). In the present study,

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peripheral smear findings were normal in most exposed workers, suggesting that exposure was not associated with obvious morphological platelet abnormalities detectable by routine microscopy. The normal bleeding time observed in this study suggests preserved primary hemostatic function under routine testing conditions. However, bleeding time has limited sensitivity for subtle platelet defects (Harrison, 2005). More specific assays, such as light transmission aggregometry or flow cytometric assessment of platelet activation markers, may detect functional changes that are not captured by bleeding time alone (Lordkipanidze, 2016). Potential effects of benzene metabolites on platelet signalling pathways, including ADP- and thromboxane-related pathways, require further study (Gawaz *et al.,* 2005).

PT, PTT, and INR did not differ significantly between gasoline station workers and controls, indicating no overall evidence of impairment in the extrinsic, intrinsic, or common coagulation pathways among the exposed workers. These findings may reflect relatively low levels of occupational exposure and suggest that hepatic synthesis of coagulation factors remains largely preserved despite chronic exposure to gasoline vapours.

The present findings differ from those reported by Oruzhov and Zhafarova (2017), who observed prolonged prothrombin time in benzene-exposed experimental animals. This discrepancy may be attributed to fundamental differences between animal models and occupational human exposure. Experimental studies typically involve controlled administration of relatively high benzene doses over short periods, resulting in acute toxic effects that may not accurately represent the chronic low-level exposure encountered in occupational settings. In addition, interspecies differences in benzene metabolism, detoxification mechanisms, and coagulation physiology may limit the direct extrapolation of animal findings to humans.

Although no significant overall differences in coagulation parameters were observed between exposed workers and controls, regional variations were detected among gasoline station workers, particularly in Zawia. One possible explanation is the proximity of Zawia to a major oil refinery, which may contribute to increased environmental exposure to petroleum-derived pollutants in addition to occupational exposure at gasoline stations. Variations in work practices, duration of employment, smoking habits, environmental conditions, and other unmeasured health-related factors may also have influenced the observed differences. Further studies incorporating environmental monitoring and biological exposure assessment are needed to clarify the factors underlying these regional variations.

The occupational safety findings are important. Nearly all workers reported direct gasoline exposure, but reported PPE use and formal safety training were extremely low. This gap between awareness and preventive practice indicates a need for workplace safety programs, routine medical screening, and exposure monitoring.

Conclusion

In this cross-sectional study, gasoline station workers did not exhibit significant overall differences in platelet count, bleeding time, PT, PTT, or INR compared with the control group, suggesting no apparent alterations in platelet-related hemostasis or coagulation function associated with occupational gasoline exposure. However, significant regional variations in platelet count and coagulation parameters were observed among exposed workers, particularly in Zawia, indicating that local environmental and occupational factors may influence haematological outcomes. Given that individual benzene exposure levels were not directly measured, these findings should not be interpreted as evidence of the absence of hematotoxic effects from gasoline-related exposures. Further studies incorporating environmental monitoring, biological exposure assessment, and longitudinal follow-up are needed to better characterize potential health risks. Regular occupational health surveillance, adherence to personal protective equipment (PPE) use, safety training, and routine monitoring of workplace benzene concentrations are recommended to protect worker health.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design precludes the establishment of causal relationships between occupational gasoline exposure and the observed haematological and coagulation parameters. Second, individual exposure to benzene and other gasoline-related toxicants was not directly measured; therefore, exposure levels could not be quantified or correlated with biological outcomes. Third, differences in smoking status between the exposed and control groups may have acted as a confounding factor, potentially influencing hematological and coagulation indices. Fourth, the assessment of platelet function was limited to platelet count and bleeding time, and more sensitive techniques, such as platelet aggregometry and flow cytometry, were not performed. In addition, the absence of longitudinal follow-up data prevented evaluation of the long-term effects of occupational exposure. Finally, the study was conducted in only three cities in northwestern Libya, which may limit the generalizability of the findings to gasoline station workers in other regions.

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References

1. U.S. Environmental Protection Agency. Benzene [Internet]. Washington (DC): U.S. Environmental Protection Agency; 2012 [cited 2026 Aug 12]. Available from: https://www.epa.gov/sites/default/files/2016-09/documents/benzene.pdf
2. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Benzene. Lyon (FR): International Agency for Research on Cancer; 2018. (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; vol. 120).
3. Snyder R. Leukemia and benzene. Int J Environ Res Public Health. 2012;9(8):2875-93. doi:10.3390/ijerph9082875.
4. Sun R, Cao M, Zhang J, Yang W, Wei H, Meng X, et al. Benzene exposure alters expression of enzymes involved in fatty acid β-oxidation in male C3H/He mice. Int J Environ Res Public Health. 2016;13(11):1068. doi:10.3390/ijerph13111068.
5. Wang L, He X, Bi Y, Ma Q. Stem cell and benzene-induced malignancy and hematotoxicity. Chem Res Toxicol. 2012;25(7):1303-15. doi:10.1021/tx3001169.
6. Lan Q, Zhang L, Li G, Vermeulen R, Weinberg RS, Dosemeci M, et al. Hematotoxicity in workers exposed to low levels of benzene. Science. 2004;306(5702):1774-6. doi:10.1126/science.1102443.
7. Rothman N, Li GL, Dosemeci M, Bechtold WE, Marti GE, Wang YZ, et al. Hematotoxicity among Chinese workers heavily exposed to benzene. Am J Ind Med. 1996;29(3):236-46. doi:10.1002/(SICI)1097-0274(199603)29:3<236::AID-AJIM3>3.0.CO;2-O.
8. Binsaleh NK, Eltayeb R, Bashir EM, Idris HME, Althobiti MM, Ahmed HG, et al. Insight into hematological parameters of petrol station workers. Eur Rev Med Pharmacol Sci. 2024;28(8):3135-43. doi:10.26355/eurrev_202404_36029.
9. Koh DH, Jeon HK, Lee SG, Ryu HW. The relationship between low-level benzene exposure and blood cell counts in Korean workers. Occup Environ Med. 2015;72(6):421-7. doi:10.1136/oemed-2014-102227.
10. Huang J, Zhao M, Wang P, Li X, Ma L, Zhang J, et al. Effects of low concentrations of benzene exposure on levels of platelet-associated antibodies and platelet parameters. J Occup Environ Med. 2014;56(10):e92-e97. doi:10.1097/JOM.0000000000000288.
11. Guo H, Ahn S, Zhang L. Benzene-associated immunosuppression and chronic inflammation in humans: a systematic review. Occup Environ Med. 2021;78(5):377-84. doi:10.1136/oemed-2020-106517.
12. Wang J, Guo X, Chen Y, Zhang W, Ren J, Gao A. Association between benzene exposure, serum levels of cytokines and hematological measures in Chinese workers: a cross-sectional study. Ecotoxicol Environ Saf. 2021;207:111562. doi:10.1016/j.ecoenv.2020.111562.
13. Harrison P. Platelet function analysis. Blood Rev. 2005;19(2):111-23. doi:10.1016/j.blre.2004.05.002.
14. Lordkipanidzé M. Platelet function tests. Semin Thromb Hemost. 2016;42(3):258-67. doi:10.1055/s-0035-1564834.
15. Gawaz M, Langer H, May AE. Platelets in inflammation and atherogenesis. J Clin Invest. 2005;115(12):3378-84. doi:10.1172/JCI27196.
16. Oruzhov RA, Zhafarova RA. Blood coagulation system in chronic benzene poisoning via inhalation. Kazan Med Zh. 2017;98(5):758-63. doi:10.17750/KMJ2017-758.

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