Comparative analysis of serum troponin i, CK-MB, Myoglobin, and NT-proBNP levels among technical and non-technical staff in a paint factory in Enugu State, Nigeria

Article *in* EUREKA Life Sciences · March 2025

DOI: 10.21303/2504-5695.2025.003726

CITATIONS
0

READS
27

6 authors, including:

Stanley Obinna Ezeadichie
Godfrey Okoye University
5 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Amechi Katchy
Godfrey Okoye University
76 PUBLICATIONS **662** CITATIONS
SEE PROFILE

Chukwukadibie Raymond Adigwe
Godfrey Okoye University
2 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Osah Martins Onwuka
Gregory University Uturu
48 PUBLICATIONS **116** CITATIONS
SEE PROFILE

COMPARATIVE ANALYSIS OF SERUM TROPONIN I, CK-MB, MYOGLOBIN, AND NT-PROBNP LEVELS AMONG TECHNICAL AND NON-TECHNICAL STAFF IN A PAINT FACTORY IN ENUGU STATE, NIGERIA

Chioma Cordelia Ugwu
Department of Medical Biochemistry
University of Nigeria
Enugu campus, Enugu State, Nigeria, 400241

Stanley Obinna Ezeadichie
Department of Medical Biochemistry[1]

Katchy Uchenna Amechi
Department of Human Anatomy[1]

Chukwukadibie Adigwe
Department of Human Physiology[1]

Mima Wariso
Department of Medical Biochemistry[1]

Osah Martins Onwuka ✉
Department of Human Physiology
Gregory University Uturu
Amaokwe Achara, Uturu, Abia State, Nigeria, 441106
osahmartinz@gmail.com

[1]*Godfrey Okoye University*
Ugwuomo-Nike, Enugu State, Nigeria, 400103

✉**Corresponding author**

Summary

Cardiovascular biomarkers (Troponin I, CK-MB, Myoglobin, and NT-proBNP) indicate myocardial injury and cardiac dysfunction. Occupational exposure to physical and chemical stressors in paint factories may elevate these biomarkers, increasing cardiovascular risk among workers. This study assessed the impact of occupational exposure by comparing serum biomarker levels between technical and non-technical staff in a paint factory.

One hundred (100) subjects participated. Health indices were collected via a structured questionnaire, and blood samples were analyzed for Troponin I, CK-MB, Myoglobin, and NT-proBNP. Descriptive statistics (frequency, percentage, mean, and standard deviation) and inferential tests (independent t-tests, Levene's test, Pearson's chi-square, and Pearson's correlation) were performed, with significance set at $p<0.05$.

Results showed significantly higher mean serum levels of Troponin I (0.669±0.604 ng/mL vs. 0.355±0.523 ng/mL, $p=0.015$), CK-MB (8.533±5.788 ng/mL vs. 4.458±0.393 ng/mL, $p<0.001$), Myoglobin (65.978±13.648 ng/mL vs. 51.064±5.916 ng/mL, $p<0.001$), and NT-proBNP (358.697±99.169 pg/mL vs. 233.903±56.459 pg/mL, $p<0.001$) in technical staff compared to non-technical staff. These elevations suggest an increased risk of myocardial stress and cardiac dysfunction due to prolonged occupational exposure to hazardous substances.

This study highlights occupational health risks in paint factories, linking exposure to elevated cardiovascular biomarkers. Findings suggest the need for workplace safety measures, exposure mitigation, and routine biomonitoring. Regular health assessments, early detection programs, and targeted interventions are crucial for protecting workers' cardiovascular health.

Keywords: cardiovascular biomarkers, occupational exposure, myocardial injury, Troponin I, CK-MB, Myoglobin, NT-proBNP, cardiac dysfunction, paint factory workers.

DOI: 10.21303/2504-5695.2025.003726

1. Introduction

The paint manufacturing industry plays a crucial role in various sectors, providing essential products for construction, automotive, and industrial applications [1]. However, workers involved in paint production and application are frequently exposed to a wide range of complex chemical compounds, some of which may pose significant health risks [1]. The industry employs a substantial workforce that handles raw chemicals, pigments, and solvents, placing them at risk for acute and chronic health effects, including dermatological, respiratory, and cardiovascular complications [2].

Paint formulation involves the combination of chemical ingredients to achieve specific properties such as color, viscosity, and drying time. These processes can lead to inhalation of volatile organic compounds (VOCs), exposure to heavy metals such as lead and chromium, and direct contact with potential skin irritants [2]. Although regulatory measures in some countries limit the presence of certain toxic compounds, many manufacturing processes continue to pose significant health risks, particularly in settings where safety guidelines are inadequately enforced [2]. Studies indicate that small-scale operations often lack proper ventilation systems, personal protective equipment (PPE), and effective health screening programs, leaving workers vulnerable to occupational illnesses that may present subtly over time [2].

The paint industry in Enugu State has experienced steady growth over the past decade, necessitating an in-depth evaluation of its dynamics, challenges, and prospects to guide policymakers, investors, and stakeholders in fostering sustainable growth and innovation. The industry encompasses a diverse range of products, including architectural paints and industrial coatings, catering to both domestic and commercial markets. In paint factories, workers frequently handle hazardous substances such as VOCs, heavy metals, and other toxic chemicals, increasing their risk of adverse health effects [3]. VOCs-including benzene, toluene, xylene, and formaldehyde – are commonly found in paint derivatives and have been linked to respiratory diseases, cardiovascular complications, and neurological disorders [4, 5]. The rapid industrialization in Nigeria, particularly in the southeastern region, has led to a proliferation of paint factories, raising significant concerns regarding occupational health and safety [6].

Evidence suggests that prolonged exposure to VOCs contributes to systemic inflammation, oxidative stress, and increased serum levels of cardiac biomarkers, all of which indicate cardiovascular strain [7]. Many workers in paint factories lack access to adequate PPE, further exacerbating their susceptibility to occupational hazards [8]. Additionally, weak enforcement of occupational health and safety regulations in Nigeria has been linked to rising cases of respiratory diseases, hypertension, and other chronic health conditions among factory workers [9]. The health consequences of VOC exposure extend beyond immediate symptoms such as headaches and dizziness to long-term effects, including hypertension and an increased risk of myocardial infarction [10].

Studies have demonstrated that chronic inhalation of VOCs leads to significant alterations in serum levels of key cardiac biomarkers, including Troponin I, CK-MB, Myoglobin, and NT-proBNP-biomarkers crucial for assessing myocardial injury [11–13]. However, there is limited research comparing these biomarkers between technical and non-technical staff in paint factories, highlighting a critical gap in occupational health studies. Addressing this knowledge gap, the present study aims to conduct a comparative analysis of serum Troponin I, CK-MB, Myoglobin, and NT-proBNP levels between technical and non-technical staff in a paint factory in Enugu State. By employing a cross-sectional observational correlational design, this research seeks to identify specific occupational health risks and propose targeted interventions to mitigate them.

Understanding the variations in these biomarkers will contribute to the development of evidence-based workplace policies aimed at improving health monitoring and implementing protective measures for workers [14]. The findings of this study will have significant implications for occupational health and safety regulations, particularly in advocating for stricter enforcement of protective measures to minimize exposure to harmful paint derivatives. Given the increasing prevalence of paint factories in southeastern Nigeria, there is an urgent need for strategic interventions to protect workers from chronic health conditions linked to VOC exposure [15, 16]. This study will provide critical insights to inform policy recommendations, support the enforcement of workplace safety laws, and promote the adoption of advanced protective measures to safeguard the well-being of employees in the paint manufacturing industry.

2. Materials and methods

Subjects. Subjects for this study were male and female workers recruited from Izuluc Paint Factory, Achara Layout, Enugu.

Sample Size Estimation. The sample size was calculated using Yamane's formula:

$$n=N/(1+N(e)^2,$$

where n – sample size;

N – population under study;

e – error margin (0.05):

$$n=133/(1+133)(0.05)^2=133/1.3325=99.81\approx100.$$

Thus, the sample size was determined to be 100 participants.

A well-structured questionnaire was used to collect responses on health indices. The questions included demographic variables, health status, medical history, and biomarker assessment. The questionnaire was built on a bipolar question scale: "yes or no."

The face validity and content validity of the questionnaire were ascertained by three experts who are lecturers in the Faculty of Basic Medical Sciences, University of Nigeria, Nsukka. The reliability of the instrument was tested by distributing the questionnaire one month before the final administration. Reliability was assessed using factor analysis, and the questionnaire was deemed reliable (Cronbach's $\alpha=0.8$).

Before the study commenced, participants were informed of the study's objectives and methodology, and their consent was obtained. Data was collected using a structured questionnaire covering demographic characteristics, work history, exposure to paint derivatives, and health indicators. The questionnaires were distributed, collected, numbered, and entered into a spreadsheet.

Two milliliters of blood were collected from participants to assess cardiac markers such as Troponin I, CK-MB, Myoglobin, and NT-proBNP levels. Blood samples were placed in plain tubes to prevent interference from anticoagulants or preservatives. Samples were centrifuged at 2,500 rpm for ten minutes to obtain serum. The levels of these biomarkers were measured using the FineCare Fluorescence Immunoassay (FIA) system.

The determination of cardiac Troponin I, CK-MB, Myoglobin, and NT-proBNP was carried out using the Finecare Fluorescence Immunoassay system (Model No. FS-112/FS-113/FS-205) by Guangzhou Wondfo Biotech Co. Ltd. The procedure was as follows:

The system settings were saved, and the "use" button was turned on.

The lot number of the test cartridge was matched with the ID chip and detection buffer.

The ID chip was inserted into the Finecare FIA system.

A transfer pipette was used to extract 75 µL of serum, which was added to the detection buffer tube.

The lid of the detection tube was closed, and the sample mixture was mixed thoroughly by shaking it about ten times.

75 µL of the sample mixture was pipetted and loaded into the sample well of the test cartridge.

The test cartridge was inserted into the test cartridge holder of the Finecare FIA system.

The test button was pressed to start the test.

Results were displayed on the main screen and printed.

Used test cartridges were discarded according to local regulations and procedures.

Results were automatically interpreted by the FIA system in ng/mL.

Data analysis was performed using IBM Statistical Package for Social Sciences (SPSS) version 23. Selected biomarker levels were calculated using frequency, percentage, mean, and standard deviation. To determine significant differences between groups, inferential statistics such as independent t-tests, Levene's test for equality of variances, Pearson's chi-square, and Pearson's correlation coefficient were used. Statistical significance was defined as a p-value of less than 0.05.

3. Results

The comparison of mean serum levels of cardiac biomarkers between technical and non-technical staff was conducted using an independent t-test. The results (**Table 1**) are as follows:

The mean serum level of Troponin I was 0.355 ± 0.523 ng/mL in non-technical staff and 0.669±0.604 ng/mL in technical staff. The independent t-test revealed a statistically significant difference between the two groups ($t(95)=–2.483$, $p=0.015$), indicating higher Troponin I levels in technical staff compared to non-technical staff.

The mean serum level of CK-MB was 4.458±0.393 ng/mL in non-technical staff and 8.533±5.788 ng/mL in technical staff. Statistical analysis showed a significant difference between the two groups ($t(95)=–3.905$, $p<0.001$), demonstrating higher CK-MB levels among technical staff.

The mean serum level of Myoglobin was 51.064±5.916 ng/mL in non-technical staff and 65.978±13.648 ng/mL in technical staff. An independent t-test revealed a significant difference between the groups ($t(95)=–5.82$, $p<0.001$), suggesting increased myoglobin levels in technical staff.

The mean serum level of NT-proBNP was 233.903±56.459 ng/mL in non-technical staff and 358.697±99.169 ng/mL in technical staff. The independent t-test demonstrated a statistically significant difference ($t(95)=–6.517$, $p<0.001$), indicating elevated NT-proBNP levels among technical staff.

The findings indicate that technical staff exhibited significantly higher levels of all assessed cardiac biomarkers compared to non-technical staff, suggesting a potential occupational health risk associated with their work environment.

Table 1

Comparison of mean serum levels of Troponin I, CK-MB, Myoglobin, and NT-proBNP between technical and non-technical staff

Independent samples test		Levene's test for equality of variances		t-test for equality of means					95 % confidence interval of the difference	
		F	Sig.	*t*	df	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Upper
Troponin I	Equal variances assumed	3.103	0.081	–2.483	95	0.015	–0.31425	0.12658	–0.56554	–0.06297
CK-MB	Equal variances assumed	17.305	0	–3.905	95	0	–4.07483	1.04359	–6.14662	–2.00305
Myoglobin	Equal variances assumed	2.619	0.109	–5.82	95	0	–14.91321	2.56242	–20.00025	–9.82617
NT proBNP (ng/mL)	Equal variances assumed	0.303	0.584	–6.517	95	0	–124.7937	19.1503	–162.8118	–86.7756

4. Discussion

Cardiac biomarkers, including Troponin I, CK-MB, Myoglobin, and NT-proBNP, are crucial indicators of myocardial injury and stress. Elevated levels of these biomarkers are associated with myocardial damage, often due to conditions such as myocardial infarction or heart failure [17]. In occupational settings, particularly among workers exposed to chemical agents like organic solvents, biomarker evaluation can provide valuable insights into potential cardiovascular risks [18].

This study compared the mean serum levels of these biomarkers between technical and non-technical staff in a paint factory in Enugu State. Results showed significantly higher levels of Troponin I, CK-MB, Myoglobin, and NT-proBNP in technical staff compared to non-technical staff. Since technical staff are directly involved in paint production and consequently more exposed to chemical agents, these findings suggest a higher degree of cardiac stress or injury potentially linked to prolonged exposure to organic solvents and other hazardous substances [19].

The elevated Troponin I levels among technical staff indicate possible myocardial injury, while increased CK-MB and Myoglobin levels suggest muscle damage, including cardiac muscle [20]. Furthermore, higher NT-proBNP levels reflect increased cardiac wall stress, which is often observed in conditions that predispose individuals to heart failure [21]. These findings align

with existing literature, which highlights the cardiovascular risks associated with occupational exposure to hazardous chemicals [8].

The significant differences observed between the two groups underscore the impact of occupational exposure to potentially cardio-toxic substances found in paint products. This reinforces the need for stringent occupational health policies, including routine health surveillance, exposure monitoring, and the provision of personal protective equipment (PPE) for technical staff [18].

However, this study has limitations. The cross-sectional design provides a single-point evaluation, which may not capture long-term exposure effects. Additionally, confounding factors such as lifestyle, pre-existing health conditions, and genetic predisposition were not controlled, which could have influenced the observed biomarker levels. Future longitudinal studies are needed to assess the chronic effects of occupational exposure and to determine the effectiveness of various protective measures in reducing biomarker levels among exposed workers.

5. Conclusions

This study examined the mean serum levels of Troponin I, CK-MB, Myoglobin, and NT-proBNP among technical and non-technical staff in a paint factory. The findings revealed significantly higher biomarker levels among technical staff, indicating increased occupational exposure to factors that may compromise cardiac health.

Elevated serum levels of Troponin I, CK-MB, Myoglobin, and NT-proBNP are well-established markers of myocardial stress and injury. The significantly higher levels observed among technical staff suggest that prolonged exposure to organic solvents and other hazardous substances in the workplace may contribute to cardiovascular risk.

These findings emphasize the need for enhanced occupational health interventions, including regular cardiac health screening, improved workplace safety measures, and better exposure control strategies. Providing technical staff with adequate PPE, enforcing safe work practices, and raising awareness about potential cardiovascular risks could help mitigate these health hazards.

Therefore, this study underscores the importance of proactive occupational health strategies in protecting workers from potential cardiovascular risks. Future research should explore longitudinal data to assess long-term exposure effects and evaluate the impact of preventive measures in reducing cardiac biomarker elevations among exposed workers.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was conducted without financial support.

Data availability

There is no associated data with this manuscript.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

References

[1] Awodele, O., Popoola, T. D., Ogbudu, B. S., Akinyede, A., Coker, H. A. B., Akintonwa, A. (2014). Occupational Hazards and Safety Measures Amongst the Paint Factory Workers in Lagos, Nigeria. Safety and Health at Work, 5 (2), 106–111. https://doi.org/10.1016/j.shaw.2014.02.001

[2] Abd El Hamid Hassan, A., Abd El Moez Elnagar, S., Mohammadi El Tayeb, I., Abd El Halim Bolbol, S. (2013). Health Hazards of Solvents Exposure among Workers in Paint Industry. Open Journal of Safety Science and Technology, 03 (04), 87–95. https://doi.org/10.4236/ojsst.2013.34011

[3] Curtis, P., Venugopal, V., Abraham, M. (2021). A study on paint industry with health risk assessment of chemicals. Available at: https://www.researchgate.net/publication/356032549_A_STUDY_ON_PAINT_INDUSTRY_WITH_HEALTH_RISK_ASSESSMENT_OF_CHEMICALS

[4] Asanga, O. O. (2023). Awareness of occupational hazards and safety practices of workers in paint factories in Akwa Ibom State, Nigeria. Asia-Africa Journal of Academic Research, 3 (2). Available at: https://journals.iapaar.com/index.php/AAJARR/article/view/131

[5] Umor, A., Righteous, I. (2021). Occupational health hazards and diseases of painters. Lambert. Available at: https://www.researchgate.net/publication/358786336_OCCUPATIONAL_HEALTH_HAZARDS_AND_PAINTERS

[6] Nazri, A. A. (2015). Study on occupational safety & health associated spray painting activities at furniture industry. CORE Available at: https://core.ac.uk/download/pdf/42955931.pdf

[7] Saironi, A., Awang, N., Ithnin, A., Kamaluddin, N. F., Ibrahim, F. W., Chan, K. M. (2023). Effect of Paint Exposure Among Paint Workers and DNA Damage: A Scoping Review. Malaysian Journal of Medicine and Health Sciences, 19 (4), 342–353. https://doi.org/10.47836/mjmhs.19.4.47

[8] Lin, C.-H., Lai, C.-H., Peng, Y.-P., Wu, P.-C., Chuang, K.-Y., Yen, T.-Y., Xiang, Y.-K. (2018). Comparative health risk of inhaled exposure to organic solvents, toxic metals, and hexavalent chromium from the use of spray paints in Taiwan. Environmental Science and Pollution Research, 26 (33), 33906–33916. https://doi.org/10.1007/s11356-018-2669-8

[9] Anderson, S. E., Meade, B. J. (2014). Potential Health Effects Associated with Dermal Exposure to Occupational Chemicals. Environmental Health Insights, 8s1, EHI.S15258. https://doi.org/10.4137/ehi.s15258

[10] Riggs, D. W., Malovichko, M. V., Gao, H., McGraw, K. E., Taylor, B. S., Krivokhizhina, T. et al. (2022). Environmental exposure to volatile organic compounds is associated with endothelial injury. Toxicology and Applied Pharmacology, 437, 115877. https://doi.org/10.1016/j.taap.2022.115877

[11] Dehghan Haghighi, J., Hormozi, M., Payandeh, A. (2022). Blood serum levels of selected biomarkers of oxidative stress among printing workers occupationally exposed to low-levels of toluene and xylene. Toxicology and Industrial Health, 38 (5), 299–307. https://doi.org/10.1177/07482337221092501

[12] Delclos, G. L., Lerner, S. P. (2008). Occupational risk factors. Scandinavian Journal of Urology and Nephrology, 42 (sup218), 58–63. https://doi.org/10.1080/03008880802284423

[13] Jogie, J. A. (2025). A Comprehensive Review of Occupational Medicine in the Paint Industry: Roles of Family Medicine and Internal Medicine. Cureus. https://doi.org/10.7759/cureus.76970

[14] Khalili, M., Farahani, M. K. (2024). Health Risk Assessment of Chemical Compounds in an Industrial Painting Workshop, Tehran, Iran. Aerosol Science and Engineering. https://doi.org/10.1007/s41810-024-00251-7

[15] Enander, R. T., Gute, D. M., Cohen, H. J. (2003). The concordance of pollution prevention and occupational health and safety: A perspective on U.S. policy. American Journal of Industrial Medicine, 44 (3), 312–320. https://doi.org/10.1002/ajim.10261

[16] Hosseinzadeh, M., Hemmatjo, R., Moutab Sahihazar, Z., Galvani, S., Hajaghazadeh, M. (2023). Probabilistic health risk assessment of occupational exposure to BTEX in a paint manufacturing plant using Monte-Carlo simulation. Human and Ecological Risk Assessment: An International Journal, 29 (3-4), 859–880. https://doi.org/10.1080/10807039.2023.2196702

[17] Thygesen, K., Alpert, J. S., Jaffe, A. S., Chaitman, B. R., Bax, J. J., Morrow, D. A., White, H. D. (2018). Fourth Universal Definition of Myocardial Infarction (2018). Journal of the American College of Cardiology, 72 (18), 2231–2264. https://doi.org/10.1016/j.jacc.2018.08.1038

[18] Stocks, S. J., Turner, S., McNamee, R., Carder, M., Hussey, L., Agius, R. M. (2011). Occupation and work-related ill-health in UK construction workers. Occupational Medicine, 61 (6), 407–415. https://doi.org/10.1093/occmed/kqr075

[19] James, I. C., Imaga, N. A., Dokunmu, T. M., Adedeji, I. O., Emmanuel, O. O., Orija, M. E. (2022). Effects of chronic exposure to paint fumes among artisans in Lagos State, Nigeria. Toxicology Reports, 9, 663–669. https://doi.org/10.1016/j.toxrep.2022.03.027

[20] Antman, E. M. (2017). The Introduction and Clinical Use of Cardiac-Specific Troponin Assays. Clinical Pharmacology & Therapeutics, 103 (1), 31–33. https://doi.org/10.1002/cpt.773

[21] Brunner-La Rocca, H.-P., Sanders-van Wijk, S. (2019). Natriuretic Peptides in Chronic Heart Failure. Cardiac Failure Review, 5 (1), 44–49. https://doi.org/10.15420/cfr.2018.26.1

Received 03.01.2025
Received it revised form 11.02.2025
Accepted 17.03.2025
Published 28.03.2025

How to cite: *Ugwu, C. C., Ezeadichie, S. O., Amechi, K. U., Adigwe, C., Wariso, M., Onwuka, O. M. (2025). Comparative analysis of serum troponin i, CK-MB, Myoglobin, and NT-proBNP levels among technical and non-technical staff in a paint factory in Enugu State, Nigeria. EUREKA: Life Sciences, 1, 41–46. https://doi.org/10.21303/2504-5695.2025.003726*