## *Original Research Article*

**OCCUPATIONAL PAINT EXPOSURE: EFFECT ON BLOOD GLUCOSE AND HEMATOLOGICAL PROFILE OF MALE PAINT WORKERS IN OWERRI, NIGERIA**

### ABSTRACT

**Background**: Paint workers are occupationally exposed to harmful chemicals; solvents, pigments and heavy metals found in paint products during their application and removal. **Objective**: This study was carried out to examine the effect of occupational exposure to paint on blood levels of glucose and haematological profile. **Methods**: A total of 80 participants constituting of 40 male paint workers and 40 healthy male controls were selected for this study. Six (6) mL of fasting venous blood was collected from each participant. Three ml of blood was dispensed into fluoride oxalate container and was used to determine the blood glucose level employing the spectrophotometric glucose oxidase method, While, 3mL was dispensed into EDTA container and used in determination of hematological profile, employing automation technique. All data generated were subjected to statistical analysis using IBM SPSS version 21. **Results**: Blood glucose was significantly higher in male paint workers (109.70±9.831 mg/dl) compared to the male controls (85.25±11.72 mg/dl) (p=0.000). However, WBC, monocytes, RBC, Hb and platelets were significantly lower in male paint workers ($3.93\pm0.625$ x $10^9$/l, $5.61\pm1.41$ %, $4.06\pm0.52$ x $10^{12}$/l, $13.34\pm0.68$ g/dl and $157.00\pm23.96$ x $10^9$/l) respectively compared to the male controls ($4.92\pm1.05$ x $10^9$/l, $6.96\pm1.79$ %, $4.88\pm0.29$ x $10^{12}$/l, $15.00\pm0.51$ g/dl and $211\pm56.60$ x$10^9$/l respectively) (p=0.000, 0.008, 0.000, 0.000 and 0.001 respectively). There were non-significant correlations of blood glucose with WBC, RBC, Hb and platelets in male paint workers (p> 0.05 in each case). There were non-significant correlations of WBC with neutrophil, lymphocyte, monocyte and eosinophil counts in male paint workers (p> 0.05 in each case). **Conclusion**: Lower levels of some haematological indices parallel higher level of blood glucose in male paint workers. This may be as a result of the toxic effects of paint constituents on the exposed male paint workers.

**Key words:** *Blood glucose, hematological profile, Nigeria, occupational exposure, paint workers.*

## INTRODUCTION

**Paint** is an exceptional homogeneous blend fluid with viscosity, typically comprising of a vehicle or binder, a pigment, a solvent or thinner and a drier which when applied to any substrate in thin layer, changes to solid film **[1]**. Paints are used to decorate/colour, offer texture and protect buildings and objects from natural processes **[2]**.

Sundry occupational sceneries such as painting generate an ambient environment that turn out to be a sink of numerous pollutants that get in direct contact with the paint workers, who are possibly occupationally exposed to the harmful chemical constituent in paint through their application and removal **[3]**. Such harmful chemicals include; dichloromethane, asbestos or crystalline silica, pigments, fillers **[4]**, Benzene **[5]**, and heavy metals; cadmium (Cd) and lead (Pb) **[6]**.

**Blood glucose** level is the content of glucose or sugar present in human or animal blood **[7]**. Glucose provides the main source of energy for body cells **[8]**. It is transported from the liver or intestines to body cells via bloodstream. Glucose is made available for cell absorption through the action of insulin **[9]**.

Persistent hyperglycaemis is a main feature of diabetes mellitus, which is the most documented predominant disorder connected with failure in regulation of blood sugar **[10, 11]**.

**Hematology Profile** also recognized as full blood count (**FBC)** is a combination of clinical laboratory investigation that deliver information of cells in individuals' blood. It specifies total white blood cell (WBC) count, differential WBC count, packed cell volume (PCV) and platelets count, red blood cell (RBC) count, red blood cell indices viz mean corpuscular volume (MCV),

mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) hemoglobin concentration and red cell distribution (RDW) **[ 12]**.

The high increase in the construction of new buildings in the fast-developing Owerri, Nigeria, led to massive influx of numerous paint workers to reside and work in Owerri. Notwithstanding the deleterious effect of some paint constituents, paint worker seems to be uninformed of possible consequence of its occupational exposure on their well-being, and therefore hematological profile. Besides, there is a paucity of reports on the blood glucose level and hematological profile of paint workers generally and particularly in Nigeria. Hence, this study is intended to bridge this gap in knowledge.

## METHODOLOGY

### Area of study

Imo State University and its environs in Owerri, the capital of Imo State, Nigeria was selected as the area of study.

### Ethics and Pre-Survey Contacts

This study was approved by the Research Ethics Committee of Medical Laboratory Science Department, Faculty of Health Sciences, Imo State University Owerri, Nigeria. Modalities for the survey were reached and dates were fixed for blood sample collection at the participants work site. Informed consent was sought and obtained before commencement of sample collections.

### Study Population and Size

The study population consists of 40 male paint workers between the age range of 20-35 years who were working in new building sites in Imo State University and its neighborhoods in Owerri. The study group was age-matched with the control group which consist of 40 apparently healthy male students of Imo state University, who are none paint workers.

### Selection Criteria

*Inclusion criteria*

    i.      Male Subjects that have been Paint worker for up to 3years

    ii.     Paint workers without any chronic disease.

    iii.    Paint workers without addiction history of smoking

    iv.    Paint workers without addiction history of alcoholism,

    v.     Subjects that gave informed consent.

*Exclusion criteria*

i.   Subjects who did not give their consent were excluded from the study.

ii.   Female subjects were excluded.

iii.   Subjects with chronic diseases.

iv.   Subjects with addiction history of smoking

v.   Subjects with addiction history of alcoholism,

**Specimen Collection and Processing**

Five (5ml) of fasting venous blood was collected from the subjects by venipuncture using sterile needle and syringes. About 2 milliliters was dispensed into fluoride oxalate container while 3 milliliters were dispensed into Ethylene Diamine Tetracetic Acid (EDTA) container. The containers were properly labelled before commencement of analytical procedures. They were stored refrigerated at 2-8 °C until analyzed within 5 hours after collection.

**Analytical Methods**

Blood glucose was determined employing Glucose GOD-PAP method **[13]** using reagent kits (Cat no GL364) manufactured by Randox diagnostics. Glucose oxidase (GOD) catalyzes the oxidation of glucose to give hydrogen peroxide (H2O2) and gluconic acid. In the presence of the enzyme peroxidase (POD), the hydrogen peroxide is broken down and the oxygen released reacts with 4-aminophenazone (4-aminoantipyrine) and phenol to give a pink color. The absorbance of color produced was measured using a spectrophotometer at 515 nm. Hematological profile was determined by the automation method as previously described by Yun-A et al., **[14]** using *Mindray BC 6800 Automated Hematology Analyzer (Mindray, China)* supplied by Med Sing Long Global Group Co LTD, GuangZhou City, China)

**Statistical Analysis**

IBM SPSS version 21 was employed in determined of student t-test and Pearson correlation. The obtained values were stated as mean $\pm$ standard deviation. Values with $p < 0.05$ were accepted to be statistically significant. The data obtained in the present study is normal distribution.

## RESULTS

### Blood Glucose, WBC and differential WBC count in Male Paint Workers versus Male Controls

There was significantly higher blood glucose level ($p$=0.000) in male paint workers compared to the male controls, while there were significantly lower WBC and monocytes in male paint workers compared to the male controls ($p$=0.000 and $p$=0.008 respectively). There was no significant difference in neutrophils, lymphocytes and eosinophiles in male paint workers compared to the male controls ($p$=0.985, $p$=0.167 and $p$=0.333 respectively) (Table 1).

### Blood Red Cell Indices in Male Paint Workers versus Male Controls

There were significantly lower levels of RBC and Hb in male paint workers compared to the male controls ($p$=0.000 and $p$=0.000 respectively). There was no significant difference in HCT, MCV, MCH and MCHC in male paint workers compared to the male controls ($p$=0.167, $p$=0.332, $p$=0.486 and $p$=0.554 respectively) (Table 2).

### Platelet count and other Haematological Indices in Male Paint Workers versus Male Controls

There was no significant difference in MPV, PDW and PCT in male paint workers when compared to the male controls ($p$=0.667, $p$=0.603 and $p$=0.124 respectively). There was a significantly lower level of blood platelet in male paint workers compared to the male controls ($p$=0.001) (Table 3).

### Correlation of Blood Glucose with WBC, RBC, Hb and Platelets in Male Paint Workers

There was non-significant correlation of blood glucose with WBC, RBC, Hb and platelets in male paint workers ($p$> 0.05 in each case) (Table 4).

**Correlation of WBC with Neutrophil, Lymphocyte, Monocyte and Eosinophil counts in Male Paint Workers**

There was non-significant correlation of WBC with neutrophil, lymphocyte, monocyte and

eosinophil count in male paint workers ($p > 0.05$ in each case) (Table 5).

**Table 1: Blood Glucose, WBC and differential WBC count in Male Paint Workers versus Male Controls**

| Variables (Mean±SD) | Male Paint Workers (*n*=40) | Male Controls (*n*=40) | *t*-value | *p*-value |
|---|---|---|---|---|
| **Glucose (mg/dl)** | 109.70±9.831 | 85.25±11.72 | 8.113 | 0.000 |
| Lower 95% C.I | 105.09 | 79.76 | | |
| Upper 95% C.I | 114.30 | 90.73 | | |
| **WBC ($10^9$/l)** | 3.93±0.625 | 4.92±1.05 | -6.308 | 0.000 |
| Lower 95% C.I | 3.63 | 4.43 | | |
| Upper 95% C.I | 4.22 | 5.41 | | |
| **Neutrophil (%)** | 38.29±10.60 | 35.80 ±7.61 | -0.019 | 0.985 |
| Lower 95% C.I | 33.32 | 43.25 | | |
| Upper 95% C.I | 34.77 | 41.90 | | |
| **Lymphocytes (%)** | 51.90±10.31 | 48.10±6.12 | 1.437 | 0.167 |
| Lower 95% C.I | 47.07 | 45.23 | | |
| Upper 95% C.I | 56.72 | 50.92 | | |
| **Monocytes (%)** | 5.61±1.41 | 6.96±1.79 | -2.975 | 0.008 |
| Lower 95% C.I | 4.94 | 6.11 | | |
| Upper 95% C.I | 6.257 | 7.80 | | |
| **Eosinophils (%)** | 4.20±4.35 | 6.60±9.87 | -0.993 | 0.333 |
| Lower 95% C.I | 2.16 | 1.98 | | |
| Upper 95% C.I | 6.23 | 11.2 | | |

*p*≤0.05 statistically significant

**Table 2: Blood Red Cell Indices in Male Paint Workers versus Male Controls**

| Variables (Mean±SD) | Male Paint Workers (*n*=40) | Male Controls (*n*=40) | *T*-value | *P*-value |
|---|---|---|---|---|
| **RBC ($10^{12}$/l)** | 4.06±0.52 | 4.88±0.29 | -6.660 | 0.000 |
| Lower 95% C.I | 3.81 | 4.43 | | |
| Upper 95% C.I | 4.74 | 5.41 | | |
| **Hb (g/dl)** | 13.34±0.68 | 15.00±0.51 | -9.631 | 0.000 |
| Lower 95% C.I | 13.01 | 14.75 | | |
| Upper 95% C.I | 13.66 | 15.24 | | |
| **HCT (%)** | 40.74±3.38 | 42.42±4.47 | -1.159 | 0.167 |
| Lower 95% C.I | 39.15 | 42.32 | | |
| Upper 95% C.I | 40.32 | 44.5 | | |
| **MCV ($\mu m^3$)** | 84.05±7.83 | 86.98±8.96 | -0.996 | 0.332 |
| Lower 95% C.I | 84.05 | 86.98 | | |
| Upper 95% C.I | 80.38 | 82.78 | | |
| **MCH (pg)** | 28.49±3.29 | 29.32±3.42 | -0.711 | 0.486 |
| Lower 95% C.I | 26.94 | 27.71 | | |
| **MCHC (g/dl)** | 338.40±11.44 | 336.60±8.72 | 0.602 | 0.554 |
| Lower 95% C.I | 333.04 | 332.51 | | |
| Upper 95% C.I | 343.75 | 340.68 | | |

*p*≤0.05 statistically significant

**Table 3: Platelet count and other Haematological Indices in Male Paint Workers versus Male Controls**

| Variables (Mean±SD) | Male Paint Workers (*n*=40) | Male Controls (*n*=40) | *t*-value | *p*-value |
|---|---|---|---|---|
| **MPV (μm$^3$)** | 9.94±1.55 | 9.74±0.97 | 0.423 | 0.677 |
| Lower 95% C.I | 9.21 | 9.28 | | |
| Upper 95% C.I | 10.66 | 10.19 | | |
| **PDW (%)** | 16.14±0.56 | 16.22±0.49 | -0.528 | 0.603 |
| Lower 95% C.I | 15.87 | 15.98 | | |
| Upper 95% C.I | 16.40 | 16.45 | | |
| **PCT (%)** | 1.81±4.44 | 1.53±0.696 | 1.611 | 0.124 |
| Lower 95% C.I | 15.87 | 15.98 | | |
| Upper 95% C.I | 15.98 | 16.45 | | |
| **Platelet (10$^9$/l)** | 157.00±23.96 | 211±56.60 | -3.928 | 0.001 |
| Lower 95% C.I | 145.78 | 168.21 | | |
| Upper 95% C.I | 185.20 | 238.19 | | |

*p*≤0.05 statistically significant

**Table 4: Correlation of Blood Glucose with WBC, RBC, Hb and Platelets in Male Paint Workers**

| Dependent Variables | N | r-value | p-value |
|---|---|---|---|
| WBC | 40 | -0.313 | 0.179 |
| RBC | 40 | -0.236 | 0.316 |
| Hb | 40 | -0.258 | 0.272 |
| Platelets | 40 | 0.222 | 0.346 |

**Table 5: Correlation of WBC with Neutrophil, Lymhocyte, Monocyte and Eosinophil counts in Male Paint Workers**

| Dependent Variables | N | r-value | p-value |
|---|---|---|---|
| Neutrophil | 40 | 0.205 | 0.385 |
| Lymphocyte | 40 | -0.142 | 0.551 |
| Monocyte | 40 | -0.254 | 0.279 |
| Eosinophil | 40 | -0.082 | 0.732 |

**DISCUSSION**

Paint workers are occupationally exposed to harmful solvents viz benzene, ethyl benzene and toluene which have been documented as carcinogens and likely reason for illnesses among paint workers **[3]**. Benzene is particularly associated with hematological and central nervous system aberrations [1**5,**16]. Paint workers are unambiguously exposed in processes that encompass physical handling thru preparation of paint for application on buildings **[3]**. The most important routes of exposure to paint includes inhalation, cutaneous/skin contact and ingestion via individual work habit **[3]**.

From our present study, blood glucose was significantly higher in male paint workers compared to the controls. It has been inferred that hyperglycemia causes a variety of long-term health problems, such as heart disease, kidney dysfunction, eyes, and nerve damage **[17]**. It is likely that the higher blood glucose level observed in paint workers may be an indication of compromised or altered blood glucose metabolism. The pancreatic β-cells, which play vital role in insulin production/secretion in humans are at grievous risk of apoptosis owing to reactive oxygen species attack more than other human cell categories. The mitochondria of β-cells can create extreme concentrations of reactive oxygen species and are together the chief source of reactive oxygen species and also a primary target for reactive oxygen species attack **[18]**. This in addition to a failure of the reactive oxygen species defense system, consequences in the comparatively high susceptibility of b-cells to oxidative stress. Cadmium is a constituent of paint which can induce oxidative stress damage, thus causes suppression of insulin secretion and consequential to apoptosis in pancreatic islet b-cells **[18]**.

Despite that cadmium and lead are among the European Union priority metals due to the increased risk of occupational exposure to humans and vulnerable groups, water-based paints

sold in Nigeria still contain large quantities of lead, arsenic and cadmium, which are harmful to human health and the entire ecosystem [6]. Cadmium exposure triggers the c-Jun N-terminal kinase (JNK) pathway that is actively involved in the apoptosis of pancreatic β-cells, and Cadmium causes cell death largely via the stimulation of JNK-controlled mitochondria-dependent apoptosis signaling in pancreatic β-cells [18]. This causes reduction of insulin secretion, subsequently poor regulation of blood sugar, hence culminates in increased blood glucose as seen in the occupationally exposed paint workers in the present study.

Likewise, Lead (Pb) disturbs the insulin secretory role of islets by triggering glycogen synthase kinase-3$\beta$ (GSK-3β) and endoplasmic reticulum stress, and amplified action of gluconeogenic enzymes in the liver manifested by glucose intolerance. Prolonged exposure to Pb can alter glucose homeostasis by disturbing pancreas and liver mostly through induction of insulin resistance [19].

Occupational exposure to several concentrations of benzene and other toxic constituents in paint can predispose several deleterious effects, including hematological system and central nervous system anomalies [15]. Prolonged exposure to benzene may be consequential to leukemia and lymphoma in humans [16]. The present study shows that total white blood cell count, monocyte count, red blood cell count and hemoglobin of male paint workers are significantly lower than those of normal healthy male controls. This may suggest that paint workers may have lower immunity as well as increased chances of developing anemia. This finding may be as a result of toxic effect of paint chemical constituents on haembiosynthesis. Also, results from this study shows a statistically lower platelet count in male paint workers than in male controls. This suggests the paint workers may be at higher risk of developing thrombocytopenia and consequently slowing down the process of blood clothing in incidents of injury, hence over

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bleeding and its associated morbidities. Exposure to benzene can cause toxic effects on red blood cell (RBC) physiology and morphology. Therefore, some authors have projected hemoglobin, mean corpuscular volume (MCV), absolute lymphocyte count, and full blood count (FBC) as suitable tests for the detection of toxic effects [16].

Heavy metals particularly lead and cadmium disturb heme synthesis as the chief iron-sequestering process of the human body. Pb and Cd contend with iron as transporters, decrease the cellular iron pool, and also bind to proteins and consequently disrupts biochemical, physiological, physical and mental processes [20]. Heavy metals primarily damage many aspects of the heme synthesis pathway: gene expression, enzyme activity, and iron incorporation into protoporphyrin IX [20]. Thus, occupational exposure to paint can pose a risk to hematological abnormalities due to its heavy metals content. Anxieties over the presence of harmful heavy metals in paints marketed in Nigeria have been expressed over time [6, 21, 22].

**Conclusion**

This study shows that male paint workers have significantly higher blood glucose level, but lower platelet count, WBC count, monocyte count, RBC count and Hemoglobin level. This suggest that occupationally exposed male paint workers may be at risk of developing hyperglycemia, thrombocytopenia, reduced immunity and anemia consequential to harmful constituents of paint marketed in Nigeria.

**Recommendation**

Owing to the conclusion of this research, more protective measures should be put into place to reduce direct exposure to paint toxins especially by inhalation and skin contact (penetration).

*DISCLAIMER*

*The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.*

*ETHICAL APPROVAL AND CONSENT*

*The study protocol was approved by the Department of Medical Laboratory Science, Imo state University, Owerri, Nigeria, Research Ethics Committee with reference number MLS/IMSU/REC/2021/011. Written informed consent was obtained from all study participants prior to their enrolment and collection of blood samples in accordance with the "1964 Helsinki declaration" and its later amendments in 2000.*

**COMPETING INTERESTS DISCLAIMER:**

**Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.**

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