



SJMLS-4 (1) -002

**Methaemoglobin Level and Packed Cell Volume in Apparently Healthy Wood-Furniture Workers Within Port Harcourt Metropolis, Rivers State, Nigeria**Eze, Evelyn Mgbeoma <sup>\*</sup>, Christian, Serekara Gideon <sup>1</sup> and Nwibani, Goodluck Felix <sup>1</sup>Department of Medical Laboratory Science, Rivers State University, Nkpolu-Oroworukwo, Port-Harcourt, Nigeria <sup>1</sup>*\*Author for Correspondence: evelyn.eze@ust.edu.ng /+234-706-675-4280***Abstract**

This study evaluated the methaemoglobin level and packed cell volume (PCV) of wood-furniture workers in Port Harcourt Metropolis. A total of one hundred (100) subjects all male were recruited, comprising of fifty-one (51) wood-furniture workers and forty-nine (49) apparently healthy controls. Blood samples from each participant was collected using a standard venipuncture technique and dispensed into a container, containing 1.2mg/ml of Potassium Ethylene Diamine Tetra Acetic Acid (K<sub>3</sub>EDTA) and transported to the Haematology Laboratory, Department of Medical Laboratory Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria for analysis, between June and August, 2018. Methaemoglobin level in percentage was determined using spectrophotometric method while PCV was determined using microhaematocrit method. All standard operating procedures were duly followed. The data collated revealed that methaemoglobin level was significantly increased in wood-furniture workers ( $9 \pm 6\%$ ) compared to the control subjects ( $1.9 \pm 0.62\%$ ) ( $p=0.0001$ ). There was also a significant increase in the packed cell volume level between test subjects ( $47 \pm 2.2\%$ ) compared to the control ( $40 \pm 2.6\%$ ) ( $p=0.0001$ ). Wood-furniture workers based on duration of exposure (years) were divided into three groups as 1-5 years (16 subjects), 5-10 years (14 subjects) and 10-15 years (21 subjects). The methaemoglobin level was significantly higher in wood furniture workers with longer period of exposure ( $4.6 \pm 1.1\%$ ), ( $7.1 \pm 1.2\%$ ) and ( $14 \pm 7\%$ ) for those exposed for 1-5 years, 5-10 years and 10-15

years respectively ( $p=0.0001$ ). Significant difference in packed cell volume level was also observed in test subjects on same duration of exposure as ( $42 \pm 1.7\%$ ), ( $40 \pm 1.7\%$ ), and ( $38 \pm 2.7\%$ ) in the same order when compared with control subjects ( $p=0.0001$ ). In conclusion, exposure to chemicals associated with wood-furniture works seems to significantly affect the methaemoglobin level and packed cell volume of exposed workers.

**Keywords:** *Methaemoglobin, packed cell volume, wood-furniture, exposure, workers*

**Introduction**

Wood-Furniture industry at present is one of the growing industries in the world, Nigeria and within Port-Harcourt Metropolis in particular. It is an industry which has different units in which people use wood or wood products to produce different furniture materials needed for both household and industrial uses. Furniture is one of the most important home accessories which exist in various forms such as doors, tables, chairs, decorations, cabinets, shelves, cupboard, beds, among others. Wooden furniture to be specific is present in homes, offices, and social infrastructural buildings such as schools, hotels, and hospitals. Most importantly, furniture adds style and elegance wherever they are because they contribute to beautification and aesthetics of a place.

Wooden furniture industry has made substantial contributions to the development in tropical countries producing important economic benefits and playing significant roles in

promoting economic growth (Apostolou *et al.*, 2004). In the area of employment, greater number of the populace are employed and they worked in various units which includes carpentry unit, spraying unit, designing unit, wood shining unit, sawing unit, tailoring unit and finishing unit. Wood based industries therefore have been identified as a veritable tool in poverty alleviation because of their potential in revenue generation, job creation, investment attraction and creation of local market products as by-product such as saw dust from the wood is of high demand by other industries such as agricultural industry, paper industry and chemical industry (Vlosky *et al.*, 2009).

In the furniture industries, workers make use of various chemical agents such as soligard used for wood shining, zotal stain used for wood staining, wood seal stain used for wood staining, top bond used for wood joining, gum used for wood binding, lacquer thinner used for wood treatment against termites and other insects that destroys wooden products, and exterior solignum used for wood preservation (Apostolou *et al.*, 2004). These chemical agents used in furniture-wood industries contains toxic substances which includes volatile organic compounds (VOCs), Polybrominated diphenyl ethers (PBDEs), perfluorinated compounds (PFCs), perchloroethylene (PCE), triclosan, chlorine, ammonia, polychloroprene, C9 petroleum resin, n-propyl acetate, petroleum ether, dimethyl carbonate, toluene, carbonathylene, chlorpyriphos (PAIS), 2,3-dichlorovinyl dimethyl Phosphate (DDVP), benzene (Vlosky *et al.*, 2009).

Wood-Furniture workers get exposed to these chemical substances through various routes such as nose (inhalation), (ingestion) or direct contact through broken skin in the form of gases, vapors, dust or mists which causes serious health effects including cancer (Price, 2002). Wood-Furniture workers are exposed to a lot of hazards particularly chemical hazard and in most cases and in our setting do not have proper understanding of the various health effect of these chemicals on humans and the environment. Absorption of nitro and amino aromatic derivatives (nitrobenzene), nitrates, aniline

usually absorbed through the lungs cause acquired methaemoglobinaemia (Trapp and Will, 2010).

The global plan of action on workers' health should be taken important since workers represent half of the world population and are the major contributors to economic and social development (WHO, 2006). Hence assessment and management of health risks at the workplace should be improved by: defining essential interventions for prevention and control of mechanical, biological, physical, chemical, and psychological hazards in the work environment. The workplace setup of Wood-Furniture industry at Timber Iloabuchi Mile 2 Diobu, Wood-Furniture industry at Marine-Base and Wood-Furniture workshops at Mile 4 along Ikwerre Road all within Port Harcourt metropolis were poorly arranged as almost all workers worked without the use of Personal Protective Equipment (PPE).

The condition of these workplaces in consideration could have serious health effects especially on the oxygen carrying capacity which is a function of the haemoglobin. Haemoglobin found in red cells whose major function is to transport oxygen to the various tissues has three species that cannot transport oxygen. These three collectively called dyshaemoglobins because of their functional inability are: carboxyhaemoglobin, sulfhaemoglobin, and methaemoglobin (Raney and Sharma, 2000).

Methaemoglobin is a dysfunctional form of haemoglobin in which the ferrous irons of haem are oxidized to the ferric state; therefore, methaemoglobin is incapable of transporting oxygen molecules (Mansouri *et al.*, 2006). As a result, high fractions of methaemoglobin would lead to tissue hypoxia and even methaemoglobinaemia (Greenberg *et al.*, 2002). Methaemoglobinaemia is a rare, but serious clinical condition in which the amount of oxygen carried through the blood stream is greatly reduced, and this give rise to functional anaemia. Ingestion and inhalation of oxidizing agents, such as nitrites and nitrates, are the most frequent causes of methaemoglobinaemia (Riggs, 2001).

Methaemoglobinaemia may be caused by congenital heart diseases or from the ingestion, inhalation, or absorption, or even medicinal administration, or anyone of several chemicals, ingestion of water containing high concentration of nitrate is also one of the major causes of methaemoglobinaemia in infants (Wendel, 2001).

## Materials and Methods

### Experimental Study Design

This study is a cross-sectional design. Subjects were recruited from the wood-furniture industry at Iloabuchi Mile 2 Diobu, Marine-Base and Mile 4 along Ikwerre Road all within Port Harcourt metropolis.

### Study Area

Port Harcourt is a Metropolitan city, the capital of Rivers State occupying approximately 1811.6km<sup>2</sup> area with a population of about 1.5 million (American Association for Advancement of Science, 2017). It constitutes the state's main city and has the largest seaports in Niger Delta region, thus being the center of administration, commerce, and industrial activities (Akukwe and Ogbodo, 2015). It is situated between latitude 4° 45'North and 4° 55'North and longitude 6° 55'East and 7° East in the State, occupying the entrance of Bonny River. The city is bounded in the north by Abia and Imo States; east by Akwa-Ibom State; west by Bayelsa State; and south by the Atlantic Ocean. It estimated mean altitude is 12km above average sea level, lying between Dockyard creek and Bonny River and Amadi Creek (Weli and Efe, 2015).

### Study Population

The study was carried out for a period of three months during which a total of 100 subjects comprising of fifty -one (51) wood-furniture workers; 19 from Marine-Base, 23 from Timber Iloabuchi Mile 2 and 11 from Mile 4 Ikwerre Road wood-furniture workshops and forty-nine (49) apparently healthy non-wood-furniture workers (control) all within Port Harcourt Metropolis were recruited.

### Informed Consent

Verbal informed consent was obtained from individuals enlisted for the study and a written

approval was obtained from the workshops to carry out this study.

### Sample Collection

Following the standard procedure for venipuncture by Jury *et al.* (2012), four milliliters (4mls) of blood sample was collected from each participant using standard venipuncture into EDTA vacutainer and the collected blood sample was adequately mixed with the anticoagulant ensuring complete uniform mixture of blood and EDTA anticoagulant. The samples were transported to the Haematology Laboratory, Department of Medical Laboratory Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria for analysis, between June and August, 2018 within 1 hour after collection.

### Sample Analysis

The analysis for methaemoglobin measurement was done based on Evelyn and Malloy (1938) standard manual method. The estimation of packed cell volume was done using microhaematocrit method.

### Principle for Determination of Methaemoglobin

Methaemoglobin has its maximum absorbance at 630nm. When cyanide is added, this absorption band vanishes and the subsequent change in absorbance is directly proportional to the concentration of methaemoglobin. The entire haemoglobin in the sample is then measured after complete conversion to carboxyhaemoglobin by the addition of ferricyanide – cyanide reagent.

### Laboratory Procedure for Methaemoglobin

The EDTA anticoagulated blood (0.2ml) was lysed in a solution containing 4ml of buffer and 6ml of detergent solution and the lysate divided into two equal volumes (A and B). The absorbance of A was measured with a spectrophotometer at 630nm wavelength and result recorded as (D1). One drop of potassium cyanide solution was added and the absorbance measured again, after mixing and recorded as (D2). One drop of potassium ferricyanide solution was added to tube A, and after 5 minutes, the absorbance was measured at the

same wavelength and recorded as (D3). Finally, one drop of potassium cyanide solution was added to tube B and after mixing a final reading (D4) was obtained. All the measurements were made against a blank containing buffer and detergent in the same proportion as present in the sample.

**Calculation:**

$$\text{Methaemoglobin (\%)} = \frac{D1 - D2}{D3 - D4} \times \frac{100}{1}$$

**Results**

**The demographic details of participants involved in the study:** fifty- one (51) wood-furniture workers (subjects) and forty- nine (49)

apparently healthy (controls) were collected using a questionnaire. All the participants were males and the age range were between eighteen (18) and fifty-five (55) years.

Table 1 shows that the mean± standard deviation of methaemoglobin level of the test subjects was 9 ± 6% while that of the control was 1.9 ± 0.62% (p<0.0001). The packed cell volume of the test subjects was 47±2.2% and that of the control was 40±2.6 % (p<0.0001).

**Table 1: Comparison of Test and Control Subjects for Methaemoglobin Level and Packed Cell Volume**

	Control	Test	p-value	Remark
<b>MetHb (%)</b>	1.9 ± 0.62	9 ± 6	0.0001	S
<b>PCV (%)</b>	47 ± 2.2	40 ± 2.6	0.0001	S

*Key: S- Significant, MetHb- Methaemoglobin, PCV- Packed cell volume*

Table 2 shows that the methaemoglobin level of the control subjects have the mean and standard deviation 1.9 ± 0.62% and the mean and standard deviation of the test subjects 1-5 years duration of exposure 4.6 ± 1.1% (p=0.0001). The packed cell volume of the control subjects has the mean and standard deviation 47±2.2% and the test subjects have mean and standard deviation 1-5 years duration of exposure 42 ± 1.7% (p=0.0001).

**Table2: Comparison of Methaemoglobin Level and Packed Cell Volume of Controls and Test Subjects who have been occupationally exposed for 1-5 year.**

	Control	Test	p-value	Remark
<b>MetHb (%)</b>	1.9 ± 0.62	4.6 ± 1.1	0.0001	S
<b>PCV (%)</b>	47 ± 2.2	42 ± 1.7	0.0001	S

*Key: S- Significant, MetHb- Methaemoglobin, PCV- Packed Cell Volume*

Table 3 shows that the methaemoglobin level of the control subjects have the mean and standard deviation 1.9 ± 0.62% and the mean and standard deviation of the test subjects 5-10 years' duration of exposure 7.1 ± 1.2% (p=0.0001). The packed cell volume of the control subjects has the mean and standard deviation 47±2.2% and the test subjects have mean and standard deviation 5-10 years' duration of exposure 40 ± 1.7% (p= 0.0001).

**Table 3: Comparison of Methaemoglobin Level and Packed Cell Volume Level of Control and Test Subjects who have been occupationally exposed for 5-10 years**

Parameter	Control	Test	p-value	Remark
MetHb (%)	1.9 ± 0.62	7.1 ± 1.2	0.0001	S
PCV (%)	47 ± 2.2	40 ± 1.7	0.0001	S

Key: S- Significant, MetHb- Methaemoglobin, PCV- Packed cell volume

Table 4 shows that the methaemoglobin level of the control subjects have the mean and standard deviation  $1.9 \pm 0.62\%$  and the mean and standard deviation of the test subjects 10-15 years duration of exposure  $14 \pm 7\%$  ( $p=0.0001$ ). The packed cell volume of the control subjects has the mean and standard deviation  $47 \pm 2.2\%$  and the test subjects have mean and standard deviation 10-15 years' duration of exposure  $38 \pm 2.7\%$  ( $p=0.0001$ ).

**Table 4 Comparison of Methaemoglobin Level and Packed Cell Volume Level of Control and Test Subjects who have been occupationally exposed for 10-15 years**

	Control	Test	P-value	Remark
MetHb (%)	1.9 ± 0.62	14 ± 7	0.0001	S
PCV (%)	47 ± 2.2	38 ± 2.7	0.0001	S

Key: S- Significant, MetHb- Methaemoglobin, PCV- Packed Cell Volume

### Discussion

From this study, there was significant increase ( $p=0.0001$ ) in the percentage of methaemoglobin level and significant decrease ( $p=0.0001$ ) in packed cell volume level of wood-furniture workers compared to non-wood-furniture workers. There was a significantly higher methaemoglobin level among non-wood-furniture workers ( $1.9 \pm 0.62\%$ ) compared to wood-furniture workers (level of  $9 \pm 6\%$ ). There was a significant decrease ( $p=0.0001$ ) in percentage of packed cell volume (PCV) from ( $47 \pm 2.2\%$ ) in control subjects to a level of ( $40 \pm 2.6\%$ ) in wood-furniture workers.

The result obtained from this study agrees with the observation made by other researchers who worked on the effect of occupational exposures on methaemoglobin level (Christian *et al.*, 2015; Sager *et al.*, 2005; Ramnik, 2003). Industrial exposure to hydrocarbon fumes, and absorption of nitro and amino aromatic derivatives through the respiratory tract or skin can result in methaemoglobinaemia and cyanosis when the percentage rises above 20%. This affects the oxygen delivery to tissues and body cells

because methaemoglobin has stronger affinity to oxygen than the normal haemoglobin.

The result of this study is in agreement with the observation of Sager *et al.* (2005), in which symptoms of more profound hypoxia, headache, dizziness, anxiety and increased heart rate, following deepening cyanosis as methaemoglobin level rises above 20%. Severe or complicated methaemoglobinaemia above 50% is accompanied with increasing breathlessness and fatigue, confusion, drowsiness and coma ensued.

We observed that there was a significant increase in methaemoglobin level ( $p=0.0001$ ) based on duration of exposures among the occupationally exposed furniture workers. This finding is in agreement with previous reports (Christian and Eze, 2017; Christian *et al.*, 2015), where increasing duration of exposures to fumes emanating from sources that increases methaemoglobin levels also affected their test subjects. In this study, there was a significant decrease in packed cell volume (PCV) level of wood-furniture workers when they were

grouped based on duration of exposure; 1-5 years, 5-10 years, and 10-15 years and compared with controls.

It was explained by some wood-furniture workers who get exposed more to these chemicals that they suffered severe headache, difficulties in breathing and even difficulties to sleep at night, some workers stated that they used milk at the close of work every day to enable them sleep. This could be as a result of the competitive binding of nitrates and nitrites and other chemical constituents in the wood sprays being used to haemoglobin in a complex of methaemoglobin at the expense of oxygen which will automatically affect the oxygen-haemoglobin dissociation curve by shifting it to the left, which does not favours oxygen delivery to tissues.

### Conclusion

This study shows that exposure to chemicals associated with wood-furniture works seems to significantly affect the methaemoglobin level and packed cell volume of exposed workers. There was a significant difference in methaemoglobin level and packed cell volume of occupationally exposed wood-furniture workers and that of non-exposed controls. There was also a significant difference on basis of duration of exposure. It is therefore imperative to consider the methaemoglobin level and packed cell volume in individuals exposed to various chemicals, as increased in methaemoglobin levels affects the binding of oxygen to haemoglobin and ultimately the delivery of oxygen to tissues and body cells that supports normal body function especially respiration and gaseous exchange in the lungs.

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**Citation:** Eze, Evelyn Mgbeoma, Christian, Serekara Gideon and Nwibani, Goodluck Felix. Methaemoglobin Level and Packed Cell Volume in Apparently Healthy Wood-Furniture Workers Within Port Harcourt Metropolis, Rivers State, Nigeria. *Sokoto Journal of Medical Laboratory Science*;4(1): 14 - 20.

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