International Journal of Health Sciences
June 2017, Vol. 5, No. 2, pp. 17-27
ISSN: 2372-5060 (Print), 2372-5079 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/ijhs.v5n2a3
URL: https://doi.org/10.15640/ijhs.v5n2a3

Blood Lead Levels among Automobile Mechanics in a Megacity, Lagos, Nigeria

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Abstract

This study assessed blood lead and Packed Cell Volume (PCV) levels among automobile mechanics in Agidingbi, Ikeja Local Government Area of Lagos. A cross-sectional study was conducted among 37 consented automobile mechanics at a mechanic village in the study setting. Interviews were conducted using a semi-structured questionnaire while blood samples were collected through antecubital fossa. Respondents' mean age was 29 ± 11 years, 64.9% were single while 37.8% were operating as a master of the facility. Some 48.6% occasionally experienced headaches while 35.1% and 29.7% experienced tiredness and abdominal pain, respectively. Most (97.3%) have not heard about lead poisoning, 91.9% did not wear any personal protective equipment (PPE) and 89.2% did not wear apron during practice. The mean blood lead level and PCV% were 4.4±2and 38.7±3.8 respectively. PCV and years of professional practice significantly reflected in blood lead level (R^2=0.679, p<0.001) while years of professional experience independently predicted blood lead level (R^2adjusted=0.656, p<0.001) when adjusted for age and level of operation. Although, the blood lead level was relatively low to warrant public health concerns, but the use of PPE was poor. Regular use of PPE is encouraged to prevent exposure to lead among automobile mechanics.

Key words: Blood Lead, Packed Cell Volume, Automobile mechanics, Personal protective equipment

1. Introduction

Lead is found in the environment (air, water and soil) as well as in most biological systems. It is a highly reactive and toxic heavy metal which accumulates in man and has no known biological function Dioka et al, 2004) but an element of risk for the environment and human health and has harmful effects that may exceed those of other inorganic toxicants. Most of the atmospheric lead is emitted from two main sources, leaded petrol in motor vehicles, industrial sources, gasoline , lead smelters, batteries and auto-radiator repair works (CDC, 2002; OLPPP, 2002). In addition, human activities also have spread lead throughout water, soil, plants and animals. Lead can be found in everyone's body (Flegal and Smith, 1992; 1995) and occupational exposure to lead could induce toxicity (Rodriguez et al., 1996). Lead adversely affects several body systems and the most sensitive are the nervous, hematopoietic, gastrointestinal, cardiovascular, musculoskeletal, renal and reproductive system (OLPPP, 2002; Alexander et al., 1996). Frequent inhalation of lead fumes and/or ingestion of lead particles are known to cause injury to the kidney. Lead toxicity is also known to have adverse effects on critical enzymes involved in harem synthesis (WHO, 1995). It is well documented, however, that lead causes symptoms of toxicity at levels of 10-20μg/dL (Sielbergeld, 1995).

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Further, Lovei (1999) documented that occupational lead exposure is entirely unregulated, often with no monitoring of exposure in many developing countries. It has also been reported that many people working for different manufacturing or service rendering organizations are involved in jobs which expose them to gradual health risks from exposure to lead without having any idea about the materials they are handling (Adela et al., 2012). Inadequate awareness about their exposure has made these categories of workers eat, smoke and/or drink while at work and such workplace practices may also aggravate their exposure (Pala et al 2009; Grandjean et al., 1981). Lead poisoning may be seen in mechanic villages as an environmental and occupational health hazard and a study conducted among occupationally exposed artisans and control subjects in Nnewi revealed an elevated blood lead levels in both groups (Dioka et al, 2004). The study attributed the increased in the blood lead level of people in this occupational setting mainly to additives, especially tetraethyl lead, in petroleum solvents. Moreover, Automobile Mechanics (AM) that does routine maintenance and repair of motor vehicles are commonly found in Nigeria and are exposed to Petroleum Motor Spirit (PMS)-a likely source of lead by sucking with their mouth through a tube in an attempt to siphon PMS from the vehicle tank. They also often wash vehicle parts with PMS without wearing any PPE like gloves. Thus, PMS gets into the body of AM either through ingestion, inhalation or contact. Similarly, there are categories of workers who seldom undergo pre-employment medical examination or provided with regular medical check-ups to detect potential serious risk the exposure to lead may cause. These are reasonable sources of lead exposure among AM and constitute a serious public health concern. Pachathundikani and Varghese, 2006 reported that drastic increase in the number of automobile vehicles in the last two decades incremented the exposure of this labour class to lead. Also, the outfits of automobile workshop workers serve as a source of lead exposure to their family members, young children in particular arise the occupational toxicity to a community problem (Ayaz et al., 2010). A successful and complete assessment of blood lead levels in mechanics in the study area will thus help in ascertaining the amount of lead in the blood of the mechanics. The data collected could be useful in environmental control programmers and future researches. Instituting control measures and exercising precautionary principle in the workplace will help to reduce their exposure to lead. Hence this study was designed to assess Blood Lead levels and PCV among Automobile Mechanics in Agidingbi, Ikeja Local Government Area of Lagos.

2. Materials and methods

2.1 Study Area

Lagos metropolis is situated between Lat. (6 22' and 6 42') N and Long. (42' and 4 22'), and shares boundaries with Ogun state on the North-East and Benin Republic on the west side. comprises of 20 Local Government Areas, namely—Agege, Ajeromi/Ifelodun, Alimosho, Amuwo-Odofin, Apapa, Badagry, Epe, Eti-Osa, Ibeju-Lekki, Ifako-Ijaiye, Ikeja, Ikorodu, Kosofe, Lagos Island, Lagos Mainland, Mushin, Ojo, Oshodi/Isolo, Somolu and Surulere. It is located in the tropical rain forest zone of the country and climate oscillates between a dry season (November to April) and a wet season May to October). Lagos city was stratified into three major areas (Table 1) based on population density (Adedibu and Okekunle, 1989). However, this study was carried out at Agidingbi (High density) area of Ikeja Local Government, Lagos State (see Figure 1 for detail). Agidingbi is situated in Agege, Lagos, Nigeria and its geographical coordinates are 6° 37' 25" North, 3° 21' 13" East.

Table 1: Category of Lagos city area

High density	Medium density	Low density
Agege	Apapa	Ikeja-Government
Agidingbi	Festac town	Reserved Area (GRA)
Ajegunle	Ikeja	Ikoyi
Badagry	Ilupeju/Isolo	Lekki Peninsula
Bariga	Maryland	Victoria Garden City
Dopemu	Satellite town	Obalende
Egbeda/Idimu/Ikotun	Surulere	Victoria Island
Idumota	Yaba	
Iyana-Ipaja	Okota	
Mushin/Idiroko		
Ojo		
Ojota/Ketu		
Oshodi/Ojodu/ Berga		

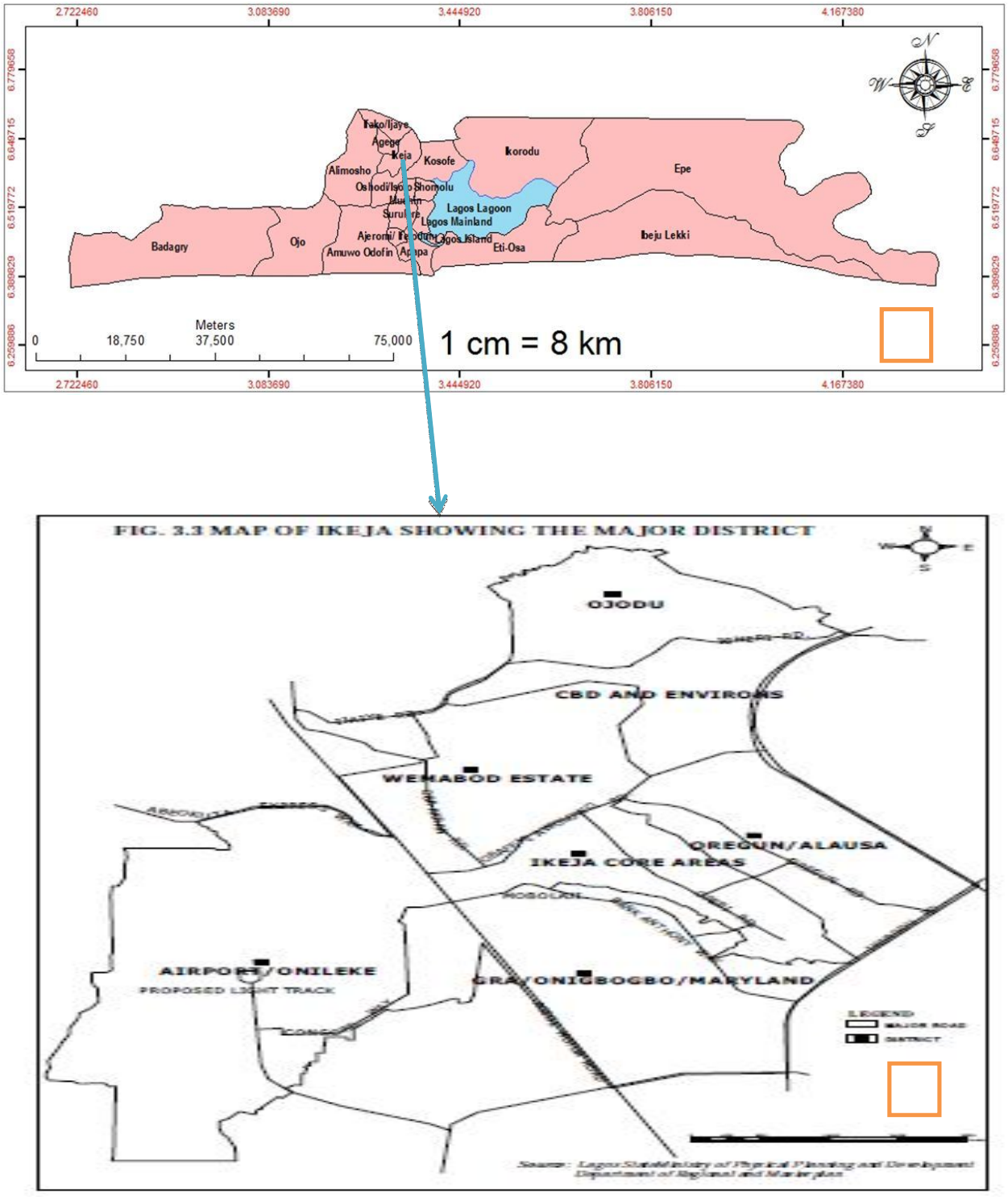


Figure 1: A=Map of Lagos state with 20 LGAs; B=Map of Ikeja LGA

2.2 Study Design

This study was cross-sectional in design and involved automobile mechanics in their workshops at Agidingbi, Ikeja LGA, Lagos State. All consented automobile mechanics participated in the study. Automobile mechanics who had received certificate and practicing after undergone Apprenticeship (Master), those who had not received certificate but International Labour Organization (ILO) recommendation that stipulated 15 years as the age for an individual to undergo Apprenticeship. A set of semi structured questionnaire was developed to collect socio-demographic characteristics of the mechanics, symptoms and factors associated with elevated levels of lead in blood; and knowledge and practices. In addition, blood samples from automobile mechanics were collected, tested for PCV and blood Pb levels.

2.3. Study population and Sampling Techniques

In Nigerian cities, automobile mechanics gather in a designated area allotted by the State Government and practice the profession. Individuals have their identity but the entire area is referred as 'Mechanic Village'. The study was carried out among automobile mechanics who practice either as a 'Master' (the main mechanic with skills), 'Join man'(a mechanic with less experience but join the main mechanic) or 'Apprentice' (a learner, often a young boy). A Mechanic Village was purposively selected at Agidingbi area of Ikeja Local Government. Thirty seven consented mechanics participated in the study. During the planning stage of the study, the researchers approached the authorities in-charge of the selected mechanic village particularly the association executive and the head of the mechanic village with formal letters to obtain permission to carry out the work in the mechanic village and also explained the study objectives. Furthermore, two meetings were organized with all the mechanic members working within the mechanic village to discuss the theme and objectives of the study. These schedules were made pertinent to ensuring that they understood all aspects of the study and informed consent taken. The association executives and head of the mechanic village granted permission and assigned three people to supervise the collection of blood samples from their members. Consent forms after they had been completed and signed, were obtained from Automobile Association authority in Agidingbi division, head of the automobile mechanic village and the individual automobile mechanic. Consenting automobile mechanics were interviewed while blood samples were collected immediately after the interview from the respondents. Interviews were conducted by two trained research assistants (a male and a female) who are university graduates and were acquainted with questionnaire research. They were trained in how to use the instrument and how they should introduce themselves and the research objectives modestly to the automobile mechanics during the interview.

2.4. Laboratory Analysis

Blood samples (about 5 ml) were collected from each consented mechanic through the antecubital fossa using disposable, pyrogen-free 5ml needle and syringe with the help of a trained laboratory scientist. The scientist employed the change of gloves, and needle and syringe with each mechanic during sample collection. The blood sample obtained was divided into two: one part (about 2 ml) was dispensed into Lithium-heparinized vacutainer for the analysis of lead in blood; and the other part (about 2 ml) dispensed into EDTA vacutainer for packed cell volume (PCV) determination. These were mixed thoroughly immediately after been dispensed into the vacutainers. The blood samples obtained were put in an ice pack and transported to the laboratory. The packed cell volume (PCV) of the blood was determined by centrifugation while blood Pb level determination was carried out using Atomic Absorption Spectrophotometer (Model PU9100X).

2.5. Data Analysis

Data generated from the field were edited daily. Then they were coded and entered into the computer for analyses using the SPSS Windows Version 18 (Chicago, IL) statistical software packaged. Data were presented as mean standard deviation for continuous variables and percentages for categorical variable. Analysis of Variance (ANOVA) statistic was used to determine the difference between four demographic characteristics, PCV level and blood lead level. Multiple regression was used to predict blood Pb level among automobile mechanic. Level of significance was set at $p<0.05$.

2.6. Ethical Consideration

The study was approved by the joint Ethical committee of University of Ibadan and University College Hospital, Ibadan, Nigeria. Also consent was obtained from Automobile Association authority in Agidingbi division, head of the automobile mechanic village and the individual automobile mechanics.

3. Results

3.1 Demographic characteristics of the participants

Demographic Characteristics of the respondents were presented in Table 1. The mean age which ranged from 15 to 50 years was 29 ± 11 years. There were more single (64.9%) than married (35.1%). Majority (62.2%) had secondary education, 37.8% were operating as a master while 13.5% were Join man. The mean length of stay in the automobile mechanic work was 10.0 ± 5.1 years (Range=3-33 years) and 48.6% had spent up to 5 years in operation.

Table 1: Socio-demographic characteristics (n=100)

Socio-demographic characteristics	Number	%
Age (Years)*		
15-24	17	45.9
25-34	10	27.0
35-44	4	10.8
45+	6	16.2
Marital Status		
Single	24	64.9
Married	13	35.1
Highest level of Education		
Quranic education	2	5.4
Primary education	12	32.4
Secondary education	23	62.2
Level of operation		
Apprentice	18	48.6
"Join man"	5	13.5
Master	14	37.8
Years of practicing+		
≤ 5	18	48.6
6-10	5	13.5
11 and above	14	37.8

+ =10 ± 5.1 years, Minimum= 3, Maximum=33
***=29±11 years, Minimum=15years, Maximum= 50 years**

3.2 Health Threats Experienced, Knowledge about Lead Poisoning and Safety Measure Practices

Table 2 presents the frequency of health threats experienced by the participants. It was found that 48.6% occasionally experienced headaches, 16.2% did so regularly while 18.9% experienced occasional drowsiness. Majority (75.7%) did not experience insomnia while 29.7% and 35.1%, respectively experienced abdominal pain and occasional tiredness. Knowledge about lead poisoning and safety measure practices are shown in Table 3. Large proportion (89.2%) of the participants had not heard about lead while 97.3% have not heard about lead poisoning. Most of the participants, 91.9% did not wear face mask, hand gloves (91.9%) while 89.2% did not wear overall garment.

Table 2: Frequency of health threats experienced by the respondents

Health threat	Frequency of health threat		
	Regularly (%)	Occasionally (%)	Not at all (%)
Headache	6 (16.2)	18 (48.6)	13 (35.1)
Drowsiness	4 (10.8)	7 (18.9)	26 (70.3)
Insomnia	5 (13.5)	4 (10.8)	28 (75.7)
Abdominal pain	1 (2.7)	11 (29.7)	25 (67.6)
Tiredness	12 (32.4)	13 (35.1)	12 (32.4)
Forgetfulness	10 (27.0)	7 (18.9)	20 (54.1)

Table 3: Heard about lead poisoning and safety measure practice / Personal Protection Equipment usage

Heard about lead poisoning	Yes (%)	No (%)
Heard about lead	4 (10.8)	33 (89.2)
Heard about lead poisoning	1 (2.7)	36 (97.3)
Safety measure practices/PPE usage		
Wear face mask	3 (8.1)	34 (91.9)
Wear hand gloves	3 (8.1)	34 (91.9)
Wear overall	4 (10.8)	33 (89.2)

3.3 History of smoking, PCV and Blood Lead Levels

Majority 81.1% were non–smokers, 13.5% smoke cigarettes ocassionally while 5.4% smoked daily as shown in Figure 1. Status of blood lead levels among the participants was illustrated in Figure 2. It was further shown that 83.8% participants had blood lead while blood lead were not detectable among 16.2% of the participants. The mean packed cell volume (PCV%) level which ranged from 29 to 45 was 38.7±3.8. Mean blood lead level was 4.4±2.1 μg/dL (Range=2-12) as presented in Table 4. Most of the respondents 96.8% had blood lead level below 10 μg/dL (Figure 3).

Figure 1: History of cigarette smoking

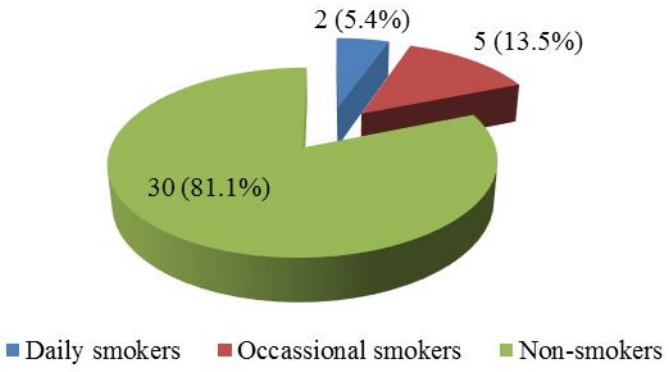


Figure 2: Status of blood lead level among the respondents

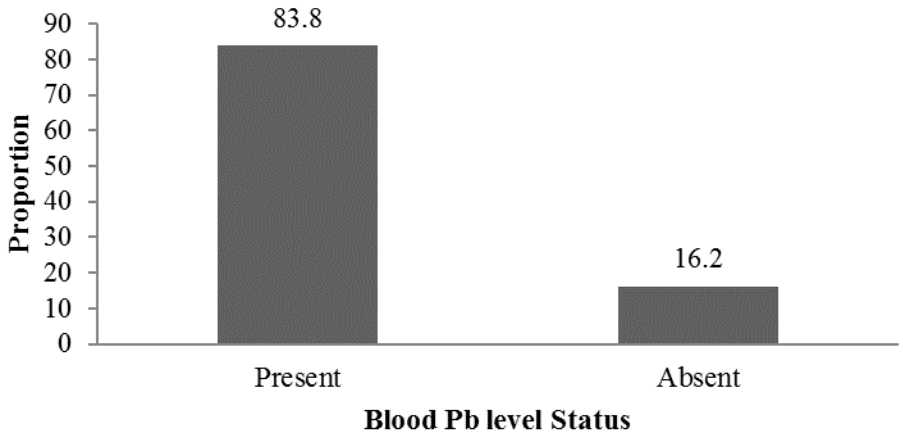
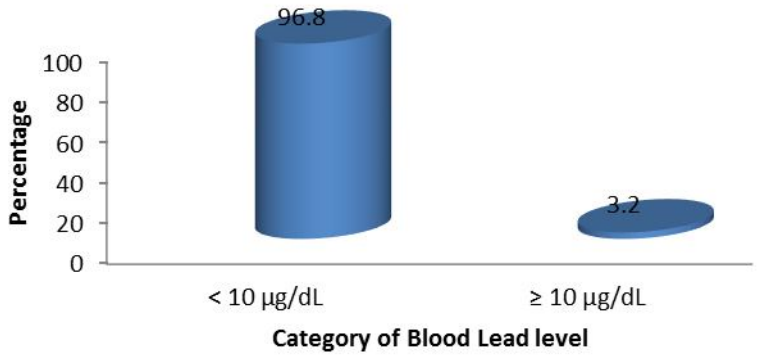


Table 4: Level of PCV and blood lead

Parameters	n	Mean±SD	Minimum-Maximum
PCV level (%)	37	38.7±3.8	29 45
Blood Lead level (µg/dL)	31	4.4±2.1	2- 12

Figure 3: Category of blood lead level among respondents



Respondents' PCV level was compared with age category, level of operation, years of professional practicing and highest level of education (Table 5). Automobile mechanics who were 45 years and above had higher PCV level (43.5 ± 0.5) compared to those who fell within 35-44 years, 25-34 years and 15-24 years of age respectively ($F = 15.616$, $p < 0.001$). Similarly, participants who were Apprentices had more PCV level (41.9±1.7) compared to those who were Masters (36.0±3.6) and Join man (39.2±0.4) ($F=17.881$, <0.001). Likewise PCV showed a significant difference in the respondents years of practicing and education level. Blood lead level of the respondents was compared with four sociodemographic characteristics as presented in Table 6. Mean blood lead level was statistically significant between the respondents age category, Level of operation, years of practicing and highest level of education.

Respondents who were Apprentices had significantly higher blood lead level (6.9±2.1 μg/dL) compared to those who were master (3.2±1.0 μg/dL) and Join man (4.4±0.8 μg/dL). Also, those who had spent 11 years and above in the practice had more blood lead level (7.1±2.1 μg/dL) compared to those who had spent 6-10 years (4.3±1.0 μg/dL) and ≤ 5 years (3.3±1.1 μg/dL) (F=21.071, p<0.001).

Table 5: Comparison of demographic characteristics and level of PCV

Characteristics	N	Mean±SD (PCV)	F/t test	p-Value
Age category				
15-24	17	35.8±3.6	15.616	<0.001
25-34	10	39.5±0.5		
35-44	4 6	41.3±0.9		
45+		43.5±0.5		
Level of operation	18	36.0±3.6	17.881	<0.001
Apprentice	5	39.2±0.4		
"Join man"	14	41.9±1.7		
Master				
Years of practicing	18	35.9±3.6	18.071	<0.001
≤ 5	5	39.5±0.5		
6-10	14	42.3±1.6		
11 and above				
Highest level of Education	2	44.0±0.1	30.864	<0.001
Quranic education Primary education	12	34.4±2.8		
Secondary education	23	40.4±2.1		

Table 6: Comparison of demographic characteristics and Blood lead level

Characteristics		Mean±SD	F/t test	p-Value
Age category				
15-24	17	3.2±1.0	21.370	<0.001
25-34	10	5.0±1.1		
35-44	4	7.9±2.8		
Level of operation	18	3.2±1.0	20.772	
Apprentice	5	4.4±0.8		<0.001
"Join man"	8	6.9±2.1		
Master				
Years of practicing	18	3.3±1.1	21.071	<0.001
≤ 5	5	4.3±1.0		
6-10	8	7.1±2.2		
11 and above				
Highest level of Education				
Primary education	12	2.8±1.0	16.433	<0.001
Secondary education	19	5.3±1.9		

There was a significat positive correlation between respondents age and years of professional practice (r=0.873, p<0.001) as seen in Table 7. This is an indication that older automobile mechanics had spent more on practice compared to the younger ones.

Respondents' PCV level was positively correlated with respondents age (r=0.755, p<0.001), years of practice (r=0.716, p<0.001) and level of operation (r=0.805, p<0.001) respectively. The correlation was significant and this suggested that respondents with higher PCV level were older in age, had spent 11 years and above in practicing and were Masters. Similarly, respondents' blood lead level correlated positively with age, years of professional practice, level of operation and PCV level.

These correlations were significant and indicated that automobile mechanics with high blood lead level were older in age, had spent more time in practicing, were masters and with high PCV level. Table 8 presents the multiple regression of PCV and year of practicing as a predictor variables of blood Lead level among automobile mechanics. It was found that PCV and year of practicing significantly predicted blood lead level (R^2=0.679, p=0. <0.001) on adjustment for age and level of operation, year of practicing independently predicted blood lead level (R^2adjusted=0.656, p<0.001).

Table 7: Correlation matrix of predictors of blood lead level among automobile mechanics

Variables	Respondents' Age	Years of practicing	Level of operation	PCV	Blood Pb Level
Respondents' Age	1				
Years of practice	0.873**	1			
Level of operation	0.925**	0.991**	1		
PCV	0.755**	0.716**	0.805**	1	
Blood Pb Level	0.769**	0.763**	0.819**	0.705**	1

** Correlation is significant at the 0.01 level (2-tailed)

Table 8: Multiple regression to predict blood Pb level among automobile mechanic

Variables	R square	Adjusted R square	Beta	F (p Value)
Blood Pb level (Non adjusted)				
Model	0.679			29.601 (<0.001)
PCV			0.387	2.897 (0.007)
Years of practice			0.532	3.988 (<0.001)
Blood Pb level (Adjusted for age and level of operation)				
Model		0.656		40.484 (<0.001)
Year of practicing			0.763	6.363 (<0.001)

5. Discussion

The study assessed blood lead and PCV levels among automobile mechanics in Agidingbi, Ikeja Local Government Area, Lagos state, Nigeria. The study revealed that large proportion of the participants have not heard about lead. This is an indication that awareness about lead poisoning among automobile mechanics in the study area was inadequate. Likewise, most of the participants have not heard about lead poisoning. This is an indication that automobile mechanics (workers) in the study area had little or no knowledge about lead and lead poisoning. Regrettably, this emphasized automobile mechanics' poor knowledge about the effect of lead and route of entry into the human body. This is in contradiction to the findings of a study where lead inhalation was more reported than dermal adsorption (EPA, 1986) and without this knowledge workers can develop serious health problems (Kenneth *et al*., 2003). High percentage of the participants did not wear face mask, not wear hand gloves and overall garment whenever they were on duty. This means that the workers' knowledge is in consonance with lead exposure preventive measures/ practices. Blayney (2001), reported that appropriate selection and use of PPE could prevent or reduce exposure to lead. However, poor practices of this safety measure in the study area could be attributed to care free attitude of the workers.

In a study carried out in Ghana, it was found that personal habit at work place appeared to play a major role in enhancing exposure to lead among lead smelters, automobile mechanics and gasoline retailers (Brockhaus *et al*., 1983). Studies have associated blood lead level with smoking, eating or chewing gum at work place (Chuang *et al*., 1999; Nuwayhud, 2001;) this might be attributed to to the ingestion of lead (contamination from hands during work) or increased absorption of inhaled lead (Zaki *et al*., 1998). Interestingly, this study observed that majority of the automobile mechanics were found to be non-smokers with only 2 (5.4%) who smoked daily.

However, this study found that 83.8% of the participants had blood lead with a mean of 4.4 ± 2.1 μg/dL while the PCV (%) level ranged from 29 to 45. The mean blood lead level was below the recommended limit of 10 μg/dL by Centers for Disease and Control (CDC, 1991). Also, the results were lower compared to the findings of other studies where a mean blood lead level of (21.12 ± 5.59 μg/dL) and (19.19 ± 4.08 μg/dL) were found among workers involved in manual auto painting and automobile mechanics, respectively (Adela *et al*., 2012). However, a similar study carried out in Bangkok among 52 mechanics, 27 dye sprayers and 20 controls, reported mean BLLs of 8.7 μg/dL, 12.02 μg/dL and 6.63 μg/dL respectively (Suwansaksri *et al*., 2002). The BLL value for the mechanics was below the recommended limits by CDC and similar to the findings of our study.

Mean blood lead level was statistically significant between the respondents age category, Level of operation, years of practice and highest level of education. Respondents who were Apprentices had significantly higher blood lead level compared to those who were 'master' and 'Join man'. Also, those who had spent 11 years and above in the practice had significantly more blood lead levels compared to those who had spent 6-10 years. This is similar to the findings of Higemengist *et al.,* (2014) where a steady increase in the proportion of individuals with higher blood lead levels with an increase in service years was observed. There was a significat positive correlation between respondents' age and years of practice, which is an indication that older automobile mechanics had spent more years on practice compared to the younger ones. Moreover, older automobile mechanics who were 45 years and above had significantly higher PCV level compared to those who were younger in age. Respondents' PCV level was positively correlated with respondents' age, years of practice and level of operation, respectively. The correlation was significant and this suggested that respondents with higher PCV level were older in age, had spent 11 years or above in professional practice and were Masters on their job. Furthermore, respondents' blood lead level correlated positively with age, years of practice, level of operation and PCV level. These correlations were significant and indicated that automobile mechanics with high blood lead level were older in age, had spent more time in profession , were masters and with high PCV level. The study found that PCV and years of practice significantly predicted blood lead level while years of practice independently predicted blood lead level on adjusting for age and level of operation.

6. Conclusion

Blood lead and PCV levels have been assessed among automobile mechanics in Agidingbi, Ikeja Local Government Area of Lagos. Generally, the blood lead levels were low. High proportion of the study population never heard of lead or lead poisoning. Further, most of the study participants did not wear PPE (face mask, hand gloves and overall garment). Although the blood lead was below the permissible limit, level of PCV and years of professional practice significantly predicted blood lead level. Years of professional practice also independently predicted blood lead level when compared to age and level of operation of the study participants. Regular use of PPE is recommended to prevent lead exposure among the automobile mechanics.

Limitations

The sample size initially calculated was fifty (50) but quite a number of participants declined to participate as giving blood sample is culturally a taboo and associated with superstitions..

Acknowledgement

The Authors acknowledge the immeasurable contribution of Automobile Mechanic Association authority in Agidingbi division, head of the automobile mechanic village and the individual automobile mechanics who had contributed to ensure the success of the work.

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