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Cardiopulmonary function, quality of life, musculoskeletal pain and serum lead level of welders in Enugu, Nigeria

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***Abstract*— *The study related serum lead level to cardiopulmonary function, quality of life and musculoskeletal pain of welders in Enugu, Nigeria. Snowball sampling technique was adopted to reach over 100 Enugu resident welders. The first 100 who met the inclusion criteria and gave their consent to participate in the study were sampled. The welders' serum lead level was 0.522µg/dl (0.06-1.26 µg/dl). The welders had prevalent low back pain and a very high quality of life for the domain of physical health with a score of 94, and high psychosocial and social relationship domains for quality of life with the scores of 69 and 75 respectively. About 64.2% of the welders had an elevated systolic blood pressure above 120mmHg and 52.6% had diastolic blood pressure elevated above 80mmHg, while only 3.2% of the welders had pulse rates above 100 beats per minute. The mean values for lung function were FVC = 1.43, FEV1 = 1.13 and PEF = 1.61. The significant relationship between serum lead levels (FVC, FEV1 and PEF) could be attributed to lead inhalation. The significant relationship between serum lead levels and low back pain and knee pain could be attributed to lead's effect on the musculoskeletal system.*

***Keywords*— cardiopulmonary function, quality of life, musculoskeletal pain, serum lead level, welders.**

I. INTRODUCTION

Welding is a very important process used for joining metal. With the quick development of science and industry, welding is used in more production fields, and the number of welders is increasing. Welders are exposed to many occupational hazards, including welding fumes, leading to serious occupational health problem all over the world. Lead affects major organ system in the body including hematopoietic, gastrointestinal, respiratory, renal, nervous and cardiovascular mainly through increased oxidative stress, ionic mechanism and apoptosis (Qin, Liu, Zhu, Weng, Xu, Ai 2014; Balkhour, Goknil 2010). Welders are also exposed to dust; heavy metals like lead; gases like fluoride, nitrogen, carbon monoxide; noise; and ultraviolet rays. Lead poisoning could cause hearing impairment, joint and muscles pains (Antonini, Santamaria, Jenkins, Albini, Lucchini 2006).

Musculoskeletal pain affects the muscles, ligaments, tendons, and nerves. It can be acute or chronic, it can be localized or widespread. Lower pain is the most common type of pain. Others are tendinitis, myalgia (muscle pain), and stress fractures. Musculoskeletal pain can also be caused by overuse. Pain from overuse affects 33% of adults. Lower back pain is the most common work-related diagnosis (Cleveland Clinic Foundation 2014).

A worker begins to fatigue when exposed to musculoskeletal pain risk factors. If the fatigue outruns the body recovery system, musculoskeletal disorder develops. Work related (ergonomic) risk factors, like high task repetition, can result in musculoskeletal risk factor. When combined with other risk factors, such as high force and/or awkward postures, high task repetition can contribute to the formation of musculoskeletal pains. A job is highly repetitive if the cycle time is 30s or less. Forceful exertions have also been found to bring about musculoskeletal pain. Many work tasks require high force loads on human body and muscle efforts increases in response to high force requirement with associated fatigue which can lead to musculoskeletal pains. Similarly, awkward postures place excessive force on joints and overload the muscles and tendons and affected joints (Ergonomics Plus 2011).

Lead is a highly toxic metal and a very strong poison. Lead poisoning is a serious and sometimes fatal condition. It occurs when lead builds in the body. Lead toxicity is rare after a sin glee exposure or ingestion of lead. A high toxic dose of lead poisoning may result in emergency symptoms, muscle weakness, severe abdominal pain and cramping, seizures, encephalopathy which manifests as confusion, coma and seizures (Healthcare Newsletter 2010).

In 2003, lead reportedly led to 853,000 deaths mostly in developing countries, and poor people are at greater risk. Lead is believed to result in 0.6% of the world's disease burden. The amount of lead in the blood tissues, as well as the time course of exposure, determine toxicity (World Health Organization 2018; Pearson, Schonfeld 2005; Needleman 2004).

The U.S. Center for Disease Control and Prevention and the WHO state that a serum lead level of 10µg\dL or above is a cause for concern. However, lead may impair development and have harmful health effects even at lower levels, and there is no known safe exposure level (Rossi 2000; Barbosa, Trans-Santos, Gerlach, Parsons 2005). The effects of metals, like lead (Pb), iron (Fe), manganese (Mn), zinc (Zn), Titanium, among others, showed significant adverse health effects, such as pulmonary inflammation, granulomas, fibrosis, genotoxicity, after inhalation (Michelle, Alexandra, Marco, Giancarlo 2012). Exposure routes of lead show that it is a common environmental pollutant. They include environmental industrial uses of lead, such as processing of lead-acid batteries or production of lead wire or pipes and metal recycling; processing of lead containing products, such as food and paints; soil and water containing lead (Manay, Cousillas, Alvarez, Heller 2004).

Cardiopulmonary function is the interrelation between the working of the heart and lung organs. The most important function of the cardiopulmonary system has to do with the flow and regulation of blood between the heart and the lungs, made through the pulmonary artery. The cardiovascular system is the method by which the heart and the entire network of blood vessels function together to direct the flow of blood throughout the body. The cardiorespiratory system describes the function of the heart in relations to the body's entire breathing mechanism, from the nose and the throat to the lungs. These three systems function interdependently. Consequently, the efficiency of heart function will depend on the strength of the heart muscle. Aerobic exercise makes the heart stronger and better equipped to propel blood. The power of the heart and clear unobstructed pulmonary artery passages performing in concert permit the efficient movement of blood to and from the lungs, where useful oxygen and waste carbon dioxide are exchanged in microscopic lining compartment known as alveoli. Chronic and acute lead poisoning cause overt, clinical symptoms of cardiac and vascular damage with potentially lethal consequences. Morphological, biochemical and functional derangement of the heart have all been described in patients following exposure to excessive lead levels. It is clear the lead toxicity affects the quality of life of individuals exposed to level of lead poisoning leading to some severe health conditions (Kopp, Barron, Tow 1988).

According to Occupational Safety and Health Administration (Occupational Safety and Health Administration 1999), work-related musculoskeletal pains currently account for one-third of all occupational injuries/illnesses reported to the Bureau of Labour Statistics (BLS) and are the largest job-related injury and illness problem in the United States today. Workers with severe musculoskeletal pains can face permanent disability which not only affects work activities but also can prevent the performance of everyday activities thereby posing treats to the quality of life of the individual. Hamburg Construction worker study found that of the subjects having a lower back disorder 60.4% had a reduction of mobility 27% had paravertebral muscle spasms, 24.4% had pain during movement and 10.7% had signs of sciatic nerve compression (Sturner, Luessenhoop, Net, Soyka, Karmaus, Tousaint, Liebs, Relder 1997). With the surge in the increased in the day to day activities, with little or no knowledge about the dangers welders are exposed such as lead toxicity which in one way or the other poses treat to health or quality of life of these group of workers in the areas of musculoskeletal systems, cardiopulmonary functions and their generalwellbeing. These heavy metals give cumulative deteriorating effects that can cause chronic degenerative changes (Ibrahim, Frobery, Wolf, Rusynick 2006), especially to the nervous system, liver and kidneys and in some cases, they also have teratogenic and carcinogenic effects (International Agency for Research on Cancer 2006).

There is paucity of studies on the topic in Nigeria especially South-Eastern Nigeria. This study aimed to relate the serum lead level to cardiopulmonary functions, quality of life and musculoskeletal pains of welders in Enugu, Nigeria by seeking the answers to the following questions:

1. What is the serum level of lead among welders in Enugu metropolis?
2. What is the prevalence of pains among welders in Enugu metropolis?
3. What is quality of life of welders in Enugu metropolis?
4. What is the cardiopulmonary functions of welders in Enugu metropolis?
5. What is the relationship between cardiopulmonary functions, quality of life, musculoskeletal pains and serum levels of lead among welders in Enugu Metropolis?
6. What is the relationship between the length of exposure, age, and serum lead level?

The specific objectives were to:

1. Determine the serum level of lead among welders in Enugu Metropolis.
2. Ascertain the prevalence of pains among welders in Enugu metropolis.
3. Ascertain the quality of life of welders in Enugu metropolis.
4. Ascertain the cardiopulmonary functions of welders in Enugu metropolis.
5. Ascertain the relationship between cardiopulmonary functions, quality of life, musculoskeletal pains and serum levels of lead among welders in Enugu Metropolis
6. Ascertain the relationship between the length of exposure, age, and serum lead level.

The hypotheses that guided the study were:

1. There is no significant relationship between musculoskeletal pains, quality of life, cardiopulmonary function and serum level of lead among welders in Enugu Metropolis.
2. There is no significant relationship between the length of exposure, age, and serum level of lead.

The findings of this study will enlighten the welders and the general public on the health status of welders in Enugu Metropolis. They will also guide physiotherapists and other health professionals on the need for holistic assessment of welders especially on quality of life and cardiopulmonary functions, and health workers on public health enlightenment on the risk of exposure to lead, especially among welders. This study will also serve a reference to point for future research in similar areas of study on exposure to lead toxicity.

II. MATERIALS AND METHODS

2.1 Design

The study utilized a cross-sectional research design. Convenience sampling technique was used based on the number of subjects present during the time of study who were willing to participate and met the inclusion criteria. A total of 100 welders participated in this study.

2.2 Inclusion and exclusion criteria

The selection criteria were inclusion and exclusion criteria. Only welders in Enugu metropolis from 18 years and above who had worked at least six (6) months were included in this study. Subjects excluded were those suffering from trauma, fracture, arthritis, neurological conditions, hypertension, cardiac problems and respiratory diseases such as asthma.

2.3 Informed consent

The study procedure was explained to the prospective subjects, from whom informed consent for participation in the study and allowing academic publication/s of the results of the study with anonymity were sought and obtained.

2.4 Ethical Committee approval

The Health Research and Ethical Review Committee of the University of Nigeria Teaching Hospital (UNTH)

Ituku-Ozalla, Enugu, which covers the area of study in the Primary Healthcare Programme of the Federal Government of Nigeria (FGN), gave the ethical approval for the study. All methods were performed in accordance with the relevant guidelines and regulations.

2.5 Samples collection

A World Health Organization (WHO) Quality of Life questionnaire, Nordic questionnaire for pain, stadiometer for measuring height, bathroom weighing scale (Hana Model calibrated in kilogram) for weight measurement, sphygmomanometer (Omrion China) for measuring the blood pressure of both the systolic and diastolic, needle and syringe for drawing blood samples, and cotton wool and methylated spirit were used. WHO questionnaire consists of 26 questions which were explained to the subject in case of any confusion or difficulty. Nordic questionnaire consists of demographic part and other sections like pain intensity rating scale, anthropometric part, and the part for treatment intervention. The completed questionnaire instrument was retrieved. The two questionnaires were either self-administered by the subjects or administered by the researchers.

To obtain the height of the participant, the improvised stadiometer calibrated in centimeter was placed on flat surface and the subject was asked to remove the footwears and stand in the platform on the stadiometer in an upright position with the heels in contact with the vertical bar of the stadiometer for the reading which was recorded. To obtain the weight, the participant was asked to step on a weighing scale with bare foot, stand erect and look straight at an eye level for a reading which was taken. To obtain the cardiovascular parameters, the subject was asked to stay quiet, calm and rest for five (5) minutes and an automatic sphygmomanometer was used to obtain the systolic and diastolic blood pressure as well as the pulse rate. The cuff was placed around a bare arm 1-2 cm above the elbow joint. While seated, the palm was supinated in front on a flat surface (desk). The cuff was fitted comfortably, yet strongly around the left arm.

New and unused sterile needles, syringes and blood sample bottles, obtained from a tertiary health institution (Teaching Hospital) that sourced pharmaceuticals and medical equipment from reputable pharmaceutical manufacturing companies in Asia and South Africa, were assumed to lead-free and used by a phlebotomist (staff of the institution) to collect the blood samples, with swab cotton wool/methylated spirit. The phlebotomist gave a sample bottle to each subject to collect early morning urine and store it in the fridge between delivering it to the medical diagnostic laboratory unit of the institution, where a medical laboratory scientist analyzed the samples for serum levels of Pb (independent variables) and the pulmonary functions (dependent variables) of the welders. The two sets of data were subjected to regression to determine the relationship between the variables. The data were subjected to descriptive statistics and analysed using paired and unpaired sample t-test. Pearson correlation was used to determine the relationship between the variables. A probability value of 0.05 was considered statistically significant. Analysis was performed using Statistical Package for Social Sciences (SPSS) 20.0 for windows evaluation version.

2.6 Determination of serum lead level

Serum lead levels were determined by Environmental Protection Agency (EPA) of the United States of America (USA) Method – 200_13 – Trace element determination via Atomic Absorption Graphite Furnace Spectrometer using Buck Scientific Atomic Absorption Spectrophotometer (GFAAS, made in USA). Ni served as matrix modifier for Pb (Bakırdere *et al*, 2013).

III. RESULTS

Table 1 shows the siociodemographic characteristics of participants.

Table 1: Siociodemegraphic characteristics

Sociodemographics characteristics	Percent	Frequency
AGE		
18-24	26	27.4
25-34	39	41.1
35-44	20	21.1
45-64	10	10.5
EDUCATION QUALIFICATION		
Informal	2	2.1
Primary	24	25.3
OND	63	66.3
BSc	4	4.2
MSc	1	1.1
PhD		
MARITAL STATUS		
Single	57	60.0
Married	38	40.0
BMI		
Underweight	8	8.4
Normal	61	64.2

Overweight	20	21.1
Obese	6	6.3
DURATION OF WORK		
< 6 months	3	2.9
6-1yr	1	1.0
1-2yrs	16	15.2
2-3yrs	17	16.2
3-4yrs	1	1.0
4-5yrs	5	4.8
>5yrs	52	49.5

Twenty-six per cent (26%) of participants were aged 18-24. Thirty-nine per cent (39%) of participants were of age bracket 25-34. Twenty per cent (20%) of participants were aged 35-44. Ten per cent (10%) of participants were of age bracket 45-64.

Participants with informal education were 2%, primary education were 24%, OND were 63%, BSc were 4%, MSc was 1%, and PhD none (0%). About equal portion of participants were single (57%) and married (58%). Participants' body mass index values were underweight (8%), normal (61%), overweight (20%), and obese (6%). Work duration of participants were 6 months (3%), 6 months to 1 year (1%), 1-2 years (16%), 2-3 years (17%), 4-5 years (1%), and less than 5 years (52%).

Table 2 shows the prevalence of musculoskeletal pain.

Table 2: Prevalence of musculoskeletal pain

Region	12-month-prevalence		Hinderance		7-day prevalence	
	Frequency	Percent	Freqeuncy	percent	Frequency	Percent
NECK						
Yes	20	21.1	1	1.1	3	3.2
No	75	78.9	94	98.9	92	96.8
SHOULDER						
Yes	19	18.1	2	2.1	2	2.1
No	76	80.0	93	97.9	93	97.9
UPPER BACK						
Yes	15	14.3	4	4.2	91	95.8
No	80	4.2	91	95.8	1	1.1
ELBOW						
Yes	12	12.6	4	4.2	1	1.1
No	83	87.4	91	95.8	94	98.9
WRIST						
Yes	15	16.0	5	5.3	4	4.2
No	79	84.0	90	94.7	91	95.8
LOWER BACK						
Yes	61	64.2	15	15.8	NR	NR
No	34	35.8	80	84.2	NR	NR
HIP						
Yes	17	17.9	2	2.1	2	2.1
No	78	82.1	93	97.9	93	97.9
KNEE						
Yes	23	21.9	5	5.3	9	9.5
No	72	75.8	90	94.7	86	90.5
ANKLE						
Yes	16	16.8	4	4.2	3	3.2
No	79	83.2	90	94.7	91	95.8

About 21.1% had neck pain which prevailed for 7 days for 3.2% of participants. About 75% did not have it and it did not prevail for 7 days in 96.8% of participants.

Almost 19% had pain in the shoulder which prevailed for 7 days for 2.1% of participants. Almost 76% did not have it and it did not prevail for 7 days 96.8% of participants.

About 15% had upper-back pain which prevailed for 7 days for 14.3% of participants. About 80% did not have it and it did not prevail for 7 days 95.8% of participants.

Nearly 12% had elbow pain which prevailed for 7 days for 12.6% of participants. Nearly 83% did not have it and it did not prevail for 7 days 98.9% of participants.

Almost 15% had wrist pain which prevailed for 7 days for 4.2% of participants. Almost 79% did not have it and it did not prevail for 7 days 95.8% of participants.

Sixty-one per cent (61%) of participants had lower-back pain, while 34% did not have it. About 17% had hip pain which prevailed for 7 days for 2.1% of participants. About 78% did not have it and it did not prevail for 7 days 97.9% of participants.

Almost 23% had knee pain which prevailed for 7 days for 9.5% of participants. Almost 72% did not have it and it did not prevail for 7 days 90.5% of participants.

About 16% had ankle pain which prevailed for 7 days for 3.2% of participants. About 79% did not have it and it did not prevail for 7 days 95.8% of participants.

Table 3 shows the classification of participants by pain intensity.

Table 3: Classification of participants by pain intensity

	PAIN INTENSITY							
REGION	no pain		mild		moderate		severe	
	fre	per	fre	per	fre	per	fre	per
NECK	71	74.7	13	13.7	8	8.4	3	3.2
SHOULDER								
Right	71	74.7	14	14.7	7	7.4	3	3.2
Left	71	74.7	15	15.8	5	5.3	4	4.2
Upper back	71	74.7	10	10.5	10	10.5	4	4.2
ELBOW								
Right	80	84.2	9	9.5	5	5.3	1	1.1
Left	78	82.1	10	10.5	5	5.3	2	2.1
WRIST								
Right	75	79.8	12	12.8	6	6.4	1	1.1
Left	76	80.0	13	13.7	3	3.2	3	3.2
Lower back	30	31.9	19	20.2	29	30.9	16	17.0
HIP								
Right	76	80.0	11	11.6	6	6.3	2	2.1
Left	75	78.9	12	12.6	5	5.3	3	3.2
KNEE								
Right	69	72.6	11	11.6	11	11.6	4	4.2
Left	67	70.5	14	14.7	10	10.5	4	4.2
ANKLE								
Right	76	80.0	10	10.5	6	6.3	3	3.2
Left	74	77.0	11	11.6	7	7.4	3	3.2

Almost 74.7% of participants had no neck pain, 13.7% had mild, 8.4% had moderate, and 3.2% had severe neck pain. Almost 74.7% of participants no shoulder pain. About 14.7% had mild right shoulder pain. Almost 7.4% had moderate right shoulder pain. Almost 3.2% had severe right shoulder pain.

About 74.7% of participants had no left shoulder pain. About 15.8% had mild left shoulder pain. About 5.3% had moderate left shoulder pain. About 4.2% had severe left shoulder pain. Almost 74.7% of participants had no shoulder upper-back pain. Almost 15.8% had mild shoulder upper-back pain. Almost 5.3% had moderate shoulder upper-back pain. Almost 4.2% had severe shoulder upper-back pain.

About 84.2% of participants had no elbow right pain. About 9.5% had mild elbow right pain. About 9.5% had moderate elbow right pain. About 5.3% had severe elbow right pain. Almost 82.1% of participants had no elbow left pain. Almost 10.5% had mild elbow left pain. Almost 5.3% had moderate elbow left pain. Almost 2.1% had severe elbow left pain.

About 79.8% of participants had no wrist right pain. About 12.8% had mild wrist right pain. About 6.4% had moderate wrist right pain. About 1.1% had severe wrist right pain. Almost 80.0% of participants had no wrist left pain. Almost 13.7% had mild wrist left pain. Almost 3.2% had moderate wrist left pain. Almost 3.12% had severe wrist left pain. About 31.9% of participants had no lower-back wrist pain. About 20.2% had mild wrist lower-back pain. About 30.9% had moderate wrist lower-back pain. About 17.0% had severe wrist lower-back pain.

Almost 31.9% of participants had no right hip pain. Almost 11.6% had mild right hip pain. Almost 6.3% had moderate right hip pain. Almost 2.1% had severe right hip pain. About 78.9% of participants had no left hip pain. About 12.6% had mild left hip pain. About 5.2% had moderate left hip pain. About 3.2% had severe left hip pain.

Almost 72.6% of participants had no right knee pain. Almost 11.6% had mild right knee pain. Almost 11.6% had moderate right knee pain. Almost 4.2% had severe right knee pain. About 70.5% of participants had no left knee pain. About 4.7% had mild left knee pain. About 10.5% had moderate left knee pain. About 4.2% had severe left knee pain.

Almost 80.0% of participants had no right ankle pain. Almost 10.5% had mild right ankle pain. Almost 6.3% had moderate right ankle pain. Almost 3.2% had severe right ankle pain. About 77.0% of participants had no left ankle pain. About 11.6% had mild left ankle pain. About 7.4% had moderate left ankle pain. About 3.2% had severe left ankle pain.

Table 4: Serum lead, cardiopulmonary functions and quality of life of participants.

Table 4: Serum lead, cardiopulmonary functions and quality of life of participants

Variables	Mean	Standard Deviation
Lead serum L	5.22	.30297
SBP	124.53	14.57
DBP	81.4737	13.36
PR	77.64	12.91
FVC	1.43	0.88
FEV1	1.13	0.65
PEF	1.61	1.16
Physical	14.00	1.48
Psychological	14.17	1.83
Social relation	15.50	2.74
Environment	12.12	1.81
Overall quality of life (QOL)	55.93	5.77

Mean serum lead level was 5,22±0.30297. Mean SBP was 124.53±14.57. Mean DBP was 81.4737±13.36. Mean PR was 77.64±12.91. Mean FVC was 1.43±0.88. Mean FEV1 was 1.13±0.65. Mean PEF was 1.61±1.16. Mean physical was 14.00±1.48. Mean psychological was 14.17±1.83. Mean social relation was 15.50±2.74. Mean environment was 12.12±1.81. Mean overall QOL was 55.93±5.77. Notably, serum lead level is related to FVC at p-value of .003, to FEVI at p-value of .002 and to PEF at p-value of .020.

Table 5 shows the relationship among serum lead level, cardiopulmonary function and quality of life.

Table 5: Relationship among serum lead level, cardiopulmonary function and quality of life

Variables	Lead serum level	
	Co-relation (R)	p-value
Physical	-.049	.637
Psychological	.138	.181
Social relationship	.131	.205
Environment	.138	.182
Overall QOL	.149	.148
FVC	.298 .003*	
FEVI	.309 .002*	
PEF	.239 .020*	

The co-relation value (R) was -.049 and probability value (p-value) was .637 for physical. R was .138 and p-value was .181 for psychological. R was .131 and p-value was .205 for social relationship. R was .138 and p-value was .181 for environment. R was .149 and p-value was .148 for overall QOL. R was .298 and p-value was 0.003* for FVC. R was .309 and p-value was .002* for FEVI. R was .239 and p-value was .020* for PEF.

Table 6 shows the association between serum lead level and self-reported prevalence of musculoskeletal pain.

Table 6: Association between serum lead level and self-reported prevalence of musculoskeletal pain

	lead category			
	accept	above accept	Chi-square	p-value
NECK PAIN – 12 MONTHS				
Yes	3	17	0.290	0.590
No	8	67		
NECK HINDERANCE				
Yes	-	1	0.132	0.716
No	11	83		
NECK PAIN – 7 DAYS				
Yes	-	3	0.406	0.524
No	11	81		
SHOULDER PAIN – 12 MONTHS				
Yes	2	17	0.026	0. 873
No	9	67		
SHOULDER HINDERANCE				
Yes	-	2	0.268	0.605
No	11	82		
SHOULDER PAIN – 7 DAYS				
Yes	-	2	0.268	0.605
No	11	82		
UPPER BACK – 12 MONTHS				
Yes	-	15	2.333	1.27

No	11	69		
UPPER BACK HINDERANCE				
Yes	-	4	0.547	0.460
No	11	80		
UPPER BACK – 7 DAYS				
Yes	-	3	0.547	0.761
No	11	80		
ELBOW PAIN – 12 MONTHS				
Yes	-	12	1.799	0.180
No	11	72		
ELBOW HINDERANCE				
Yes	-	4	0.547	0.460
No	11	80		
ELBOW PAIN – 7 DAYS				
Yes	-	1	0.132	0.716
No	11	83		
WRIST PAIN – 12 MONTHS				
Yes	-	15	2.365	0.124
No	11	68		
WRIST HINDERANCE				
Yes	-	5	0.691	0.406
No	11	79		
WRIST PAINS – 7 DAYS				
Yes	-	4	0.547	0.460
No	11	80		
LOWER BACK – 12 MONTHS				
Yes	8	53	0.393	0.531
No	3	31		
LOWER BACK HINDRANCE				
Yes	4	11	3.960	0.047*
No	7	73		
LOWER BACK PAIN – 7 DAYS				
Yes	NR	NR		
No				
HIP PAIN – 12 MONTHS	NR	NR		
Yes	-	17	2.711	1.00
No	11	67		
HIP PAIN ENDURANCE				
Yes	-	2	0.268	0.605
No	11	82		

HIP PAIN – 7 DAYS				
Yes	0	2	0.268	0.605
No				
KNEE PAIN – 12 MONTHS				
Yes	-	23	3.974	0.046*
No	11	61		
KNEE PAIN HINDRANCE				
Yes	-	5	0.691	0.046*
No	11	79		
KNEE PAIN – 7 DAYS				
Yes	-	9	1.302	0.254
No	11	75		
ANKLE PAIN – 12 MONTHS				
Yes	-	16	2.520	0.112
No	11	68		
ANKLE HINDRANCE				
Yes	-	4	0.691	0.708
No	11	79		
ANKLE PAIN – 7 DAYS				
Yes	-	3	0.547	0.761
No	11	80		

Notably, serum lead level and self-reported prevalence of musculoskeletal pain (lower-back pain) were significantly associated at p-value of 0.047. Also, serum lead level and knee pain at 12 months were significantly associated at p-value of 0.046. Again, serum lead level and knee pain hindrance were significantly associated at p-value of 0.046.

Table 7 shows the association among serum lead, age, BMI and work duration.

Table 7: Association among serum lead, age, BMI and work duration

	Serum level of lead			
	Acceptable	Unacceptable	Chi-square	p-value
AGE (YEARS)				
18-24	2	24	1.008	0.799
25-34	6	33		
35-44	2	18		
45-54	1	9		
55-64	-	-		
BMI CATEGORY				
Underweight	1	8	4.060	0.255
Normal	10	51		
Overweight	1	19		
Obesity	-	6		
DURATION OF WORK				

< 6 months	1	3	18.184	0.006*
6-1yr	1	-		
1-2yrs	1	15		
2-3yrs	1	16		
3-4yrs	1	-		
4-5yrs	1	4		
>5yrs	5	47		

Notably, serum lead level was significantly associated with duration of work (< 6 months to > 5 years) at p-value of 0.006.

Table 8 shows the association between serum lead level and regional pain intensity.

Table 8: Association between serum lead level and regional pain intensity

	lead category			
pain intensity	accept	above accept	chi-square	p-value
NECK				
No pain	9	62	3.586	0.310
Mild	-	13		
Moderate	2	6		
Severe	-	3		
RIGHT SHOULDER				
No pain	8	63	8.922	0.030*
Mild	-	14		
Mod	3	4		
Severe	-	3		
LEFT SHOULDER				
No pain	10	61	3.270	0.352
Mild	-	15		
Mod	1	4		
Severe	-	4		
UPPER BACK				
No pain	11	60	4.205	0.240
Mild	-	10		
Mod	-	10		
Severe	-	4		
RIGHT ELBOW				
No pain	11	69	2.333	0.506
Mild	-	9		
Mod	-	5		
Severe	-	1		
LEFT ELBOW				
No pain	11	67	2.711	0.438

Mild	-	10		
Mod	-	5		
Severe	-	2		
RIGHT WRIST				
No pain	11	64	3.156	0.368
Mild	-	12		
Mod	-	6		
Severe	-	1		
LEFT WRIST				
No pain	11	65	3.110	0.375
Mild	-	13		
Mod	-	3		
Severe	-	3		
LOWER BACK				
No pain	3	27	5.463	0.141
Mild	-	19		
Mod	4	25		
Severe	4	12		
RIGHT HIP				
No pain	11	65	3.110	0.375
Mild	-	11		
Mod	-	6		
Severe	-	2		
LEFT HIP				
No pain	11	64	3.317	0.345
Mild	-	12		
Mod	-	5		
Severe	-	3		
RIGHT KNEE				
No pain	11	58	4.688	0.196
Mild	-	11		
Mod	-	11		
Severe	-	4		
LEFT KNEE				
No pain	11	56	5.199	0.158
Mild	-	14		
Mod	-	10		
Severe	-	4		
RIGHT ANKLE				
No pain	11	65	3.110	0.375

Mild	-	10		
Mod	-	6		
Severe	-	3		
LEFT ANKLE				
No pain	11	63	3.530	0.317
Mild	-	11		
Mod	-	7		
Severe	-	3		

IV. DISCUSSION

The average, 0.522µg/dl, and range, 0.06-1.26 µg/dl, for serum level of lead in welders in Enugu metropolis fell within the range of literature reports. Shuitz *et al* (2005) reported 0.27µg/dl and a range of 0.15-0.77 µg/dl in German smelters. Barbosa *et al* (2005) reported 0.66 µg/dl with a range of 0.02-2.9 µg/dl in men who had long term exposure to lead. Verseieck and Cornelis (1998) found the serum lead level of 1.45µg /d1 in workers exposed to lead. Also, Bergdah *et al* (2010) reported a range of 0.02-1.30µg/dl.

The normal serum lead levels in unexposed subjects have been reported as 0.020-0.054 µg/dl and 0.002–0.29 µg/dl, with mean values of 0.066 µg/dl and 0.002 µg /d1 (Balkhour, Goknil 2010; Barbosa, Trans-Santos, Gerlach, Parsons 2005; Versieck, Cornelis 1988). The increase can be attributed to occupational exposure to lead due to exposure to lead oxide in the welding processes.

A significant relationship was found in this study between serum lead levels; FVC, FEV1 and PEF. This could be as a result of the report that the prevalent route of entry of lead in the body system of welders is via inhalation before it is absorbed into the blood stream.

On the other hand, there was no significant relationship found between quality of life and serum lead levels, but a significant relationship was found between serum lead levels and low back pain, knee pain (12 months) and knee pain hindrance, which could be as a result of the oxidative nature of lead and its effect on the musculoskeletal system. The study found no relationship between serum lead level, length of exposure and age.

The prevalent low back pain among welders could be as a result of the heavy lifting and repeated trunk flexion and rotation which have been found to be risk factors for low back pain (Hoogendoorn, Bongers, de Vet, Douwes, Koes, Miedema, Bouter 2006). The welders perceived their quality of life as regards environment as average, as they reported their physical environment as being a little or moderately safe, having little money to meet their needs, moderate; availability to information needed for their day to day life, satisfaction with access to health services and time for leisure activities, and a majority reported being satisfied and/or slightly satisfied with their transportation.

The finding of cardiopulmonary functions of welders assessed in the study showed that 64.2% of the welders had an elevated systolic blood pressure above 120 mmHg and 52.6% had diastolic blood pressure elevated above 80mmHg, while only 3.2% of the welders had pulse rates above 100 beats per minute. The mean values for lung function reported for the study were FVC = 1.43, FEV1 = 1.13, PEF = 1.61, which were lower than those previously reported in literature as mean FVC of 4.73, FEV1 of 3.70 (Emam, Alissa, Gordon, Fumes 2011) and FVC of 4.97 and FEV1 of 4.15 (Golbabaei1, Monazzam, Hematjo, Hosseini, Dehghan 2013; Neighbourhood Case Research 2008; Bergdahl, Sheveleva, Schu¨tz, Artamonova, Skerfving 1988). This confirms the reports of previous studies that suggest that welders were predisposed to pulmonary malfunction due to exposure to lead. A reduction in FEV1 usually indicates airway obstruction and welding processes resulted in obstructive airway changes (Rossi 2000).

V. CONCLUSIONS

The relationships between serum lead level and cardiopulmonary function, quality of life and musculoskeletal pain of welders in Enugu, Nigeria were investigated. With serum lead level of 0.522µg/dl (0.06-1.26 µg/dl), the welders had prevalent low back pain and a very high quality of life for the domain of physical health with a score of 94, and high psychosocial and social relationship domains for quality of life with the scores of 69 and 75 respectively. About 64.2% of the welders had an elevated systolic blood pressure above 120mmHg and 52.6% had diastolic blood pressure elevated above 80mmHg, while only 3.2% of the welders had pulse rates above 100 beats per minute. The mean values for lung function were FVC = 1.43, FEV1 = 1.13 and PEF = 1.61.

The significant relationship between serum lead levels (FVC, FEV1 and PEF) could be attributed to lead inhalation. The significant relationship between serum lead levels and low back pain and knee pain could be attributed to lead's effect on the musculoskeletal system.

REFERENCES

[1] Antonini JM, Santamaria AB, Jenkins NT, Albini E, Lucchini R (2006) Fate of manganese associated with inhalation of welding fumes: Potential neurological effects. *Neurotoxicol.* 27: 304-310.

[2] Bakırdere S, Yaroğlu T, Tırık N, Demiröz M, Fidan AK, Maruldalı O and Karaca A (2013) Determination of As, Cd, and Pb in Tap Water and Bottled Water Samples by Using Optimized GFAAS System with Pd-Mg and Ni as Matrix Modifiers, J Spec. 2013, https://doi.org/10.1155/2013/824817

[3] Balkhour MA, Goknil MK (2010) Total fume and metal concentrations during welding in selected factories in Jeddah Saudi Arabia. Int. J. Envir. Res. Pub. Health. 2978-2987.

[4] Barbosa JF, Trans-Santos JE, Gerlach RF, Parsons PJ (2005) A Critical Review of Biomarkers used for monitoring Human Exposure to Lead: Advantages, limitations and furniture needs. Environ Health Pers, 1669-1674.

[5] Bergdahl IA, Sheveleva M, Schu¨tz A, Artamonova VG, Skerfving S (1998) Plasma and blood lead in humans: capacity-limited binding to d-aminolevulinic acid dehydratase and other lead-binding components. Toxicol Sc, 46: 247–253.

[6] Cleveland Clinic Foundation (2014) Musculoskeletal Pain: Management and Treatment. Available at https://my.clevelandclinic.org/health/diseases/14526-musculoskeletal-pain/management-and-treatment

[7] Emam M, Alissa M, Gordon A (2011) Fumes. J Toxicol, 44(1): 19-23.

[8] Ergonomics Plus (2011) Definition and causes of musculoskeletal pain. Available at https://ergo-plus.com/musculoskeletal-disorders-msd/

[9] Golbabaei1 F, Monazzam MR, Hematjo R, Hosseini M, Dehghan SF (2013) The Assessment of Heat Stress and Heat Strain in Pardis Petrochemical Complex, Tehran, Iran. Int J Occ Hyg, 5: 6-11.

[10] Healthcare Newsletter (2010) Lead poisoning. California: Healthcare.

[11] Hoogendoorn WE, Bongers PM, de Vet HC, Douwes M, Koes BW, Miedema MC, Bouter LM (2006) Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. Spine, 25(23): 3087-3092.

[12] Ibrahim B, Frobery A, Wolf DE, Rusynick D (2006) Heavy metal poisoning. Clinical presentations and pathophysiology. *Clinics Lab Med*, 126: 67-97.

[13] International Agency for Research on Cancer (IRAC) (2006) Monographs on the evaluation of the carcinogenic risk and arsenic compounds, 100-106.

[14] Kopp SJ, Barron JT, Tow JP (1988) Cardiovascular system actions of lead and relationship to hypertension: A review. Environ Health J, 78: 9-19.

[15] Manay Ni, Cousillas Az, Alvarez C, Heller T (2004) Lead contamination in Uruguay, The La Teja, 311-317.

[16] Michelle AR, Alexandra L, Marco ID, Giancarlo C (2012) Lead poisoning: Historical aspects of paradigmatic "occupational and environmental disease". Safety Work Health J, 3(1): 11-16.

[17] Needleman H (2004) Lead poisoning around. Res Med, 55: 209-222.

[18] Neighbourhood Case Research. Envir Contam Toxicol, 195: 9515.

[19] Occupational safety and health administration, OSHA (1999) Preventing work related disorder. Available at www.OSHA-slk.gov./sltc/enviorns

[20] Pearson HA, Schonfeld DJ (2005) Lead. Paed, 369.

[21] Qin J, Liu W, Zhu J, Weng W, Xu J, Ai Z (2014) Health related quality of life and influencing factor among welders. Plos One, 7:213-219.

[22] Rossi E (2000) Low level environmental lead exposure - A continuing challenge. The Clinical Biochemist Rev./Australian Assoc. Clin. Biochemists, 63-70.

[23] Schütz A, Olsson M, Jensen A, Gerhardsson L, Börjesson J, Mattsson S, Skerfving S (2005) Lead in finger bone, whole blood, plasma and urine in lead-smelter workers: extended exposure range. Int Arch Occup Environ Health, 78(1): 35-43 (2005).

[24] Sturner T, Luessenhoop S, Net A, Soyka M, Karmaus W, Tousaint R, Liebs TR, Relder U (1997) Construction work and Low Back Disorder; Preliminary Finding of Hamburg Construction worker study. Spine, 2558-2563.

[25] Versieck, J. & Cornelis, R. *Trace Elements in Human Plasma and Blood. Boca Raton.* (Florida: CRC Press, 1988).

[26] World Health Organization, WHO. Lead poisoning and health. Available at www.who.int/news-room/fact-sheets|details/lead-poisioning-and-health,2018 (2018).