

1 **Influence of serum lead level on prevalence of**  
2 **musculoskeletal pain, quality of life and**  
3 **cardiopulmonary function among welders in Enugu**  
4 **metropolis, Southeast, Nigeria**

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12 ***Abstract***

13 *Exposure of welders to welding fumes is a serious occupational health problem all over*  
14 *the world. This often leads to musculoskeletal pain and influences quality of life and*  
15 *cardiopulmonary function, which can be acute or chronic, localized or widespread. The study*  
16 *aimed to assess the serum level of lead and relate it to musculoskeletal pains, quality of life and*  
17 *cardiopulmonary functions of welders in Enugu metropolis, Southeast, Nigeria. Snowball*  
18 *sampling technique was adopted to reach over 100 welders working and residing in Enugu*  
19 *metropolis and who met the inclusion criteria for their informed consent to participate in the*  
20 *study. The first 100 to give the consent were selected for the study. results showed that the mean*

21 *serum level of lead in welders in Enugu metropolis was 0.522 $\mu$ g/dl with a range of 0.06-1.26*  
22  *$\mu$ g/dl. Low back pain was prevalent among welders. The welders had a very high quality of life*  
23 *for the domain of physical health with a score of 94, and high psychosocial and social*  
24 *relationship domains for quality of life with the scores of 69 and 75 respectively. The welders*  
25 *perceived their quality of life as regards environment as average, as they reported their physical*  
26 *environment as being a little or moderately safe, having little money to meet their needs,*  
27 *moderate; availability to information needed for their day to day life, satisfaction with access to*  
28 *health services and time for leisure activities, and a majority reported being satisfied and/or*  
29 *slightly satisfied with their transportation. About 64.2% of the welders had an elevated systolic*  
30 *blood pressure above 120mmHg and 52.6% had diastolic blood pressure elevated above*  
31 *80mmHg, while only 3.2% of the welders had pulse rates above 100 beats per minute. The mean*  
32 *values for lung function reported for the study were FVC = 1.43, FEV1 = 1.13 and PEF = 1.61.*  
33 *The significant relationship between serum lead levels (FVC, FEV1 and PEF) could be*  
34 *attributed to inhalation. The significant relationship between serum lead levels and low back*  
35 *pain and knee pain could be attributed to lead's effect on the musculoskeletal system.*

36 **Keywords:** *occupational health, musculoskeletal pain, quality of life, cardiopulmonary function*

## 37 **Introduction**

38 Welding is a very important process used for joining metal. With the quick development  
39 of science and industry, welding is used in more production fields, and the number of welders is  
40 increasing. Welders are exposed to many occupational hazards, including welding fumes, leading  
41 to serious occupational health problem all over the world. Lead affects major organ system in the  
42 body including hematopoietic, gastrointestinal, respiratory, renal, nervous and cardiovascular  
43 mainly through increased oxidative stress, ionic mechanism and apoptosis [1,2]. Welders are also

44 exposed to dust; heavy metals like lead; gases like fluoride, nitrogen, carbon monoxide; noise;  
45 and ultraviolet rays. Lead poisoning could cause hearing impairment, joint and muscles pains [3].

46 Musculoskeletal pain affects the muscles, ligaments, tendons, and nerves. It can be acute  
47 or chronic, it can be localized or widespread. Lower pain is the most common type of pain.  
48 Others are tendinitis, myalgia (muscle pain), and stress fractures. Musculoskeletal pain can also  
49 be caused by overuse. Pain from overuse affects 33% of adults. Lower back pain is the most  
50 common work-related diagnosis [4].

51 A worker begins to fatigue when exposed to musculoskeletal pain risk factors. It the  
52 fatigue outruns the body recovery system, musculoskeletal disorder develops. Work related  
53 (ergonomic) risk factors, like high task repetition, can result in musculoskeletal risk factor. When  
54 combined with other risk factors, such as high force and/or awkward postures, high task  
55 repetition can contribute to the formation of musculoskeletal pains. A job is highly repetitive if  
56 the cycle time is 30s or less. Forceful exertions have also been found to bring about  
57 musculoskeletal pain. Many work tasks require high force loads on human body and muscle  
58 efforts increases in response to high force requirement with associated fatigue which can lead to  
59 musculoskeletal pains. Similarly, awkward postures place excessive force on joints and overload  
60 the muscles and tendons and affected joints [5].

61 Lead is a highly toxic metal and a very strong poison. Lead poisoning is a serious and  
62 sometimes fatal condition. It occurs when lead builds in the body. Lead toxicity is rare after a sin  
63 glee exposure or ingestion of lead. A high toxic dose of lead poisoning may result in emergency  
64 symptoms, muscle weakness, severe abdominal pain and cramping, seizures, encephalopathy  
65 which manifests as confusion, coma and seizures [6].

66 In 2003, lead was believed to have resulted to 853,000 deaths. It occurs most commonly  
67 in developing countries, and poor people are at greater risk. Lead is believed to result in 0.6% of  
68 the world's disease burden. The amount of lead in the blood tissues, as well as the time course of  
69 exposure, determine toxicity [7-9].

70 The U.S. Center for Disease Control and Prevention and the WHO state that a blood lead  
71 level of 10 $\mu$ g/dL or above is a cause for concern. However, lead may impair development and  
72 have harmful health effects even at lower levels, and there is no known safe exposure level  
73 (Rossi, 2008 and Barbosa et al., 2005). The effects of metals, like lead (Pb), iron (Fe),  
74 manganese (Mn), zinc (Zn), Titanium, among others, showed significant adverse health effects,  
75 such as pulmonary inflammation, granulomas, fibrosis, genotoxicity, after inhalation [10].  
76 Exposure routes of lead show that it is a common environmental pollutant. They include  
77 environmental industrial uses of lead, such as processing of lead-acid batteries or production of  
78 lead wire or pipes and metal recycling; processing of lead containing products, such as food and  
79 paints; soil and water containing lead [11].

80 Cardiopulmonary function is the interrelation between the working of the heart and lung  
81 organs. The most important function of the cardiopulmonary system has to do with the flow and  
82 regulation of blood between the heart and the lungs, made through the pulmonary artery. The  
83 cardiovascular system is the method by which the heart and the entire network of blood vessels  
84 function together to direct the flow of blood throughout the body. The cardiorespiratory system  
85 describes the function of the heart in relations to the body's entire breathing mechanism, from  
86 the nose and the throat to the lungs. These three systems function interdependently.  
87 Consequently, the efficiency of heart function will depend on the strength of the heart muscle.  
88 Aerobic exercise makes the heart stronger and better equipped to propel blood. The power of the

89 heart and clear unobstructed pulmonary artery passages performing in concert permit the  
90 efficient movement of blood to and from the lungs, where useful oxygen and waste carbon  
91 dioxide are exchanged in microscopic lining compartment known as alveoli. Chronic and acute  
92 lead poisoning cause overt, clinical symptoms of cardiac and vascular damage with potentially  
93 lethal consequences. Morphological, biochemical and functional derangement of the heart have  
94 all been described in patients following exposure to excessive lead levels. It is clear the lead  
95 toxicity affects the quality of life of individuals exposed to level of lead poisoning leading to  
96 some severe health conditions [12].

97         According to OSHA [13], work-related musculoskeletal pains currently account for one-  
98 third of all occupational injuries/illnesses reported to the Bureau of Labour Statistics (BLS) and  
99 are the largest job-related injury and illness problem in the United States today. Workers with  
100 severe musculoskeletal pains can face permanent disability which not only affects work activities  
101 but also can prevent the performance of everyday activities thereby posing treats to the quality of  
102 life of the individual. Hamburg Construction worker study found that of the subjects having a  
103 lower back disorder 60.4% had a reduction of mobility 27% had paravertebral muscle spasms,  
104 24.4% had pain during movement and 10.7% had signs of sciatic nerve compression [14].With  
105 the surge in the increased in the day to day activities, with little or no knowledge about the  
106 dangers welders are exposed such as lead toxicity which in one way or the other poses treat to  
107 health or quality of life of these group of workers in the areas of musculoskeletal systems,  
108 cardiopulmonary functions and their generalwellbeing. These heavy metals give cumulative  
109 deteriorating effects that can cause chronic degenerative changes [15] especially to the nervous  
110 system, liver and kidneys and in some cases, they also have teratogenic and carcinogenic effects  
111 [16].

112           There is paucity of studies on the topic in Nigeria especially South-Eastern Nigeria. This  
113 study aimed to assess the influence of serum lead level on prevalence of musculoskeletal pain,  
114 quality of life and cardiopulmonary function among welders in Enugu metropolis, Southeast,  
115 Nigeria. It set out to answer the following questions:

- 116 1. What is the serum level of lead among welders in Enugu metropolis?
- 117 2. What is the prevalence of pains among welders in Enugu metropolis?
- 118 3. What is quality of life of welders in Enugu metropolis?
- 119 4. What is the cardiopulmonary functions of welders in Enugu metropolis?
- 120 5. What is the relationship between cardiopulmonary functions, quality of life, pain and serum  
121 levels of lead among welders in Enugu Metropolis?
- 122 6. What is the relationship between the length of exposure, age, and serum lead level?

123           The specific objectives were:

- 124 1. Determine the serum level of lead among welders in Enugu Metropolis.
- 125 2. Ascertain the prevalence of pains among welders in Enugu metropolis.
- 126 3. Ascertain the quality of life of welders in Enugu metropolis.
- 127 4. Ascertain the cardiopulmonary functions of welders in Enugu metropolis.
- 128 5. Ascertain the relationship between cardiopulmonary functions, quality of life, pain and serum  
129 levels of lead among welders in Enugu Metropolis
- 130 6. Ascertain the relationship between the length of exposure, age, and serum lead level.

131           The hypotheses were:

- 132 1. There is no significant relationship between musculoskeletal pain, quality of life,  
133 cardiopulmonary function and serum level of lead among welders in Enugu Metropolis.

134 2. There is no significant relationship between the length of exposure, age, and serum level of  
135 lead.

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

## 142 **Materials and methods**

143 The study utilized a cross-sectional research design. Convenience sampling technique  
144 was used based on the number of subjects present during the time of study who were willing to  
145 participate and met the inclusion criteria. A total of 100 welders participated in this study. The  
146 selection criteria were inclusion and exclusion criteria. Only welders in Enugu metropolis from  
147 18 years and above who have worked at least six (6) months were included in this study.  
148 Subjects not excluded were those suffering from trauma, fracture, arthritis, neurological  
149 conditions, hypertension, cardiac problems and respiratory diseases such as asthma.

150 Used for data collection were a World Health Organization Quality of Life questionnaire,  
151 Nordic questionnaire for pain, stadiometer for measuring height, bathroom weighing scale (Hana  
152 Model calibrated in kilogram) for weight measurement, sphygmomanometer (Omarion China)  
153 for measuring the blood pressure of both the systolic and diastolic, needle and syringe for  
154 drawing blood samples, and cotton wool and methylated spirit.

155 The procedure for the study was explained to the subjects from whom informed consent  
156 was sought. The two questionnaires were either self-administered by the subjects or administered

157 by the researchers. WHO questionnaire consists of 26 questions which were explained to the  
158 subject in case of any confusion or difficulty. Nordic questionnaire consists of demographic part  
159 and other sections like pain intensity rating scale, anthropometric part, and the part for treatment  
160 intervention. The completed questionnaire instrument was retrieved.

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

172 An ethical clearance certificate was obtained from the Health Research and Ethical  
173 Review Committee of University of Nigeria Teaching Hospital (UNTH) Ituku-Ozalla, Enugu.  
174 The purpose and procedure of the study was explained to the participants and the informed  
175 consent obtained.

176 The data were subjected to descriptive statistics and analysed using paired and unpaired  
177 sample t-test. Pearson correlation was used to determine the relationship between the variables.  
178 A probability value of 0.05 was considered statistically significant. Analysis was performed  
179 using Statistical Package for Social Sciences (SPSS) 20.0 for windows evaluation version.

## 180 **Results and discussion**

181 The mean serum level of lead in welders in Enugu metropolis was found to be 0.522 $\mu$ g/dl  
182 with a range of 0.06-1.26  $\mu$ g/dl. This result is similar to those obtained by Shuitz et al [17],  
183 0.27 $\mu$ g/dl and a range of 0.15- 0.77  $\mu$ g/dl found in German smelters, and that by Barbosa et al,  
184 [18], 0.66  $\mu$ g/dl with a range of 0.02- 2.9  $\mu$ g/dl in men who had long term exposure to lead, just  
185 as Verseeck and Cornelis [19] found the serum lead level of 1.45 $\mu$ g /dl in workers exposed to  
186 lead so also did Bergdah et al [20] with a range of 0.02-1.30 $\mu$ g/dl. This was above the normal  
187 serum lead levels found in unexposed subjects, which were 0.020-0.054  $\mu$ g/dl, 0.002–0.29  $\mu$ g/dl  
188 (mean, 0.066  $\mu$ g/dl) and 0.002  $\mu$ g /dl [18-20]. This increase can be as a result of the exposure to  
189 lead following exposure to lead oxide in the welding processes.

190 Low back pain was prevalent among welders. This could be as a result of the heavy  
191 lifting and repeated trunk flexion and rotation which have been found to be risk factors for low  
192 back pain [21].

193 The welders had a very high quality of life for the domain of physical health with a score  
194 of 94, and high psychosocial and social relationship domains for quality of life and the scores of  
195 69 and 75 respectively. The welders perceived their quality of life as regards environment as  
196 average, as they reported their physical environment as being a little or moderately safe, having  
197 little money to meet their needs, moderate; availability to information needed for their day to day  
198 life, satisfaction with access to health services and time for leisure activities, and a majority  
199 reported being satisfied and/or slightly satisfied with their transportation.

200 The cardiopulmonary functions of welders were assessed in this study; it was found that  
201 64.2% of the welders had an elevated systolic blood pressure above 120mmHg and 52.6% had  
202 diastolic blood pressure elevated above 80mmHg while only 3.2% of the welders had pulse rates

203 above 100 beats per minute. The mean values for lung function reported for the study were; FVC  
204 = 1.43, FEV1 = 1.13, PEF = 1.61, these were lower than those found in previous studies where  
205 the mean FVC was 4.73, FEV1 was 3.70 [22] and FVC of 4.97, and FEV1 of 4.15 (Golbabaei et  
206 al, 2013). This result confirms findings from other studies that suggests that welding exposure  
207 adversely affects pulmonary function. A reduction in FEV1 usually indicates airway obstruction  
208 and welding processes resulted in obstructive airway changes [23].

## 209 **Conclusion**

210 A significant relationship was found in this study between serum lead levels; FVC, FEV1  
211 and PEF. This could be as a result of the report that the prevalent route of entry of lead in the  
212 body system of welders is via inhalation before it is absorbed into the blood stream. On the other  
213 hand, there was no significant relationship found between quality of life and serum lead levels,  
214 but a significant relationship was found between serum lead levels and low back pain and knee  
215 pain, which could be as a result of the oxidative nature of lead and its effect on the  
216 musculoskeletal system. The study found no relationship between serum lead level, length of  
217 exposure and age.

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