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Research Article

Respiratory Symptoms, Ventilatory Function and Health-Related Quality of Life of Arc-Welders in Ile-Ife, a South Western City in Nigeria

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Abstract

Background: Welding is associated with inherent occupational hazards which may result in severe consequences on health of workers performing this task [1].

Several authors have investigated the effects of various occupational exposure on lung health in Nigeria [2], but few of these were focused on arc-welders, [3,4] the few studies were on eyes and the skin [3]. Few others were limited by inability to do chest radiographs [5]. Little information exists regarding health hazards and how they are controlled among welders.

In view of the fact that small scale industries including welding account for a large portion of the manufacturing activities in developing countries [4], an evaluation of the respiratory health hazards of this group of workers is important. However, impact of these hazards on HRQL has not been previously investigated among welders in Nigeria. This study has been designed to evaluate the respiratory symptoms, ventilatory function and Health-Related Quality of Life of Arc-welders in Ile-Ife.

Methodology: This is a cross-sectional descriptive study evaluating 103 Arc-welders matched with 99 Controls from the Maintenance Unit in Ile-Ife. Subjects were recruited after clearance of Ethics and Research Committee of the Hospital and informed consent had been obtained.

Information on socio-demographic characteristics and Medical History were obtained using the MMRC questionnaire. HRQL was assessed using the Short Form-12 questionnaire.

Additionally, lung function was assessed by Spirometry and dyspnoea severity by MMRC dyspnoea scale. Subjects underwent Physical Examination including measurement of BMI and Chest Examination. A PA View Chest Radiograph of subject with either respiratory symptom and/or abnormal lung function test was taken.

The data was analyzed using the SPSS version 17 software (SPSS, Chicago, IL, USA). In all the statistical test, a p value < 0.05 was considered significant.

Results: The mean age of the welder subject group (n=103) was 32.90 ± 8.54, and the mean age of the control group (n=99) was 34.27 ± 10.03. Majority (52) of the welders were between 30 years to 45 years age bracket (50.5%) while 44 (45.5%) of the controls were above 45 years. Sixteen (15.5%) of the welder group and 12 (12.1%) of the control group were less than 30 years.

The most frequent lower respiratory tract symptoms were sputum (45.6%) and cough (27.2%). Arc welders showed a significant reduction in lung function parameters relative to controls.

Six dimensions including Role Physical (RP), Bodily Pain (BP), General Health (GH), Validity (VT), Social Functioning (SF), and Mental Health (MH) were significantly reduced in welders compare to controls. Lung function, welding work, duration of exposure, type of materials welded are independent predictors of HRQL of welders.

Conclusion: The study had demonstrated that welders exposed to welding fumes and gases have predominant lower respiratory tract symptoms. The most frequent symptoms were cough with sputum production. All the spirometric indices [FEV1, FVC and FEV1/FVC] were significantly reduced in the welders compared to their matched controls ($p< 0.05$). Forty seven (45.6%) of the study subjects had restrictive lung defect as compared to 39 (37.9%) with obstructive lung defect ($p<0.0001$). Logistic regression showed that the Health Related Quality of Life of welders was significantly related to age, duration of exposure, educational status, average hour spent at work, and the use of PPEs ($p<0.05$), therefore welders should have a pre-occupational lung function assessment to identify workers with pre-existing respiratory impairments so as to limit the effects on their HRQL.

Keywords: Respiratory; Symptoms; Quality; Arc-welders; Nigeria

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Introduction

Electric welding was introduced in about 1940 [6] and the use of welding has increased in recent years, chiefly in the form of fusion welding. It is estimated that more than 1 million workers worldwide perform some types of welding as parts of their work duties [6,7]. Though, there are about 60 different methods of welding, gas and arc welding are the types commonly practiced in the developing countries [8]. Isah et al. [9] reported that the commonest type of welding in Benin City, Nigeria are the gas and electric arc welding. Other forms of welding include carbon arc welding, cold welding, flux

core arc welding, gas welding, gas tungsten arc welding and laser beam welding, plasma arc welding and oxyacetylene welding. Welding is the process in which metal or other thermoplastic are joined together by the application of heat or pressure, or both with or without the use of filler metal [10,11].

In arc-welding, heat is generated by striking an arc between an electrode and the base metal. The temperature is about 4000 degree Celsius when the pieces fuse together. Many arc welding processes are automatic or semi-automatic, but it is also carried out manually, the process is known as manual metal arc or open arc welding [1]. Most conventional arc-welding is done manually by means of a covered (water) consumable electrode held in an electrode holder.

These processes lead to the generation of fumes or particles which are dangerous especially to the respiratory system if inhaled [12]. The particles in these fumes are generally so small that they can reach the narrowest branches of the respiratory organs [13].

Opinions about the respiratory effects of welding differ. Respiratory effects seen in welders have included chronic bronchitis, asthma and possible increase in lung cancers. Pulmonary infections are increased in term of severity, duration and frequency among welders [7]. Reports have shown that pulmonary functions in the welders were found significantly altered with increasing length of exposure [14]. Increasingly, it has been recognized that health status, especially HRQL is an important outcome of medical care. The degree to which health impacts on a person's ability to perform and derive fulfillment from activities of daily life based on the self-determined evaluation of satisfaction is referred to as HRQL. Chronic exposure to welding fumes and its attendant squeal has a decremental effect on the HRQL of affected welders.

Though, the severity of disease is an important determinant of the individual health, individual perception and adaptation largely defines the overall Quality of Life. Moreover, since pulmonary function is chronically and irreversibly impaired in this group of workers, treatment should not be directed only towards improving the pulmonary function.

In addition, because of the observation that symptom burden is more closely related to HRQL than to FEV1, increasing attention is now being given to HRQL as an important outcome of medical care. However, HRQL measures do not substitute for physiologic parameter, but can complement these by including aspects of health and disease that are directly perceived by the individual.

In Nigeria, there are few studies on respiratory symptoms and ventilatory patterns in welders [15]. Erhabor et al. [9] reported that the most frequent symptom among welders is cough compared with the controls and were also found to have significantly lower lung function parameters than controls. Few other studies were limited by inability to do chest radiograph.

However, there are no indexed studies detailing or assessing the HRQL of arc-welders in Nigeria, necessitating the need for this study.

Rationale for study

The International Labor Organization (ILO) has estimated that over 2 million people die every year from work related accidents and diseases and that over 300 million non-fatal accidents are recorded each year. This translates into more than 6,000 deaths and over 800,000 non-fatal accidents every day.

In addition, ILO estimates that more than 160 million people suffer from occupational and work related diseases. In many developing countries such as Nigeria, statistics on occupational health hazards especially those with respiratory sequelae are limited. Occupational deaths and injuries take a heavy toll among the poor and least protected. Furthermore, literature has shown that welders in SSEs are least aware of health effects emanating from the activities and materials in their work environment.

In Nigeria, there is an information gap on welding occupational hazards as well as prevalence of both acute and chronic respiratory diseases among welders. Such information is vital in understanding the extent of the problem and may be useful when designing intervention strategies targeted at promoting and upholding good health and safety standards in this important working group- hence the study.

Aim and Objectives

General

To determine the respiratory symptoms, ventilatory function and Health-Related Quality of Life of Arc-welders.

Specific

- To describe the pattern of respiratory symptoms in arc-welders.
- To assess the pattern of ventilatory function in arc-welders and matched controls.
- To assess the Health-Related Quality of Life of arc-welders.
- To assess the determinants of Health-Related Quality of Life of arc-welders.

Methodology

Location of study (study area)

The study was conducted in Ile-Ife, an ancient Yoruba City in South-Western Nigeria in Osun State. Ile-Ife is about 218 km (135 miles) North East of Lagos.

Administratively, Ile-Ife has 2 local Governments and the population according to the 2006 National Census, is put at 167,254 and 188,027 respectively. Ile-Ife inhabitants are primarily town dwelling farmers.

Study design

The study is a cross-sectional descriptive study on arc-welders in Ile-Ife, Nigeria.

Sample size

Sample size was calculated using the formula for estimating a single proportion at a specified precision.

$$n = \frac{Z\alpha^2 pq}{d^2}$$

n = minimum sample size.

Z = normal Standard Deviation set at 1.96 corresponding to 95% confidence interval.

P = proportion of target population estimated to have a particular characteristic (Prevalence of respiratory symptoms in arc-welders), this was taken to be 50.09% [4].

q = 1-p = confidence level that the estimate is the distance d of the proportion of interest.

d = degree of accuracy desired (precision). This was taken as 10%.

Therefore, n =1=1.96 × 1.96 × 0.509 × (1-0.509) / 0.1 × 0.1=96.00%. Therefore, 96 welders with an additional 10% of the population to allow for any attrition. Total of 106 welders were used for the study.

Sampling Technique

Study participants were recruited using a multi-stage sampling technique. Workers with 5 years and above of practice were recruited for the study based on their different zones.

There are about 8 different zones. Each zone having a membership of 20-30. Four zones will be randomly selected from the 8 zones till the sample size is complete.

The control population was drawn from workers in the Maintenance Unit of Obafemi Awolowo University, Ile-Ife who had no previous exposure to welding fume. They will be matched in age and sex with the study cases.

Study population

Two hundred and two individuals (202) were recruited i.e., one hundred and three (103) welders and ninety nine (99) healthy controls.

Inclusion criteria

- Arc-welders whose main occupation is welding.
- Workers must be currently engaged in the art.
- Willingness to participate.
- Ability to demonstrate sufficient proficiency in performing the tests necessary to assess ventilatory function.
- Welders with 5 and above years of practice.

Exclusion criteria: Subjects with the following were excluded

- Workers with pre-existing respiratory diseases like asthma, COPD.
- Workers with past history of pulmonary tuberculosis.
- Current smokers and past smokers.

Ethical approval

- Ethical approval was obtained from the Ethics and Research Committee of the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife (Appendix II) before the study was commenced.
- Informed consent of the individuals for the study was obtained.

Data Analysis

Data collection

Subjects enrolled into the study were assessed using the following

- Modified Medical Research Council UK Respiratory questionnaire was used to obtain demographic information about the patient as well as respiratory symptoms.
- Health-Related Quality of Life of welders was evaluated using the Short Form- 12, a generic quality of life tool.
- Spirometry was done to assess lung function in the study population.
- A PA-View chest radiograph of subject with respiratory and/or abnormal lung function test was taken.

Procedure

Questionnaires were administered using structured interview method. Modified Medical Research Council (MRC) respiratory Questionnaire**.**

A modified version of the Medical Research Council (MRC) questionnaire [16] was used to obtain information on socio-demographic characteristics and respiratory symptoms of the subjects and dyspnoea severity score ranges from 0 to 4 as shown in appendix 1.

Health-related quality of life

Health-Related Quality of Life was evaluated using the Short Form- 12, a generic quality of life tool [17].

S-F 12 is one of the scales used in measuring quality of life. It is a general concept scale. It contains 12 items from the original S-F 36 [18] across all dimensions. The 12 items include the self-assessment of health; physical functioning; physical role limitation; mental role limitation; social functioning; mental health and pain. These 12 items selected for inclusion can reproduce at least 90% of the variance in the physical and mental subscales of the SF-36 [19].

The 12 items yield the 8 dimensions of the S-F 36, but with fewer levels and less precise scores. SF-12, therefore displays greater floor and ceiling effects compared to SF-36.

The SF-12 is suitable for self-administration, computerized administration or administration by a trained interviewer. It can be administered in 5 minutes to 10 minutes with a high degree of acceptability and data quality. The data obtained with the SF-12 has been developed, tested and validated by Quality Metric Incorporation. SF-12 has been used in numerous populations and with good test- and retest reliability. A Yoruba translated version of SF-12 questionnaire was used for participants who are literate in Yoruba language and prefers the Yoruba version.

The SF-12 was scored using the recommended Medical Outcome Study (MOS) software program that creates two summary scores, Mental health score (MCS 12), and physical health (PCS 12). The scores were represented as t- scores that are linear transformations within a mean of 50 and SD of 10 in the general population.

All subscales scores were transformed to 0 to 100 scale with the higher score indicating less dysfunction, impairment, or pain consistent with the recommended procedure for scoring.

Lung Function Test

Lung function of the subjects was assessed according to the American thoracic society guideline using a standardized Spirometer (Spiro-lab III) manufactured by Micro Medical U.S.A. The Spirometer uses a turbine sensor, which is sensitive and temperature, pressure or gas density do not affect its measurements. Hence, it does not require calibration. Subjects were instructed to refrain from undergoing vigorous exercise for 1 hour, eating a large meal for at least 2 hours before the test. Subjects height was measured without shoes to the nearest centimeter using a wall mounted Stadiometer on a flat surface while weight was measured to the nearest 0.1 kilogram using a portable weight scale after zero calibration check. Body Mass Index (BMI) was calculated as a ratio of measured weight to the square of the measured height (kg/m^2).

The Spirometry was performed with the subjects seated on a comfortable chair with no arm rest. They were instructed initially on the process of doing a Spirometry test with emphasis on the importance of having lips sealed around the mouthpiece, how to avoid tongue occlusion or obstruction during the manoeuvre. Also they were taught on how to achieve maximal effort by inhalation to total lung capacity before uninterrupted forced exhalation. Subjects that showed obstructive ventilatory pattern were assessed 10 minutes to 20 minutes after inhalation of 400 µg of salbutamol using a metered dose inhaler with a spacer device.

The spirograms were accepted if they meet the following ATS/ERS acceptability criteria:

- They are free from artifacts, glottis closure, early terminations, leaks or non-maximal efforts.
- The back extrapolated volume less than 5% of the FVC or 0.15L, whichever is greater.
- When the spirograms show satisfactory exhalation duration of > 6 seconds or by manual pattern recognition of at least a plateau in the volume-time curve.

The highest of the 3 spirograms which met the acceptability criteria was chosen for measurement of the following parameters:

- Forced Expiratory Volume in 1 second (FEV1) which is the maximal volume of air exhaled during the first second from total lung capacity during a forced manoeuvre.
- Forced Vital Capacity (FVC) which is the maximum volume of air that can be delivered by a maximal forced exhalation after a full inspiration.
- Ventilatory ratio which is the ratio of FEV1/ FVC multiplied by 100.

Chest radiograph

A PA-View chest radiograph of each eligible subject was taken. Standard CXR was reported in liaison with a Consultant Radiologist in accordance with International Labour Organisation (ILO) Chest X-Ray Grading.

Data analysis

The data was analyzed using the Statistical Package for Social Science (SPSS) IL, Chicago Version 17. Descriptive tools; frequency tables, mean, standard deviation and charts were employed to describe the age distribution, gender, socio demographic characteristics and clinical characteristics (the pattern of respiratory symptoms) among respondents.

Continuous data were presented in Means and Standard Deviation while categorical data were presented using proportions and frequencies. An unpaired t-test analysis was used to compare the ventilatory function and Health-Related Quality of Life of arc-welders with matched controls.

In order to determine the independent predictors of Health-Related Quality of Life of arc-welders, a linear multivariate regression analysis was done, while adjusting for possible confounding variables such as age, sex, socio-economic status and smoking. The 5% probability level was accepted as significant.

Results

Socio-demographic characteristics of the welder and control groups

A total of 202 subjects were recruited for the study, 103 welders and 99 controls, all fulfilling the inclusion and exclusion criteria for subjects and controls respectively.

The mean age of the welder subject group (n=103) was 32.90 ± 8.54, and the mean age of the control group (n=99) was 34.27 ± 10.03. Fifty-two welders were between 30 years and 45 years (50.5%) while 44 controls were above 45 years (45.5%). Most welders and controls were married, 64.1% and 71.7% respectively. Forty six percent (46.6%) of the welders had primary school education compared to 43.4% of the controls. Thirty-five (35.4%) of the controls however had secondary education. Most of the respondents were of Yoruba ethnicity and Christians (Table 1).

Occupational history of welders: The Table 2 shows that 49 (47.6%) of the respondents had duration of exposure between 10 years and 19 years, 33 (32%) of them had duration of exposure for more than 20 years while only 21 (20.4%) of the welders had less than 10 years of exposure.

Fifty-six (54.4%) of the welders spent between 6 hours and 10 hours at work, 35 (34.0%) of them spent more than 10 hours and 12 (11.6%) less than 6 hours. Eighty-six welders (83.5%) used eye goggle as personal protective equipment during welding operation while only a few 17 (16.5%) of them used face masks. However, 74 (71.8%) reported occasional use of PPE as compared to 29 (28.2%) who used it always.

Fifty-five (53.4%) of the welders worked on both steel and iron, 48 (46.6%) only worked on iron. Amongst the welders, 86 (83.5%) had open workplace, 12 (11.7%) had both open and confined workplace while 5 (4.8%) had confined workplace. Greater number of welders 99 (96.1%) used to eat at or during work, while 4 (3.8%) did not.

Symptoms between welders and controls

In Table 3, 28 welders (27.2%) had cough compared to 9 (8.74%) of the matched controls, 21 (20.4%) of the welders occasionally had it while 3 (2.9%) often had it. Of the 9 (8.74%) controls who had cough, only 3 (2.91%) had it often. The cough was productive of phlegm in 47 (45.6%) of the welders compared to 35 (23.4%) of the controls while 14 welders (13.6%) and 8 (7.8%) of the controls often produced sputum respectively.

Fever was present in 46 welders (44.7%) compared to 34 (33.1%) of the controls who had fever. Wheeze was reported in 20 welders (19.4%) compared with 6 (5.82%) of the controls. Weight loss was also reported in 27 (26.2%) of the welders in contrast with 14 (13.6%) in the controls.

Thirty welders (29.2%) had chest pain out of which 19 (18.5%) had it occasionally and 11 (10.7%) had it often. This was in contrast to what was obtained in the controls with 13 (12.2%) having chest pain of which 2 (1.9%) and 11 (10.3%) had it often and occasionally respectively.

Wilcoxon test results showed that only in cough, wheeze, and chest pain, the differences were significant ($p<0.05$).

Physical and chest examinations of the welder and control groups compared

In Table 4, more abnormalities were detected on the general physical examination in the welders than the controls. Pallor was seen in 12 welders (11.6%) and 3 (3.0%) of the controls. central cyanosis in

Table 1: Socio - demographic characteristics of welder and control groups.

Variable	Welder (%) N = 103	Control (%) N = 99	χ^2	p - value
Age (in years)				
Less than 30	16 (15.5)	12 (12.1)	2.4	0.306
30 - 45	52 (50.5)	43 (43.4)		
Above 45	35 (34.0)	44 (44.5)		
Mean Age ± SD				
Marital Status				
Single	17 (16.5)	10 (10.1)	3	0.39
Married	66 (64.1)	71 (71.7)		
Separated	11 (10.7)	7 (7.1)		
Widowed	9 (8.7)	11 (11.1)		
Educational Status				
None	13 (12.6)	5 (5.1)	5.3	0.153
Primary	48 (46.6)	43 (43.4)		
Secondary	32 (31.1)	35 (35.4)		
Tertiary	10 (9.7)	16 (16.2)		
Ethnic Group				
Yoruba	96 (93.2)	88(88.9)	2.3	0.518
Igbo	3 (2.91)	6 (6.1)		
Hausa	2 (1.94)	1 (1.0)		
Others	2 (1.94)	4 (4.0)		
Religion				
Christianity	79 (76.7)	84 (84.9)	3.5	0.174
Islam	19 (18.4)	14 (14.1)		
Others	5 (4.9)	1 (5.0)		

Table 2: Occupational history of welders under study.

Variable	Frequency (N = 103)	Percentage
Length of Experience (in years)		
Less than 10	21	20.4
19-Oct	49	47.6
20 and above	33	32
Average hours spent per day at workshop		
Below 6	12	11.6
10-Jun	56	54.4
Above 10	35	34
Type of PPE use		
Glasses	86	83.5
Face Mask	17	16.5
Frequency of PPE use		
Always	29	28.2
Occasionally	74	71.8
Types of materials wedded at workshop		
Iron only	48	46.6
Iron and Steel	55	53.4
Type of welding workplace		
Open	86	83.5
Confined	5	4.8
Both	12	11.7
Eat during work		
Yes	99	96.1
No	4	3.8
Have bath after day's work		
Yes	71	68.9
No	32	31.1

15 welders (14.6%) compared to 4 (4.0%) of the controls, weight loss was found in 16 welders (15.5%) and 6 (6.1%) of the controls while 4 welders (3.9%) had digital clubbing and none of the controls had such.

In the chest examination, 83 welders (80.6%) of the welders had normal respiratory rate while 20 welders (19.4%) had abnormal respiratory rate compared to 90 (90.9%) of the controls having normal respiratory rate and only 9 (9.1%) with abnormal respiratory rate.

Abnormal findings on inspection were seen in 8 welders (7.8%) and 1 (1.0%) of the controls, on percussion; 17 welders (16.5%) and 11 (11.1%) of the controls while on auscultation 23 welders (22.3%) and 8 (8.1%) of the controls.

The differences in the general physical examination findings such as pallor, central cyanosis, weight loss, and chest examination on inspection and auscultation were statistically significant.

Ventilatory Function between Welders and the Controls

The arc welders recorded significantly reduced lung function parameters when compared with the controls. The mean of FEV1 in liter was 4.49 ± 1.12 for the welders and 4.91 ± 1.66 for the controls. The means of FEV1 (% predicted) in both the welder and control groups were 85.23% and 87.91% respectively. The means of FVC in liters were 4.37 and 4.88 for the welders and the controls respectively, while the means of FEV1/FVC (% predicted) were 74.4 for the welders and 76.6 for the controls. Differences in all the parameters measured were statistically significant ($p<0.05$).

Lung impairments in arc -welders and control group

The pattern of lung function abnormality is presented in Table 5 which showed that 47 (45.6%) of the subjects had restrictive lung defects as compared to 18 (18.2%) of the controls. Thirty-nine (37.9%) of the subjects had obstructive defects as compared to 12 (12.1%) of the controls.

Seventeen (16.5%) of the welders had normal lung function while 69 (69.6%) of the controls had normal lung function. These findings were statistically significant ($p<0.001$).

Relationship of occupational history and health-related quality of life of welders

Table 6 shows that subjects with the following parameters had good HRQL; (a) 10 to 19 years of exposure, (b) welder who spent 6 hours to 10 hours at work, (c) welded only iron in an open workplace, (d) who always use their personal protective equipment, (e) who did not normally eat during work and (f) who normally had their bath after the day work. All parameters tested were statistically significant with the exception of the type of materials welded and type of working place.

Logistic regression (odd ratio) showing the determinants of health related quality of arc-welders under study

Table 7 represents the logistic regression showing the determinants of Health related quality of life of welders. Subjects above 45 years of age and those between 30 years and 45 years were seven (7) times and approximately two (2) times respectively better than subjects with less than 30 years.

Those subjects who had primary education had almost the same HRQL as those with no formal education while those welders with secondary education were four (4) times more likely to have better HRQL than those with no formal education. The welders with more than 20 years of exposure and between 10 years and 20 years of exposure were four (4) times likely to have better HRQL than those with less than 10 years of exposure.

Discussion

Small Scale Enterprises (SSE) account for a large portion of the manufacturing activities in the developing countries [4]. Welding is a common industrial process but one with the potentials to be extremely harmful and detrimental to the health of welders [20]. One of the main risk factors to which welders are exposed is welding fumes and gases. The main disorder caused by such exposure include respiratory disorders.

Table 3: Comparison of some health symptoms of the welders and control groups.

Variable	Welder (%) N = 103	Control (%) N = 99	χ^2	p - value
Cough				
Not at all	75 (72.8)	90	11.2	**0.004**
Occasionally	21 (20.4)	6		
Often	7 (6.8)	3		
Phlegm				
Not at all	56 (54.4)	64	2.69	0.26
Occasionally	33 (32.0)	27		
Often	14 (13.6)	8		
Fever				
Not at all	57 (55.3)	65	2.84	0.241
Occasionally	41 (39.8)	32		
Often	5 (4.9)	2		
Wheeze				
Not at all	83 (80.6)	89	7.46	**0.024**
Occasionally	16 (15.5)	5		
Often	4 (3.9)	1		
Weight loss				
Not at all	76 (73.8)	85	3.92	0.067
Occasionally	22 (21.4)	13		
Often	5 (4.8)	1		
Chest Pain				
No	77 (74.8)	86	8.56	**0.014**
Occasionally	19 (18.5)	11		
Often	11 (10.7)	2		

Table 4: Ventilatory function in arc - welder and the control groups.

Variable		Welder (%) N = 103	Control (%) N = 99	t	p – value
FEV_1 (L)	Mean ± SD	4.49 ± 1.12	4.91 ± 1.66	2.16	**0.036**
FEV_1 (%)	Mean ± SD	85.23 ± 6.18	87.91 ± 6.26	3.06	**0.003**
FVC (L)	Mean ± SD	4.37 ± 0.98	4.88 ± 1.24	3.25	**0.001**
FEV_1/FVC (%)	Mean ± SD	74.41 ± 4.08	76.64 ± 5.84	3.16	**0.001**

t= Independent t test; (L)= Litres; FEV1= Forced respiratory volume in one second; FEV1(%)= FEV1 as percent predicted; FVC= forced vital capacity

Table 5: Lung impairments in arc - welders and control group.

Lung impairment	Welder (%) N = 103	Control (%) N = 99	χ^2	p - value
Obstructive pattern	39 (37.9%)	12 (12.1%)	17.73	< **0.0001**
Restrictive pattern	47 (45.6%)	18 (18.2%)	**14.32**	< **0.0001**
Normal lung function	17 (16.5%)	69 (69.6%)	**64.46**	< **0.0001**

Pneumoconiosis resulting from inhalation of iron in welding fume is a long-recognized, well catalogued but less common type in which the dust load is heavy but pulmonary reaction minimal. Principles of management of pneumoconiosis have included lung function test, an integral part of diagnosing and managing patients with respiratory diseases. However, these end points do not fully represent the wide spectrum of disease burden in this form of pneumoconiosis when not used in conjunction with the clinical, occupational history and chest radiograph.

The International Labour Organization (ILO) standard films for the descriptive interpretation of the radiologic appearance of diffuse parenchymal lung [21], were originally developed for epidemiologic studies of occupational lung disease.

Chest radiograph is the corner stone of surveillance for pneumoconiosis in this less form of pneumoconiosis may actually help in predicting the overall outcome in this group of workers.

The welding activities being associate with exposure to welding fume and gas and the observations that respiratory symptoms burden, lung impairments are closely related to Health Relate Quality of Life (HRQL), increasing attention is now being given to HRQL as an important outcome of medical care.

Pattern of respiratory symptoms

Our study showed that respiratory symptoms were significantly more prevalent among the welders than the controls ($p<0.05$). Various studies in the industrialized countries have also reported an increase in respiratory symptoms usually of the acute type. These symptoms depend on the degree of exposure of fumes released during welding.

This study is comparative to a study done by Erhabor et al. [3] on 44 arc-welders in Modakeke, a suburb of Ile-Ife in Nigeria, which showed that the welders had more respiratory symptoms compared to the controls.

Another review of 119 welders and 90 controls, matched for age and height as well as smoking history showed that there were more significant respiratory symptoms in the welders than the controls [3]. Our data were in agreement with Kernig et al. who reported higher frequencies of respiratory symptoms in welders. They concluded that age and smoking were the main etiological factors, and that they enhance the effects of welding fumes. Arc welding is known to release gases, which are toxic respiratory irritants.

The commonest respiratory symptom as shown by this study was cough with sputum production, 47 (45.5%). This seem plausible because accumulation of welding particles in small airways can increase mucus production and lead to stagnation of secretion.

Although, prevalence of phlegm, fever and weight loss was higher among the welders, these differences were not statistically significant (Table 3).

This finding was not in tandem with the finding from a study of 156 Danish welders and 152 controls from the same plant, where no statistical difference in the rate of chronic bronchitis was seen when compared with the control group. In addition Antiipoika et al. indicated that welders were not at a greater risk of developing serious respiratory ailments than the controls. Other studies have also shown increased prevalence of acute upper and lower respiratory tract infections. Chemical irritations in particular exposure to metal fumes of the airway epithelium is a suspected cause of increased incidence of respiratory infections. Reported an increase in respiratory symptoms usually of the acute type. These symptoms depend on the degree of exposure of fumes released during welding.

This study is comparative to a study done by Erhabol et al. [3] on 44 arc-welders in Modakeke, a suburb of Ile-Ife in Nigeria, which showed that the welders had more respiratory symptoms compared to the controls.

Another review of 119 welders and 90 controls, matched for age and height as well as smoking history showed that there were more significant respiratory symptoms in the welders than the controls [22]. Our data were in agreement with Kernig et al. who reported higher frequencies of respiratory symptoms in welders. They concluded that age and smoking were the main etiological factors, and that they enhance the effects of welding fumes. Arc welding is known to release gases, which are toxic respiratory irritants.

The commonest respiratory symptom as shown by this study was cough with sputum production, 47 (45.5%). This seem plausible because accumulation of welding particles in small airways can increase mucus production and lead to stagnation of secretion.

Although, prevalence of phlegm, fever and weight loss was higher among the welders, these differences were not statistically significant (Table 3).

Table 6: Relationship between occupational history and health related quality of life of welders.

Variable		Health - Related QoL				
		Good (%)	Poor (%)	Total		
		N = 57	N = 46	N = 103	χ^2	p - value
Length of Experience (in years)						
	Less than 10	6 (28.6)	15 (71.4)	21	7.69	**0.021**
	19-Oct	30 (61.2)	19 (38.8)	49		
	20 and above	21 (63.6)	12 (36.4)	33		
Average hours spent per day at workshop						
	Below 6	7 (58.3)	5 (41.7)	12	9.87	**0.007**
	10-Jun	38 (67.9)	18 (32.1)	56		
	Above 10	12 (34.3)	23 (65.7)	35		
Type of PPE use						
	Glasses	43 (50.0)	43 (50.0)	86	4.01	**0.045**
	Face Mask	13 (76.5)	4 (23.5)	17		
Frequency of PPE use						
	Always	22 (75.9)	7 (24.1)	29	7.52	**0.006**
	Occasionally	34 (45.9)	40 (54.1)	74		
Types of materials wedded at workshop						
	Iron only	30 (62.5)	18 (37.5)	48	1.86	0.172
	Iron and Steel	27 (49.1)	28 (50.9)	55		
Type of welding workplace						
	Open	52 (60.5)	34 (39.5)	86	5.79	0.055
	Confined	1 (20.0)	4 (80.0)	5		
	Both	4 (33.3)	8 (66.7)	12		
Eat during work						
	Yes	54 (54.6)	45 (45.4)	99		0.626**
	No	3 (75.0)	1 (25.0)	4		
Have bath after day's work						
	Yes	45 (63.4)	26 (36.6)	71	5.98	**0.014**
	No	12 (37.5)	20 (62.5)	32		

**= Fisher Exact

Table 7: Logistic regression (odd ratio) showing the determinants of health -related quality of life of arc – welders under study.

	OR (95% Confidence Interval)	p
Age (in years)		
Less than 30	1	
30 - 45	1.32 (0.37 - 4.87)	0.634
Above 45	6.67 (1.153 - 31.08)	**0.002**
Educational Status		
None	1	
Primary	0.93 (0.21 - 4.32)	0.911
Secondary	21.75 (3.28 - 177.31)	< **0.001**
Tertiary		
Length of Experience (in years)		
Less than 10	1	
19-Oct	3.95 (1.16 - 13.95)	**0.012**
20 and above	4.38 (1.17 - 17.14)	**0.012**
Average hours spent per day at workshop		
Below 6	1	
10-Jun	1.51 (0.35 - 6.35)	0.527
Above 10	0.37 (0.08 - 1.71)	0.143
Type of PPE use		
Glasses	1	
Face Mask	3.25 (0.89 - 12.94)	**0.045**
Frequency of PPE use		
Always	1	
Occasionally	0.22 (0.07 - 0.61)	**0.001**
Have bath after day's work		
Yes	1	
No	0.35 (0.13 - 0.89)	0.014

This finding was not in tandem with the finding from a study of 156 Danish welders and 152 controls from the same plant, where no statistical difference in the rate of chronic bronchitis was seen when compared with the control group. In addition Antiipoika et al. indicated that welders were not at a greater risk of developing serious respiratory ailments than the controls. Other studies have also shown increased prevalence of acute upper and lower respiratory tract infections. Chemical irritations in particular exposure to metal fumes of the airway epithelium is a suspected cause of increased incidence of respiratory infections.

Oxhoj et al. in Sweden in 1990 investigated 119 Shipyard welders who had welded for 5 years or more and 90 clerks who had never welded as controls. The respiratory symptoms such as cough, wheeze and dyspnoea were more prevalent in welders than in controls, which are also reflected in this study. The authors concluded that these could be attributable to deposition of welding fumes in the small airways and alveoli.

Occupational characteristics of welders

Length of experience (years): In this study, 49 (47.6%) of the welders had duration of exposure between 10 years and 19 years. This suggests an association between the length of employment and lung impairments in arc welders. Excessive exposure can lead to overloading of alveolar macrophages which can be pro-inflammatory even with relative non-particulate. This finding was consistent with the finding of Erhabor et al. [3] who reported the mean number of years of 44 arc welders studied as 13 years. All the subjects who developed the obstructive pattern of lung disease had it after 9 years of employment as contrasted to those with restrictive lung disease of less than 9 years.

Similar study by Sultan et al. also showed that a duration of more than 9 years was associated with a significant reduction in spirometric patterns relative to their controls, whereas, those workers between 5 years and 9 years and those of occupational exposure of less than 5 years did not show a significant reduction in lung function parameters. It also showed a strong association with a dose response effect, between welding years and decreased MVV, FEV1, and FVC. This trend may suggest gradually accumulating lung pathology in welding workers. Increasing welding years may affect physical function, general health thus reducing quality of life. From our study, we found out that a large proportion of the welders, 56 (54.4%) spent between 6 hours and 10 hours at work.

Type of Personal Protective Equipment (PPE) and its use: The use of face mask was reported low, 17 (16.5%) in this study which may be due to poor knowledge of hazard associated with non- or irregular use of face mask among the respondents and kind of training they received as almost all of the welders in the developing countries were trained through hands of apprenticeship. The use of face mask reduces the inhalation of welding fumes that may result in the development of respiratory diseases.

Further study by Chan et al. reported that face mask was sufficient in blocking the inhalation of particles but was not efficient in blocking gases found in welding fumes.

Types of welding materials and working places: Results from this study showed that majority, 55 (53.4%) of the welders welded both iron and steel as compared to 48 (46.6%) who welded only iron. This disparity might be due to increase use of steel now in developing countries in building constructions.

The study also revealed that amongst the welders, largest proportion, 86 (83.5%) had open workplaces. It has previously been shown that welders who worked in open workplaces had no significant decrease in lung function. Those welders working in well ventilated areas showed no obstructive signs or radiological abnormalities, relative to welders working in poor ventilated areas. In

addition, welding years and the use of PPEs were found to be factors influencing HRQL of welders.

Lung Function

Pulmonary function testing are an integral part of diagnosing and managing patients with respiratory diseases. Several studies had been done to evaluate some specific group of workers or patients. However, the use of the lung function to assess the adverse effects of long-term exposure to welding fume are inconsistently reported. Osim et al. assessed the lung function of some Nigeria bank workers; Okpapi et al. evaluated the respiratory symptoms and lung function among textile workers at Kano textile mills, Kano, Nigeria. Other studies on lung function were that of Ozoh et al. also studied the prevalence of respiratory symptoms and lung function of flour mills workers in Ilorin, North Central Nigeria.

The results of the present study established a statistically significant reduction in the mean value of FVC (%), FVC (L), FEV1 (%), FEV1 (L) and FEV1/FVC in the welders compared with controls ($p< 0.05$) (Table 4). This finding is consistent with the finding by Erhabor et al. [3] in a study of 44 arc welders in Modakeke, Nigeria that showed that welders were found to have characteristically lower lung function parameters when compared to controls.

Akbarkhaaden et al. [14] observed the different parameters of pulmonary function test between welders and controls and reported that FEV1, FEV1/FVC were significantly decreased in welders compared with controls. Stern RM et al. [23] reported that FEV1 and FVC were also reduced in the welders. A previous study showed no significant differences between the ventilatory function test results of welders and controls [5]. This might be explained by the presence of absences and respiratory symptoms.

Ekijuntii- Pekkanen et al. [24] reported that welders who smoked had a significantly greater annual decline (88.8 ml) in FEV1 than non-smoker welders who had a slight non-significant annual decrease (34.2 ml). In addition, they showed that welders without respiratory protection or local exhaust ventilation while welding had a greater annual decline both in FVC and FEV1 than welders with protection. These findings confirm the findings of others, that, welding fume adversely affects lung function parameters of welders relative to controls.

The low FEV1 may indicate obstructive lung disease or reduction in the lung volumes and might be due to exposure to welding fumes and duration might be due to exposure to welding fumes and duration.

Our study has also shown that restrictive ventilatory pattern was seen more in the study subjects, 47 (45.6%) compared with 39 (37.9%) that had obstructive ventilatory pattern. The reason for this may be as a result of parenchymal responses which include nodular fibrosis, diffuse fibrosis, and macule formation with focal emphysema. This finding was corroborated by the finding of Erhabor et al. that also showed restrictive pattern as predominant ventilatory defect noticed among the welders, 18 (40.9%) of them had the restrictive pattern of the ventilatory defect as compared to 10 (22.7%) with obstructive pattern. They also found that all the subjects who developed the obstructive pattern of lung disease had it after 9 years of employment as contrasted to those with restrictive lung disease. It was concluded in their study that the early effects of exposure to arc welding is to produce a restrictive lung disease, although later a mixed pattern, may emerge.

In this present study, 18 (18.2%) of the controls had restrictive ventilatory pattern. This finding was comparatively higher than that of Erhabor et al. [3] where none of the controls had restrictive disease.

Health-Related Quality of life (HRQL)

Previous studies showed that the SF-12 has a good reliability and validity [25]. Our study showed that increasing age and higher level of education were associated with good HRQL in the welders and that the welders had a poor HRQL compared to the controls.

Previous study by Qinj et al. also revealed that the welders had poor (lower scores of SF-12) HRQL compared to the controls which was reflected in our study.

HRQL may be influenced by multiple factors. This study has shown age and level of education to be statistically significant. It was also reported in this study that welders above 45 years of age had better HRQL, 28 (80.0%) compared to those between 30 years and 45 years, 23 (44.2%) and those less than 30 years, 6 (37.5%). Tertiary education was found to be associated with good HRQL.

In exploring these factors further, our results showed that the length of experience; average hours spend per day at work; frequency and type of PPEs use, and having bath after the day's work were associated with good HRQL. However, factors such as types of material welded, types of welding workplace and eating at work were also associated with good HRQL but not statistically significant. These findings were consistent with the finding of Qinj et al.

Multivariate logistic regression was used to determine the independent predictors of HRQL in arc welders. Factors such as age above 45 years, length of experience (years) of more than 20 years and between 10 years and 19 years, use of face mask were significantly associated with good HRQL.

Conclusion and Recommendations

Conclusion

- This study had demonstrated that welders exposed to welding fumes and gases have predominant lower respiratory tract symptoms.
- The study also showed that the commonest respiratory symptom among the welders is cough and sputum production.
- The study also showed that all the Spirometric indices (FEV1, FVC, and FEV1/FVC) were significantly reduced in the welders compared to controls.
- Health related quality of life of arc-welders is significantly associated with age, duration of exposure, educational status, average hours spent at work, and the use of Personal Protective Equipment (PPEs).

Recommendations

- Arc-welders should have a pre-occupational lung function assessment to identify workers at risk/or with pre-existing respiratory impairments.
- Arc-welders should have periodic testing during their welding years to detect pulmonary disease in its earliest stages when corrective measure measures are likely to be beneficial.
- Arc-welders should use the appropriate Personal Protective Equipment (PPE) regularly.

Further research is recommended to study and measure each particulate matters so as to determine the degree of the hazard.

Limitations of Study

- Inability to measure directly different particulate matters, fumes or gases inhaled by the subjects.
- A longitudinal study would have been preferred to a cross-sectional study to enable documentations of findings over time.

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