Comparative analysis of Pneumosiderosis among different metal workers within Malumfashi Local Government Area of Katsina State, Nigeria

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ABSTRACT: Pneumosiderosis is an occupational lung disease acquired when metal workers are exposed to iron dust particles during their occupation. Sixty (60) sputum samples and ten sputum samples were collected both as test and control from different metal workers. The highest frequency of occurrence was recorded among blacksmiths with 15(25%), followed by aluminium pot makers with 14(23%), welders with 13(21.7%), grinders with 10(16.7%) and the least was recorded among Turners with 8(13.3%) frequency of occurrence. The age range 20-29 years recorded highest with 25(41.7%) frequency of occurrence, followed by age range of 30-39 years with 16(26.7%) and the least was from the age range of 40-49 years with 4(6.7%) frequency of occurrence for the test subjects. The length of the exposure to metallic dust particles revealed that; those exposed from 6-10 years recorded highest 21(35%), followed by 1-5 years exposure with 16(26.7%) and the least duration of exposure was recorded among the rest ranging from 21-40 years having 3(5.0%) each. Many iron deposits were detected in the sputum specimen giving positive reaction with Perl's Prussian Blue method with 43(71.7%) frequency and only 17(28.3%) recorded as negative for test subjects. Consequently, 40% recorded as positive case for control subjects. Papanicolaou method was adopted for this research; some cytological findings observed were variables. Long-term exposure to metallic dust particles, inadequate working ventilation as well as the unawareness of its effects were among the risk factors that increased the infection, even among the apparently healthy individuals. The treatment is usually symptomatic; prognosis is generally favourable if strict avoidance of the iron dust is adopted.

Index Terms: Pneumosiderosis, Sputum, Metalworkers, Iron dust.

ISSN 2229-5518

1. INTRODUCTION

Pneumosiderosis or welder's lung is an occupational lung disease, which is usually seen after chronic exposure to iron dust particles especially in welders and other metal workers (4). Siderosis is suffix derived from a Greek word "sidero" meaning iron, while "Pneumo" is a prefix derives from Greek word meaning breath. Therefore, siderosis is a chronic inflammation of the lungs caused by excessive inhalation of dust containing iron salts or particles (1).

Siderosis is a form of Pneumoconiosis due to the inhalation of iron or other matallic particles, excess of iron in the blood, deposition of iron in the tissue. The tissues on which the iron can be deposited may be the eye or skin which causes injury as the iron chemically reacts with cells and tissues (2). Iron oxide present in welding material is the causative agent of pneumosiderosis. It can also be caused by powdered hematite (5).

There are different metallic products which when exposed to the dust particles can affects the body such as Iron, Alumminum, silver, Nickel, magnesium etc. Although it takes years of exposure for a patient to become symptomatic, the symptoms are usually non-specific which most commonly include shortness of breath, cough and sputum production. With continued exposure, patients can develop chronic interstitial lung disease, chronic bronchitis (regardless of smoking), decline in pulmonary function and persistent symptoms (4).

Activities such as burning, welding, sawing, brazing, machining and grinding may result in the following effects if there is exposures to metallic products; the target organs is respiratory system.

- Acute effects through inhalation of metal dust in to the eyes, skin and mucous membrane.
- Chronic effects that are associated with iron oxide which may result in benign pneumoconiosis called "siderosis"

Individuals with chronic respiratory disorder (such as asthma, chronic bronchitis or emphysema) may be affected by any fumes or airborne particulate matter exposure (6). Inhalation of dust is irritating and may be harmful while inhalation of fumes may cause metal fume fever, characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increase white blood cell count which may cause lungs damage. Severe over dose of iron dust particles may have corrosive effect on gastrointestinal system, with necrosis, perforation and stricture. Symptoms of abdominal pain, nausea, vomiting diarrhea may be delayed several hours (7). However, long term inhalation can cause siderosis, a benign pneumoconiosis. Long term exposure may cause effects to the liver, pancreas, gastrointestinal system, blood and cardiovascular system which may lead to diabetic and cardiac abnormalities. The preventive measures are respiratory protection by using dust/mist mask, dust/mist filter respirator (7). Prognosis is generally favourable if strict avoidance from the iron dust is adopted (4).

2. MATERIALS AND METHOD

Seventy (70) sputum samples were collected and analyzed within Malumfashi LGA. Sixty (60) of these were collected from individuals involved in different types of metal work (such involved welders, blacksmith, Aluminum pot makers, Turners, and Grinders), while the remaining 10 samples were collected from non-metal workers to serve as control. The 10 control subjects were apparently healthy and normal individual with no present or past cases of any serious pulmonary disease.

Early morning sputum samples were collected and used for the study. During sample collections, the individuals were

instructed to gaggled their mouth and buccal cavity, with water and spitted it out, and then they were asked to take about four deep breaths, then followed by a few short cough, then inhaled and cough out forcefully and then expectorated the sputum in to clean sterile container. The samples were carried to the laboratory as quick as possible for subsequent processing.

All the sputum samples collected were smeared immediately on a clean grease-free microscopic glass slides and promptly immersed in 95% ethanol for fixation. The smears were transferred into coplin jars containing the fixative and were allowed for 30 minutes before staining.

3. RESULTS AND DISCUSSION

The assessment of the age distribution from the test subjects shows those 20-29 years has the highest frequency of occurrence 25(41.7%), followed by 30-39 years with 16 representing 26.7% (Table 1). The least frequency of occurrence was recorded among the age group 40-49 years with 4(6.7%). Table 2 also showed frequency of occurrence among the control subjects, but none of the control group falls within the age group 10-19 and 50-59 years.

The exposure to metallic dust particles varies significantly among the test individuals. The highest duration was recorded among 6-10 years with the frequency of 21(35%), followed by age range of 1-5 years with 16(26.7%). The least exposure duration was recorded among the age range of 21-40 years with frequency of 3(5.0%). This length of exposure to metallic dust particles increased the risk of infection to pneumosiderosis within the study area. This finding is comparable with that of (9) where they diagnosed 32years old welder man who initially developed breath shortness within 18 months of his work. The research also tallied with that of (8) who worked on chronic effect of exposure to welding occupation.

Cytological findings using Perl's Prussian Blue Staining Techniques, for test individuals (table 8) indicated the presence of hemosiderin and ferric iron deposits within the sputum samples processed. Out of 60 tested individuals, 43(71.7%) were positive for the disease while 17(28.3%) were negative. The presence of iron powder in the sputum may be related to exposure and working condition within inadequately ventilated environment. This finding correlates with the work of (5) on pneumosiderosis. A similar case was that of 30 years old female working and grinding tungsten rod with exposure to metallic dust particles, as reported by (10).

On the other hand, the cytological findings using Perl's Prussian Blue staining techniques for control group (Table 9) recorded a significant positive number with 40% frequency of occurrence. Even though, the sputum specimens were from non-metal workers, who were apparently healthy. However, the responses got from the questionnaire given to them, show that, some of these individuals in the control group reside close to the test groups or were associating with metallic fumes and smoke in their working place.

The different cytological findings using Papanicolaou Staining Techniques, for test subjects (Table 10) revealed the following:

Inflammatory cells: Of the (Sixty) 60 metals workers examined, 18(30%) had cellular finding indication in their sputum specimens. This number varied with the finding of (11) who found 78.1% of inflammatory cells among asbestosis patients. The length of exposure and their occupations were not related to the presence of findings indicating inflammatory with Papanicolaou staining.

Ferruginous bodies: Finding of ferruginous bodies among test subjects revealed 3.3% in this study which is close to the finding of Matti *et al*, (1978) with 1.4% but among non-

exposed patients. In addition, the higher values of ferruginous bodies were found according to (11), with 43% among asbestos workers.

Abnormal squamous cells: During this research, 56.7% of abnormal squamous cells were found, which is closely related with the work of (12) with 63%.

Dust cells: These are key cells to identify as one measure of adequacy of a sputum specimen. In the research 35% value was recorded with this carbon laden alveolar macrophages and they are common in smokers and urban dwellers.

Siderophages: A small value was recorded (6.7%) of siderophages among 60 metal workers examined. In relation to bleeding, these macrophages contain blood pigment hemosiderin-laden macrophages.

Giant cell histiocytes: Only 3.3% was found which can be seen in apparently healthy people, which is associated with Tuberculosis. This occurs in foreign body reaction, silicosis, fungal infection, and specimen for normal lung can have small numbers of giant cell histiocytes.

Curschmann's spirals: Very small number was found (1.7%) which is insignificant, although they are much more commonly found in sputum, but occur rarely in pap smear and is not related to cigarette smoking. Curshmann's spirals found in condition associated with excess mucous production as in patient with asthma and in smokers.

Fungal hyphae was found in the sputum with 11(18.3%) test individuals, spores in 1(1.7%), and Parasites in 1(1.7%) of the study individuals, and no any bacteria found in this research. This is contrary to the finding of Umeafoekwe, 2010, who found fungal hyphae of 40%, spores 18%, Bacteria 42% and no any parasite found. This is because his cytological finding was based on poultry feed mill workers.

4. CONCLUSION

Many iron deposit particles were detected in the sputum specimens of different metalworkers. Iron gives positive reaction to Perl Prussian Blue staining technique, iron dust in sputum is associated with the exposure to inhaled iron dust particles, inadequate working environments ventilation which may increase the risk of respiratory disorders and impairment of pulmonary functions. It has also been found even among the apparently healthy individuals within the study area. Based on the findings in this research, the following recommendations were made:

- Strict avoidance of exposure to iron dust particles should be adopted.
- Working in a well and adequately ventilated area should be ob served.
- Katsina state government should supply and provide the metal workers with the modern dust mask or dust filter respirator, to prevent them from inhaling dust particles during their work.
- Anybody who experienced the symptoms or have persistent symptoms as mentioned in the text should rush to the hospital for proper diagnosis.
- Awareness and enlightenment campaign should be organized all round the state on the various effects and epidemiology of inhaling iron dust particles, not only among the metal workers, but other individuals in order to get rid of it.
- More researches should be carried out on the topic, in not only the state but also the nation at large.

REFERENCES

[1] American Heritage Dictionary (A.H.D, 2009): *The American Heritage Dictionary,* Mifflin Company. USA.

[2] Fidan, F., Esme, H., Unlu, M., Albayrak. R. and Dilek, F.H. (2005): Welder's lung associated with pneumothorax. *Journal of thoracic imaging*. US National Library of Medicine by LIPPIN COTT Williams and Wilkins Inc U.S.A.

[3] http//:www.espimetals.com.

[4] Imran, K., Khalid, T.J., and Jennings, J.H. (2009); "A welder with pneumosiderosis: a case report'' *Cases Journal* Vol. 2 No: 6639.

[5] Strobel, Stephen L. (2002) *Archives of pathology and Laboratory medicine .Online*

[6] Powder technology inc. (2008). ''Material safety data sheet''. Online.

[7] CCINFO disc; cheminfo(2008); Budavari; *the merck index* 12th edition prepared by caledon laboratories ltd.

[8] Ozdemir O., Numanoglu N., Gonullu U., Savasi Alper D., Gurses H. (1995);''chronic effects of welding exposure on pulmonary function tests and respiratory symptoms''.*U.S National Library of Medicine*.

[9] Glass W.I, Taylor D.R, Donoghue A.M. (1994); ''Chronic Interstitial lung disease in a welder of galvanized steel''*U.S. National Library of Medicine*.

[10] Dai J.H, Miao L.X, Xiao Y.L, Meng F.Q, Cai H.R, (2009); ''Giant cell Interstitial pneumonia associated with hard metals: a case report and review of the literature''. *U.S National Library of Medicine*.

[11] Matti S., Huuskonem, M.D., (1978); Sputum Cytology of asbestosis Patients; *Scan Journal work environ and health.* Vol. 4, pp 284-294.

[12] Umeafoekwe Jennifer U.(2010);Cytological study of the Respiratory Tract of Poultry feed mill workers. *Research project in FSMLS-JUTH;* Jos, Nigeria (Unpublished).

Table 1: Age distribution of test individuals

Age		Frequency	Percent
Years	10-19	9	15.0
	20-29	25	41.7
	30-39	16	26.7
	40-49	4	6.7
	50-59	6	10.0
	Total	**60**	**100.0**

Table 2: Age distribution of control individuals

Age	Frequency	Percent
20-29	4	40.0
30-39	4	40.0
40-49	2	20.0
Total	**10**	**100.0**

Table 3: Marital status distribution of test samples

	Frequency	Percent
Single	27	45.0
Married	33	55.0
Total	**60**	**100.0**

Table 4: Marital status distribution of control individuals

	Frequency	Percent
Single	2	20.0
Married	8	80.0
Total	**10**	**100.0**

Table 5: Distribution of different types of metal workers

Metal work	Frequency	Percent
Welders	13	21.7
Turners	8	13.3
Blacksmith	15	25.0
Aluminum pot makers	14	23.3
Grinders	10	16.7

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	Welders	13	21.7
	Turners	8	13.3
	Blacksmith	15	25.0
	Aluminum pot makers	14	23.3
	Grinders	10	16.7
	Total	**60**	**100.0**

Table 6: Macroscopic distribution of sputum appearance of test individuals

Appearance	Frequency	Percent
Black mucoid	14	23.3
Mucoid	15	25.0
Creamy	16	26.7
Foamy	14	23.3
Watery	1	1.7
Total	**60**	**100.0**

Table 7: Macroscopic distribution of sputum appearance of control individuals

Appearance	Frequency	Percent
Mucoid	2	20.0
Creamy	2	20.0
Foamy	6	60.0
Total	**10**	**100.0**

Table 8: Duration of Exposure to Metallic dust particles

	Duration	Frequency	Percent
Years	1-5	16	26.7
	6-10	21	35.0
	11-15	9	15.0
	16-20	5	8.3
	21-25	3	5.0
	26-30	3	5.0
	36-40	3	5.0
	Total	**60**	**100.0**

Table 9: Cytological findings using Perl's Prussian Blue Staining Techniques for test samples

	Frequency	Percent
Positive	43	71.7
Negative	17	28.3
Total	**60**	**100.0**

Table 10: Cytological findings using Perl's Prussian Blue Staining Techniques for control samples

	Frequency	Percent
Positive	4	40.0
Negative	6	60.0
Total	**10**	**100.0**

Table 11: Cytological findings using Papanicolaou staining techniques for test samples

Findings	Frequency of occurrence	Relative percentage of Frequency (%)
Abnormal Squamous cells	34	56.7
Dust Cells	21	35
Curschmann's Spirals	1	1.7
Siderophages	4	6.7
Ferruginous Bodies	2	3.3
Giant Cell Histiocytes	2	3.3
Inflammatory Cells	18	30
Fungi Hyphen	11	18.3
Spores	1	1.7
Bacteria	-	-
Parasite	1	17

Table 12: Cytological findings using Papanicolaou staining techniques for control samples

Findings	Frequency of occurrence	Relative FrequencyPercentage
Abnormal Squamous cells	1	10
Dust Cells	5	50
Curschmann's Spirals	-	-
Siderophages	-	-
Ferruginous Bodies	-	-
Giant Cell Histiocytes	1	10
Inflammatory Cells	2	20
Fungi Hyphen	-	-
Spores	-	-
Bacteria	-	-
Parasite	-	-