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Effects of Dust Particles on Human Respiratory System among Otukpo Rice Mill workers

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Abstract: *Exposure to dust has become a great concern to the public due to its adverse effect on human respiratory related diseases. In this study, the effect of dust from rice processing in two major rice mills (Ijami road rice mill and Okete-Oglewu rice mill) were investigated systematically to ascertain their effect on human respiratory system. Dust particles were collected from six (6) processing spots (Paddy, Sack, swaying sieve, Polish, Sieving and Bran fill processing spot) in each of the rice mill in Otukpo LGA using Hand held Air Sampling Pump. A Cascade Impactor is used to determine the aerodynamic particle of the size distributions of the possible inhaled products. A lung performance test was carried out using Spirometer on 12 workers, with each worker chosen from the selected spot. From the analyzed results, there was a significant increase in values of dust measured in the two rice mills which was greater than permissible limit of 15 mg/m^3 except at the sack processing spot of Okete-Oglewu rice mill with lower dust concentration. The dust concentration at Ijami road rice mill ranges from 18.22- 34.88 mgm^{-3} in the order of: rice sack station< Bran Filling Station < Swaying Sieve Station < Polish station < Sieving station < Paddy station. The concentration at Okete-Oglewu rice mill ranges from 10.50-21.05 mgm^{-3} in the order of: rice sack station< Bran Filling Station < Swaying Sieve Station < Polish station < Sieving station < Paddy station. The results obtained are quite interesting and will serve as a guide for policy makers when enacting policies for human and environment safety.*

Keywords: *Aerodynamic, Ambient Conditions, Exposure, Inhalation, Spirometer*

ABBREVIATIONS

FVC	Forced Vital Capacity (%)
FEV	Forced Expiratory Volume (%)
I.R	Ijami road rice mill
O.R	Okwete-Oglewu rice mill
RH	Relative Humidity (%)
OSHA	Occupational Safety and Health Administration
COSHH	Control of Substances Hazardous to Health
PEL	Permissible Exposure Limit
ACGIH	American Conference of Governmental Industrial Hygienists
TLV	Threshold Limit Value

1. INTRODUCTION

Rice milling is the process of helping to remove outer and coarse grains from grains to produce refined rice. Rice is rich in intrinsic miscellaneous items and many varieties have been developed around the

world. Rice has always been one of the most valuable foods for human beings [1]. It is a food that feeds two-thirds of the world's population and is deeply rooted in the national customs of society. More than two-thirds of the world's rice is produced by smallholder farmers and consumed locally. Rice cultivation can be done in irrigated and non-irrigated fields. Rice is harvested, dehydrated and chopped. Dust is a small, dry solid particle that is ejected into the air by forces such as wind, volcanic eruptions, and by manual processes such as crushing, grinding, milling, drilling, dismantling, shoveling, conveying, sifting, bagging, and sweeping in [2]. The large amount of dust generated by the rice milling process is experienced. Not only the workers of the rice mill, but also the boarding community of the rice mill, who breathe dust-laden air into their respiratory tract every day. This can cause respiratory problems and potentially reduce the quality of life in the hosting community as a whole. Workers in factories may be exposed to living (organic) and inanimate dust and man-made chemicals that may be hostile to the respiratory system. The health effects of rice milling dust exposure, as well as the long history of associated disease and its adverse conditions on many human organs such as eyes, nostrils, skin, lungs, and blood parameters, have been reported and strongly supported by many researchers [3]. The effects of grain dust on the respiratory system seriously threaten the human respiratory system, including cough and dyspnea, asthma, chronic bronchitis, rhinitis, chronic obstructive pulmonary disease, and organic dust poisoning syndrome [4]. Several respiratory diseases are associated with exposure to inhalable dust. Workers in rice mills are associated with an increased incidence of respiratory warning signs, such as coughing, asthma, eye and nose discomfort, and the risk of long-term bronchitis [5]. The husks of grains such as rice have been found to contain extraordinary levels of silica. This alteration of the genome of an organism by silica may adversely affect blood parameters [6]. Dust particles smaller than 10 μm generated by rice mills are called respirable dust, which easily pass through the respiratory tract and seriously reduce the health status of rice milling workers [7]. The large amount of dirt or dust created during the rice milling process is very skilled. Not only rice mill workers, but residents of nearby communities breathe dust-laden air into their respiratory tracts every day. This leads to air pollution in the community, which reduces the quality of life and the nature of health [9]. However, pulmonary function tests are critical for measuring and estimating forced vital capacity (FVC) and forced expiratory volume (FEV) of rice mill workers in order to quantify the severity of respiratory disease. It therefore facilitates early detection as well as an expected medical history and rapid return to treatment. To date, many scientific researchers have done multiple works to evaluate lung function tests in health and disease [10-12], but the effect of sizes and amount of dust emitted during rice processing has seldom been reported. It is on this note that this research paper is centred around assessing the size and amount of dust particles released from two selected rice mills (Ijami road rice mill and Okete-Oglewu rice mill) in Otukpo LGA of Benue State, Nigeria.

2. Materials and Methods

2.1. Study Area

The study was conducted at two major rice mills (Ijami Road Rice Mill and Okete-Oglewu Rice Mill) in Otukpo LGA, Benue State, Nigeria. Otukpo is one of the largest local governments in Benue C, with a population of approximately 266,411 as of the 2006 census. The main occupations of Otukpo residents are agriculture and fishing. They grow the following crops; yam, cassava, rice, soybean, peanut, etc. A high percentage of the population works in the agricultural sector, including rice milling. The region has two main tropical climate seasons; the dry season and the rainy season. The rainy season lasts from April to October, while the dry season lasts from November to March. The average monthly temperature is 28 ^{0}C.

2.2. Dust Collection

Dust was collected from two rice mills (Ijami Road Rice Mill and Okete-Oglewu Rice Mill) at six different locations using a hand-held air sampling pump, recorded in mg/m^3, and aerodynamics determined using a cascade impactor The particle size distribution of the possible inhalation product.

From February 2 to March 14, environmental conditions were also measured at six sampling locations for each rice mill to determine differences in temperature and humidity at the sampling sites.

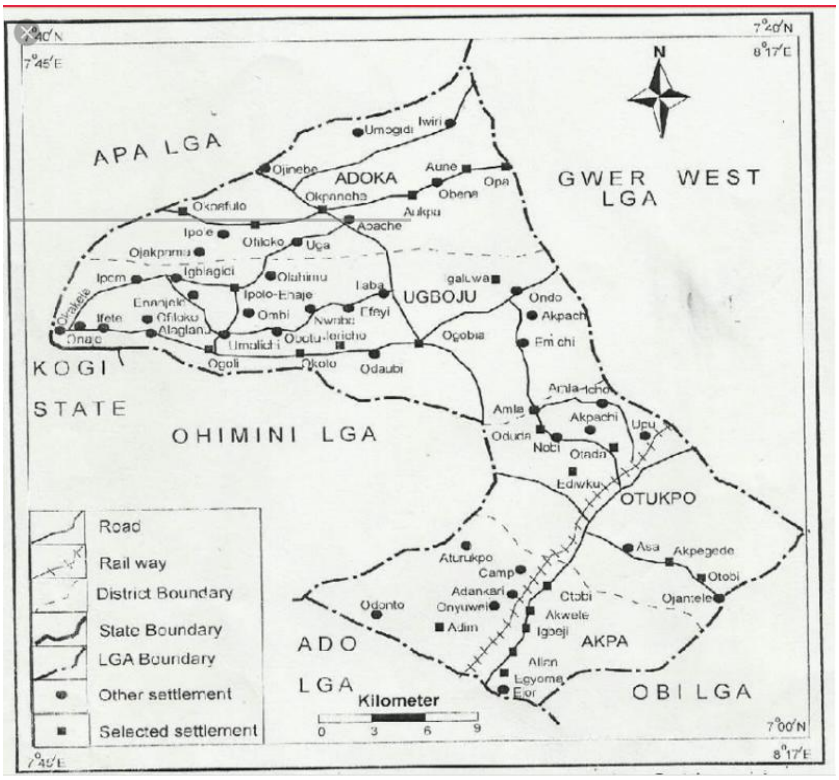


Figure1. *Map of Otukpo Local Government Area (study Area).*

Sampling Area Coordinates

Table1. *Sampling Area Coordinates of Ijami Road Rice Mill*

S/NO	Sampling Area	Coordinates	
		Latitude	Longitude
1	A	7.12 N	8.80 E
2	B	7.14 N	8.50 E
3	C	7.50 N	7.33 E
4	D	8.51 N	7.55 E
5	E	7.15 N	8.82 E
6	F	7.50 N	7.52 E

Table2. *Sampling Area Coordinates of Okete-Oglewu Rice Mill*

S/NO	Sampling Area	Coordinates	
		Latitude	Longitude
1	A	7.15 N	8.00 E
2	B	7.12 N	8.82 E
3	C	7.10 N	8.15 E
4	D	7.11 N	8.11 E
5	E	7.50 N	8.90 E
6	F	7.14 N	8.88 E

2.3. Lung Performance Test

Workers' lung function tests are performed using a spirometer. Basically, forced vital capacity (FVC) and forced expiratory volume (FEV) were collected from 12 workers, one at each sampling site, six (6) at Ijami Road Rice Mill, six (6) at Okete-Oglewu, (3) males and three (3) females from two sample rice mills.

2.4. Working Principle of Spirometer

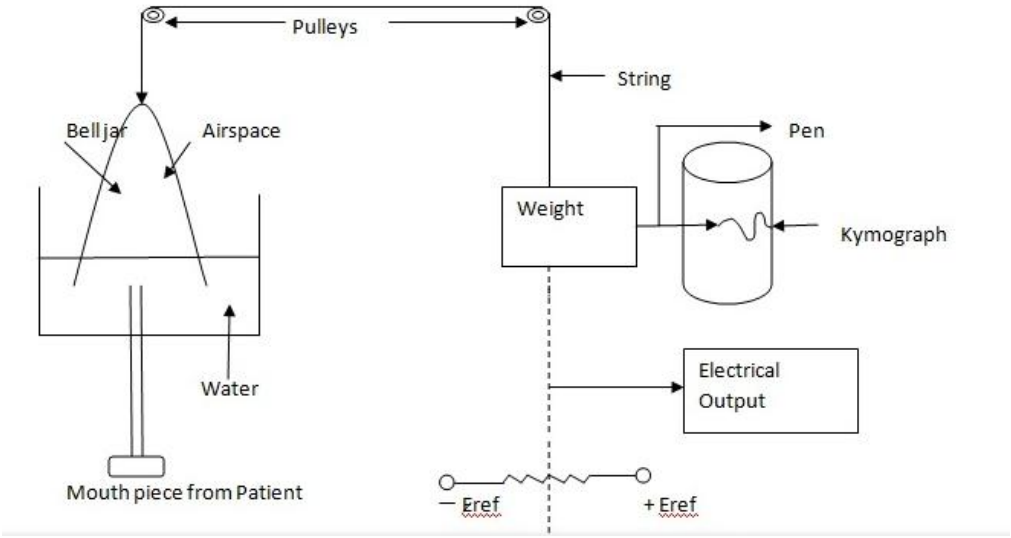


Figure1. *Working Principle of Spirometer*

A spirometer is a medical device used in environmental and biomedical sciences to measure lung function. Sampling workers use a spirometer to draw air through a suction nozzle into a capillary-like tube. During each cycle of inhale (inhale) and exhale (exhale), the clock moves up and down. The performance function depends on the amount of air inhaled or exhaled within the bell. The weight attached to the spine moves up and down with the movement of the clock.

3. Results and Discussion

Dust Concentration of the Sampled Location: The value of dust measured at each location in mgm^{-3} in given in the table below:

Table3. *Dust Concentration of the Sampled Location (mgm^{-3})*

Location	Ijami Raod Rice Mill	Okete-Oglewu Rice Mill
A (Paddy Station)	34.88	21.05
B (Sieving Station)	33.25	20.10
C (Polish Station)	31.50	20.20
D (Swaying Sieve Station)	25.22	19.22
E (Bran Filling Station)	20.25	18.25
F (Rice Sack Station)	18.22	10.50
Mean Total	26.55	18.55

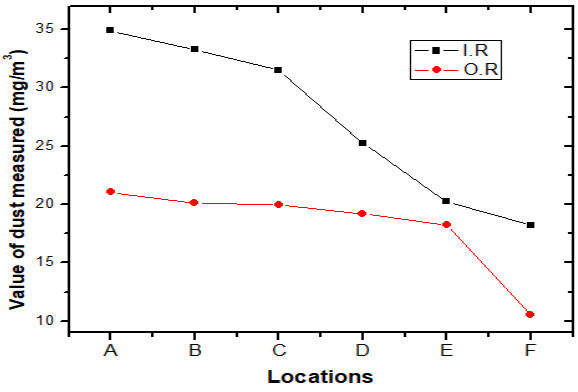


Figure2. *Graph of dust measured against Locations*

Keys: ***I.R:*** *Ijami road rice mill.* ***O.R:*** *Okete-Oglewu rice mill*

The dust concentration results at the sampling points are shown in Table 4 and Figure 2, indicating that the total dust content measured at the rice pouring station (point A) is the highest. The lowest total dust particles were measured at the rice bag station (position F). Nonetheless, all measured locations, paddy dumping station (position A), screening station (position B), polish station (position C), swing sieving station (position D), bran filling station (position E) and paddy Dumping stations (Location F of the two sampled rice mills) are locations where total dust particles exceed standard allowable levels, with the exception of the rice bag station at Okete-Oglewu rice mill, where minimum dust is below allowable limits. At these sampling stations, a dust safety plan should be followed to enforce worker awareness of inhalable and respirable dust. The measured dust decreases sequentially: rice pouring station > screening station > Poland station > shaker station > wheat bran filling station > rice bag station.

Ambient Conditions of Ijami Road Rice Mill: The ambient condition of Ijami road rice mill was measured and recorded in percentage (relative Humidity) and degree centigrade (Temperature) as shown in the table below:

Table5. *Ambient Conditions of Ijami Road Rice Mill*

Position (%RH)	Date	Temperature (^{0}C)	Relative Humidity
A	02 Feb.2022	34.80	44.00
A	04 Feb.2022	34.55	43.50
B	02 Feb.2022	33.00	43.00
B	04 Feb.2022	35.00	45.00
C	15 Feb.2022	38.00	40.00
C	24 Feb.2022	38.50	39.50
D	15 Feb.2022	38.00	40.00
D	24 Feb.2022	38.60	39.50
E	02 Feb.2022	36.00	39.00
E	14 Feb.2022	35.00	42.00
F	02 Feb.2022	36.00	39.00
F	14 Feb.2022	35.00	42.00

Ambient Conditions of Okete-Oglewu Rice Mill: The ambient condition of Okete-Oglewu rice mill was measured and recorded in percentage (relative Humidity) and degree centigrade (Temperature) as shown in the table below:

Table6. *Ambient Conditions of Okete-Oglewu Rice Mill*

Position	Date	Temperature (^{0}C)	Relative Humidity (%RH)
A	08 Feb.2022	34.00	45.00
A	19 Feb.2022	37.00	38.00
B	08 Feb.2022	34.00	45.00
B	19 Feb.2022	37.50	37.90
C	27 Feb.2022	36.00	40.00
C	05 Mar.2022	37.00	39.50
D	27 Feb.2022	36.00	40.00
D	05 Mar.2022	37.00	39.50
E	10 Mar.2022	38.50	36.00
E	20 Mar.2022	36.00	38.00
F	10 Mar.2022	38.50	36.00
F	20 Mar.2022	36.00	38.00

As can be seen from Tables 5 and 6, as the ambient temperature increases, the relative humidity of the environment decreases, and vice versa, which definitely affects the dust value. When the temperature is high and the relative humidity is low, the measured dust will end up being high, and vice versa.

Lung Performance Test for Ijami road rice mill: Forced Vital Capacity (FVC) and the Forced Expiratory Volume (FEV) of 6 workers at Ijami road rice mill were tested and recorded as shown in the table below:

Table7. *Results for Lung Performance Test for Ijami road rice mill*

Description	Forced Vital Capacity (FVC) (%)	Forced Expiratory Volume (FEV) (%)
1st Worker (male)	70	92
2nd Worker (male)	72	97
3rd Worker (male)	76	98
4th Worker (female)	56	74
5th Worker (female)	55	74
6th Worker (female)	50	69

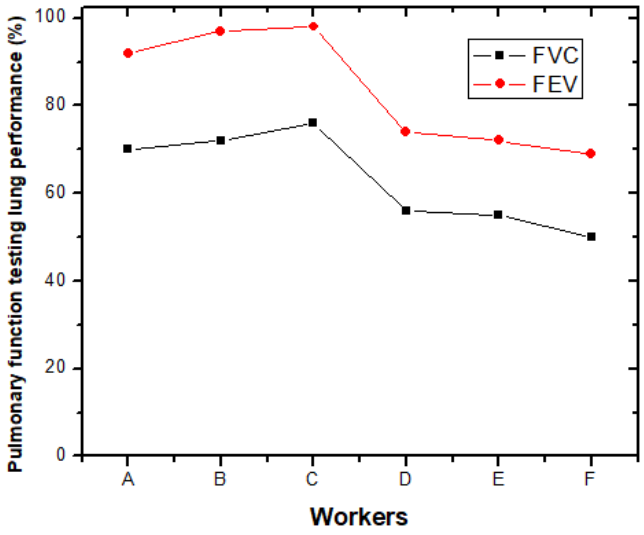


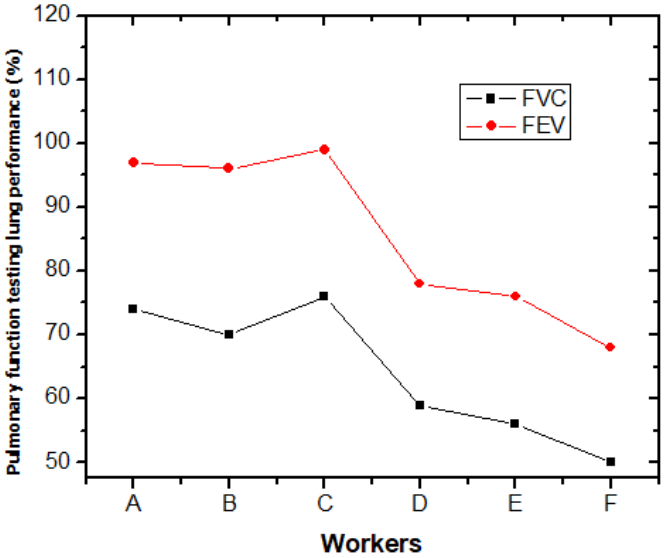
Figure2. *Graph of pulmonary function testing lung performance against workers in Ijami road rice mill*

Keys: ***FVC:*** *Forced Vital Capacity,* ***FEV:*** *Forced Expiratory Volume,* ***A to C:*** *Male workers and* ***D to F:*** *Female workers.*

Lung Performance Test for Okete-Oglewu rice mill: Forced Vital Capacity (FVC) and the Forced Expiratory Volume (FEV) of 6 workers at Okete-Oglewu rice mill were tested and recorded as shown in the table below:

Table8. *Results for Lung Performance Test for Okete-Oglewu rice mill*

Description	Forced Vital Capacity (FVC) (%)	Forced Experience Volume (FEV) (%)
1st Worker (male)	74	97
2nd Worker (male)	70	96
3rd Worker (male)	76	99
4th Worker (female)	59	78
5th Worker (femlae)	56	76
6th Worker (female)	50	68



Keys: FVC: Forced Vital Capacity, **FEV:** Forced Expiratory Volume, **A to C:** Male workers and **D to F:** Female workers.

Figure3. *Graph of pulmonary function testing lung performance against workers in Okete-Oglewu rice mill.*

In a study evaluating pulmonary function in two rice mill workers, the results are shown in Tables 7 and 8. In the test results, the male worker's FEV (forced expiratory volume) exceeds my safe body standard, while the female worker's FEV (forced expiratory volume) exceeds my safe body worker is within the allowable range set by the safety agency. All workers in the sampled area had an FVC (forced vital capacity) of less than 80%, within the standard allowable limits set by the Occupational Safety and Health Administration (OSHA). So, all the workers at both rice mills are safe. The FEV values for male workers are above the norm because they are not as directly exposed to dust as female workers. In addition, from Figures 2 and 3, it can be found that the values of FEV and FVC decreased geometrically, but at point C (polishing station), since the workers at this station did not wear any protective material, the values increased more than each Dot like other workers at other stations.

Occupational Exposure Limits for Dust: According to the Control of Substances Hazardous to Health (COSHH), if the dust concentration in the air is equal to or greater than 10.0 mg/m3 (for inhalable dust) or 4.0 mg/m3 (for respirable dust), humans in such an environment is prone to respiratory problems [11]. In addition, the Occupational Safety and Health Administration (OSHA) stipulates that the permissible exposure limit (PEL) for respiratory dust must not exceed 5.0 mg/m3 for 8 hours [12]. Table 8: Occupational Exposure Limits for Dust.

Compound	ACGIH (TLV)	OSHA (PEL)
Total Dust mg/m^3	-	15.00
Respirable Dust mg/m^3	3.00 mg/m^3	5.00
Inhalable Dust	10.00 Mg/m^3	-

Keys: ACGIH: American Conference of Governmental Industrial Hygienists, **TLV:** Threshold Limit Value, **PEL:** Permissible Exposure Limit

4. CONCLUSION

In this study conducted at two different rice mills in Otukpo (Ijami Road Rice Mill and Okete-Oglewu Rice Mill), the focus was on evaluating the particle size distribution and quantity of dust particles during rice milling. With six measuring positions: paddy pouring station (position A), screening station (position B), polish station (position C), shaker station (position D), bran filling station (position E) and rice pouring station (Location F), and observe the data over a month and analyze it. The results showed that the rice dumping station was the most dangerous point of the two sampled rice mills, with a high likelihood of causing respiratory problems for workers. The results of this study are expected to be used in preventive strategies to reduce the exposure of local rice mill workers to dust particles. There is also a need to increase awareness of the toxicity and impact of dust on workers in filling stations. This will allow them to wear protective clothing while on duty and visit the hospital from time to time.

REFERENCES

[1] Ahinsa Trinpathi, N.B Singh and R.K Singh, 2015. Analysis of Environment Factors in Rice Mill Workers of Uttar Pradesh, India. *G-Journal of Environmental Science and Technology*, 2 (5), pp 77-80.

[2] Kiattisak Batsungneon and Thanat Chai Kulwora Wanich Pong, August 2011. Effect of Dust Particles in Local Rice Mills on Human Respiratory System. *Journal of World Academy of Science, Engineering and Technology*, 80 (1), pp 421-426.

[3] Amiratul Aifa Mohamad Asri, Siti Marwans Anua, Sabreeena Safuan, Siti Farhanah Md Shakri, Nur Safuraa Mat Hussein, Nur Syafiqah Ishak and Ros Aida Mohd Zin, November, 2020. Inhalable Dust Exposed and Lung Function Among Rice Mill, Sawmill and Furniture Factory Workers. *Malaysian Journal of Medicine and Health Sciences,* 16 (11), pp 49-55.

[4] Mahmoud.M., Faremeh.R., Siavash.E. and Jamshid Y. C., 2017. Risk Assessment of Rice Husk Dust Among Rice Mill Workers. *Fresenius Environmental Bulletin*, 26 (1a), pp 892-897.

[5] Ghosh T, Gangopadhyay S, and Das B., 2014. Prevalence of Respiratory Symptoms and Disorders Among Rice Mill Workers. *Environ Health Prevalence,* 19 (13), pp 226-233.

[6] Health and Safety Executive, General Methods for Sampling and Gravimetric Analysis of Respirable, Thoracic and Inhalable Aerosols. *United Kingdom: Health and Safety Executive*. p 13, 2014.

[7] Shobana BV, Krisnan GV and Bhurkar M., 2015. Assessment of Peak Expiratory Flow Rate with Years of Exposure in Power Loom Workers in Rural Areas in Salem District. *International Journal of Pure and Applied Bioscience,* 3 (8), pp 192-195.

[8] Ghorani-Azam A, Riahi-Zanjani B and Balali-Mood M., 2016. Effects of Air Pollution on Human Health and Practical Measures for Prevention in Iran. *Journal of Research in Medical Sciences,* 2, p 65.

[9] Kiattisak Batsungneon and Thanatchai Kulworawanich Pong, 2011. *World Academy of Science, Engineering and Technology*, 8 (4), pp 421-426.

[11] Shama R, Jain A, Arya A and Chowdhary BR., 2002. Peak Expiratory Flow Rate of School Going Rural Children Aged 5-14 Years from Ajmer District. *Indian Paediatrics,* 39 (6), pp 75-77.

[12] Tandon S, Sadhoo SR and Dhar GL, 1990. A Study of Dynamic Lung Functions in Silk Factory Workers. Indian *Journal of Physiotherapy and Allied Health Sciences*, 44. pp 7-12.

[13] Liu Y, Lee K, Perez-Padilla R, Hudson NL and Mannino DM., 2008. Outdoor and Indoor Air Pollution and COPD-Related Diseases in High- and Low-Income Countries. *International Journal of Tuberculosis and Lung Diseases,* 12. pp 115-127.

[14] Control of Substances Hazardous to Health (COSHH). 17th January, 2020.

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