INTRODUCTION:

Rice is a seed of the monocot plants *Oryza sativa* is aedible as a grain and most widely consumed staple food for a large part of the world's human population. The harvested rice kernel, known as paddy or rough rice, is enclosed by the hull or husk. Milling usually removes both the hull and bran layers of the kernel, and rice that is processed to remove only the husks, called rice, contains about 8 percent protein and small amounts of fats and is a source of thiamine, niacin, riboflavin, iron, and calcium. Rice that is milled to remove the bran as well is called white rice and is greatly diminished in nutrients. Parboiled white rice is processed before milling to retain most of the nutrients. Hulls are used for fuel, packing material, industrial grinding and fertilizer manufacture. Paddy are first milled using a rice huller to remove the chaff (the outer husks of the grain). At this point in the process, the product is called brown rice. The milling may be continued, removing the bran, *i.e.*, the rest of the husk and the germ, thereby creating white rice. Primary milling of rice is the most important activity in food. Due to increasing trend especially in urban areas to buy branded Products of rice, it is estimated that the number of units under this category of industries are continuing to increase throughout the country and generating substantial amount of pollution. Rice Husk contains about 75 % organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, known as Rice Husk Ash (RHA). Composition of Rice Husk Ash on Dry Basis.[1] Rice mill Workers are exposed to respirable dust mainly silica causing occupational disease by either repeated or a single severe exposure leading to acute or chronic respiratory ailments. There are large number of mills engaged in processing and milling of rice, and are spread over in almost all states across the country leading to dust and air pollution as a result from various milling operations.

Typically, the rice processing units in the country are small, medium and large size mills. The mills with capacity < 3 ton/hrs.as categorized as Small Mills, 3 to15 ton/hrs capacity as Medium and > 15 ton/hrs.capacity as Large.

Most of the large and medium units generally produce both the Parboiled and White (Raw) Rice using separate production lines.

Both Parboiled and White (Raw) Rice factory units covering various unit operations, such as cleaning, parboiling, drying, hulling, de-husking, polishing and sorting will produce lot of dust(air pollution).

Rice husk is the largest by-product of rice milling industry which amounts to 22-24 percent of the total paddy.

Pulmonary function tests provides an objective and quantifiable measure of lung functions. It permits an accurate and reproducible assessment of the functional state of the respiratory system and allows quantification of severity of disease. These functions depend on the integrity of the airways, pulmonary vascular system, alveolar septa, respiratory muscles and respiratory control mechanisms.[3]

Spirometry, the most frequently performed pulmonary function test (PFT), is the cornerstone of occupational respiratory evaluation programs. In the occupational health setting, spirometry plays a critical role in the primary, secondary, and tertiary prevention of workplace-related lung disease. It isused for both screening and clinical evaluations.[4] Periodic spirometry screening of individual workers can detect changes in lung function over time among groups of workers with similar exposures and thus help to recognize serious health effects in the workplace at a time when individual results may not be severe or noticeable.

Considering the fact that rice mill workers as one of the major employers of labour as well as the means of livelihood for many people in Kolar, we therefore conducted this study to determine the prevalence of respiratory problems and impaired lung functions among rice mill workers in and around Kolar. We also tried to document

The availability of health care facilities and safety measures at the site as ways of minimizing occupational health hazards associated with rice mill workers.

AIMS:

1. To assess the pulmonary functions in rice mill workers and to compare it with the unexposed population.

2. To correlate the pulmonary function tests with duration of work in rice mill workers

REVIEW OF LITERATURE:

A: Anatomy of the lungs

The respiratory system is made up of a gas-exchanging organ (the lungs) and a "pump" that ventilates the lungs. The pump consists of the chest wall; the respiratory muscles, which increase and decrease the size of the thoracic cavity; the areas in the brain that control the muscles; and the tracts and nerves that connect the brain to the muscles. At rest, a normal human breathes 12 to 15 times per minute.[10]

Structure of Respiratory tract.

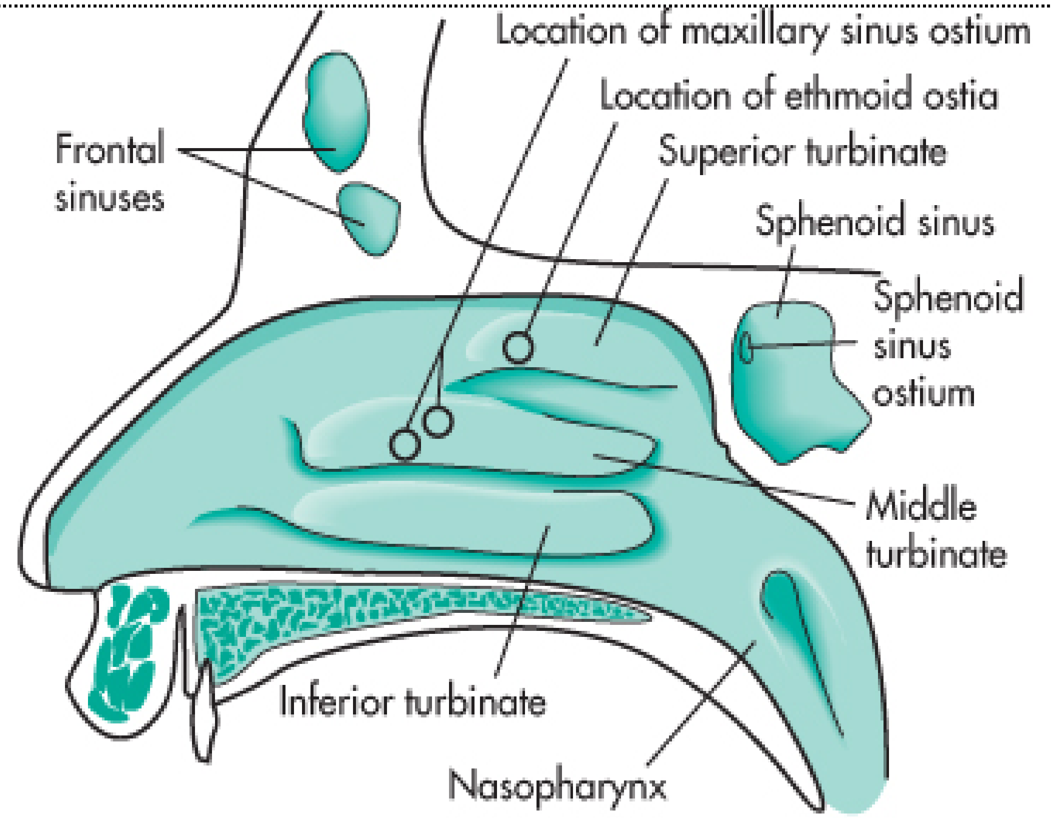
Upper respiratory tract: It consists of nose, Pharynx, Paranasal sinuses and Eustachian tube.

Nose: it plays a role in air conduction and conditioning, and clearance of particles and microorganisms. The mucous membrane of the nose is lined with ciliated epithelium. The cilia of the anterior part of nares, before the turbinates', beat anteriorly and propel mucous and entrapped particles towards the nostrils. From the turbinates' backwards, the cilia beat so as to propel particles towards the pharynx. The structure of nose is adapted to its important function of warming and humidification of inspired air.

Pharynx: It lies behind the nasal cavities, the mouth and the Larynx, ending at the level of sixth thoracic vertebra where it is continuous with the esophagus. It is lined in the upper part by ciliated columnar epithelium, which changes through transitional to stratified squamous epithelium over the lower part.

Paranasal sinuses and Eustachian tube:

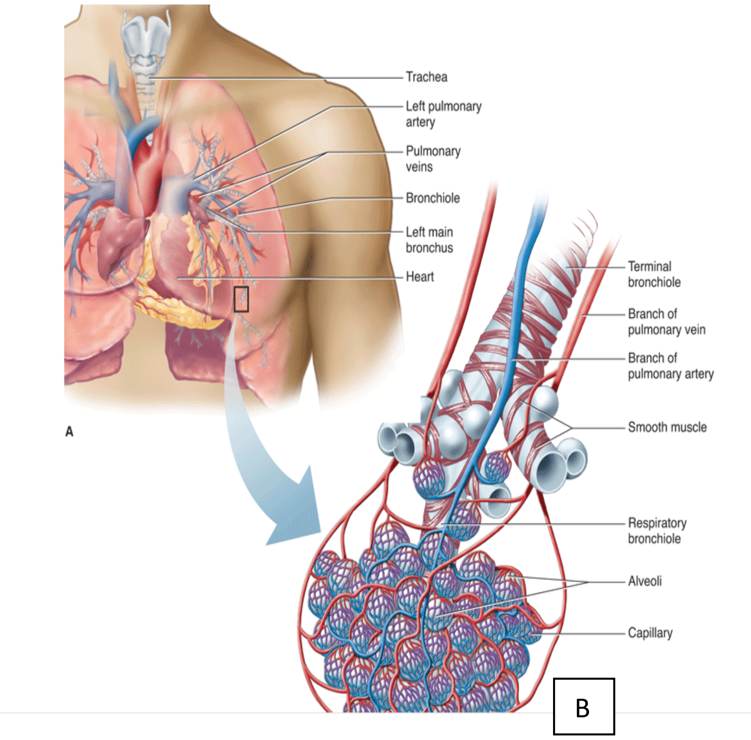
Figure 1 showing the opening of the Paranasal sinuses.



Paranasal sinuses are paired maxillary sinuses, between the orbit and the molars, each having an ostium that opens into the middle meatus, between the superior and the inferior turbinates. This is lined by ciliated columnar epithelium which contains mucus glands, the cilia sweeping the mucus towards and through the ostium. Frontal sinuses, above the orbits, drains inferiorly into the middle meatus while ethmoidal and sphenoidal sinuses superior and middle meatuses. The Eustachian tube connects the middle ear to the pharynx.[11]

Air Passages: Inspired air, after passing through the nasal passages and pharynx, where it is warmed and takes up water vapor, passes down the trachea and through the bronchioles, respiratory bronchioles, and alveolar ducts to the alveoli, where gas exchange occurs (Figure 2). Between the trachea and the alveolar sacs, the airways divide 23 times. The first 16 generations of passages form the conducting zone of the airways that transports gas from and to the exterior. They are made up of bronchi, bronchioles, and terminal bronchioles. The remaining seven generations form the transitional and respiratory zones where gas exchange occurs; they are made up of respiratory bronchioles, alveolar ducts, and alveoli. These multiple divisions greatly increase the total cross-sectional area of the airways, from 2.5 cm^2 in the trachea to 11,800 cm^2 in the alveoli. Consequently, the velocity of air flow in the small airways declines to very low values.

Figure 2



Structure of the respiratory system:

A) The respiratory system is diagrammed with a transparent lung to emphasize the flow of air into and out of the system. B) Enlargement of boxed area from (A) shows transition from conducting airway to the respiratory airway, with emphasis on the anatomy of the alveoli. Red and blue represent oxygenated and deoxygenated blood, respectively.

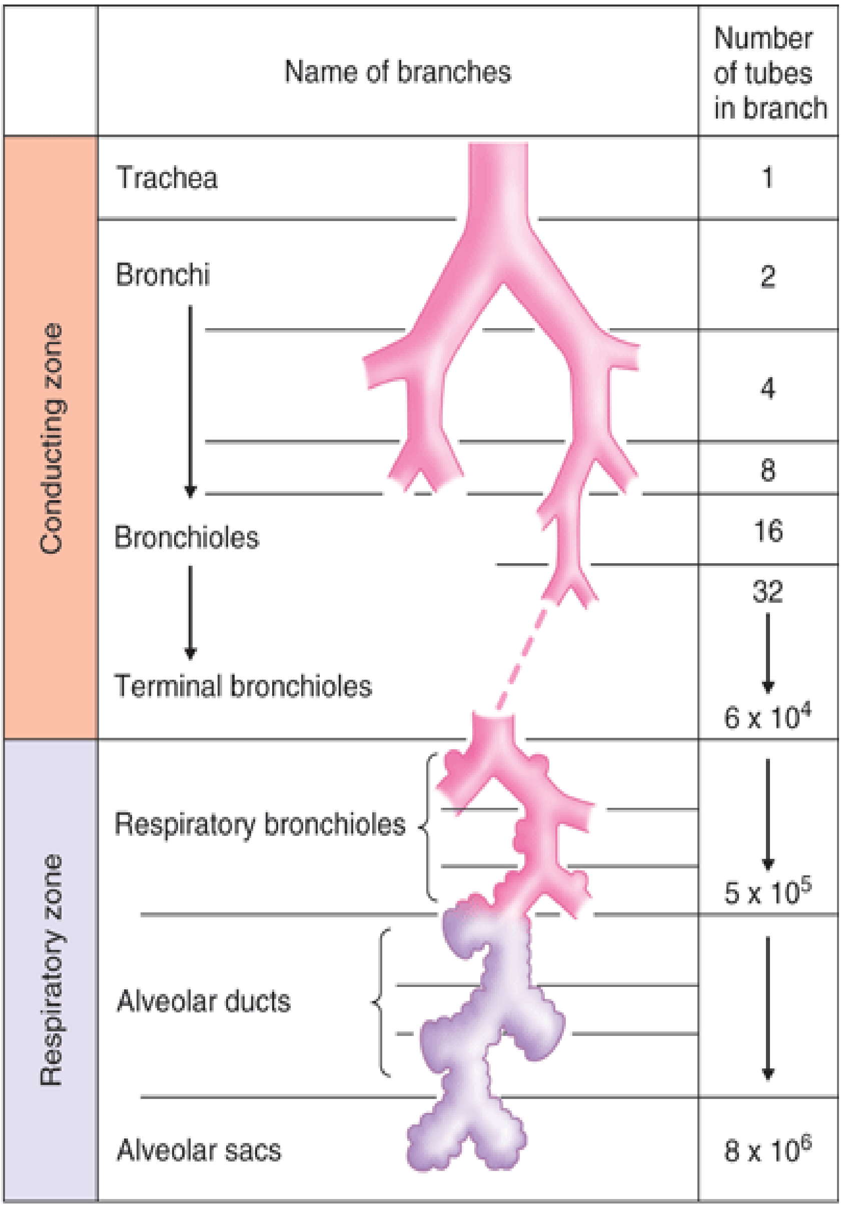


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Figure 2: (C) The branching patterns of the airway during the transition form conducting to respiratory airway are drawn (not all divisions are drawn, and drawings are not to scale).

The alveoli are surrounded by pulmonary capillaries (Figure 2). In most areas, air and blood are separated only by the alveolar epithelium and the capillary endothelium, so they are about 0.5µm apart. Humans have 300 million alveoli, and the total area of the alveolar walls in contact with capillaries in both lungs is about 70 m^2.

The alveoli are lined by two types of epithelial cells. Type I cells are flat cells with large cytoplasmic extensions and are the primary lining cells of the alveoli, covering approximately 95% of the alveolar epithelial surface area. Type II cells (granular pneumocytes) are thicker and contain numerous lamellar inclusion bodies. A primary function of these cells is to secrete surfactant; however, they are also important in alveolar repair as well as other cellular physiology. Although these cells make up approximately 5% of the surface area, they represent approximately 60% of the epithelial cells in the alveoli. The alveoli also contain other specialized cells, including pulmonary alveolar macrophages (PAMs, or AMs), lymphocytes, plasma cells, neuroendocrine cells, and mast cells. The mast cells contain heparin, various lipids, histamine, and various proteases that participate in allergic reactions.

The Bronchi & Their Innervation:

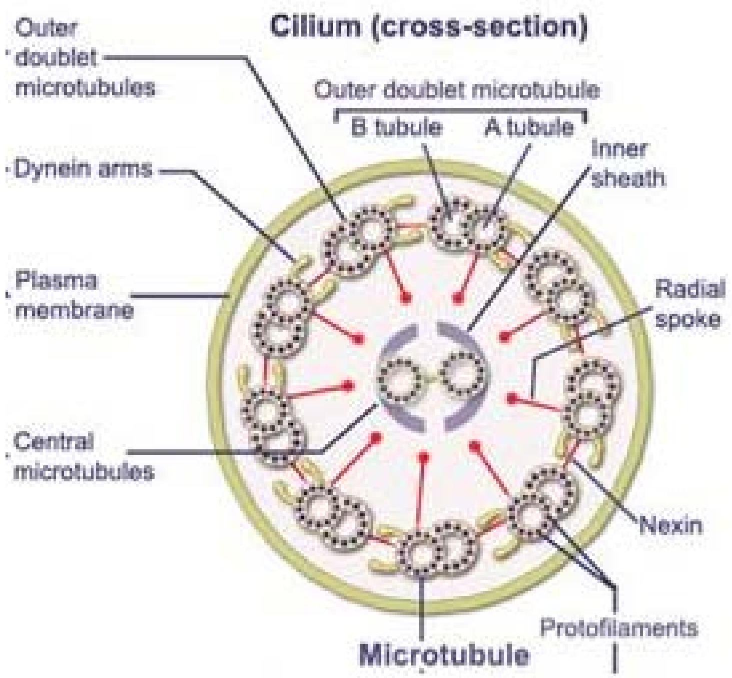
The trachea and bronchi have cartilage in their walls but relatively little smooth muscle. They are lined by a ciliated epithelium that contains mucous and serous glands. Cilia are present as far as the respiratory bronchioles, but glands are absent from the epithelium of the bronchioles and terminal bronchioles, and their walls do not contain cartilage. However, their walls contain more smooth muscle, of which the largest amount relative to the thickness of the wall is present in the terminal bronchioles.[19]

Mucosa

The ciliated cell has approximately 200 cilia, each between 5 and 10µm in length. Microvilli occur between the cilia. The epithelium contains some 1500-2000 cilia/cm^2, although the cells become sparse in peripheral airways. The cilia beat about 1000 times per minute, always with an active stroke in the direction of the oropharynx, followed by an inactive recovery stroke. The net effect is to convey bronchial secretions towards the pharynx where they can be swallowed or coughed up.[20]

Structure of cilium.

Figure 3: showing the cross section of cilium



The shaft consists of longitudinal fibrils in a cytoplasmic matrix. There are nine paired outer fibrils and two inner ones. These fibrils are specialized protein microtubules. The peripheral nine pairs each consists of one complete and partial microtubule. Adjacent pairs are connected by nexin links, while outer fibrils are connected to the central pair by radial spokes. These linking proteins are proteins. From each of the complete outer microtubules two arms extend towards the adjacent pair. These are known as dynein arms and consist of an ATPase protein. Bending of cilium appears to result from an active sliding movement between adjacent pairs of tubules, powered by an ATP-dependent shearing force developed by the Dynein arms linking them. The short, rapidly beating cilia of bronchial epithelium are well adapted to the transport of mucus floating on a layer of watery fluid. The cilia of an individual cell beat synchronously, while there is coordination between adjacent cells in that those at right angles to the effective stroke beat synchronously and those parallel to it beat in sequence. This results in propagation of wave over the cilial surface (metachronism).

The goblet cell is responsible for the secretion of mucin. It is present in large numbers in the proximal airways and become more sparse in the peripheral bronchi and bronchioles.

The clara cell is most profuse in the bronchioles and distal bronchi. It bulges above the ciliated cells into the airway lumen and has a secretory function .[21]It has an irregular nucleus, an abundant smooth endoplasmic reticulum and mottled secretory granules at the luminal end. These cells produce surfactant-associated glycoprotein.

Basal cells are small conical cells on the basement membrane that are overlapped by the ciliated and secretory cells. They are undifferentiated cells with the potential to develop into the more specialized epithelial cells. Basal cells are found mainly in bronchi and infrequently in bronchioles. Intermediate cells are more elongated than basal cells and may reach the airway lumen. They have microvilli on their surface but have not yet acquired cilia or secretory granules. They are found equally in central and peripheral airways. Brush cells occur throughout the airways.They have a well-marked surface covering of microvilli up to 2µm in length.

Submucosa

It is a thicker layer external to basement membrane and contains elastic fibers, mainly in longitudinal bundles but also connected with the mucous membrane and with circular fibers of fibrocartilage nous layer. In addition submucosa contains mucus glands, smooth muscle, nerves and lymphatics. Mucus glands are most abundant in medium sized bronchi. Chronic airway irritation by cigarette smoke or dust results in increased number of glands and also increases in their size.

Secretions of the airway

The secretions of the airway are normally contaminated by surfactant from alveoli and by fluid transudate. The bulk is secreted by the serous and mucus cells of the bronchial glands, with important contributions from the goblet cells of the bronchial epithelium as well as from the Clara cells.

Mucus is present over the bronchial epithelium as a continuous sol layer, in which the cilia beat, and a gel layer, which at bronchiolar level appears as distinct rafts floating over the sol layer; these gradually merge together to provide an almost complete covering of the epithelium in the large airways. The depth of the sol layer is about 5µm, just sufficient to cover the cilia during their effective stroke so that the gel layer is propelled over the surface. While the gel layer is clearly secreted by the mucus glands and the goblet cells, the sol layer is probably derived largely from Clara cells with some contribution from transudate fluid. The watery sol layer has been shown to contain albumin, lysozyme, immunoglobulin, α_1-antitrypsin and glycoprotein, with very little lipid. The gel layer contains 95% water, protein, carbohydrate and lipid, DNA and electrolytes. The proteins are mainly complex polydispersed glycoproteins called mucins, and immunoglobulins, especially IgA. The glycoprotein of mucus has a high molecular mass, with a long protein core and carbohydrate side chains, mains ones being galactose, N-acetylglucosamine and N-acetylgalactoseamine.

The function of bronchial mucus include waterproofing, thus diminishing water loss from the respiratory tract; protection of the epithelium, by forming a barrier between it and particles in the inhaled air. Defence, by removal of inhaled particles as a result of ciliary activity, and by acting as a vehicle for immunoglobulins.

The two most characteristic physical properties of bronchial mucus are its viscosity and elasticity. In bronchial clearance, the viscosity of mucus allows the cilia to engage it during their effector stroke and to stretch it, because of its elasticity, in an upward direction. The elastic property of the mucus allow it to transfer the energy imparted by the cilia to the transport of particles caught upon its surface.[11]

The walls of the bronchi and bronchioles are innervated by the autonomic nervous system. Muscarinic receptors are abundant, and cholinergic discharge causes bronchoconstriction. The bronchial epithelium and smooth muscle contain $_2$-adrenergic receptors. Many of these are not innervated. Some may be located on cholinergic endings, where they inhibit acetylcholine release. The β_2 receptors mediate bronchodilation. They increase bronchial secretion, while α_1 adrenergic receptors inhibit secretion. There is, in addition, a noncholinergic, nonadrenergic innervation of the bronchioles that produces bronchodilation, and evidence suggests that vasoactive intestinal polypeptide (VIP) is the mediator responsible for the dilation.

B: PULMONARY FUNCTION TESTS.

Historical Review:

129-200 AD-A Greek doctor and philosopher**,** Claudius Galen**,** performed a volumetric experiment on human ventilation. He had a boy breathe in and out of a bladder and discovered that after a period of time, the volume of gas did not change.

1681- Giovanni Alfonso Borelli attempted to measure the volume of air inspired in one breath by sucking a liquid up a tube and measuring its volume.

1718 -Jurin J**.** blew air into a bladder and measured the volume of air in the bladder by the principles of Archimedes. He measured 650 ml tidal volume and maximal expiration of 3610 ml.

1727-Hales St. approves the results of Jurin.

1749-Bernouilli D. describes a method of measuring an expired volume.

1788- Goldwyn E stated that the vital capacity could reach as much as 4460 ml. He corrected for temperature, but he did not use a nose-clip.

1793-Abernethy tried to determine how far expired gases had been depleted of oxygen.

1796- Menzies R. determined the tidal volume by body plethysmography.

1799- Pepys W.H. jun. found the tidal volume to be 270 ml by using two mercury gasometers and one water gasometer.

1800 -Davy H. measured his own vital capacity 3110 ml, his tidal volume 210 ml with a gasometer and the residual volume 590-600 ml by a hydrogen dilution method.

1813-Kentish E. used a simple 'Pulmometer' to study ventilatory volumes in disease. An inverted bell jar standing in water, with entry at its top controlled by a tap, and graduated in pints down the side.

1831-Thrackrah C.T. describes a 'Pulmometer' similar to that of Kentish, but air enters the glass jar from beneath. There is still no correction for pressure, so that machine measures still not only respiratory volumes but also the power of the expiratory muscles.

1844-Maddock, A.B. publishes in the Lancet a letter to the editor about his 'Pulmometer'. The principle of the machine was first suggested by the late Mr. Abernethy.

1845-Vierordt described some parameters like residual volume and vital capacity.

1852- Hutchinson, John publishes his paper about his water spirometer which is still used today with little alterations only. He showed the linear relationship of vital capacity to height and also showed that that vital capacity does not relate with weight at any given height.

1854-Wintrich developed a modified spirometer. He concluded that 3 parameters determine the vital capacity: body heights, weight and age.

1859-Smith E. developed a portable spirometer and tried to measure gas metabolism.

1866-Salter added the kymograph to the spirometer to record time as well as the volume obtained.

1868-Bert P. introduces the total body plethysmography.

1879-Gad J. publishes a paper about the Pneumatograph and suggested a new name for his Pneumatograph as Aeroplethysmograph..

1904-Tissot introduces a close-circuit spirometer.

1929-Knipping HW introduces a standardized method for spirometry.

1959-Wright BM and McKerrow CB introduced the peak flow meter.

1969-DuBois AB and van de Woestijne KP presented the whole body plethysmography on humans.

1970-The measurements of lung volumes and capacities are made using Spirometer. Some spirometers primarily sense volume and are known as Volume type Spirometer**,** while others primarily sense air flow at particular times, which are known as Flow typeSpirometers. Flow type spirometer use pneumotachograph or rotating turbines to determine air flow.1974-Campbell et al presents a cheap and light development of a peak flow meter.

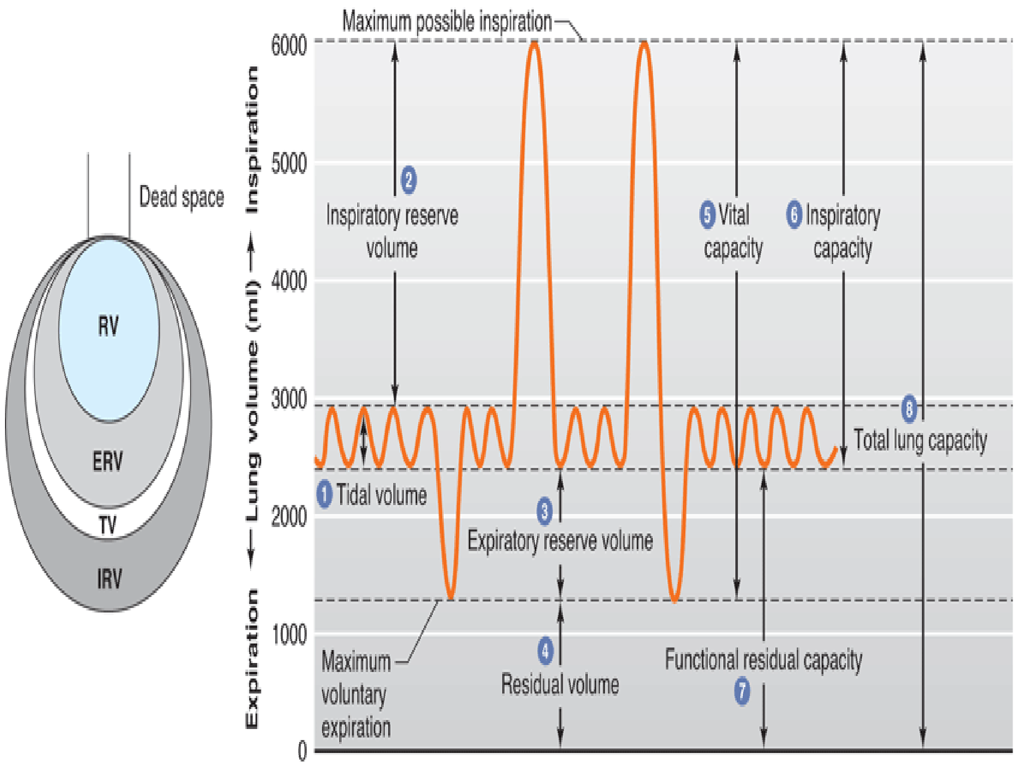


Figure4: Lung volumes and capacity measurements. **Top left**: A diagrammatic representation of lung space divided into lung volumes. Dead space refers to areas where gas exchange does not occur. **Top right**: Spirometer recordings are shown with marked lung volumes and capacities.

LUNG VOLUMES	Normal values (Adults) in ml	
	Males	Females
1. Tidal volume(TV): The amount of air that moves into the lungs with each inspiration (or the amount that moves out with each expiration)	500	500
2. Inspiratory reserve volume (IRV): The air inspired with a maximal inspiratory effort in excess of the tidal volume	3300	1900
3. Expiratory reserve volume (ERV): The volume expelled by an active expiratory effort after passive expiration.	1000	700
4. Residual volume: The amount of air left in the lungs after a maximal expiratory effort.	1200	1100

LUNG CAPACITIES	Normal values (Adults) in ml	
	Males	Females
1. Inspiratory capacity: Maximum amount of air that can be inhaled after a normal tidal expiration. (TV+IRV)	3500	2200
2. Functional residual capacity: Amount of air remaining in lungs after normal tidal expiration. (RV+ERV).	2300	1800
3. Total lung capacity: Maximum amount of air the lungs can contain.(RV+VC)	5800	4200
4. Vital capacity: The amount of air that can be expired maximally after a maximal inspiratory effort.[35,44]	1200	1100

Vital capacity is a useful predictor of pulmonary diseases.[22]

Vital capacity, tidal volume, inspiratory reserve volume, expiratory reserve volume and inspiratory capacity are measured directly by simple spirometry whereas residual volume, functional residual capacity and total lung capacity can be measured by indirect methods using inert gas (like helium) dilution techniques, nitrogen washout technique and Body Pletheysmography.[10]

Spirometry is measured by different spirometers:

The commonest being:

1. Simple spirometer/ student spirometer/ vitalograph.
2. Recording spirometer.
3. Wright's peak flow meter.
4. Computerized spirometer.[23]

Respiratory dead space: The space in the conducting zone of the airways occupied by gas that does not exchange with blood in the pulmonary vessels.

Pulmonary ventilation, Respiratory minute volume: The amount of air inspired per minute is normally about 6 L (500 mL/ breath x 12 breaths/min).

Dynamic lung volumes

One of the most common pulmonary function tests is spirometry, derived from the Greco-Latin term meaning "to measure breathing".

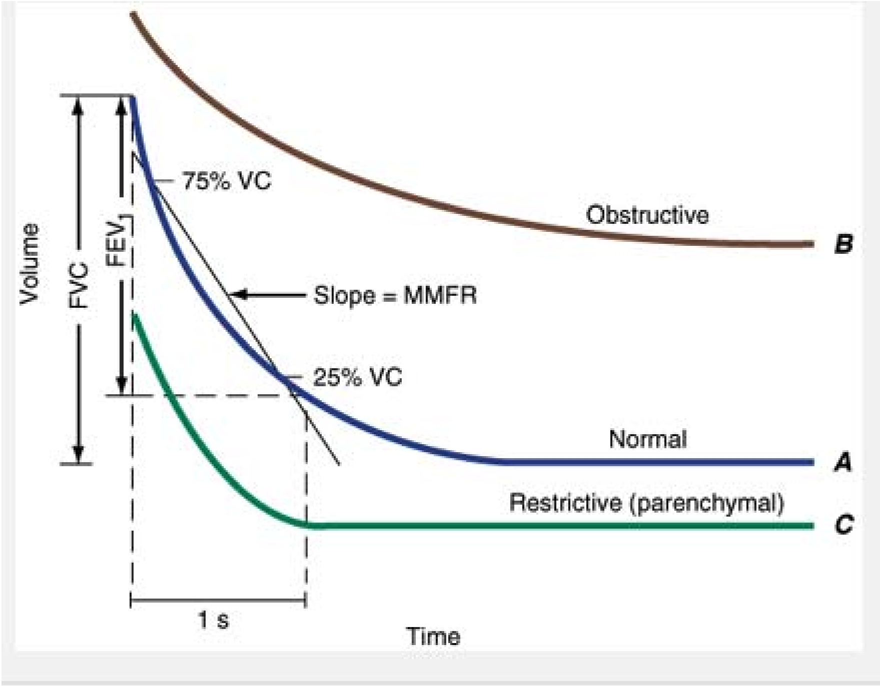


Figure 5: Spiro graphic tracings of forced expiration, comparing a normal tracing (A) and tracings in obstructive (B) and parenchymal restrictive (C) disease. Calculations of FVC, FEV_1, and $FEF_{25\text{-}75\%}$ are shown only for the normal tracing. Since there is no measure of absolute starting volume with spirometry, the curves are artificially positioned to show the relative starting lung volumes in the different conditions.[24]

<u>Forced vital capacity (FVC)</u>: The largest amount of air that can be expired after a maximal inspiratory effort, is frequently measured clinically as an index of pulmonary function. It gives useful information about the strength of the respiratory muscles and other aspects of pulmonary function.

The fraction of the vital capacity expired during the **first second** of a forced expiration is referred to as **FEV_1** (formerly the timed vital capacity). Normal: **80%.**

FEV_2: The volume of FVC expired in **first 2 seconds**. Normal**: 95-97**%

FEV_3: The volume of FVC expired in **first 3 seconds**. Normal: **97-100**%

A **Spiro gram**is a graphical representation of bulk air movement depicted as a volume-time tracing or as a flow volume tracing. Values generated from a simple Spiro gram provide an important graphic and numeric data regarding the mechanical properties of the lung, including airflow FVC, FEV_1 and others.

The maneuver may be performed in a forceful manner to generate a **forced vital capacity** (**FVC**) or in a more relaxed manner to generate a **slow vital capacity** (**SVC**- the patient takes a full breath in as before but exhales slowly in their own time.).

In normal person, the inspiratory vital capacity, expiratory SVC, and expiratory FVC are essentially **equal**. However, in patients **with obstructive small airway disease**, **the expiratory SVC** is generally **higher than FVC**.

Ventilatory function is measured under static conditions for determination of forced expiratory flow rates. The lung volume measurements should be corrected for body temperature and ambient pressure saturated with water vapor (BTPS).[45]

The measurement is typically expressed in liters for volumes or in liters per second for flows and is corrected for BTPS (body temperature and pressure saturated with water vapor) of gas that is saturated with water vapor.

Ambient temperature in ^{0}C	Multiplier to convert volume to BTPS*
20	1.101
21	1.096
22	1.091
23	1.085
24	1.080
25	1.074
26	1.069
27	1.062

*Volume at ATPS(Ambient temperature and pressure saturated with water vapor) x multiplier= Volume of BTPS.[46]

By convention all Lung volumes and rates of airflow are expressed in BTPS. This enables direct comparison of pulmonary function from laboratories operating at different ambient temperature.

The FEV_1 to FVC ratio (FEV_1/FVC) is a useful tool in the diagnosis of airway disease. A decrease in FEV_1/ FVC ratio is useful in identifying obstructive lung disease and a decrease in FVC with normal or increased FEV_1/ FVC ratio suggests restrictive lung disease. Visualizing the MEFV curve provides excellent quality control for obtaining reliable measurements of FEV_1, and FVC. Normal young adults usually complete forced expiration by 3 seconds**.**

	TLC	**VC**	**FEV_1/FVC**
Obstructive lung diseases	**Normal or increased**	**Decreased or normal**	**Decreased**
Restrictive lung diseases	**Decreased**	**Decreased**	**Normal or increased**

In restrictive lung diseases both FVC and FEV_1 are reduced in approximate proportion.[16]

These tests are often valuable for following the progress of a patient with chronic pulmonary disease and assessing the results of treatment.[47]

<u>Maximal voluntary ventilation (MVV):</u> It is the largest volume of gas that can be moved into and out of the lungs in 1 min by voluntary effort. The normal MVV is 125 to 170 L/min.

Technologies used in spirometers:

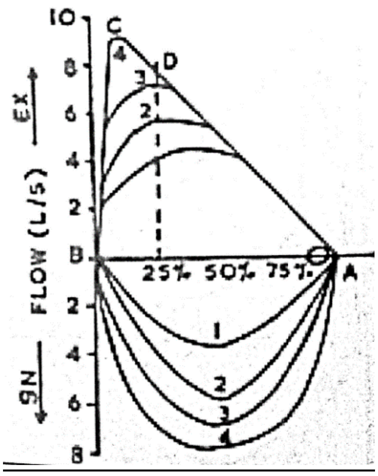
Volumetric Spirometers

- Water bell
- Bellows wedge
- Rolling seal
- Dry
- Flow measuring spirometers

- Fleisch-pneumotach
- Lilly (screen) pneumotach
- Turbine (a rotating vane, the revolutions are counted by light beam)
- Pitot tube
- Hot-wire anemometer
- Ultrasound
- FVC maneuver can be displayed in two different ways:

1. Flow-volume loop
2. Spiro gram

Figure6: Flow volume loop



Normal flow-volume curve with various inspiratory and expiratory efforts

A: Residual volume**, B** :Total lung capacity, **AB** : Inspiration, **BA** : Expiration, **C** **:**PEFR**, DA**: Independent expiratory effort.

Flow volume loop FVC maneuver can be recorded as instantaneous flow rate versus volume. This is flow volume loop. It can record instantaneous flow both during expiration and inspiration. It is recorded by asking the subject to take a maximal inspiration to total lung capacity (from the environment) and then to breath out as fast as possible until he can exhale no further (a maximal exhalation to residual volume), then take a rapid and deep inspiration (through the mouth piece). Flow rates above the horizontal line are expiratory flow-volume loop. Flow rates below the horizontal line are inspiratory flow-volume loop.

The highest flow rates are obtained during the first part of expiration and these are effort dependent, i.e. after approximately 1/3 (25-33%) of vital capacity. The linear part of the curve after 1/3 of expiration is called the effort independent i.e. increase in effort above a certain level will produce no further increase in flow due to the presence of dynamic compression of large airways. Effort dependent portion of the curve is primarily due to the subject's muscular effort rather than on the mechanical characteristics of the lung. The flow rates at lower lung volumes depend on the elastic recoil pressure of lungs and the resistance of the airways upstream or distal to the point at which dynamic compression occurs.[48] Changes in this portion (independent) represent changes either in the recoil pressure of the lung or in the resistance of the small airways.

The shape of the flow volume curves gives a clue whether the curves are normal or abnormal. The abnormality can be due to either obstructive or restrictive ventilatory defects. In obstructive ventilatory defect, the level of obstruction ie.,intrathoracic (below 6th tracheal ring) or extra thoracic, fixed or variable and reversibility to bronchodilators can be assessed by FV curves. In restrictive defect, the stage of disease (early or late) may be determined.

Obstructive Ventilatory Defect

a) Peripheral Obstructive Flow Volume curves are recorded in diseases such as asthma, chronic bronchitis and emphysema (Fig7).

There is a reduction in the peak flow rate but the most characteristic feature is the curvilinear shape (upward concavity) of descending limb of curve. It is probably due to abrupt emptying of large central airways associated with vigorous exhalation that causes these airways to collapse and generate a brief period of high flow. This loss of linearity is related to the severity of the obstruction as well as the type of disease.

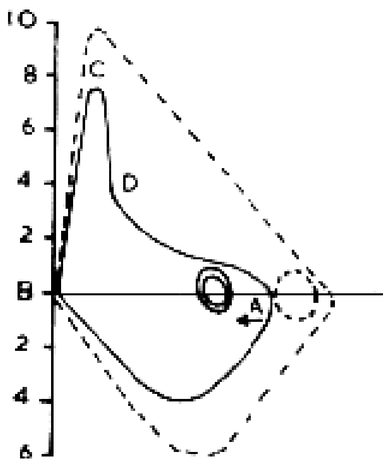
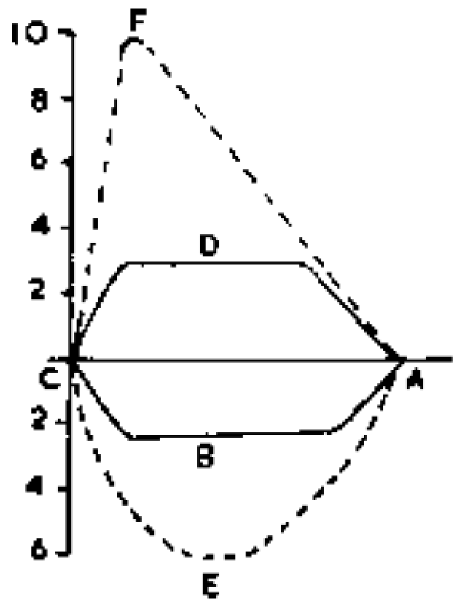


Figure 7: Flow volume curve in peripheral airways obstruction **C**; Reduced PEFR, **CD** : Period of high flow, **CA** : Curvy-linear shape. Arrow: Tidal volume loop moving towards vital capacity.

b) Major central obstructive flow volume curves: The inspiratory portion of the maximal flow volume curve is more sensitive to major central airways obstruction than the expiratory limb. It has great diagnostic usefulness when central airways obstruction is suspected, a situation in which ordinary spirometry reveals a nonspecific pattern. Some cases of stridor may be mistaken for wheeze arising from within the chest and in such circumstances; the first indication towards the correct diagnosis may be obtained from the following features of FV curves.

i) Fixed upper airway obstruction (Fig8): Both the inspiratory and expiratory limbs are truncated. The shape is quite characteristic with more or less equal restriction of both inspiratory and expiratory flow rates.

ii) Intrathoracic variable obstruction (Fig8): Obstruction at expiration. Expiratory limb is flattened and inspiratory limb is normal.



.**Figure 8**: Flow volume curves in central airways obstruction: **Curve ABC - CDA** = Fixed obstruction Curve. **AEC - CDA** = Intrathoracic variable obstruction Curve **ABC - CFA** = Extra thoracic variable obstruction

iii) Extra thoracic variable obstruction (Fig8): Obstruction at inspiratory phase. Inspiratory limb is flattened and expiratory limb is normal

Restrictive Ventilatory Defect:

Any disease which decreases the lung expansion either by chest wall diseases or by space occupying lesion in the pleural cavity or lung **causes restrictive type of abnormality**.

The Fig 9 shows the restrictive type where **curve 'C'** is normal. In early interstitial lung disease **(curve a)** even before lung volumes are decreased, the FV curves usually show super maximal expiratory airflow associated with a steep descending limb of the curve (due to increase in lung elastic recoil) and the curve becomes tall and narrow or vertically oriented with respect to the volume axis. In severe reduction of lung volumes **(curve b)**, the FV curve may maintain a relatively normal shape but appears miniatured in all directions.

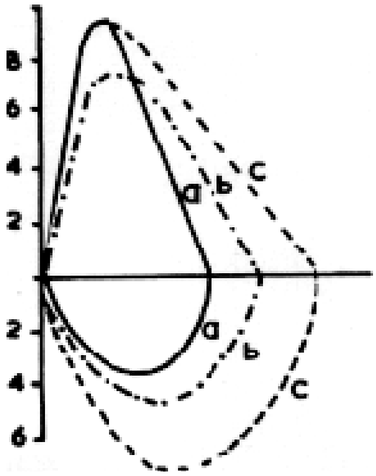


Figure 9: Flow volume curve in restrictive airways disease a : early stage of restrictive type, b : late stage of restrictive type, c: normal curve

Shape of FV curves gives extremely useful information with regard to in identification of the cause of airway obstruction and detection of early changes.[49]

Flow-volume loop yields the following main pulmonary function tests data:

1. **FEV_1**
2. **FVC**
3. **Peak expiratory flow rate (PEFR)**: It is the maximum flow rate achieved during the maneuver measured in L/min or L/sec. Normal- 500 L/min. Peak flow is largely a function of the large airway caliber. It greatly depends on expiratory muscle strength and the patient's effort and co-ordination. It is highly effort dependent and hence many clinicians use PEFR in addition to FVC and FEV_1.

4. **Forced expiratory flow 50%** is the volume achieved after exhaling 50% of the total FVC.

5. **Forced expiratory flow 25-75%** or average **mid expiratory flow** (MMEF) is the average flow rate over the middle section of the vital capacity and is calculated from the Spiro gram by dividing the vital capacity into quarters, drawing a line from the first (25%) and third (75%) quartiles. This indicates the patency of small airways.

6. **FEV_1/FVC ratio**: expressed in percentage of FVC.

FEV_1/FVC >**70%- Normal.**[50]

<70% - Mild obstruction

<60% - Moderate obstruction

<50% - Severe obstruction

C: <u>EFFECTS OF RESPIRABLE RICE HUSK DUST(SILICA) ON RESPIRATORY SYSTEM</u>:

Rice Husk contains about 75 % organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, known as Rice Husk Ash (RHA). Composition of Rice Husk Ash on Dry Basis.[1]

<u>Constituent Mass Fraction</u> : Silica (SiO_2) 80-90,Alumina 1-2.5,Ferric oxide 0.5,Calcium oxide 1-2,Magnesium oxide 0.5-2.0,Sodium oxide 0.2-0.5,Potash-0.2%.[1]Occupational exposures to respirable crystalline silica occur in a variety of industries and occupations because of its extremely common natural occurrence and the wide uses of material and products that contain it. Silica refers to the chemical

compound **silicon dioxide (SiO2),** which occurs in a crystalline or non-crystalline (amorphous) form. Crystalline silica may be found in more than one form **(polymorphism**). Each polymorph is unique in its spacing, lattice structure, and angular relationship of the atoms. In nature, the alpha (or low) form of quartz is the most common. This form is so abundant that the term quartz is often used in place of the general term crystalline silica. Occupational exposure to respirable crystalline silica is a serious but preventable health hazard.[5]Rice husk is known to have a high silica content and this biogenic silica may cause pulmonary disease resembling asbestosis, namely pleural thickening, fibrosis and possibly bronchogenic carcinoma.[6]According to the International Standardization Organization **"Dust** is defined as small solid particles, conventionally taken as those particles below 75µm in diameter, which settle out under their own weight but which may remain suspended for some time**"**.[51]

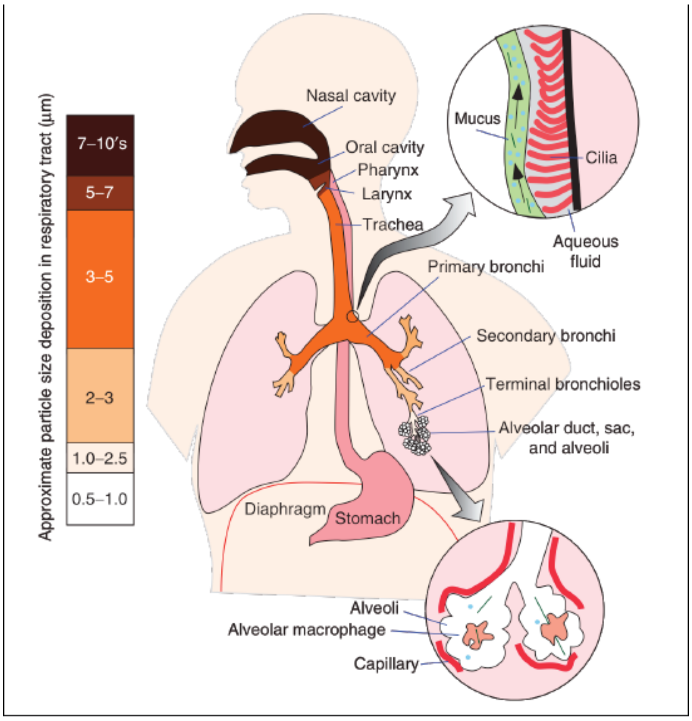
According to the "Glossary of Atmospheric Chemistry Terms","**Dust is Small, dry, solid particles projected into the air by natural forces,** such as wind, volcanic eruption, and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shoveling, conveying, screening, bagging, and sweeping**.** Dust particles are usually in the size range from about **1 to 200µm** in diameter, and they settle slowly under the influence of gravity.[52]It is considered that dusts are solid particles, ranging in size from below 1µm up to at least 200 µm, which may be or become airborne, depending on their origin, physical characteristics and ambient condition. Dust particles smaller than 10µm, or calledRespirable dust, could be passed through the human lung and can seriously cause degradation of healthy condition of the dust exposed workers.[3]

Penetration and deposition of particles in the human respiratory tract:

Particles of <10µ small enough to stay airborne may be inhaled through the nose (nasal route) or the mouth (oral route). The probability of inhalation depends on particle aerodynamic diameter, air movement round the body, and breathing rate. The inhaled particles may then either be deposited or exhaled again, depending on a whole range of physiological and particle-related factors. The five deposition mechanisms are sedimentation, inertial impaction, diffusion (significant only for very small particles < 0.5µm), interception, and electrostatic deposition.Sedimentation and impaction are the most important mechanisms in relation to inhaled airborne dust, and these processes are governed by particle aerodynamic diameter. There are big differences between individuals in the amount deposited in different regions.[53,54]

The largest inhaled particles, with aerodynamic diameter greater than about 30 µm, are deposited in the air passages between the point of entry at the lips or nares and the larynx. During nasal breathing, particles are deposited in the nose by filtration by the nasal hairs and impaction where the airflow changes direction. Retention after deposition is helped by mucus, which lines the nose. In most cases, the nasal route is a more efficient particle filter than the oral, especially at low and moderate flow rates. Thus, people who normally breathe part or all of the time through the mouth may be expected to have more particles reaching the lung and depositing there than those who breathe entirely through the nose. During exertion, the flow resistance of the nasal passages causes a shift to mouth breathing in almost all people. Of the particles which fail to deposit in the air passages between the point of entry at the lips or nares and the larynx, the larger ones will deposit in the tracheobronchial airway region and may later be eliminated by mucociliary clearance or - if soluble - may enter the body by dissolution. Inhaled mineral dust with an aerodynamic diameter bigger than 10 µm, stops in the upper respiratory tract where the particles get trapped in the mucous lining of the nasopharyngeal tract. They are normally of an only small health concern, unless the particles are of toxic mineralogy. If the dust particles have an aerodynamic diameter smaller than 10 µm, they can penetrate more deeply into the lung passages to the tracheobronchial regions, where they also get trapped in a layer of mucus.[55] In aerodynamic diameter terms, only about 1% of 10-µm particles gets as far as the alveolar region, so 10 µm is usually considered the practical upper size limit for penetration to this region. Particles ≤ 4.0 µm are defined as respirable dust and those particles are small enough to even reach the gas-exchange region of the lung, the alveoli.[56] Material-specific factors of a particle, like size, shape, charge and relative weight, host factors, like air speed, diameter of the airways and health status determine where a particle is deposited in the respiratory tract.

Figure 10: Figure showing approximate particle deposition in respiratory tract.

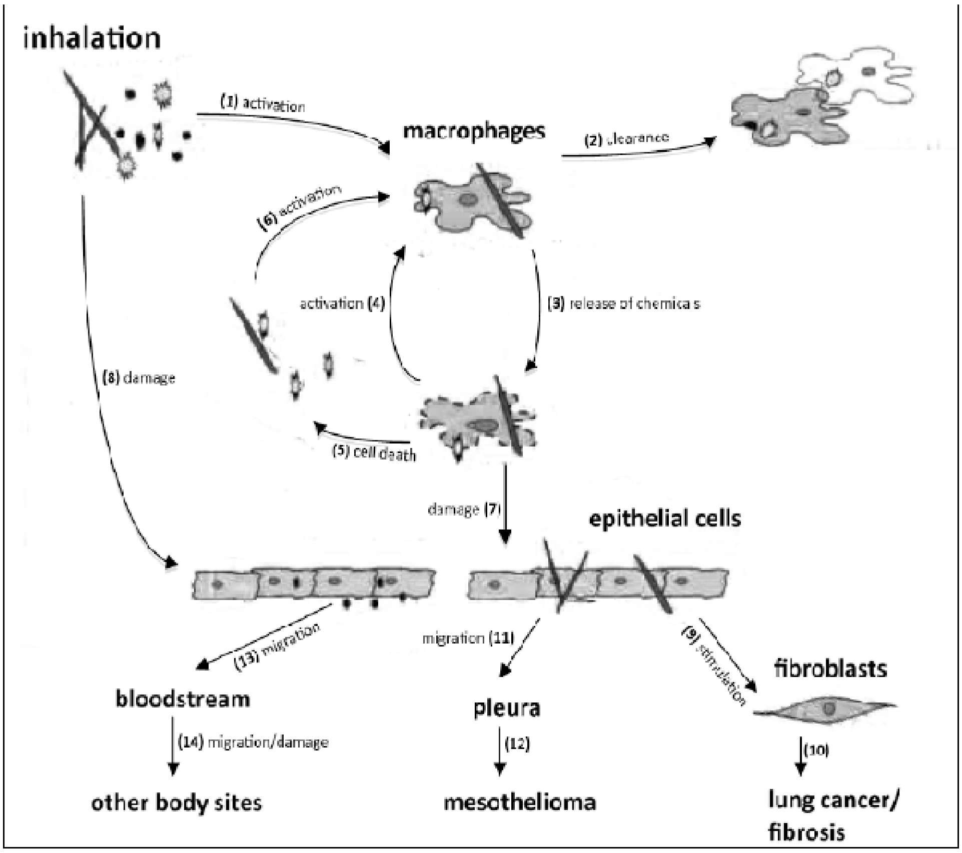


Clearance of particles from the respiratory tract:

After deposition, the subsequent fate of insoluble particles depends on a number of factors. Soluble particles depositing anywhere may dissolve, releasing potentially harmful material to the body. In the nose and airways an active epithelium protected with a viscous layer of mucus, acts as a barrier to prevent damage from entered particles. In the alveoli the barrier between the alveolar wall and the capillaries is only very thin, to allow an intense air-blood contact for gasexchange. This and the large surface area make the alveoli more vulnerable to environmental particles than the nose and airways.[57]

As mineral particles get into the respiratory tract, the body tries to clear them the bigger particle which gets trapped in the mucus of the nasopharyngeal tract, are cleared by sneezing, blowing, dripping through the nose or by flow into the pharynx where they may be swallowed. The particles, which are deposited in the mucus of the tracheobronchial region are cleared to some extent by coughing and to another extent by the movement of ciliated cells in this region. The cilia are in continuous and synchronized motion, which causes the mucous layer to have a continuous upward movement, reaching a speed in the trachea of 5-10 mm per minute. Insoluble particles deposited on the ciliated epithelium are moved towards the epiglottis, and then swallowed or spat out within a relatively short time.[71]This process is called mucociliary escalator and is dominating the clearance of particles from the nose and airways. It is interesting to note that the rate of clearance by the mucociliary mechanism may be significantly impaired by exposure to cigarette smoke. The smallest particles ($\leq$ 4.0 μm), which are of main interest, are grouped by Fubini and Fenoglio (2007) into three groups: micron-sized mineral particles, mineral fibers and nanoparticles. Those groups induce to some extent different clearance mechanism, but all are cleared predominantly by macrophage phagocytosis.

Figure 11: Pathology of inhaled silica dust.



The micron-sized mineral particles, which settled in the pulmonary alveoli, are cleared by different modes. Foreign substances in the human body lead to the activation of macrophages, in the case of particles in the alveoli it leads to the activation of alveolar macrophages (mononuclear phagocytes in the lung alveoli). The activated macrophages ingest the particles. As they contain lysosomes with acidic pH and digestive enzymes, they can degrade and clear the particles. They also release chemicals to activate other macrophages. Alveolar macrophages have a life span of about 50 days in average. When they eventually die, they release their contents, which consist of already engulfed particles and many substances of which some lead to the recruitment of new macrophages. Those then again re-ingest the dying macrophages released particles. This cycle of cell death and newly recruited cells in the alveoli can lead to increased inflammation, lower rate of particle clearance and a reduced capacity of the lung to perform gas exchange.[58]An increased particle load in the alveoli can have the same effect, due to a high dose of inhaled particles. This exceeds the phagocytic capacity of the alveolar macrophages, their efficiency in particle uptake decreases and thus the particle burden in the alveoli increases. As long as particles exist in the alveoli, the inflammation will last. The cytokines, growth factors, and reactive oxygen species, which are released by the dying macrophages, can directly damage the cells in the alveoli. With a diameter of 10 μm, macrophages are able to ingest particles up to a diameter of 5 μm. If particles are larger than 5 μm macrophages are not able to ingest them fully, but as the particles penetrate the plasma membrane of the macrophages, lysosomal fluids and enzymes can flow out and in turn lead to the activation of new macrophages or lead to the damage of surrounding cells. [58]Another process for the clearance of micron-sized mineral particles is dissolution in the fluid lining the alveoli. Particles can get to some extent or entirely dissolved over time. Especially particles composed of mainly calcium carbonate and some other metal carbonates, like limestone, marble or dolomite easily get dissolved in the acidic pH of the lysosomal fluids and enzymes released by alveolar macrophages. The dissoluted particles can be retained by the mucus or absorbed into the body through the epithelium of the respiratory tract. Not all of the particles in the alveoli get degraded by the macrophages or dissolved, but some remain as free mineral particles in the alveoli. While some of the remaining mineral particles induce no harm, others can damage the epithelial cells and by this stimulate fibroblastic cells. Fibroblastic cells can lead to the deposition of collagen, a protein which is needed in the white fibers of skin, in the cartilage and the connective tissue. If those processes go on for some time, it might result in the development of lung cancer or fibrosis. The detection of fibrosis in the lung by radiograph may work only after years of ongoing fibrosis.[58]The second group, the mineral fibers, induce almost the same reactions in the body as explained above, though their case is a little more complex. They can be from a few micrometers up to several hundred micrometers long, while their diameter is just a few tenths of a micrometer. If the fibers are short, they get easily enfolded and ingested by macrophages, but if they are long the macrophages are not able to engulf them and they remain in the alveoli. As described before they can damage the surrounding cells and macrophages. The long, thin and rigid fibers are even able to cause mesothelioma, a fatal neoplasia (abnormal proliferation of cells) of pleural mesothelialcells (membrane that covers the lung), because they may migrate to the pleura.[58]The third group, the nanoparticles induce a different reaction in the body. The small size of the nanoparticles hinders the clearance by macrophages, leading to a higher burden of them in the alveoli. Because they are so small, some are able to migrate through the surrounding cells (alveolar membrane) and get into the interstitial lung tissue. They can remain there or migrate further on, to the lymphatic system. Normally, most of those particles get filtered in the lymph nodes and remain there. Still some get via the lymph into the bloodstream. On this way they can get away from the lung, reach other organs and possibly cause some harm at other sites in the body than the lung (Fubini and Fenoglio, 2007). The degree of toxicity of nanoparticles is not totally clear yet. Some studies have shown that at a certain mass they can result in greater inflammation than bigger particles. It is assumed that this is due to the high surface area, the large amount of reactive “edge” and “corner” sites of the small particles. This inhibits phagocytosis, enhances oxidative stress, enhances inflammation in the lung epithelium and permits the ultrafine particles to diffuse more readily into the lung interstitium. There is also some evidence that nanoparticles are not in all circumstances more toxic than bigger particles.[57]

Risk to health:

Wherever the particles are deposited, either in the upper respiratory tract or in the lung, they have the potential to cause harm either locally or subsequently elsewhere in the body. Particles that remain for a long time have increased potential to cause disease. This is why inhaled particles are important in relation to environmental evaluation and control. Health effects, which may result from exposure to different types of dust, include pneumoconiosis, cancer, systemic poisoning, hard metal disease, irritation and inflammatory lung injuries, allergic responses (including asthma and extrinsic allergic alveolitis), infection, and effects on the skin.[715]Rice husk is known to have a high silica content and this biogenic silica may cause pulmonary disease resembling asbestosis, namely pleural thickening, fibrosis and possibly bronchogenic carcinoma.[6]Silicosis, asbestosis and coal workers' pneumoconiosis (CWP) are the best known diseases caused by the mineral dusts.

Occupational exposure to dust is a well-known phenomenon, especially in developing countries.[59,60.]Although sources of air pollutants include power plants, cement factories, refineries and petrochemical industries, the emission of particulates is quite high from quarries.[61]cleaning, drying, hulling, de-husking, polishing and sorting will produce lot of dust(air pollution) may produce fine silica dust. Production process of most factory-made products is harmful to our health and environment.

Paddy husk (75% silica) is the most important dust pollutant in rice mills.Rotary drill operators, front-end loader operators, truck drivers, and crusher operators are permanently exposed to stone dust.[62]Few epidemiological studies have supported the association between respiratory impairment and occupational exposure to dust.[36]Again, individuals working in dusty environment have been found to carry the risk of inhaling particulate materials (e.g., silica) that may lead to adverse respiratory effects,such as chronic bronchitis, emphysema, acute and chronic silicosis and lung cancer which are disabling and can even be fatal.[7,8,34] Prevalence of restrictive lung disease is high among stone cutters.[30] Many rice mill workers 42.66% had respiratory morbidity, PEFR less than 200L/min, 26.66% had low backache, knee joint pain and 20% had generalized / musculo skeleton pain. 6.6% suffered from allergic conjunctivitis and 4% had skin allergy.[2] Air pollution due to rice husk dust is very high during the dry season as dust concentration is higher.[17]

Silicosis: Silicosis is a fibrotic disease of the lungs due to inhalation of crystalline silicon dioxide, usually in the form of quartz. Such a disease has occurred in rice mill workers and masons since ancient times, since therewas no big modernized rice mills. Silicosis may affect anyone involved in the rice mill workers like paddy pourers, de-stone section, bran section, husk section and husk ash section.

Etiology and pathology: Silica is present in the earth's crust usually as quartz, although other forms such as crystobalite andtridymite occur occasionally. All are extremely toxic to macrophages. This concept is supported by experimental evidence that rice husk and other chemicals which occlude the surface reduce the toxicity of inhaled quartz when inhaled simultaneously in mixtures of dust.Inhaled particles of silica small enough (generally less than 7 μm aerodynamic diameter) to reach the acinus are engulfed by macrophages and cause disruption of the phagosome, probably by peroxidation of membrane lipids. Before macrophage death, other reactions occur leading to release of inflammatory mediators, includingIL-1, various growth factors, tumor necrosis factor, and fibronectin, largely from interstitial rather than alveolar macrophages. Silica is probably transported across the alveolar epithelium by migrating macrophages and by endocytosis by type 1 alveolar cells, and it is clear from the distribution of pathological lesions that silica is transported widely in the lung via lymphatics, much of it ultimately being deposited in hilar nodes, which it destroys. This destruction of the nodes is very likely to be responsible for blockage of the exit route for further inhaled dust, and therefore for its retention in the lung and the development of progressive massive fibrosis or, rarely, accelerated or even acute silicosis.

Macroscopic inspection of silicotic lungs shows fibrous pleural adhesions, enlarged lymph nodes that contain fibrotic, often calcified, nodules, and grey nodules throughout the lung. These nodules vary from a few millimeters to several centimeters in diameter and are more profuse in the upper zones. They may be calcified, and they have a typical whorled appearance when cut across. The largest lesions consist of many such nodules that have become confluent, and, as in coal-worker's pneumoconiosis, this progressive massive fibrosis may undergo ischemic necrosis and cavitate. Under the microscope the silicotic nodule consists of concentric layers of collagen surrounded by a zone of doubly retractile silica particles, macrophages, and fibroblasts. The nodule may contain the remnants of the respiratory bronchiole and arteriole, destroyed by fibrosis. The mechanisms responsible are destruction of macrophages leading to inflammation and laying down of collagen, release of the silica, further macrophage attraction, and repetition of the cycle. This presumably occurs first in nodes on the drainage pathway, and as these become progressively blocked the process is repeated in the lung. As the silica never gets removed thereafter, the process continues indefinitely and severity of disease depends on the mass inhaled and retained.[16]There is growing evidence for Hg contamination of rice throughout Asia due to point and diffuse sources of Hg pollution. The magnitude of the associated risk must be quantified through better understanding of the localization and speciation of mercury in rice.[15]Pathological varieties of silicosis include simple (nodular) silicosis, progressive massive fibrosis, silicoproteinosis (acute silicosis) and diffuse interstitial fibrosis.A study showed that patients who were exposed by dry-cutting a relatively new, artificial, decorative stone product with high crystalline silica content, had moderate-to-severe restrictive lung disease, few of them developed acute silicosis and few deaths were also reported. The patients all reported that their work was performed with maximum dust suppression (e.g., closed chamber for dust sucker or effective local ventilation), typically working without any personal respiratory protection, an average of 10 to 12 hours daily. The workerswere not aware of any industrial hygiene measurements and thus there was no data quantifying the airborne dust concentrations that occurred.[14] The Turkish quarry and construction workers who were exposed to silica dust were found to develop lung cancer. It was also seen that smoking is a potential threat for the development of lung cancer among those exposed to silica dust.[63]Studies have revealed high morbidity and mortality among stone workers of Shakarpur due to silicosis. Besides the fatal disease, the workers also suffer from debilitating co-morbidities especially tuberculosis and under nutrition.[13]

For workers in workplaces with high dust levels, administrative measures can also be used to reduce exposure to silica dust e.g., by cutting short their working hours or job rotation. Exposure control at the worker level includes training and education on work practices, and personal protection. Personal protection equipment such as respirators is a good solution for short duration tasks. Regular medical evaluation may detect adverse health effects among exposed workers before disease reaches advance stages. Medical evaluation commonly includes respiratory questionnaires, physical examination, and spirometry.[12]

MATERIALS AND METHODS :

SOURCE OF DATA

A Community based cross- sectional study was conducted in 500 subjects, which included 250 exposed and 250 un exposed of between 20-40 years of age who volunteered for the study.

SELECTION OF SUBJECTS

Ethical clearance for the study was obtained from the Institutional Ethical Committee. The exposed population was recruited based on various inclusion and exclusion criteria from rice mills in and around Kolar after taking written informed consent.

CRITERIA FOR SELECTION OF STUDY GROUP

Inclusion criteria:

Exposed group:

1. Male subjects between 20-40yrs of age.

Unexposed group:

1. Male subjects between 20-40yrs of age.

Exclusion criteria:

Based on history and clinical examination subjects with

1. Smoking, Diabetes mellitus, pulmonary tuberculosis, bronchial asthma, malignancy, Peripheral nerve disorder
2. Neuromuscular disorders like Myasthenia gravis.
3. Subjects with thoracic cage abnormalities, severe anemia, kyphoscoliosis, chest and abdominal surgery.

The rice mill workers were categorized based on their work as per the different sections loaders, paddy pourers, paddy cleaning section workers, Boiler section workers, Drying section workers, paddy hulling section workers, workers, Blowers with Husk section, Bran section workers finally Ash section.

PADDY POURING SECTION:

VIBRATOR MACHINE (DE-STONE MACHINE):

DUST CLEANING SECTION:

PADDY BOILING SECTION:

PADDY DRYER SECTION:

HULLER:

DESTONE MACHINE:

RICE POLISHER:

CLOSED HUSK CHAMBER

ASH COLLECTION SEGMENT:

SECTION STUDY:

STUDY PERIOD: December 2012 to December 2013

SAMPLE SIZE ESTIMATION:

Anticipated population proportion: 50%, 50%

Confidence interval is at 95%

Absolute precision is at 10% points

Intermediate value of 0.5

V=0.05, d=0.1, n= 193 in each arm (250 exposed and 250 unexposed)

$n = Z^2_{1} - \alpha/2\ [P_1 (1-P_1) + P_2 (1-P_2)] / d^2$ (or)

$n = Z^2_{1} - \alpha/2\ V/d^2$ where, $V = P_1 (1-P_1) + P_2 (1-P_2)$

METHODOLOGY

After taking informed consent of the subjects, information was collected about demographic characteristics like age, height and weight from both rice mill workers and unexposed group.

Pre- requisites for Spirometry:

The individual was enquired about potential contraindications for spirometry such as hemoptysis, recent history of surgery and present history of acute illness that might alter the test validity and reliability.

History regarding consumption of alcohol or strenuous exercise within the preceding hour was enquired. Individual with affirmative response to any of the above were requested to avoid alcohol and exercise for 24hours and then the test was done the next day.

Before starting the lung function tests, the subjects were asked to loosen tight clothing if any.

The study was conducted at the same time of all the days to rule out diurnal variation.

The instrument used in this study was portable PFT system **RMS-MEDSPIROR**.

PORTABLE PUMONARY FUNCTION TEST INSTRUMENT:**RMS-MEDSPIROR**.

SPIROMETRYPerformance with result paper **[SPIROGRAM]** released.

Spirometry was performed after demonstration of the required procedure. The subject was asked to take deep inspiration from environment followed by forceful expiration into the mouth piece of the MEDSPIROR in standing posture. The mouthpiece was required to be inserted without leak of air or obstruction by the lips or teeth and forced expiration continued to completion without a pause and without leak of air around the mouthpiece. Individuals were asked to repeat the procedure three times and the best one was printed out.

All the lung volumes and capacities obtained (FVC, FEV_1, PEFR and FEV_1/FVC ratio) were expressed with correction for body temperature at the ambient pressure, saturate with water vapor (BTPS).

RESULTS & ANALYSIS:

In the present study, 250 rice mill workers (Exposed population) and 250 unexposed gender,age &BMI matched controls were selected considering the inclusion and exclusion criteria and were subjected to pulmonary function test recordings. The data was analyzed using appropriate statistical methods and discussed below.

Presentation of data:

Master chart showing age, BMI, FVC, FEV_1, PEFR, FEV_1/FVC ratio of the exposed population and unexposed population, duration of exposure in years and category of occupation among exposed population.

Statistical Treatment of the data:

The data was suitably arranged into tables for discussion under different headings. Descriptive statistical analysis was carried out on this data. Results on continuous measurements are presented as mean $\pm$ standard deviation and results on categorical measurements are presented in number%. Significance was assessed at 5% level of significance. To compare the differences between the mean Spiro metric values (FVC, FEV_1, PEFR, FEV_1/FVC ratio) of exposed and unexposed age matched controls independent student't' test was employed.[64,64.] The level of significance was fixed at $p<0.05$.

To estimate the relationship quantitatively between two variables namely, duration of exposure in years and various Spiro metric parameters Pearson's correlation co-efficient was estimated.[32]ANOVA results was used to compare FVC,FEV1,PEFR & FEV1/FVC among the different occupational groups in exposed groups. Post Hoc Bonferroni test was done to know which category was affected most in comparison with other categories.[33]

Conclusions are drawn based on the outcome of this statistical treatment.

RESULTS :

Table1: Independent 't' test Comparing Age, BMI&pulmonary function test in Exposed and Unexposed:

parameters	Unexposed Mean ±SD	Exposed Mean±SD	p value
Age	31.66±5.29	30.83±5.80	0.092
BMI(Wt./Ht^2)	22.65±3.03	22.38±3.60	0.377
FVC(L)	3.13±0.52	2.87±0.77	0.001**
FEV1(L)	2.86±.60	2.57±0.57	0.001**
PEFR(L/S)	6.92±1.21	4.61±1.31	0.001**
FEV1/FVC%	91.75±12.54	90.50±8.99	0.043*

Table.1 shows that there was no significant difference for age & BMI among Exposed and Unexposed. There was a significant reduction of FVC, FEV_1, PEFR and FEV_1/FVC ratio among the exposed population as compared to unexposed population.

Table 2: Pearson's Correlation between duration of exposure and Pulmonary function tests in Exposed group.

Duration of Exposure inyears in exposed groups.		
	r (Correlation coefficient)	p
FVC	-0.078	0.219
FEV1	-0.097	0.124
PEFR	-0.185	0.003*
FEVI/FVC	-0.003	0.960
*. Correlation is significant at the 0.05 level (2-tailed).		

Table.2 shows that there is significant negative correlation between duration of exposure and PEFR i.e. as duration of exposure increased there was decrease in PEFR. There was no significant correlation with respect to FVC, FEV1 and FEV1/FVC%.

Figure 1: Bar diagram showing distribution of occupation workers in Rice mill

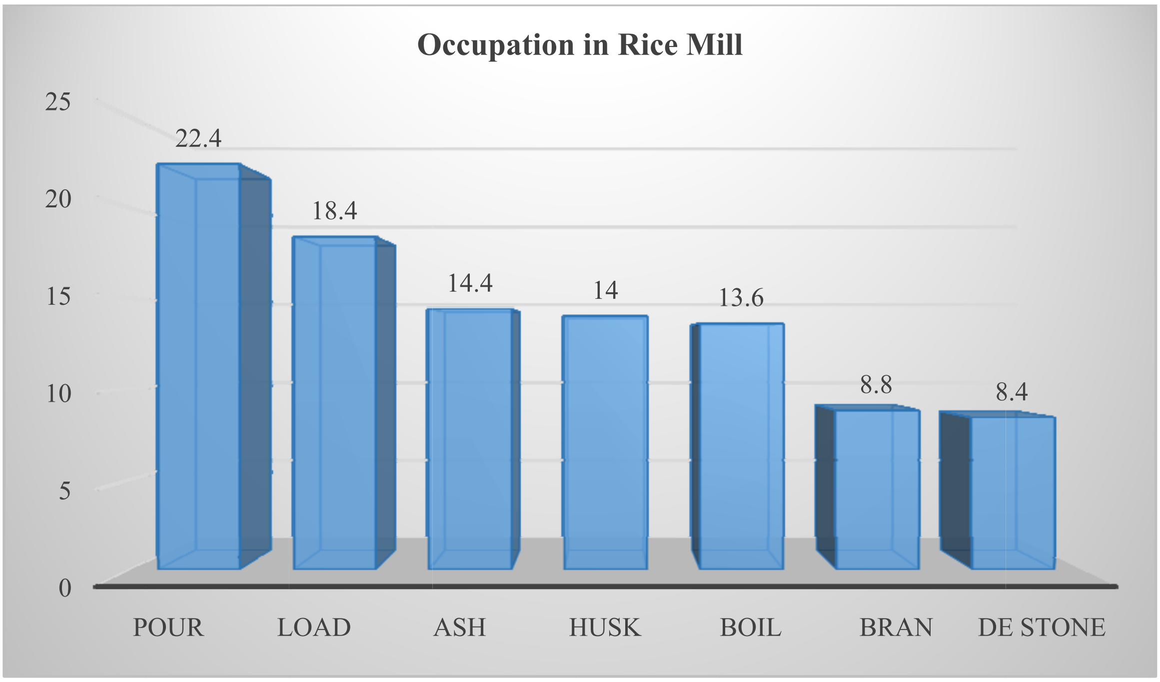


Fig 1.Shows distribution of rice mill workers under various categories in percentage. In this study majority of them were in paddy pouring work i.e. 22% followed by loading the rice 18.4% and Ash removal work 14.8%.

Table 3:ANOVA results comparing FVC,FEV1,PEFR AND FEV1/FVC among the different occupational groups in exposed groups.

Variables	Occupational Groups							P value
	Pour	Load	Ash	Husk	Boil	Bran	De stone	
FVC(L)	2.58±0.74	2.98±0.81	2.87±0.67	2.96±0.73	3.07±0.76	2.91±0.79	2.93±0.82	0.066
FEV_1(L)	2.38±0.63	2.56±0.52	2.56±0.50	2.61±0.51	2.80±0.56	2.65±0.62	2.59±0.58	0.061
PEFR(L/S)	4.39±1.01	4.45±1.39	5.81±1.38	4.45±1.17	4.86±1.13	4.23±1.26	3.77±0.90	0.001*
FEV_1/FVC%	92.57±8.28	88.37±11.16	90.78±7.02	88.22±9.90	90.89±70.58	92.21±7.71	90.49±9.59	0.192

One-way ANOVA test showed that there was significant difference between the groups with respect to PEFR. PEFR has significantly decreased among workers who were working in de-stone group compared to other categories in the exposed groups.

Table -4:POST HOC BONFERRONI TEST Comparing means of PEFR between different categories of rice mill workers in exposed group:

	Ash	Boil	Bran	Destone	Husk	Load	
Ash		**P=0.023***	**P=0.001***	**P=0.001***	**P=0.001***	**P=0.001***	**P=0.001***
Boil	**P=0.023***		P=1.000	**P=0.027***	P=1.000	P=1.000	P=1.000
Bran	**P=0.001***	P=1.000		P=1.000	P=1.000	P=1.000	P=1.000
Destone	**P=0.001***	**P=0.027***	P=1.000		P=0.868	P=0.701	P=0.959
Husk	**P=0.001***	P=1.000	P=1.000	P=0.868		P=1.000	P=1.000
Load	**P=0.001***	P=1.000	P=1.000	P=0.701	P=1.000		P=1.000
Pour	**P=0.001***	P=1.000	P=1.000	P=0.959	P=1.000	P=1.000	

POST HOC analysis using BONFERRONI criteria for significance of PEFR was significantly lower in de-stone group compared to other catagories of rice mill workers.($P<0.05$).

Pair wise comparision of PEFR is significantly lower in de-stone category compared to boil group.

DISCUSSION:

With modern civilization, industrialization is increasing day by day also as a result, air pollution is increasing leading to various lung diseases among which chronic obstructive lung diseases predominate and subjects with workplace exposure to organic dust have high prevalence of respiratory diseases[36] like acute and chronic respiratory effects of grain dust exposure can include such responses as Farmer's Lung[37], Grain Fever Syndrome [38] chronic bronchitis[39] and asthma.[40] The gram negative bacterial endotoxins can elicit profound immunotoxic and immunomodulating effects in vitro and in vivo[42] and therefore can exacerbate adverse pulmonary reactions to grain dust.

Rice is the largest staple food in our country and most of the local population. In & around kolar also peoples consume rice as a major share of food and hence due to more demand for rice, many local rice mills have erupted in and around kolar. Most of people work in the rice mills and these workers are exposed to dust in the rice mill, dust particles smaller than 10 μ are called respirable dust, could be passed through the human lung and can seriously cause degradation of healthy condition of workers get adverse respiratory impairments like chronic bronchitis, similar to that of silicosis, as rice husk is made of 90% of silicon[(1,2,3,4,6)]Rice Husk dust causes damage to bronchial passages, along with damage to the elastic component of alveolar walls. Rice husk dust contains some air borne endotoxins which cause inflammatory reactions in broncho-pulmonary system. [29]Silicosis is one of the predisposing causes for pulmonary tuberculosis and lung cancer.[7,8] Silicosis cannot be cured as it damages the lung tissue irreversibly and before the morbidity of the lung occurs it can be prevented by primary investigation with the help of spirometer which gives basic idea of lung ventilation volumes & capacities. And this intended to do pulmonary function tests in the rice mill workers and compared it with normal healthy unexposed population to dust and the study was planned and designed to find any abnormality of respiratory health status among rice mill workers and also to bring them awareness regarding dust pollution in rice mill causing respiratory ailments. By evaluating various lung parameters, only few like FVC, FEV1,PEFR and FEV1/FVC can usually provide possible diagnosis of the underlying pathophysiological aspects of various lung diseases.[43]

The present study recorded PFT in rice mill workers exposed and compared it with age & BMI matched unexposed groups to study the effect of pulmonary function.

Spiro metric results of the rice mill workers in our study showed significant decrease in FVC, FEV_1, PEFR and FEV1/FVC in exposed compared to unexposed group. The pathophysiology of impairment of lung functions among rice mill workers is most likely due to the deposition of rice mill dust consisting of husk dust & its ash which consists of 90% of silica[1] which gets deposited in the lungs by inhalation. This causes irritation and inflammatory reactions and healing of this inflammatory process would cause fibrosis leading to defective oxygen diffusion and impaired pulmonary function.[9]Thus may lead to pulmonary dysfunction of the restrictive type. The FEV_1 and FVC are significantly reduced in rice mill workers as quoted earlier but the FEV_1/FVC was above 70% showing a restrictive type of abnormality which is also recorded by many others. [31,14.]

The decrease in PEFR is significant among rice mill workers which may be again due to increased dust exposure. Peak flow is mainly a function of the large caliber airways. It greatly depends on expiratory muscle strength. Decrease in PEFR is probably due to hypertrophy of mucosal cells due to irritation by grain dust and smoke resulting in the increased secretion of mucous and formation of mucosal plugs which cause obstruction to the exhaled air[26].

The present study showed negative Correlation between lung parameters FVC, FEV_1, PEFR and FEV_1/FVC ratio with duration of exposure in exposed group. And among them the negative Correlation between PEFR& duration of exposure was statistically significant (<0.05).Our study corroborated with many studies where the pulmonary function tests declined with increasing duration of exposure to dust. Also other study shows that FVC goes on decreasing with increased duration of exposure of rice husk dust[25]and the decrease in FVC may be due to much more changes to the bronchi and elastic component of lungs resulting in restrictive type of lung impairment.[18] An another study reveals that a decrease in FEV1 indicates more exposure to dust causes early obstructive pulmonary impairment which further increases with increase in number of years of exposure.[27] and One more study showed that rice granary workers had lower mean FEV1/FVC values both pre and post shift, which exhibits that there was an association between chronic grain-dust exposure and chronic airway obstruction[29].Another study showed that there was comparative decrease in PEFR/min within 1 year after the workers joined the job [63].

In our study One-way ANOVA test showed that there was significant difference between the categories of exposed with respect to PEFR at a significant level. PEFR has significantly decreased among workers who were working in de-stone group compared to other categories in the exposed groups and this may be due to release of air borne endotoxin which may cause inflammatory reaction in the broncho-pulmonary system.[28] POST HOC analysis using BONFERRONI criteria for significance of PEFR was significantly lower in de-stone group compared to other categories of rice mill workers(P<0.05).Pair wise comparision of PEFR is significantly lower in de-stone category compared to boil group.

In the present study de-stone workers are around 8.4% working in the rice mill & as their PEFR values are decreased compared to other categories of exposed group ,more attention should be given to their working conditions in rice mills. Thus by frequently rotating all categories of workers to various working sections in exposed group at regular intervals would reduce the risk of harmful effects of airborne particles.

Management and supervisors were educated on the importance of prevention of health hazards at source by using engineering measures such as enclosure of dust and effective ventilation, pre-employment screening, education, training and supervision of workers, seeking advice for environmental monitoring by central pollution control board [cpcb] and getting health surveillance by conducting periodic medical checkup at least once annually.

CONCLUSIONS:

- PFT of rice mill workers was significantly reduced as compared to that of unexposed group.
- There was a significant negative correlation between PEFR and duration of exposure among the rice mill workers .
- Lung impairment was more among the de-stone section workers followed by paddy pourers
and loaders showing that cumulative dust exposure was a contributing factor.
- PFT analysis served as a useful tool in early diagnosis of lung impairment among the rice mill workers.

SUMMARY:

This study was conducted to evaluate the effect of dust and duration of exposure to dust in rice mill workers. Age & BMI matched among the 250 exposed & 250 unexposed groups were subjected to pulmonary function tests. Statistical analysis revealed that rice mill workers had significantly reduced PFT values as compared to unexposed group and they had a restrictive pattern of lung disease. There was a significant negative correlation between pulmonary function and duration of exposure among the rice mill workers, the de-stone workers were the most affected followed by paddy pourers and loaders, showing that more the cumulative exposure to dust and showed decrease in their pulmonary function. PFT analysis might be necessary tool for early diagnosis of lung impairment among the rice mill workers.

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"ASSESEMENT OF RESPIRATORY HEALTH OF RICE MILL WORKERS"

by

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A dissertation submitted to the Sri DevarajUrs Academy of Higher Education & Research, Tamaka, Kolar, Karnataka

in partial fulfillmentof the requirements for the degree of

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in
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Under the guidance of

DR. M.S.VINUTHA SHANKAR. M.D

DEPARTMENT OF PHYSIOLOGY
Sri DevarajUrs Medical College, Kolar

2015

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEAECH, TAMAKA, KOLAR, KARNATAKA

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I **Dr.S.PARASURAMAN** hereby declare that dissertation entitled**, “ASSESMENT OF RESPIRATORY HEALTH IN RICE MILL WORKERS”** is a bonafide and genuine research work carried out by me under the guidance of **Dr.M.S.VINUTHA SHANKAR,** Professor of Department ofPhysiology, Sri DevarajursMedical College, kolar.

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This is to certify that the dissertation entitled **"ASSESMENT OF RESPIRATORY HEALTH OF RICE MILL WORKERS"** is a bonafide research work done by **Dr. S.PARASURAMAN** in partial fulfillment of the requirement for the degree of **DOCTOR OF MEDICINE (M.D.) in PHYSIOLOGY** during the academic year 2015.

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This is to certify that, the ethical committee of Sri Devaraj urs medical college,Tamaka,kolar has unanimously approved **DR.S.PARASURAMAN**, Post graduate student in the department of physiology of Sri Devaraj Urs medical college to take up the dissertation work entitled "**ASSESMENT OF RESPIRATORY HEALTH OF RICE MILL WORKERS**" to be submitted to the Sri Devaraj urs academy of higher education and research, Tamaka, kolar.

MEMBER SECRETARY **PRINCIPAL**

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LIST OF ABBREVIATIONS:

PFT : Pulmonary Function Tests

FVC : Forced Vital Capacity

FEV1 : Forced Expiratory Volume of first second

PEFR : Peak Expiratory Flow Rate

FEV1/FVC : Ratio of Forced Expiratory Volume of first second and Forced Vital Capacity.

RH :Rice Husk.

RHA : Rice Husk Ash.

CONTENTS

LIST OF TABLES

LIST OF GRAPHS

MASTER CHART OF EXPOSED SUBJECTS TO RICE MILL DUST

SL. NO.	AGE	BMI	FVC	PRED%	FEV1	PRED%	PEFR	PRED%	FEV1/FVC	PRED%	DURATION OF EXPOSRE	CATAGORIES OF WORKERS
1	25	22.49	2.01	50	2.03	60	2.89	41	100	116	7	pour
2	25	20.4	1.32	34	1.32	41	3.43	33	100	119	7	pour
3	25	20.03	1.03	51	1.02	61	3	43	99	112	7	pour
4	25	18.36	2.2	49	2.2	58	4	50	100	114	7	pour
5	32	22.77	3	73	2.8	74	3.56	32	93	101	9	pour
6	32	19.92	2.12	70	2.12	77	6	61	100	109	10	pour
7	32	19.78	3.06	67	3	73	5	46	98	108	9	pour
8	33	16.65	3	87	3	101	4	46	100	114	7	pour
9	34	20.66	3.02	100	3.02	112	4	41	100	112	10	pour
10	36	18.49	3	90	3	94	5	53	100	104	7	pour
11	37	24.22	2.02	52	2.02	61	5	50	100	118	10	pour
12	30	26.99	2	62	2	75	5	101	100	120	12	pour
13	30	20.38	1.98	51	1.98	62	5	90	100	121	12	pour
14	30	29.41	3.17	50	3.17	55	4.12	43	100	110	11	pour
15	30	26.42	4	87	3	94	5.15	66	75	107	11	pour
16	32	23.94	3	69	2.87	79	5	78	95	115	13	pour
17	32	26.42	2.04	81	1.78	88	2.73	59	87	111	16	pour
18	32	22.22	3	68	2.45	39	3	36	81	112	12	pour
19	32	21.74	3.02	89	2.77	102	3.75	62	91	115	22	pour
20	32	21.56	3	100	2.7	117	3	114	90	116	11	pour
21	32	19.1	3.03	87	3.02	105	5	98	99	119	21	pour
22	34	19.23	2	90	1.78	112	6	95	89	124	17	pour
23	34	22.27	2	67	1.67	79	5	57	83	107	12	pour
24	34	21.41	2.89	71	2.4	85	4	107	83	118	13	pour
25	34	20.42	2.7	31	2.4	35	6	40	88	95	14	pour
26	34	25.93	2.99	84	2.8	93	2.6	73	93	111	11	pour
27	34	24.15	2	64	2	80	4	99	100	103	15	pour
28	34	24.66	2.8	86	2.3	102	4	53	82	118	16	pour
29	34	26.12	2.01	53	2.01	61	5	50	100	116	12	pour
30	34	26.12	3.2	58	2.6	68	4	48	81	117	12	pour
31	35	24.34	4	81	3.23	95	3.5	91	85	117	16	pour
32	35	24.76	2.96	92	2.8	109	3.4	74	94	118	17	pour
33	36	25	1.98	76	1.99	79	4	51	88	103	12	pour
34	36	25	2.7	51	2.5	60	7	90	92	69	12	pour
35	37	20.7	1	38	1	44	3	31	100	117	15	pour
36	38	31.02	2.02	65	2.02	65	3.2	101	100	102	18	pour
37	38	19.49	3.01	63	2.77	59	3.7	77	92	92	19	pour
38	38	22.94	3	87	3	98	4.5	98	94	113	18	pour
39	38	20.81	3.98	62	4	67	5.45	86	83	107	17	pour
40	38	22.94	4.01	148	3.75	79	6	112	93	53	17	pour
41	38	24.07	3.14	79	2.5	93	5	105	79	108	12	pour
42	38	21.27	2.32	82	2.33	93	4.52	81	94	89	17	pour
43	38	19.94	2	54	2	65	5	51	100	106	17	pour
44	38	26.51	2.12	90	2.12	101	6	70	100	96	12	pour
45	40	23.67	4	54	3	65	5	51	83	120	16	pour
46	40	22.07	2	46	2	54	5.13	71	100	117	15	pour
47	40	22.96	1.9	65	1.81	74	3	32	98	113	16	pour
48	40	22.63	3	71	3	82	4	42	99	116	17	pour
49	40	22.68	3	83	3	86	6	69	100	103	15	pour
50	40	17.92	2	59	2	68	4	45	100	117	18	pour
51	40	24.16	1.95	57	1.75	65	5	50	89	112	19	pour
52	40	22.79	2.86	47	2.11	55	4	156	73	117	20	pour
53	40	21.1	1	41	1	43	4	45	89	106	18	pour
54	40	24.1	2.88	64	2.03	74	5	59	70	116	19	pour
55	40	23.45	2	71	2	84	5	60	100	116	20	pour
56	21	24.62	3.43	140	2.82	88	3.24	89	82	107	20	pour
57	33	21.88	2.7	71	2.14	81	3	36	79	112	4	load
58	26	24.16	4	29	3	28	3.42	18	75	94	8	load
59	26	19.94	3.89	100	3.12	85	4	39	80	85	8	load
60	26	24.81	4	225	3	25	6	164	75	11	8	load
61	26	30.12	3.79	202	2.76	11	4	148	72	5	8	load
62	34	29.27	2	60	2	69	6	65	100	103	8	load
63	34	24.14	4	101	3	36	4.21	25	75	113	6	load
64	38	25	1.99	53	1.99	47	3	29	100	80	8	load
65	35	23.2	2.77	68	2	68	3	29	72	99	16	load
66	35	23.81	3.67	89	2.78	94	5	57	75	105	14	load
67	35	20.6	3.89	71	2.89	74	6	81	74	103	12	load
68	35	24.36	4	94	3	95	4.34	79	75	101	18	load
69	35	28.36	3	74	2.89	87	5	54	96	116	16	load
70	35	22.34	3.7	57	2.54	63	6	63	90	109	17	load
71	35	26.3	2.8	68	2.4	79	5	61	85	108	18	load

72	35	21.38	2.5	76	2.5	94	4	120	100	123	18	load
73	35	25.31	3.01	59	2.44	5	3	38	81	103	17	load
74	35	26.15	3.9	76	3.23	86	3	35	82	113	14	load
75	35	21.46	3	77	3	89	4.33	76	100	115	11	load
76	35	21.3	3.98	57	2.89	61	4	82	72	107	12	load
77	38	29.41	3.12	115	2.77	100	2	38	88	76	17	load
78	38	21.78	1.97	91	1.96	105	5	75	99	109	22	load
79	38	24.91	3	87	3	105	3	93	100	120	17	load
80	38	24.05	2.9	68	2.67	56	6.4	80	92	96	17	load
81	39	24.09	4	50	3.44	56	6	31	86	111	18	load
82	39	28.08	2	96	2	118	5.87	58	100	107	20	load
83	39	20.44	3.02	50	3.02	60	5	96	100	96	20	load
84	39	19.52	3	66	2.15	78	6	152	71	6	19	load
85	40	28.71	3.9	111	2.9	64	7.1	45	74	58	18	load
86	40	26.01	3	102	2.57	38	6	48	85	37	16	load
87	40	19.73	2.91	78	2.91	82	7	69	100	106	16	load
88	40	22.04	3	87	3	100	3	36	100	114	18	load
89	40	30.84	2	80	2	90	4	42	100	113	17	load
90	40	21.46	1.56	42	1.4	45	2.23	24	89.74	106	17	load
91	40	19.32	1.91	69	1.91	79	5.89	73	100	78	15	load
92	40	22.79	1.02	46	1.02	56	1.88	30	100	102	18	load
93	40	21.78	2.95	96	2.93	116	4.59	55	99.65	98	21	load
94	40	27.75	2.51	75	2.51	87	5.21	59	100	76	16	load
95	40	24.93	4	165	3.2	100	4	68	80	65	17	load
96	40	21.46	2	51	2	60	3.77	44	100	118	20	load
97	40	24.45	3.66	58	2.99	68	3.25	40	81	117	19	load
98	40	21.78	3.32	42	2.9	50	3	35	87	118	16	load
99	40	21.78	2	85	2	97	6	71	100	113	17	load
100	40	25.65	4	54	3	64	3.22	64	75	79	18	load
101	40	21.3	2	90	2	100	3	40	100	101	17	load
102	40	21.71	2	71	2	77	6	67	100	92	16	load
103	25	22.28	2.95	85	2.6	96	6.5	85	88.43	113	7	husk
104	25	19.73	3.19	96	2.86	64	4.56	51	89	67	7	husk
105	25	20.68	3.03	134	2.78	81	3.36	56	91	60	7	husk
106	25	18.96	4.16	96	3.8	111	6	97	91	88	7	husk
107	25	22.46	1.56	40	1.56	46	2.64	27	100	116	7	husk
108	25	19.39	3.85	93	3.26	10	6.5	70	84.89	11	7	husk
109	25	23.46	3.06	65	2.78	83	4.27	77	90	128	7	husk
110	25	21.95	1.73	59	1.73	73	5.78	72	100	124	7	husk
111	25	21.3	2.7	90	2.65	104	4.6	112	98	116	7	husk
112	25	19.52	3.29	87	2.95	92	5.32	81	89.93	105	7	husk
113	25	20.91	3.19	96	2.45	119	4.13	69	77.04	123	7	husk
114	25	19.11	2.6	76	2.6	88	5.82	65	100	103	7	husk
115	25	28.41	4	201	3	13	4	119	75	6	7	husk
116	25	23.03	3	73	3	79	3.3	101	100	108	7	husk
117	25	22.84	3.65	65	2.89	66	5	97	79	121	7	husk
118	25	23.24	4.2	57	2.76	69	6	90	65	120	7	husk
119	25	25.34	1.9	67	1.9	78	4	97	100	109	7	husk
120	26	25.56	3	78	3	92	6	68	98	95	8	husk
121	26	28.88	3	46	3	48	3.67	29	88	105	8	husk
122	26	22.92	3	105	2	101	3	34	66	96	8	husk
123	26	23.39	2	61	2	64	3	27	86	104	8	husk
124	26	23.67	2.98	58	2.4	71	3.22	74	80	122	8	husk
125	26	22.09	2	49	2	52	6	65	87	105	8	husk
126	26	20.05	4	73	3.21	74	4.7	32	80	101	8	husk
127	26	20.76	2.79	54	2.79	62	4	67	100	114	8	husk
128	26	20.2	4	78	3	88	3	90	75	112	8	husk
129	26	23.36	3.88	92	2.97	105	4.5	77	76	114	8	husk
130	26	21.45	3	89	2.6	96	4	44	86	106	8	husk
131	26	23.94	2	68	2	81	3	47	92	118	8	husk
132	27	22.64	2.06	69	2.02	81	4.2	93	98.05	103	8	husk
133	27	19.49	2.47	68	2.39	78	3.81	85	97.15	114	7	husk
134	27	22.49	2.56	71	2.56	83	2.88	72	100	117	8	husk
135	27	19.49	3.62	119	3.36	131	4.21	50	92.81	109	7	husk
136	27	23.63	2.27	67	1.91	67	4.41	51	84.51	99	7	husk
137	28	20.99	3.22	63	2.67	74	6.49	70	82.91	116	8	husk
138	35	24.38	1	41	1	42	2.5	40	100	103	9	destone
139	36	20.23	2	59	2	69	4.1	87	100	79	10	destone
140	36	20.38	3	83	3	93	4.3	75	100	94	10	destone
141	36	20.29	4	95	3	96	3.2	85	86	100	10	destone
142	36	22.84	2	85	2	103	3.51	59	100	98	7	destone
143	36	21.31	3.2	58	2.8	58	2.87	93	87	100	8	destone
144	35	19.08	3.76	100	2.66	59	4.11	66	70.4	59	15	destone

145	35	21.39	3.43	51	2.78	63	5	97	81	123	14	destone
146	35	23.46	3	236	3	14	4.12	143	100	56	14	destone
147	35	22.74	4	203	3	12	4	136	83	65	13	destone
148	35	21.3	3	77	2.8	92	4	72	93	87	11	destone
149	35	21.84	3.77	73	3.24	82	2	26	85	99	15	destone
150	35	18.84	3.65	75	2.98	89	3.23	58	81	106	17	destone
151	35	21.3	2	71	2	91	5	59	100	98	17	destone
152	35	21.3	3	93	3	110	4.23	90	85	118	14	destone
153	35	20.37	4	58	3.5	68	3.2	48	87	87	12	destone
154	35	24.07	3	78	3	92	6	72	100	117	12	destone
155	36	21.5	2.9	79	2.56	107	3.56	115	88	104	17	destone
156	36	24.45	2	51	2	61	3.28	52	100	77	12	destone
157	36	20.31	2.98	55	2.22	47	3	38	74	86	19	destone
158	36	23.88	2	44	2	54	4	72	100	120	17	destone
159	28	22.49	3.02	84	2.53	90	6.34	106	83.77	106	7	bran
160	28	22.57	2.84	88	2.43	103	7	73	85.56	116	8	bran
161	28	21.13	2.37	73	2.36	82	5.91	67	99	112	8	bran
162	28	22.34	3.02	76	2.53	73	4.1	40	83.77	94	6	bran
163	28	23.78	3.7	37	3.02	45	4.01	43	81.62	122	7	bran
164	28	22.72	2.68	85	2.47	90	5.2	100	92.16	106	7	bran
165	28	25.01	1.73	58	1.7	71	5.95	74	98.83	122	8	bran
166	28	22.84	2.78	93	2.78	107	3.65	113	100	114	7	bran
167	28	24.62	3.24	86	3	101	3.44	94	95.06	110	7	bran
168	28	22.72	1.62	71	1.62	88	2.97	48	100	123	7	bran
169	29	17.24	2.9	65	2.8	75	5	56	96	116	7	bran
170	29	20.83	2	67	2	77	5	66	100	114	7	bran
171	29	19.37	2.4	75	1.99	87	3.55	62	82	116	8	bran
172	29	23.88	4.42	64	3.67	69	3	58	83	107	8	bran
173	30	23.89	2	63	2	65	3.27	89	100	118	8	bran
174	30	25.2	4.16	63	3.78	77	3.65	83	90	121	7	bran
175	30	23.92	3	71	3	82	3.27	147	100	102	6	bran
176	30	27.76	3.23	44	2.87	51	2	27	88	114	9	bran
177	30	20.09	4	95	3.12	112	3.33	94	78	117	7	bran
178	30	24.57	3	91	3	105	3.6	108	100	115	8	bran
179	30	25.08	3.98	48	3.7	58	4	43	92	120	9	bran
180	30	19.94	2	60	2	71	5	58	100	117	11	bran
181	22	24.54	3.34	102	2.83	19	4.21	123	84.73	18	4	boil
182	30	19.78	3	86	3	75	3	29	100	87	5	boil
183	25	22.91	3	211	3	83	3.2	104	85	39	7	boil
184	27	26.7	2.81	85	2.64	66	2.63	31	93	78	6	boil
185	28	21.43	3.75	138	3.12	84	5	160	83	61	8	boil
186	28	29.73	2.81	74	2.72	76	5	85	96.79	87	8	boil
187	28	22.72	2.72	68	2.27	65	4	38	83.45	95	8	boil
188	28	21.66	3.81	164	3.08	12	5	119	80.83	70	7	boil
189	28	27.36	4.09	160	3.43	11	5.1	156	84.06	7	6	boil
190	28	24.64	1.91	69	1.76	72	5.93	73	92.63	78	7	boil
191	28	27.31	3.43	230	3.1	63	5	123	90	40	7	boil
192	28	25.46	2.85	69	2.85	83	3.89	59	100	61	6	boil
193	29	22.4	4	169	3.56	123	5	63	89	72	8	boil
194	29	24.54	4.34	103	3.67	109	5	75	84	95	8	boil
195	29	19.52	4	200	3	11	3.5	163	83	5	8	boil
196	29	24.67	4.43	94	3.4	97	5	60	76	103	7	boil
197	29	27.64	3	67	3	70	5.3	82	100	105	7	boil
198	29	16.62	3	104	2.76	100	4.2	81	92	95	8	boil
199	29	19.32	3	93	3	88	4	40	82	94	9	boil
200	30	20.94	1	68	1	84	4	72	100	78	7	boil
201	30	18.73	2	61	2	70	6	60	97	115	7	boil
202	30	26.81	3.12	66	2.86	71	6	59	91	106	10	boil
203	30	21.88	3	99	3	114	5.7	111	100	106	10	boil
204	30	9.68	2	54	2	64	6	64	100	93	10	boil
205	30	10.49	2	44	2	52	4	39	100	117	9	boil
206	30	25.08	4	62	3.5	64	4.4	83	87	104	9	boil
207	30	25.13	2	64	2	74	8	80	100	116	8	boil
208	30	23.39	3.13	76	2.99	80	4	148	95	105	9	boil
209	30	18.52	3	81	3	94	5.2	80	100	115	10	boil
210	30	19.93	3.7	90	3.12	100	6	75	82	110	10	boil
211	30	20.07	3	123	3	111	7	42	89	90	8	boil
212	30	22.49	3	80	3	86	6	145	90	108	10	boil
213	30	18.21	3.3	70	2.65	70	4	46	80	88	12	boil
214	30	22.04	3	82	3	94	5	56	100	69	11	boil
215	20	21.26	2.71	74	2.64	85	6.34	96	97.77	114	2	ash
216	22	18.42	3.28	73	2.88	82	5.4	52	87.8	112	4	ash
217	22	21.3	2.44	85	2.44	97	6.5	79	100	114	4	ash

218	22	21.04	2.86	75	2.3	73	2.98	31	80.41	96	4	ash
219	22	21.6	3.12	83	2.7	81	6.3	93	86	102	4	ash
220	22	24.22	1.73	59	1.73	73	5.78	72	100	123	4	ash
221	22	29.3	3.4	70	2.76	87	5	155	81.17	123	4	ash
222	22	20.07	3.67	70	3.16	81	6	88	86.33	116	4	ash
223	22	27.68	3.51	70	3	77	8	61	85.71	109	4	ash
224	22	25.39	2.34	69	2.32	80	5.84	66	99.14	115	4	ash
225	22	24.97	2.78	73	2.35	74	5.06	54	84.53	101	4	ash
226	22	25.95	3.13	66	2.45	56	4.82	49	78.27	36	4	ash
227	22	25.71	3.34	67	2.83	79	6	40	84.73	118	4	ash
228	22	28.52	3.38	81	2.96	13	7	68	87.57	16	4	ash
229	22	22.49	3.59	227	3.03	13	7.3	136	84.63	42	4	ash
230	22	21.48	3.39	85	3.08	90	5.4	72	91.12	106	4	ash
231	22	20.2	1.6	39	1.6	48	5.87	61	100	122	4	ash
232	22	20.2	2.36	65	2.36	76	5.14	55	100	116	4	ash
233	23	28.13	2.01	64	1.94	72	4.61	54	97	112	5	ash
234	23	23.44	2.6	80	2.26	84	3.84	45	86.92	104	5	ash
235	23	18.78	2.93	97	2.6	16	6.5	62	89.04	17	5	ash
236	23	21.64	2.08	68	2.08	82	6.66	80	100	119	5	ash
237	23	23.59	2.28	60	2.28	69	6.12	81	100	115	5	ash
238	23	19.84	4.03	202	3.35	11	6	164	83.3	20	5	ash
239	24	20.2	3.47	90	3.21	98	7.1	74	92.77	108	6	ash
240	24	19.14	2.09	67	1.95	74	2.62	31	93.75	109	6	ash
241	24	21.64	2.51	78	2.51	90	6.8	41	100	100	6	ash
242	24	17.58	1.57	58	1.48	67	2.81	36	94.87	66	6	ash
243	24	22.48	3.1	92	2.66	107	6	100	85.8	78	6	ash
244	24	20.32	3.48	42	3.04	48	8	24	87.35	115	6	ash
245	24	21.88	4.35	87	3.77	73	7	71	86.86	84	6	ash
246	24	18.49	3.13	203	2.6	78	9	101	83.06	68	6	ash
247	24	19.53	3.48	98	2.9	13	6	105	83	53	6	ash
248	24	21.48	2.9	74	2.56	78	5	64	98.46	104	6	ash
249	24	22.41	2.69	98	2.69	94	4.59	56	100	117	6	ash
250	24	22.35	2.19	63	2.01	46	5.82	64	91	73	6	ash

MASTER CHART OF UNEXPOSED SUBJECTS TO RICE MILL DUST

SL. NO.	AGE	BMI	FVC	PRED%	FEV1	PRED%	PEFR	PRED%	FEV1/FVC	PRED%
1	21	23.44	4.17	50	3.96	119	8.64	89	94.96	114
2	22	22.03	4.1	34	3.23	103	4.88	74	78	122
3	22	22.76	4.09	51	3.9	117	8.13	84	95.58	115
4	22	24.65	4	49	3.11	97	7.03	96	77.75	114
5	22	20.03	4	73	3.4	70	4.59	59	85	104
6	22	29.3	3.93	70	2.84	85	6.91	92	72.26	99
7	22	20.76	3.91	67	3.78	61	6.15	62	96	117
8	22	21.88	3.89	87	1.96	64	7.93	86	50.38	117
9	22	20.99	3.2	100	2.89	96	5.17	80	90	120
10	23	27.34	3.83	90	3.64	105	7.35	74	95.28	114
11	23	24.68	3.77	52	2.89	53	6.53	66	76	118
12	23	26.5	3.7	62	3.7	100	6.74	78	100	115
13	23	25.71	3.7	51	2.06	69	9.03	100	55.67	115
14	23	28.34	3.69	50	3.64	136	8.6	101	98.91	113
15	23	26.67	3.69	87	3.64	136	8.6	101	98.91	113
16	24	24.97	3.67	69	2.6	102	4.47	53	70.8	118
17	24	20.99	3.63	81	3.63	84	7	120	92.81	107
18	24	24.34	3.6	68	2.98	103	4.88	74	82	122
19	24	24.91	3.6	89	3.26	60	8.38	94	90.55	119
20	24	24.97	3.6	100	3.26	92	5.16	115	90.55	112
21	24	23.44	3.52	87	2.93	65	8.95	51	83.23	120
22	24	27.34	3.47	90	3.43	100	7.56	76	99.13	117
23	25	26.12	3.8	67	3.46	91	2.55	82	91	114
24	25	20.2	3.42	71	3.26	81	7.19	90	95.32	110
25	25	20.2	3.42	31	3.26	19	8	132	95.32	121
26	25	20.57	3.41	84	2.99	82	6.6	91	87	118
27	25	23.44	3.4	64	2.89	63	7.56	80	85	102
28	25	23.44	3.4	86	2.87	86	6.86	85	84	116
29	25	27.34	3.4	53	2.73	58	7.66	84	80	119
30	25	27.58	3.35	58	2.8	100	7.06	81	83.83	95
31	25	25.39	3.3	81	3.06	109	6.55	75	92.72	105
32	25	21.48	3.26	92	2.99	100	7.4	107	91.71	109
33	25	13.67	3.26	76	2.99	106	4.85	55	91.71	108
34	25	22.86	3.23	51	3.07	105	6.91	77	95.34	114
35	26	31.98	3.19	38	3.19	99	5.22	55	100	115
36	26	25.71	3.19	65	2.06	63	7.93	83	64.57	114
37	26	26.03	3.19	63	1.82	57	7.56	80	57.09	114
38	26	25.3	3.15	87	3.13	110	5.06	57	99.68	120
39	26	24.84	3.14	62	3.14	85	5.7	55	100	117
40	26	22.49	3.14	148	2.78	53	5.72	60	88	121
41	26	25.39	3.12	79	2.05	81	6.63	80	65.7	117
42	26	25.91	3.11	82	3.11	99	5.66	60	100	115
43	26	19.49	3.11	54	2.47	101	5.77	34	79.67	96
44	26	18.19	3.41	90	3.11	82	5.93	96	91	119
45	27	27.55	3.07	54	3.07	85	8.46	83	100	118
46	27	23.15	3.06	46	2.88	107	7.6	109	94.11	108
47	27	25.18	3.04	65	2.6	75	4.24	43	85.52	101
48	27	24.14	3.04	71	3.04	89	6.24	64	100	119
49	27	25.71	2.99	83	2.9	86	5.01	90	96	113

50	27	19.57	2.96	59	2.17	51	7.93	78	73.31	103
51	28	26.99	2.95	57	1.57	45	3.06	31	53.4	63
52	28	22.06	2.95	47	2.95	91	7	95	100	118
53	28	24.61	2.95	41	2.56	78	6.55	68	87.07	104
54	28	20.81	2.94	64	2.94	96	6.66	96	100	117
55	28	27.7	2.92	71	2.92	74	6.5	60	100	118
56	28	21.48	2.92	140	2.92	92	5.6	89	100	120
57	28	19.72	2.9	71	2.89	86	8.74	89	99.65	118
58	28	27.22	2.9	29	2.17	70	5.38	58	74.82	117
59	28	18.18	2.89	100	2.89	96	8	104	100	115
60	28	18.31	2.89	225	2.89	85	5.8	98	100	113
61	28	21.08	2.88	202	2.87	107	6.5	100	99.65	116
62	29	24.22	2.88	60	2.23	90	8.5	116	77.43	117
63	29	17.58	2.88	101	1.99	74	5.97	70	69.09	116
64	29	19.96	2.87	53	2.21	65	4.67	62	77	98
65	29	19.43	2.86	68	2.6	75	8.09	102	90.9	107
66	29	22.04	2.85	89	2.85	82	8.64	87	100	117
67	29	21.78	2.85	71	2.57	67	7.56	96	90.49	118
68	29	19.05	2.84	94	2.84	101	7.2	109	100	114
69	29	18.37	2.82	74	2.55	77	8.74	90	90.42	108
70	29	23.73	2.82	57	2.32	82	4.06	98	82.26	101
71	29	17.86	2.81	68	2.65	90	7.4	110	94.64	114
72	29	22.49	2.79	76	1.93	65	9.39	105	69.17	116
73	29	22.19	2.78	59	2.35	74	5.06	54	84.53	101
74	29	19.23	2.78	76	2.56	70	8	99	92.08	111
75	29	25.25	2.78	77	2.6	82	7.4	103	93.52	112
76	29	31.61	2.78	57	2.52	69	7.6	96	90.64	110
77	29	20.07	2.78	115	1.97	51	8.38	79	70.86	109
78	29	27.34	2.78	91	1.98	73	6.6	77	71.22	114
79	29	26.67	2.76	87	2.52	91	7.19	83	91.3	108
80	29	22.83	2.76	68	2.61	83	9.62	102	93.81	114
81	29	20.81	2.75	50	2.58	89	9.73	109	94.16	113
82	29	17.78	2.74	96	2.56	67	8	98	93.43	112
83	29	23.59	2.73	50	2.56	82	7.6	108	93.77	110
84	29	26.57	2.73	66	2.52	91	9.67	111	92.64	112
85	29	30.8	2.72	111	2.43	66	8.69	84	89.33	107
86	29	20.7	2.72	102	2.55	68	8	97	93.75	113
87	29	24.39	2.72	78	2.56	84	5.62	61	94.11	112
88	29	23.05	2.72	87	2.52	89	5.66	91	92.64	117
89	29	25.69	2.71	80	2.22	72	7.49	81	81.19	97
90	29	15.19	2.7	42	2.46	71	7.86	97	91.11	109
91	29	22.51	2.7	69	2.6	81	7.86	91	96.29	116
92	30	32.05	2.7	46	2.47	80	9.34	111	91.48	110
93	30	21.64	2.7	96	2.51	67	9.5	92	92.96	114
94	30	20.08	2.7	75	2.34	82	5.21	91	86.66	115
95	30	20.81	2.69	165	2.63	95	6.47	75	97.76	113
96	30	19.57	2.69	51	2.4	66	7	94	89.55	105
97	30	21.88	2.69	58	2.51	73	8	93	93.65	113
98	30	30.84	2.68	42	2.46	75	6.2	97	91.79	108
99	30	20.03	2.68	85	2.47	92	7.5	109	92.16	111
100	30	19.53	2.67	54	2.47	67	6.7	90	92.85	109

101	30	21.48	2.67	90	2.48	76	6.6	103	93.23	111
102	30	19.47	2.67	71	2.49	68	7	90	93.6	115
103	31	22.77	2.66	85	2.46	63	7.2	87	92.48	109
104	31	25.07	2.66	96	2.45	84	6.2	108	92.1	110
105	24	31.67	2.65	134	2.56	81	6	103	96.96	113
106	32	19.23	2.65	96	2.52	96	6.8	115	95.45	110
107	24	18.51	2.65	40	2.45	111	7	120	92.8	111
108	32	22.04	2.64	93	2.48	65	7	88	93.93	110
109	24	24.22	2.64	65	2.64	94	6	112	100	98
110	32	23.11	2.64	59	2.35	67	6	86	89.01	105
111	32	23.78	2.64	90	2.4	71	6.4	93	90.9	107
112	32	20.81	2.64	87	2.35	69	5	90	89.01	106
113	32	22.89	2.64	96	2.46	86	7.2	111	93.18	110
114	32	26.67	2.64	76	2.49	72	7.4	100	94.31	113
115	32	16.65	2.64	201	2.47	67	8	86	93.56	113
116	32	16.53	2.63	73	2.21	75	8.33	81	84.03	109
117	32	17.63	2.62	65	2.45	95	8.6	117	93.51	112
118	32	25.86	2.62	57	2.52	88	8.2	108	96.18	117
119	32	21.34	2.61	67	2.51	68	6	91	96.53	113
120	32	25.21	2.61	78	2.14	63	8.46	87	82.3	97
121	32	32.05	2.61	46	2.44	65	6.4	86	93.84	112
122	32	18.52	2.61	105	2.41	65	6.5	91	92.61	112
123	26	19.14	2.61	61	2.48	51	5.93	67	95.01	120
124	32	28.65	2.6	58	2.4	79	8.83	97	92.3	108
125	30	22.64	2.6	49	2.48	67	7.6	93	95.38	113
126	33	20.9	2.6	73	2.46	74	7.2	96	94.61	111
127	33	29.64	2.6	54	2.43	65	8.88	86	93.46	112
128	33	28.88	3.6	78	3.16	85	8.33	86	87.77	99
129	33	27.56	2.6	92	2.42	71	7.4	96	93.07	113
130	33	18.31	2.59	89	2.58	132	7.66	119	100	121
131	34	20.28	2.59	68	2.59	81	8.25	88	100	116
132	34	20.76	3.69	69	3.59	102	7.63	92	97.28	119
133	34	23.34	2.58	68	2.58	86	7.66	84	100	116
134	34	23.63	2.58	71	2.42	61	8.88	83	93.79	111
135	34	23.44	2.58	119	2.33	67	7.8	93	90.31	107
136	34	24.65	2.58	67	2.41	73	7.9	97	93.41	113
137	34	23.44	2.58	63	2.39	68	6.5	88	92.63	113
138	34	19.38	2.57	41	2.45	60	7	82	95.7	115
139	30	20.76	2.57	59	2.3	71	8.42	88	89.84	108
140	34	18.5	2.56	83	2.38	61	6	87	92.96	109
141	34	18.52	2.56	95	2.42	71	9.23	94	94.53	111
142	34	20.24	2.56	85	2.34	72	9.03	94	91.4	102
143	34	23.05	2.56	58	2.39	76	6	99	93.35	113
144	35	17.67	2.55	100	2.33	64	6.56	90	91.73	109
145	35	19.75	2.55	51	2.36	63	8	88	92.91	112
146	34	21.11	2.55	236	2.27	70	7	90	89.37	107
147	35	18.41	3.55	203	3.4	90	7	110	95.77	113
148	35	19.84	2.55	77	2.35	86	6.9	107	92.51	111
149	35	20.76	2.54	73	2.54	88	7.39	105	100	116
150	35	19.44	2.54	75	2.27	90	7	106	89.37	106
151	35	19.94	2.54	71	2.28	65	8	94	89.76	108

152	35	16.9	3.54	93	3.38	92	8.6	116	95.48	113
153	35	19.38	3.53	58	3.44	88	7	118	97.45	116
154	36	21.88	3.53	78	3.31	81	7	93	93.76	110
155	36	20.42	3.53	79	3.29	81	3.76	112	93.2	110
156	36	18.52	4.52	51	4.38	95	8	87	94.69	106
157	32	20.57	4.52	55	4.3	93	6.7	86	95.13	123
158	36	20.28	4.52	44	4.38	92	5.8	94	98.64	113
159	36	20.48	3.52	84	3.26	76	7.42	95	92.61	124
160	26	20.28	4.52	88	4.33	77	7	98	93.72	121
161	36	20.06	3.51	73	3.35	71	7	101	95.44	111
162	26	19.59	3.51	76	3.33	76	7.2	106	94.87	113
163	36	19.25	3.5	37	3.36	82	7	97	96	117
164	36	19.82	3.5	85	3.47	82	7	88	99.14	116
165	26	17.67	3.5	58	3.5	49	7.2	90	100	117
166	36	20.07	3.5	93	2.8	64	7	86	80	116
167	36	18.73	3.5	86	3.5	80	7.3	83	100	112
168	36	17.26	3.49	71	3.47	90	7.35	85	99.59	114
169	36	20.76	3.49	65	3.3	85	7.4	95	94.55	108
170	36	20.31	3.49	67	3.34	76	7.3	87	95.7	110
171	36	17.3	3.49	75	3.26	80	6	81	93.4	108
172	36	17.3	3.49	64	3.28	88	5	98	93.98	102
173	36	19.03	3.48	63	3.33	85	6	100	95.68	108
174	36	24.22	3.48	63	3.12	87	6.1	82	89	114
175	36	20.07	3.48	71	3.28	80	6.3	95	94.25	116
176	26	22.04	3.47	44	3.37	74	5.9	96	97.11	114
177	36	22.04	3.47	95	3.34	72	5.7	88	96.25	113
178	36	21.63	3.47	91	3.27	88	6	82	94.24	111
179	36	18.69	3.47	48	3.33	84	7.6	100	95.96	114
180	36	24.97	3.47	60	3.34	86	6.2	91	96.53	115
181	36	21.64	3.47	102	3.25	75	7.3	85	93.65	112
182	36	18.78	3.46	86	3.34	97	5.6	101	96.53	110
183	37	23.44	3.46	211	3.26	81	7.6	98	94.21	110
184	32	28.13	3.46	85	3.27	85	5.6	99	94.5	111
185	37	20.2	3.46	138	3.27	86	8	98	94.5	112
186	33	20.2	3.65	74	3.28	89	8.74	96	89.86	110
187	37	21.48	3.45	68	3.41	90	7.3	104	98.84	118
188	37	22.49	3.45	164	3.24	88	7	110	91.8	111
189	37	28.52	3.45	160	3.2	90	6.88	109	92.75	110
190	37	25.71	3.45	69	3.12	86	7.4	97	90.43	114
191	37	25.95	3.44	230	3.28	90	7	96	95.34	110
192	27	15.82	3.44	69	3.26	82	6	91	94.76	110
193	37	25.39	3.44	169	3.26	79	6.5	86	94.76	112
194	37	27.68	3.44	103	3.19	86	3.79	99	92.73	118
195	37	20.07	3.43	200	3.21	88	7	96	93.58	108
196	37	23.31	3.43	94	3.39	81	5	52	98.76	117
197	37	20.07	3.43	67	3.19	79	7.2	98	93	108
198	38	24.24	3.43	104	3.43	102	6	103	100	122
199	38	25.39	3.42	93	3.17	89	6.5	96	92.69	108
200	38	29.3	2.41	68	2.26	84	7.2	87	93.77	112
201	38	18.73	3.41	61	3.26	88	6	103	95.6	110
202	38	24.91	3.41	66	3.41	87	8	115	100	123

203	38	19.11	3.4	99	3.25	82	6.7	86	95.58	112
204	28	19.65	3.4	54	3.4	96	6	104	100	120
205	38	23.83	3.39	44	3.39	91	7	78	100	122
206	38	20.28	3.39	62	3.22	89	6	120	94.98	112
207	38	20.2	2.39	64	2.17	72	6	90	90.17	109
208	38	20.8	2.39	76	2.27	62	7	85	94.37	115
209	38	26.64	3.88	81	3.38	79	4.72	99	87.11	114
210	28	21.48	3.38	90	3.19	86	6.5	108	94.37	108
211	38	25.71	3.36	123	3.29	94	6.2	110	97.91	114
212	38	18.66	2.38	80	2.3	70	6.2	92	96.63	116
213	32	16.65	3.86	70	3.36	84	7.49	86	87.04	114
214	34	25.21	3.36	82	3.36	86	6	117	100	121
215	38	25.14	3.36	74	3.21	89	6.5	98	95.53	110
216	38	21.22	3.85	73	3.19	79	8.74	85	82.85	108
217	38	9.18	3.35	85	3.21	76	7.2	93	95.82	109
218	34	31.49	3.35	75	3.19	79	5.8	89	95.22	113
219	32	24.03	3.35	83	3.17	89	7.35	93	94.62	112
220	28	18.42	4.35	59	3.9	97	6.11	120	89	114
221	34	17.69	3.34	70	3.33	96	6.94	122	99.7	115
222	39	21.34	2.34	70	2.26	79	8	91	96.58	111
223	39	25.86	3.34	70	3.21	89	8.17	95	96.1	111
224	39	24.97	4.34	69	4.34	98	7	123	100	120
225	36	28.65	3.34	73	3.2	70	8.13	87	95.8	113
226	39	29.64	3.64	66	3.43	101	7	122	94.23	120
227	39	22.64	2.33	67	2.33	68	7.89	80	100	116
228	39	20.76	3.33	81	3.33	102	7	108	100	120
229	39	22.49	3.32	227	3.32	77	6.78	89	100	121
230	39	20.06	2.32	85	2.18	65	7.49	77	93.96	113
231	39	20.99	4.32	39	3.91	86	7.35	86	90.5	121
232	39	18.73	2.31	65	2.15	56	6	83	93.47	110
233	39	20.06	4.31	64	4.13	97	6.4	103	95.8	124
234	40	20.37	4.3	80	4.12	98	5.2	108	95.81	116
235	40	23.53	3.3	97	3.07	83	5.9	77	93.03	107
236	40	20.06	2.3	68	2.3	80	6.08	68	100	120
237	39	22.49	3.28	60	3.13	87	7	98	95.42	112
238	40	21.3	2.26	202	2.07	62	7.63	79	91.59	109
239	40	20.99	2.25	90	2.12	57	6	79	94.64	114
240	40	20.98	2.24	67	2.16	57	7.74	74	96.42	114
241	40	19.14	3.24	78	3.24	89	5.8	70	100	106
242	40	22.46	2.16	58	2.09	92	5.65	123	96.75	115
243	39	21.6	2.14	92	2.14	79	7.49	88	100	115
244	40	22.34	3.12	42	3.12	80	6.2	82	100	91
245	40	20.53	4.11	87	3.99	70	7	90	97.08	113
246	40	22.46	2.11	203	2.02	81	7.66	93	95.05	117
247	38	22.79	4.04	98	4	98	7	122	99	124
248	38	22.49	4.01	74	3.98	97	8.1	121	99.25	120
249	38	23.88	3.01	98	2.91	84	6.3	87	96.67	115
250	38	22.49	3.04	63	3	70	5.14	78	98.68	118