"A STUDY OF EFFECT OF OCCUPATIONAL EXPOSURE TO SUGARCANE DUST ON PULMONARY FUNCTIONS AND ELECTROCARDIOGRAM IN SUGARCANE FACTORY WORKERS OF BIJAPUR AND BAGALKOT DISTRICTS"

By

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DISSERTATION SUBMITTED TO BLDE UNIVERSITY, BIJAPUR,

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Under the guidance of

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ABBREVIATIONS

RR	-	Respiratory Rate
PR	-	Pulse Rate
BP	-	Blood Pressure
BMI	-	Body Mass Index
BSA	-	Body Surface Area
SBP	-	Systolic Blood Pressure
DBP	-	Diastolic Blood Pressure
bpm	-	beats per minute
cpm	-	cycles per minute
HR	-	Heart Rate
Ht	-	Height
Wt	-	Weight
FVC	-	Forced Vital Capacity (in ml)
FEV1	-	Forced Expiratory Volume at the end of first second (in ml)
FEV1%	-	Forced Expiratory Volume in one second (in %)
PEFR	-	Peak Expiratory Flow Rate (in L/min)
TV	-	Tidal Volume (in ml)
IRV	-	Inspiratory Reserve Volume (in ml)
ERV	-	Expiratory Reserve Volume (in ml)
IC	-	Inspiratory Capacity (in ml)
MEP	-	Maximum Expiratory Pressure (in mmHg)
Int	-	Interval
Amp	-	Amplitude
Com	-	Complex

ABSTRACT

Background & objective:

A study was conducted to determine the effect of sugarcane dust in sugarcane factory workers on pulmonary functions and ECG and to compare them with that of skilled non exposed workers.

Material & methods:

The Study group consisted of 60 unskilled volunteered workers who were exposed to sugarcane dust for more than 5years and the Control group consisted of 60 skilled volunteered workers who were not exposed to dust from the same factory by applying inclusion and exclusion criteria. Detailed anthropometric and physiological data were collected. Pulmonary functions were recorded by using Computerized Spiro excel. Parameters recorded were Forced Vital Capacity (FVC in ml), Forced Expiratory Volume in 1^{st} sec (FEV1 in ml) & FEV1 %, Peak Expiratory Flow Rate [PEFR in L/min was recorded by mini Wright's Peak flow meter] and Maximum Expiratory Pressure [MEP in mmHg was recorded by Modified Black's apparatus]. The ECG of all workers was recorded by using a BPL cardiaart 108T/MKECG machine. Parameters recorded were Heart rate, Rhythm, 'P' wave, PR interval, ST segment, QRS complex, QT interval, QTc interval, QRS frontal axis, T wave, Amplitude of 'R' wave and Amplitude of 'S' wave.

Statistical analysis was done by calculating Mean±SD by using student's t-test. Correlation between duration of exposure and pulmonary functions was done by Pearson's correlation

Results: No significant changes were observed in Anthropometric (Age, Height, Weight, BMI and BSA) and Physiological parameters (SBP, DBP, PR and RR) among sugarcane factory workers as compared to subjects of control group.

We observed highly significant reduction in PEFR (p=0.000), FEV_1 (p=0.04) and insignificant reduction in $FEF_{25-75\%}$ (p= 0.40) among sugarcane factory workers exposed to dust as compared to subjects of control group.

A significant increase was observed in PP interval (p=0.013), PR interval (p=0.0015) and ST (p=0.0019) segment and insignificant reduction in Heart Rate (p=0.12) among sugarcane factory workers exposed to dust as compared to subjects of control group..

A significant negative correlation between duration of exposure and values of FEV1, FVC, FEV1%, PEFR &MEP were observed between control and study groups.

Interpretation & conclusion:

The present study showed decline in FEV1 and PEFR is suggestive of obstructive changes. The study demonstrated significant changes in pulmonary functions in the workers of sugar factory, thereby suggesting that occupational exposure to Bagasse leading to pulmonary impairment. Longer the duration of occupational exposure to the organic dust (Bagasse), more is the pulmonary functional impairment in sugar factory workers.

The study also showed no significant change in the heart rate although significant increase in PP interval, PR interval and ST segment among the factory workers exposed to dust in comparison to control.

All the physiological parameters evaluated were within normal range. The ECG changes are suggestive of possible slow atrio ventricular conduction in factory workers exposed to dust.

The observed ST segment in case of factory workers (who were exposed to sugarcane dust) may be due to early repolarization. The electrocardiographic observations may be considered as indicator of greater cardiac efficiency and healthy life style with humanization of work environment.

Key Words: Sugarcane factory workers, Pulmonary functions, Electrocardiogram.

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INTRODUCTION

Industrialization is a new culture of modern society, which influences the socioeconomic lifestyle of the people. India has a large number of sugarcane factories. Among them, North Karnataka is one which has large number of sugarcane factories where a sizeable population is engaged for their livelihood. Occupational exposure to dust is a well-known phenomenon especially in developing countries like India where majority of workers work without proper protection. Thus, the health aspect is overlooked[1.] The significance of occupational hazards and need for protecting the health of industrial workers has been well recognized as early as latter half of 17th century.

Occupational pulmonary diseases are more widespread, more disabling and top the list of occupational diseases. Industrial dust inhalation over a long period leads to proliferative and fibrotic changes in the lungs.

There is a widespread misconception that occupational health is mainly concerned with industries and industrialized countries. But in a country like India, millions of people are engaged in labour like street sweeping, stone grinding, paddy thrashing, weaving etc[2.] This also has impact on pulmonary functions.

The occupationally related lung diseases are most likely due to the deposition of dust in the lungs. They are influenced by the type of dusts**,** period of exposure**,** concentration and size of the air borne dust in the breathing zone[3.]

Lungs, by virtue of their direct contact with the atmospheric air are naturally first to bear the onslaught of air contaminants[4.]

The lungs with their extensive surface area, high blood flow, thin alveolar epithelium and direct contact with external environment may be considered as the most important site to be affected by hazardous substances.

There are different types of dust particles (organic and inorganic) to which the person is exposed continuously due to the occupation, industrialization and atmospheric pollution. The organic dust contains high concentration of bioaerosols such as bacteria, actinomycetes and fungi of plant and animal origin[5.]

Among the hazardous substances in sugarcane factory, organic dust 'Bagasse' is found to be the most important one. Bagasse is a byproduct of sugar cane crushing. The size ranges from 0.5–3 microns are called as respirable dust to which sugar factory workers are exposed. Bagasse is a byproduct of sugar cane processing and composed of fiber, pith, non soluble solids and water. Inhalation of bagasse dust causes diseases of respiratory system known as "Bagassosis'' which is actually "hypersensitivity pneumonitis" or "variant of farmer's lung"[6.] The cane fibre is utilized in the manufacture of paper and cardboard. Therefore, bagassosis is seen in all these industries.

Pandit T and Singh A et al[7] identified 93 fungal types from sugar factory which are responsible for respiratory symptoms and pulmonary abnormalities in workers. They observed 40% of the symptomatic workers reported improvement in their symptoms when they were away from work.

Reduction in lung functions has been reported in cotton workers, coal miners, grain and flour mill workers, quarry workers and workers who are exposed to tobacco dust, barley dust and talc dust[8, 9, 10.]

Work related with dust exposure is a risk factor for acute and chronic respiratory irritation and inflammation with the possibilities of development of atherosclerosis and coronary artery diseases [11.]

Alveolar inflammation induced by inhaled particles may either directly or via oxidative stress leads to systemic inflammation with increased levels of blood

coagulability, progression of atherosclerosis and destabilization or even rupture of vulnerable plaques resulting in acute ischemic events[12.]

There are a number of epidemiological studies showing that ambient exposure to particulate air pollution is a risk for cardiovascular diseases. A strong support to the hypothesis that exposure to particulate air pollution increases the risk of dying from ischemic heart diseases (IHD), not only when the exposure is environmental but also when it is occupational[13.] The review of individual morbidity status also suggests that the findings are consistent with ambient air pollution studies which have found an increase in myocardial infarction with increase in particulate exposure [14, 15, 16.] These reviews reveal that there is a sizeable proportion of evidence indicating relationship between changes in pulmonary lung function tests and ECG in workers exposed to dust in sugarcane factories.

There is no data available on a comparative study of changes in pulmonary function tests and ECG in sugarcane factory workers of North Karnataka. Hence, this study was designed to compare changes in pulmonary functions tests and ECG in unskilled sugarcane factory workers and skilled sugarcane factory workers who were not exposed to dust. This may provide guidelines in the future for suggesting preventive measures to be adopted for sugarcane factory workers.

Early recognition of altered lung functions will be of great clinical, social and preventive significance in workers, who are constantly exposed to various air borne pollutants.

PULMONARY FUNCTION TESTS

The pulmonary function tests provide an assessment of respiratory system of its functions. The pulmonary function test is age old but time tested parameter for assessing respiratory health of a person with increased urbanization, increased

population, indiscriminate industrialization and increased use of automobiles as a mode of transport, the level of pollution is increasing day by day. All these factors affect respiratory health of population[17, 18, 19.]

There are various pulmonary function tests. These tests provide quantitative and objective assessment with pulmonary diseases. They do not give a specific etiological or pathological diagnosis[20, 21.] The tests can be divisible into categories which are as follows[22.]

A. Tests to assess ventilatory function of lungs-

1. Measurements of various lung volumes and capacities
2. Measurements of dead space
3. Measurements of compliance
4. Measurements of airway resistance

B. Tests of diffusion

C. Tests of ultimate purpose of respiration

D. Tests during exercise

Volumes and capacities. : Volumes are basic entities while Capacity is derived from Volumes. Each Capacity is the sum of two or more Volumes.

LUNG VOLUMES:

A. **Tidal Volume (TV):** It is the volume of air that is inspired or expired during normal respiratory cycle. Normal value 500ml
B. **Inspiratory Reserve Volume (IRV):** It is the maximum volume of air which can be inspired after complete normal tidal inspiration. Normal value 2000 to 3200ml
C. **Expiratory Reserve Volume (ERV):** It is the volume of air which can be expired after complete normal tidal expiration. Normal value 750 to 1000ml

D. **Residual Volume (RV):** It is the volume of air that is remaining in the lungs at the end of maximum expiration. Normal value .1000 to 1200ml

LUNG CAPACITIES:

A. **Inspiratory Capacity(IC):** It is the maximum volume of air which can be inspired after complete tidal expiration Normal value: 2500 to 3700ml.

IC=TV+IRV

B. **Expiratory Capacity (EC):** It is the maximum volume of air which can be expired after complete tidal inspiration Normal value: 1250 to 1500ml.

EC=TV+ERV

C. **Functional Residual Capacity (FRC):** It is the volume of air that is remaining in the Lungs at resting expiratory level. It is about 2300ml.

FRC=ERV+RV.

D. Vital Capacity (VC): It is the maximum volume of air which can be expired from lungs by forceful efforts followed by a maximal inspiration. Normal value: 4.8L in males and 3.2L in females.

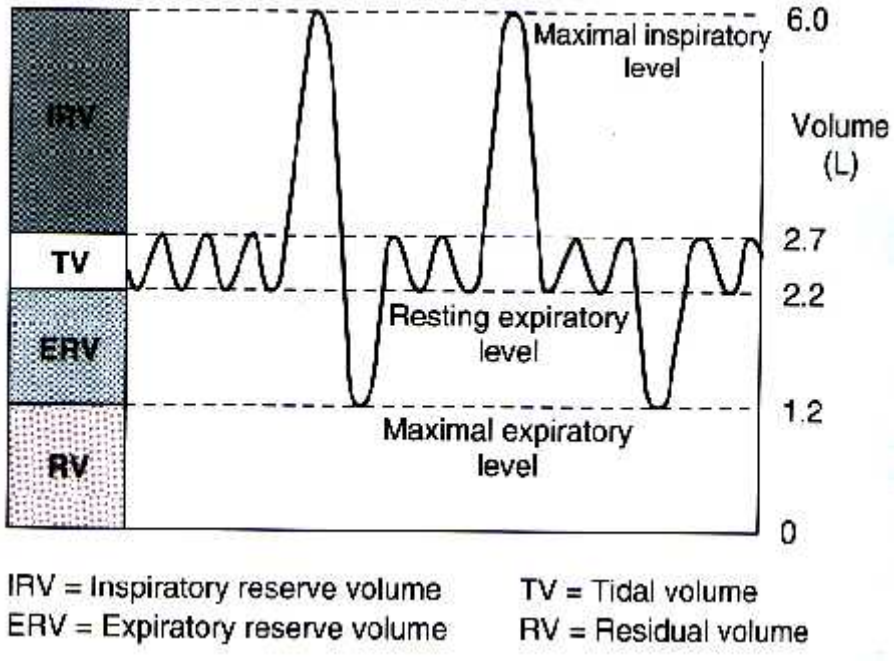
VC=TV+IRV+ERV

E. Total Lung Capacity (TLC): It is the amount air that can be present in the lungs at the end of maximum inspiration. It is about 5800ml.

TLC=VC+RV.

All these lung volumes and capacities can be measured by Spirometry. In the present study, by computerized Spirometer with the exception of Residual Volume and Functional Residual Capacity.

Fig. 1: Spirogram



DYNAMIC LUNG FUNCTION TESTS:

1. **Forced Vital Capacity(FVC) :**

   This is the volume of air which can be breathed out as forcefully and as rapidly as possible following a maximum inspiration. Thus, Forced Vital Capacity is exactly similar to Vital Capacity except that there is a special stress on rapid forceful and complete exhalation.

2. **Forced Expiratory Volume or Timed Vital Capacity (FEV or TVC):**

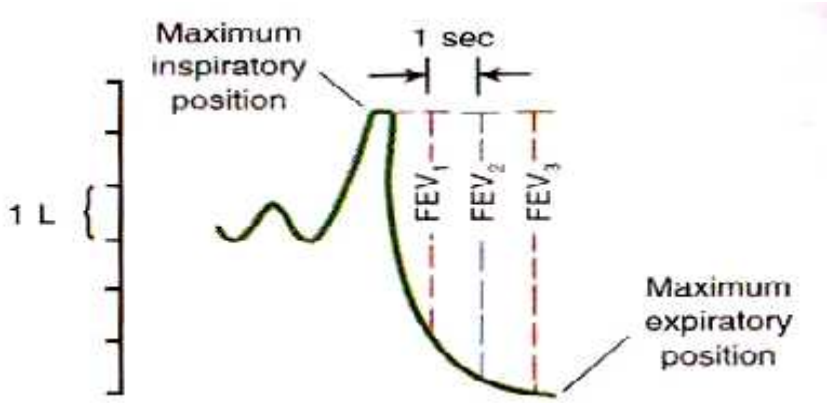
   If the vital capacity is recorded on a kymograph (Spirograph) at a known speed, volume of air expired can be timed. This is TVC.

Components of TVC:

1. FEV_1: Forced Expiratory Volume at the end of 1^{st} second i.e., volume of FVC expired in first second of exhalation. Normally 80% of FVC.
2. FEV_2**:** Forced Expiratory Volume at the end of 2^{nd} second i.e., volume of FVC expired at the end of 2nd seconds of exhalation. Normally 95% of FVC.

3. FEV_3**:** Forced Expiratory Volume at the end of 3rd second i.e., volume of FVC expired at the end of 3rd second of exhalation. Normally 98-100% of FVC.

Fig. 2: Record of Timed Vital Capacity



FEV1%=Volume of air exhaled in the first secondX10 0

Vital Capacity

4. **FEV1/FVC ratio (FEV1%):**

This ratio in healthy adults should be approximately 75-80%. FEV_1% is more sensitive indicator of airway obstruction than FVC or FEV_1 alone. FEV1/FVC decreases in obstructive diseases. But in the early phase of obstruction which originates in the small airways, this ratio may be normal.

5. **Peak Expiratory Flow Rate (PEFR):**

This is the expiratory flow rate during the peak of FVC. It is recorded with a mini Wright's Peak Flow Meter. PEFR measures efficiency of lungs by recording maximum flow of air. Peak Expiratory Flow Rate is dependent upon age, sex, build, etc. Normal value: 400- 450 liters per minute. In a young adult, it is about 400L/min. It falls dramatically in such as COPDs.

6. **Maximum Expiratory Pressure (MEP):**

Various respiratory symptoms are associated with respiratory muscle dysfunction. There are reports of progressive weakness of respiratory muscles in patients with multicore myopathy, multiple sclerosis, Motor Neuron disorder, Malnutrition and Congestive Heart Failure. Measurement of strength of respiratory muscles is useful in order to detect the weakness of respiratory muscles and to quantify its severity. In patients with severe weakness of respiratory muscles, Vital Capacity is reduced. But it is non specific and relatively insensitive measurement. Conventionally, strength of respiratory muscles is evaluated by determining Maximum Expiratory Pressure (MEP).

However, studies showed that Maximal Expiratory Pressure alone can be used as a measuring tool for strength of respiratory muscles. MEP is useful in determining the ability of a person to cough effectively. MEP is reflecting the strength of the abdominal muscles and other expiratory muscles by using a modified Black's apparatus.

Pictures - mini Wright's Peak flow meter **Modified Black's apparatus**

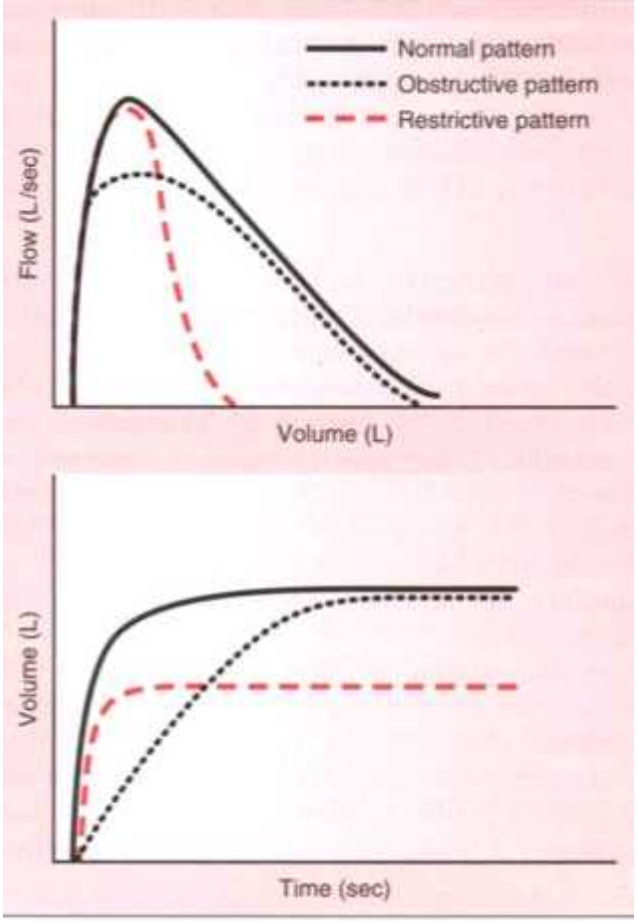
Spirometry:

Spirometry measures ventilation, the movement of air into and out of the lungs. The Spirogram will identify two different types of abnormal ventilation patterns, obstructive and restrictive[23.]

Common causes of an obstructive pattern are cystic fibrosis, asthma, bronchiectasis, bronchitis, and emphysema. Chronic bronchitis, emphysema and asthma result in dyspnea (difficulty breathing), a ventilatory deficiency a condition which is known as Chronic Obstructive Pulmonary Disease (COPD). COPD is the fourth leading cause of death among Americans[23.]

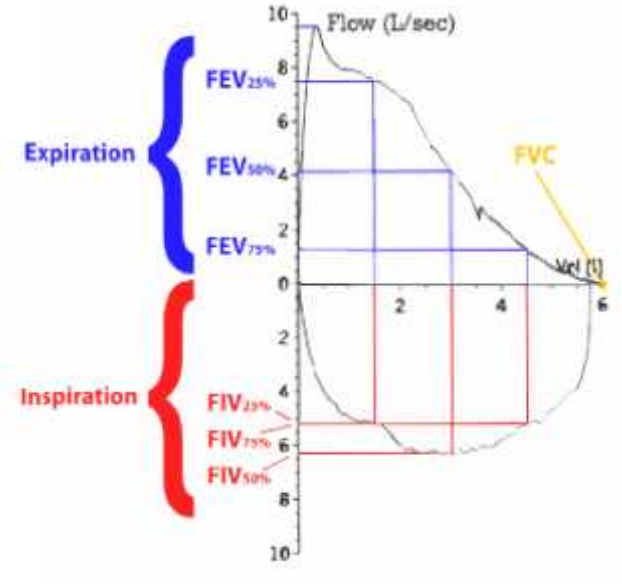
Common causes of restrictive pattern are pneumonia, heart disease, pregnancy, lung fibrosis, pneumothorax (collapsed lung) and pleural effusion (compression caused by chest fluid) [23.]

Figure 3: Spirograms showing obstructive & restrictive patterns.



Obstructive and restrictive patterns can be identified on Spirograms using both "y" and "x" axes. Volume (liters) is plotted on the y-axis versus time (seconds) on the x-axis. A restrictive pattern is characterized by a normal shape showing reduced volumes for all parameters. The reduction in volumes indicates the severity of the disease. An obstructive pattern produces a Spirogram with an abnormal shape. Inspiration volume is reduced. The volume of air expelled is normal but the air flow rate is slower causing an elongated tail to the FVC.

Figure 4: Flow Volume Spirogram



A Flow-Volume loop Spirogram is another way of displaying spirometric measurements. This requires the FVC manouvre followed by a Forced Inspiratory Volume (FIV). Flow rate in liters per second is plotted on the y-axis and volume (liters) is plotted on the x-axis. The expiratory phase is shown on top and the inspiratory phase on the bottom.

The flow-volume loop spirogram is helpful in diagnosing upper airway obstruction and can differentiate some types of restrictive patterns [23.]

Spirometry is used to assess lung function over time and often to evaluate the efficacy of bronchodilating inhalers such as albuterol. Spirometry is contraindicated in patients whose condition will be aggravated by forced breathing such as [23.]

- hemoptysis (spitting up blood from the lungs or bronchial tubes)
- pneumothorax (free air or gas in the pleural cavity)
- recent heart attack
- unstable angina
- aneurysm (cranial, thoracic, or abdominal)
- thrombotic condition (such as clotting within a blood vessel)

- recent thoracic or abdominal surgery
- nausea or vomiting

The test should be terminated if the patient shows signs of significant head, chest or abdominal pain while the procedure is in progress.

Spirometry is dependent upon the patient's full compliance with breathing instructions, especially his or her willingness to extend a maximal effort at forced breathing. Therefore, the patient's emotional state must be considered[23.]

Assessment of restrictive and obstructive ventilatory defects[24.]

Obstructive lung disease	**Restrictive lung disease**
High TLC	Decreased TLC
Low FEF_{25-75}	Normal FEF_{25-75}
VC normal/increased	Decreased VC
FEV_1 decreased	FEV_1 normal
FEV_1 /FVC decreased	FEV_1 / FVC normal
MVV decreased	MVV normal
Residual volume increased	Residual volume decreased

PHYSIOLOGICAL BASIS OF ELECTROCARDIOGRAPHY

The electrocardiogram (ECG) is the graphical recording of the electrical activity of the heart obtained from the body surface by electrodes which are positioned to reflect the activity from variety of spatial perspectives [25.]

The following factors are involved in the genesis of the electrocardiogram:

1) Initiation of impulse formation in the primary pacemaker (SAN).
2) Transmission of impulse through the specialized conducting system of the heart.

3) Depolarization of the atrial and ventricular myocardium (activation).

4) Repolarization of all the above areas (recovery)

Intracellular Potentials:

Most of the cardiac cells maintain a Resting Membrane Potential (RMP) of -90mv with inside of the cell being negative with respect to outside. The major factor that determines the RMP is gradient of Potassium (K^+) across the cell membrane. Intracellular concentration of K^+ is 30 to 45 times higher than the extra cellular concentration of Na^+ (It is about 10-15 times higher than intracellular concentration). At the onset of depolarization of the cardiac muscle cell, there is an abrupt change in permeability of cell membrane to Na^+ ions (and Calcium ions to a lesser degree). Na^+ ions enter the cell and result in sharp rise in intracellular potential to +20mv.This is designated as phase 0 and represents first inward current.

Following the depolarization, there is a relatively slow and gradual return of intracellular potential to RMP (Phase 4). This is called repolarization. It is divided into three phases:

Phase – 1: An initial return of intracellular potential to 0mv. This results mainly due to abrupt closing of Sodium channels. Chloride ions entering the cell may also contribute to this phase.

Phase – 2: A plateau phase of repolarization owing to slow entrance of Calcium ions into the cell.

Phase – 3: This represents the slow gradual return of intracellular potential to RMP. It is due to extrusion of K^+ out of cells, which reestablishes normal negative resting potential.

However, the cell is left with an excess of Na^+ and deficit of K^+. To restore the original ionic concentration in the cell membrane, Sodium Potassium pump

mechanism becomes effective. The energy required for this pump is derived from breakdown of ATP to ADP. This pump pumps $3Na^+$ ions out and $2K^+$ ions in.

Body fluid is a volume conductor. The fluctuations in potential that represent algebric sum of the action potentials of myocardial fibers can be recorded extracellularly. The record of these potential fluctuations during the cardiac cycle is called as Electrocardiogram (ECG). Most of electrocardiographic machines record these fluctuations on moving strip of paper[26.]

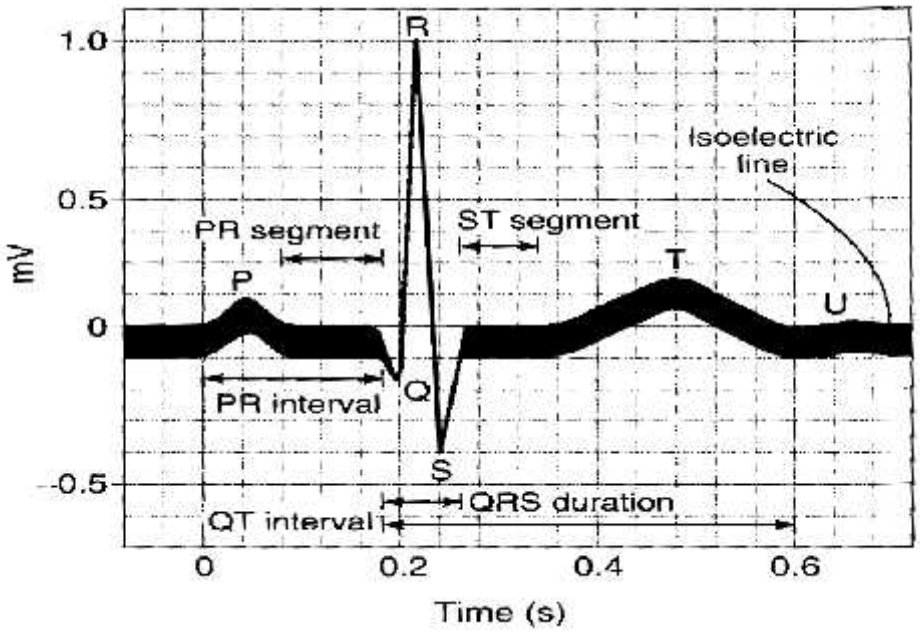
The ECG may be recorded by using an active or exploring electrode connected to an indifferent electrode at zero potential (unipolar recording) or by using two electrodes (bipolar recording). In a volume conductor, the sum of potentials at the point of equilateral triangle with a current source in the centre is zero at all times. A triangle with the heart at its centre (Einthoven's triangle) can be approximated by placing electrodes on both arms and on left leg. There are three Standard Limb Leads in electrocardiography. If these electrodes are connected to a common terminal, an indifferent electrode that stays near zero potential is obtained.

Depolarization moving toward an active electrode in a volume conductor produces a positive deflection, whereas depolarization moving in the opposite direction produces negative deflection. Various normal waves and segments of ECG are shown in figure 5. Conventionally, upward deflection is written when the active electrode becomes positive relative to the indifferent electrode and a downward deflection is written when active electrode becomes negative.

The P wave is produced by atrial depolarization, QRS complex by ventricular depolarization and ST segment and T wave by ventricular repolarization. The manifestations of atrial repolarization are not normally seen as they are obscured by

QRS complex. The U wave, an inconstant finding believed to be due to slow repolarization of papillary muscles[26.]

Figure 5: Normal Waves & Segments of an ECG



ELECTROCARDIOGRAPHIC LEADS[27]:

Electrocardiographic leads may be divided into two groups depending upon their orientation to the heart.

1. Frontal plane leads: These are oriented in the frontal plane or coronal plane of the body and consist of standard limb leads I, II, III and aVR, aVL and aVF.
2. The horizontal plane leads: These are oriented in the transverse or horizontal plane of the body and consist of precordial leads V1 to V6[27.]

Bipolar limb leads (Figure 6):

Bipolar limb leads were used before unipolar leads were developed. Leads I, II and III are regarded as Standard Limb Leads, each of which will record the differences in potential between two limbs. Since current flows only in the body fluids, the records obtained are those that would be obtained if the electrodes were at

the points of attachment of the limbs, no matter where on the limbs the electrodes are placed.

In lead I: The electrodes are connected so that upward deflection is inscribed when negative electrode is placed on the right arm and positive electrode on the left arm.

In lead II: The electrodes are connected so that upward deflection is inscribed when negative electrode is placed on the right arm and positive electrode on the left foot.

In lead III: The electrodes are connected so that upward deflection is inscribed when negative electrode is placed on the left arm and positive electrode on the left foot.

Unipolar leads (Figure 7):

An additional nine unipolar leads are also used in clinical electrocardiography. There are three unipolar limb leads: VR (right arm), VL (left arm) and VF (left foot) and six unipolar chest leads (precordial leads) which are designated as V1, V2, V3, V4, V5 and V6.

Augmented Limb Leads:

There are three augmented limb leads which were devised by Emmanual Goldberger.

They are named as aVR, aVL & aVF. The augmented limb leads are the recordings between one limb and other two limbs. This arrangement increases the size of potential by 50% without any change in configuration from non-augmented record.

aVR: It is the augmented unipolar right arm lead. This lead is considered to be oriented to or faces the heart from the right shoulder. This lead is usually oriented to the cavity of the heart. Thus, all deflections – P wave, QRS complex and T wave are normally negative in this lead.

aVL: It is the augmented unipolar left arm lead. This lead is considered to be oriented to or faces the heart from the left shoulder. This lead is usually oriented to the anterolateral or superior surface of the left ventricle.

aVF: It is the augmented unipolar left leg lead. This lead is considered to be oriented to the inferior surface of the heart.

Unipolar leads can also be placed at the tips of the catheters and inserted into esophagus and heart.

Precordial Leads or Chest Leads:

The chest leads V1- V6 record electrical activity from the chest.

- V1 - Fourth intercostal space at the right sternal border.
- V2 - Fourth intercostal space at the left sternal border.
- V3 – mid way between lead V2 and lead V4 electrode position.
- V4 – fifth intercostal space in the left midclavicular line
- V5 - fifth intercostal space in the left anterior axillary line
- V6 - fifth intercostal space in the left mid axillary line[28.]

Fig 6: Standard Bipolar Limb Lead

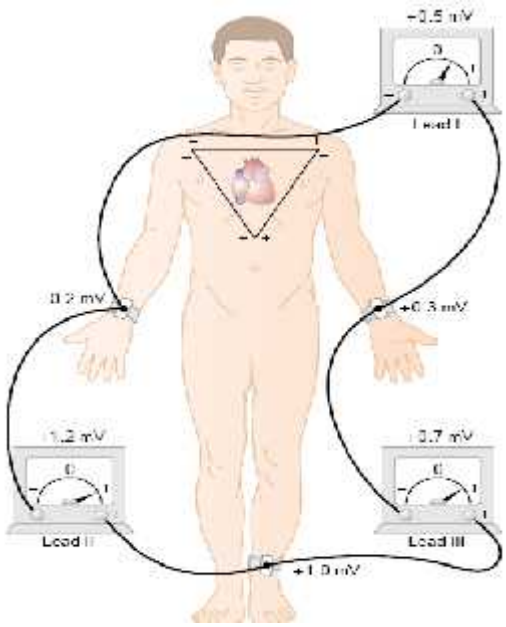
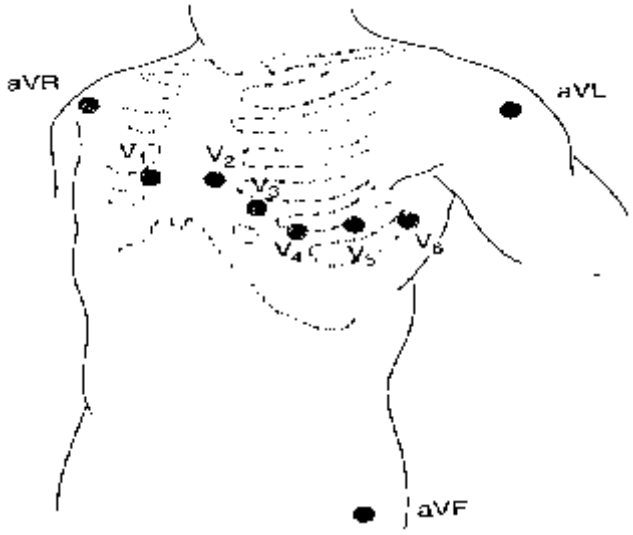


Fig 7: Unipolar electrocardiographic leads.



ECG Interpretation:

Before recording ECG, the electrocardiograph has to be properly calibrated so that standardization mark is 10mm tall. One has to check also for limb lead reversal and ECG artifacts.

P wave:

Normally, P wave does not exceed 2.5 mm in amplitude and less than 3mm wide in all leads.

It does not exceed 0.11sec in duration. Tall peaked P waves may be a sign of right atrial overload (P pulmonale). Wide P waves (P mitrale) are seen with left atrial abnormality.

PR Interval:

The normal PR interval (measured from the beginning of P wave to beginning of QRS complex) is 0.12 to 0.2 seconds. A uniformly prolonged PR interval is often referred to as first degree AV block. A short PR interval with retrograde P waves generally indicates an ectopic.

Width of QRS complex:

Normally QRS width is 0.04 to 0.1 second.

Following are the causes for wide QRS complex:

1. Bundle branch blocks including classical RBBB, LBBB patterns.
2. Toxic conduction delay due to some extrinsic factors such as hyperkalemia or drugs.
3. Beats arising in the ventricles which may be ventricular premature beats or ventricular ectopic beats.
4. WPW type pre excitation

Intervals	Normal Duration (s) Average	Range	Events in the Heart During Interval
PR interval[a]	0.18[b]	0.12–0.20	Atrial depolarization and conduction through AV node
QRS duration	0.08	to 0.10	Ventricular depolarization and atrial repolarization
QT interval	0.40	to 0.43	Ventricular depolarization plus ventricular repolarization
ST interval (QT minus QRS)	0.32	...	Ventricular repolarization

[a]Measured from the beginning of the P wave to the beginning of the QRS complex.
[b]Shortens as heart rate increases from average of 0.18 s at a rate of 70 beats/min to 0.14 s at a rate of 130 beats/min.

QRS voltage:

One has to look for signs of right or left ventricular hypertrophy. Low voltage may be due to pericardial effusion or pleural effusion.

T wave:

Normally, they are positive with positive QRS complex in Lead II and LeadsV3 to V6 in adults. They are negative in Lead aVR.

QT interval:

A prolonged QT interval may be due to electrolyte disturbances (hypocalcemia or hypokalemia), drug effects or myocardial infarction. Shortened QT intervals are seen with hyperkalemia and digitalis effect.

QTc interval:

It is basically the QT interval corrected for Heart rate**.**

It is calculated by using Bezzett's formula

$$QTc = \frac{QT\ Interval}{\sqrt{RR\ interval}}$$

The cut off point for QTc is 390 ms.

Mean QRS axis:

The mean QRS axis is determined in frontal plane. By inspection, it is possible to decide whether the axis is normal or not (it is normally between -30 to +100, or whether left or right axis deviation is present).

Abnormal Q waves:

Prominent Q waves in leads II, III and aVF may indicate inferior wall infarction. Prominent Q waves in leads I, aVL, and V1 to V6 may indicate anterior wall infarction.

ST segment:

One has to look for ST elevation or depression. Horizontal ST segment depression over 1.0mm, down sloping ST segment depression over 1 mm with J point depressed by 2 mm or more beyond 0.8 sec from the J point is considered to be significant and indicates myocardial hypoxia.

U wave:

One has to look for prominent U waves. These waves may be a sign of hypokalemia or drug effect or toxicity.

Heart rate:

The following methods can be used to measure the heart rate:

1. When heart rate is regular, the number of large boxes between two successive QRS complexes is counted. Then, this is divided by a constant.

2. If heart rate is irregular, an average rate is determined by counting the number of cardiac cycles every 6 seconds and multiplying this number by 10.

If the heart rate is faster than 100beats per minute, tachycardia is present. Heart rate slower than 60 beats per minute means bradycardia is present.

Rhythm:

The rhythm is usually of

1. Normal sinus rhythm
2. Sinus rhythm with extra ectopic beat such as atrial/ventricular premature beats.
3. Extreme ectopic rhythms such as atrial fibrillation or flutter, ventricular tachycardia or an AV junctional escape rhythm.

Bipolar limb leads & cardiac vector:

As the standard limb leads are the records of the potential differences between two points, the deflection in each lead at any instance indicates the magnitude and direction in the axis of the lead of the electromotive force generated in the heart (cardiac vector or axis).

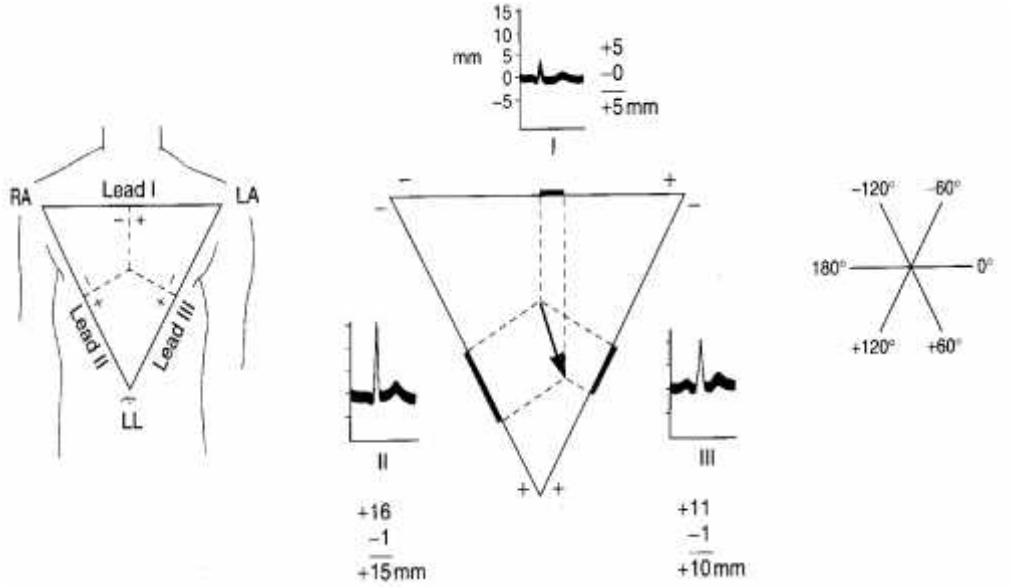
The vector at any given moment in two dimensions of the frontal plane can be calculated from any two standard limb leads if it is assumed that the three electrode locations from the points of an equilateral triangle (Einthoven's triangle) and that the heart lies in the center of the triangle. These assumptions are not completely warranted but calculated vectors are useful approximations.

An approximate mean QRS vector is often plotted by using the average QRS deflection in each lead. This is a mean vector as appose to an instantaneous vector. The average QRS deflection should be measured by integrating the QRS complexes. However, they can be approximated by measuring the net differences between positive and negative peaks of QRS.

The normal direction of the mean QRS vector is generally said to be -30 to +110 on the coordinate system shown in figure 9. The left or right axis deviation is

said to be present if the calculated axis falls to the left of -30 or to the right of +110 respectively. Right axis deviation suggests right ventricular hypertrophy and left axis deviation may be due to left ventricular hypertrophy. But, there are better and more reliable ECG criteria for determining ventricular hypertrophy.

Figure 8: Cardiac Vector



A- Einthoven's triangle B-Calculation: QRS vector C- Reference axis

Einthoven's triangle [Fig-8A]:

Perpendiculars dropped from mid points from the sides, of the equilateral triangle intersect at the center of electrical activity. (RA – Right arm, LA Left arm,LL – Left leg).

Calculation of mean QRS vector: **[Fig-8B]**

In each lead, distances equal to the height of the R Wave minus the height of the largest negative defection in the QRS complex are measured from the mid point of the side of the triangle representing that lead. An arrow drawn from the center of electrical activity to the point of intersection of perpendiculars extended from the distances measured off on the sides represents the magnitude and direction of the mean QRS vector.

AIMS AND OBJECTIVES OF STUDY

To study the effect of sugarcane dust on pulmonary functions and ECG in sugarcane factory workers and compare them with that of skilled non exposed workers.

REVIEW OF LITERATURE

Hippocrates (460-377 B.C) and Galen believed that breathing was for cooling the heart. Galen (130-211 A D) gave an idea that respiratory act was dependent upon the diaphragmatic contraction and wall movement.

Robert Boyles (1627-91) noted that air contained vital constituents required for life. In 1680, G. A. Borllely for the first time measured the Inspiratory Volume and he also mentioned Residual Volume (as quoted by Fenn 1976). J Black (1728-1799) discovered CO_2. Later in 1800, Sir Humphrey Davy measured the Lung Volumes by using Hydrogen. In 1846, John Hutchinson measured Vital Capacity and made the subdivision of Lung Volume. The Functional Residual Capacity was measured by N. Grehent in 1880[29.] In 1933 introduced word Maximum Breathing Capacity. In 1950, the unanimously agreed nomenclature was given by United State respiratory physiologist committee. In 1951, Tiffeneau, Pineli and Gaesler developed the technique for measuring Timed Volumes and the procedure. The procedure was referred to Forced Vital Capacity manoeuvre which quantified the Volume dynamics and showed the rates of air flow along the respiratory tree and useful for obtaining pulmonary function tests. (Fenn 1965) [30.]

Bernadino Ramazinni recognized the influence of occupational medicine. Respiratory problem is one of the major health hazards in dust-exposed workers. It is a major cause of morbidity and mortality all over the world.

Bagassosis was first reported in India by Ganguli and Pal in 1955 in a cardboard manufacturing firm near Kolkata[1.]

The history of electrocardiography dates from the end of 18th century[31.]

In 1787 – Aloysio Luigi Galvani demonstrated that the muscle of the hind limbs of a frog also manifested electromotive phenomena[38.] He accidentally observed

that the muscles of a frog exhibited vigourous contractions whenever sparks were drawn from an electrical machine and the nerves of the preparation were touched with a knife simultaneously. He suspected that this phenomenon was related to the electrical discharge[31.]

In 1856 – Rudolph Von Kolliker and Heinrich Muller demonstrated the presence of electrical currents associated with each heart beat by applying a galvanometer to the base and apex of exposed ventricle[32.]

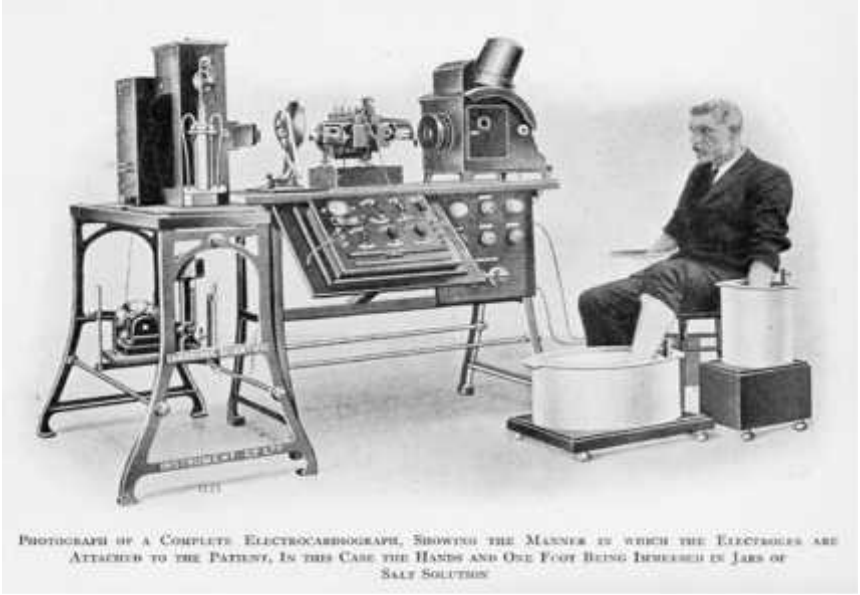
In 1876 – Marey used the electrometer to record the electrical activity of an exposed frog's heart[32.]

In 1878 – Saunderson and Page recorded the cardiac events in laboratory animals by means of the capillary electrometer [31.]

In 1887 – Augustus D Waller was first to demonstrate a measurable amount of current in the human body associated with contraction of the heart by using the capillary electrometer[32.] He showed that the currents produced by the heart muscle could be recorded in intact animals by the use of surface electrodes. He then proceeded to apply this method to human beings. He discovered that the electrical activity of the human heart could be recorded by means of the capillary electrometer without opening the chest and exposing the heart [31.]

In 1902 - The electric current from the human heart was registered in an accurate quantitative manner by the application of a new instrument, String Galvanometer by William Einthoven. He was awarded Noble prize for his contributions in the field of cardiology in 1924[33.]

Figure 9: Electrocardiograph constructed by William Einthoven



PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

In 1932 - Direct writing electrocardiography was designed by Duchosal and Luthi[34.]

In 1933 – Frank N Wilson and his associates devised the unipolar lead system. The unipolar method of recording electrical activity of the heart was first used for experimental purposes. Later on, it was adopted for clinical medicine. Today, the conventional clinical ECG consists of 12 leads which constitutes so called "Scalar ECG"[35.]

After paying tribute to these great Scientists, we will now move on to review of literature proper.

In a study conducted in 2013 in sugarcane factory workers[36] showed that there was a significant reduction in FEV1 in Bagasse workers, manufacturing dept and engineering dept. workers as compared to controls indicated the prevalence of obstructive type of pulmonary impairment. There was a significant reduction in the values of FEV1 as well as ratios of FEV1/FVC in Bagasse workers and Manufacturing dept. workers. The values of PEFR were reduced in Bagasse workers, manufacturing dept. and engineering dept. workers, showed maximum obstruction to peripheral airways.

A study was conducted in sugarcane factory, Marathwada region of Maharashtra during years 2011. The pulmonary tests were studied with "MEDSPIROR" in age matched sugarcane factory male workers exposed to sugarcane dust (n=95) and normal healthy controls (n=100). A highly significant decrease was noticed in FVC and PEFR in all age groups. Even MVV and $FEF_{25-75\%}$ showed a highly significant decline. $FEF_{25-75\%}$ is a sensitive index indicating small airway obstruction resulting from hypersensitivity pneumonitis.

In 2008, a study was reported from western Maharashtra[37] and showed decrease in FVC, FEV, PEFR and MVV in exposed group as compared to non exposed group to bagasse.

In April 2013, a cross sectional observational study was conducted at 7 various stone crushing units of Marathwada region of Maharashtra in 120 subjects aged 25-55 years. The values of FVC, FEV1, FEV1%, FEF25-75%, PEFR and MVV went on significantly decreasing in stone crushing workers as the duration of exposure to stone dust was increased[38.]

In 2012, a study was conducted on construction workers and sanitary workers. A total of 157 subjects ranging in age from 20 to 60years participated in the study. In both construction and sanitary workers**,** the mean of actual values of FVC, FEV_1, FEV1/FVC%, PEFR and $FEF_{25-75\%}$was significantly decreased to a greater extent when compared to control group[39.]

In 2013, study was conducted on 25 female sweepers in the age group of 20–50 years engaged in street sweeping and 25 healthy female controls comparable in age, height and weight. The results showed a significant reduction in percent predicted values and mean values of FVC, FEV_1, PEFR, FEF25-75% and FEF between sweepers

and their matched controls. Pulmonary function after sweeping showed a significant decrease[40.]

In 2011, a study was conducted on workers between the ages of 18–40 years. Their pulmonary functions were assessed. 31 plastic factory workers formed the study group. The Pulmonary function parameters were compared with that of 31 males of same socioeconomic status and age who were not exposed to similar environment served as control. The subjects working for at least one year were selected for the study. Most of the expiratory flow Rates (PEFR, MEF 50%, and MEF 75%, FEF 25-75%) as well as the lung volumes (FVC, FEV1, VC, TV, ERV, MVV) were significantly decreased in the plastic factory workers [41.]

A study was conducted between October 2006 and May 2007[42.] In this study, a total of 656 persons of which 328 were wood workers and 328 controls. Physical examination and the pulmonary function tests of the workers were recorded. The mean FEV_1 and FVC values of woodworkers among both smokers and non smokers were significantly low, although the FEV_1/FVC value was high ($p < 0.05$). An increase in both FEV_1 and FVC values was detected among the woodworkers who had a working period less than 10 years.

A study was conducted to evaluate quantitatively components of ECG among workers who were exposed to carbon disulfide[43.] The components of ECG of 253 workers exposed to carbon disulfide (CDS) and those of 99 controls were quantitatively measured and evaluated. ECG of the exposed workers showed a stastically significant higher prevalence of ECG pathological changes, higher P amplitude, Macruz index, longer P duration, longer both crude and corrected Q-T Intervals and R-R Intervals, shorter P-R segments and QRS Intervals than that of the controls. On the other hand, P-R intervals and heart rates of the two groups were not

significantly different. Among both the exposed and control groups, value of P duration was significantly negatively correlated with that of P-R segment. Values of the ECG components were not related to duration of exposure to CDS.

A cohort study in 2011 on coal dust exposure and mortality from IHD among coal miners showed the association of risk of IHD mortality with cumulative particulate exposure was consistent with air pollution.

Another study carried out in 2011 on effect of wood dust on cardiopulmonary functions and anthropometric parameters of carpenters and non carpenters showed a significant increase in systolic BP, diastolic BP and mean arterial blood pressure in carpenters. There was a significant change in pulse rate of the carpenters [44.]

In clinical practice, cases having respiratory problems especially COPD should be assessed for ECG changes[45.] Hospital based cross sectional study was conducted during July 2000-june 2001. A total of 60 patients having various respiratory problems were evaluated for COPD. ECG changes were found to be 35.7% sensitive and 95.6% specific in diagnosis of COPD among patients having respiratory problems. Duration of P wave was normal in all cases of COPD. Sinus tachycardia was noticed in about 4% of population, peaked P wave was present in 53.3% of COPD cases and 5% had left axis deviation.

Occupationally exposed groups often have high exposure to particulate air pollutants such as wood dust, silica dust, asbestos or welding fumes. But whether such dust exposure increases the risk for ischemic heart disease is not clear yet. Consequently, the aim of this study was also to determine the role and the possible mechanism of occupational exposure to sugarcane dust emitted during sugar processing in increasing the risk of ischemic heart disease (IHD) among sugarcane factory workers.

MATERIALS AND METHODS

Source of Data

The study was conducted on the sugarcane factory workers near Jamkhandi in North Karnataka.

Method of collection of Data

Study group: This group consisted of 60 unskilled volunteered workers who were exposed to sugarcane dust for more than 5years.

Control group: This group consisted of 60 skilled volunteered workers who were not exposed to dust from the same factory.

Duration of study: From November 2012 to April 2014.

Age of the subjects: In both the groups, subjects more than 25years were included.

Sample size: There are 7 factories in Bijapur and Bagalkot districts. Around 300 workers are exposed to sugarcane dust and around 350 workers are in clerical post not exposed to sugarcane dust. Around 400 workers will always be available in these factories. For stastical purpose, 30% of total can be taken into study. Hence, 60 each subjects each were included in study and control groups[46].

Sampling technique: Subjects were selected using convenience sampling method.

Inclusion criteria:

Only healthy workers were included in the study. The apparent health status of each subject was ascertained through thorough clinical examination and history taking.

Exclusion criteria:

The following subjects were excluded from the study:

1. Subjects with any known history of cardiopulmonary disorders.
2. Subjects with any known history of endocrine disorders.

3. Subjects with any known history of congenital defects
4. Smokers.

The following Parameters were recorded in the subjects:

I. Record of Physical Anthropometry of subjects.

1. Height (in centimeters): This was measured with each subject standing without his/her footwear nearest to 0.1 centimeter.
2. Weight (in kilograms): The subjects were weighed in standardized machine with minimum clothing nearest to 0.1 kilogram.
3. Chest circumference (in cm): It was measured at deep inspiration position at the level of the nipple with minimum clothing with the help of standard tailor tape nearest to 0.1centimetre.
4. Body Mass Index (kilogram/meter^2): This was calculated for each subject from Weight in kgs and height in meters by using Quetlet index.

II. Record of Physiological Parameters [47,48,49,50.]

1. Pulse Rate (PR): It was expressed as beats per minute by palpating right radial artery.
2. Blood Pressure (SBP and DBP): It was measured by mercurial sphygmomanometer in mm of Hg.
3. Mean Arterial Pressure (MAP): It was measured in mm of Hg by using following formula DBP$\pm$1/3 pulse pressure (PP).
4. Respiratory Rate (RR): It was expressed as cycles per minute by manual method.

III. Record of Pulmonary function Parameters[51, 52, 53.]

The following pulmonary function parameters were recorded using Spiropac, (MEDICAID) in each subject.

1. Forced Vital Capacity (FVC) in ml.
2. Forced Expiratory Volume at the end of first second (FEV1) in ml.
3. Percentage of Forced Expiratory Volume at the end of first second (FEV 1%). FEV1% was calculated mathematically using following formula: FEV1%=FEV1/FVCX100.
4. Peak Expiratory Flow Rate (PEFR) in L/min by using mini Wright's peak flow meter.
5. Maximum Expiratory Pressure (MEP) in mmHg by using Modified Black's apparatus.

Spirometry is the most widely used pulmonary function test. It records the amount of air breathed in and out and the rate at which this process takes place. The device used in this test is a spirometer, a long piece of tubing with a mouth piece at one end and a recording device at the other. Spirometry reveals degree of obstruction and restriction of the airway.

Figure 10: Spiroexel instrument

Procedure: Spirometry requires that the nose to be pinched off as the subject breathes through a mouthpiece attached to the spirometer. The subject is instructed on how to breathe during the procedure. Three breathing manouvre are practiced before recording the procedure and the highest of three trials is used for evaluation. This procedure

measures air flow by electronic or mechanical displacement principles and uses a microprocessor and recorder to calculate and plot air flow[23.]

Purpose: Spirometry is the most commonly performed pulmonary function test (PFT). The test can be performed at the bedside, in a physician's office or in a pulmonary laboratory. It is often the first test performed when a problem with lung function is suspected. Spirometry may also be suggested by an abnormal x ray, arterial blood gas analysis or other diagnostic pulmonary test result. The National Lung Health Education Program recommends that regular spirometric tests are to be performed on persons over 45 years old who have a history of smoking. Spirometric tests are also recommended for persons with a family history of lung diseases, chronic respiratory ailments and advanced age.

Precautions: The subject should inform the physician of any medications he or she is taking, or of any medical conditions that are present. These factors may affect the validity of the test. The subject's smoking habits and history should be thoroughly documented. The subject must be able to understand and respond to instructions for the breathing manouvre. Therefore, the test may not be appropriate for very young, unresponsive, or physically impaired persons[23.]

Preparation: The subject's age, gender and race are recorded. Height and weight of each subject are measured before the procedure. The subject should not have eaten heavily within three hours of the test. He or she should be instructed to wear loose-fitting clothing over the chest and abdomen area. The respiratory therapist or other testing personnel should explain and demonstrate the breathing manouvre to the patient. The subject should practice breathing into the mouthpiece until he or she is able to duplicate the manouvre successfully on two consecutive attempts[23.]

Picture of Pulmonary function test recording in Study group

Picture of Pulmonary function test recording in Control group

Graph 1- Recording of lung functions by Spiroexcel instrument in Control group

Medicaid Systems
389, Phase-II, Industrial Area

Last Name: renake
First Name: prakash
ID: 14
Date: 07/02/2013
Predicted: ERS 93

Date of Birth: 01/06/1964
Sex: Male
Ethnic Corr.: 100%
Description:
Comments:

Age: 50
Weight (Kg): 68
Height (cm): 155
BSA (m2): 1.67
Smoke: no

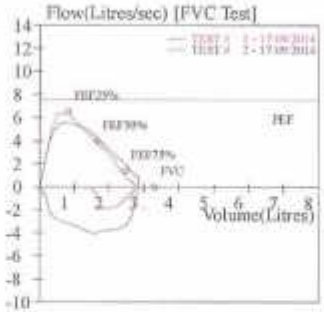
Spirometry Results

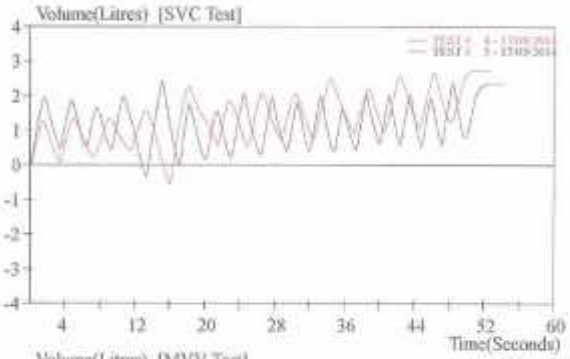
Parameter		Pred	Pre	%Pred	Pre	%Pred	%Chg
FVC	(L)	3.29	2.88	88	3.01	91	5
FEV5	(L)	----	1.97	----	1.91	----	-3
FEV1	(L)	2.72	2.63	97	2.81	103	7
PEFR	(L/s)	7.52	6.4	85	5.62	75	-12
PIFR	(L/s)	----	1.97	----	4.04	----	105
FEF25-75	(L/s)	3.56	4.27	120	4.29	121	----
FEF 25%	(L/s)	6.54	6.29	96	5.62	86	-11
FEF 50%	(L/s)	3.97	4.6	116	4.61	116	----
FEF 75%	(L/s)	1.41	2.58	183	2.74	194	6
FEV1/FVC	(%)	78.21	91.32	117	93.36	119	2
FVC Time	(Sec)	----	1.72	----	1.26	----	-27
SVC	(L)	3.4	2.39	70	2.61	77	9
ERV	(L)	-----	0.21	----	0.39	----	86
!RV	(L)	-----	0.96	----	0.79	----	-18
VE	(L/min)	-----	18.3	----	28.6	----	56
Rf	(1/min)	-----	15	----	20	----	33
Ti	(sec)	-----	2.38	----	1.62	----	-32
Te	(sec)	-----	1.62	----	1.38	----	-15
Vt	(L)	-----	1.22	----	1.43	----	17
Vt/Ti	(L/s)	-----	0.51	----	0.88	----	73
Ti/Ttot	(sec)	-----	0.6	----	0.54	----	-10
IC	(L)	-----	2.18	----	2.22	----	2
MVV	(L/min)	105.7	76.8	73	-----	----	----
MRf	(1/min)	-----	60	----	-----	----	----
MVt	(L)	-----	1.28	----	-----	----	----
MVVt	(sec)	-----	15.38	----	----	----	----
ELA	**(Years)**	**51**	**54**		**48**		

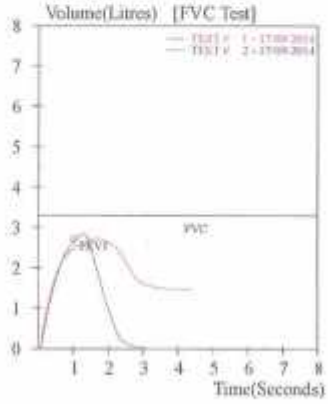
Pre Medication Report Indicates
Normal Spirometry(%FEV1/FVC>80%Pred%FEV1
/FVC and FVC>80%PredFVC)

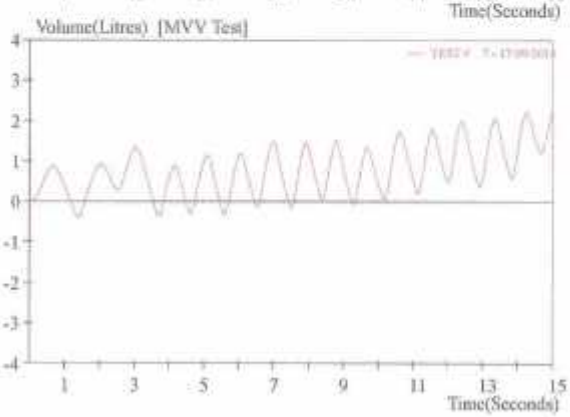
Pre Medication Report Indicates
Normal Spirometry(%FEV1/FVC>80%Pred%FEV1
/FVC and FVC>80%PredFVC)

Printed 17/09/2014
SPIRO EXCEL 1.1









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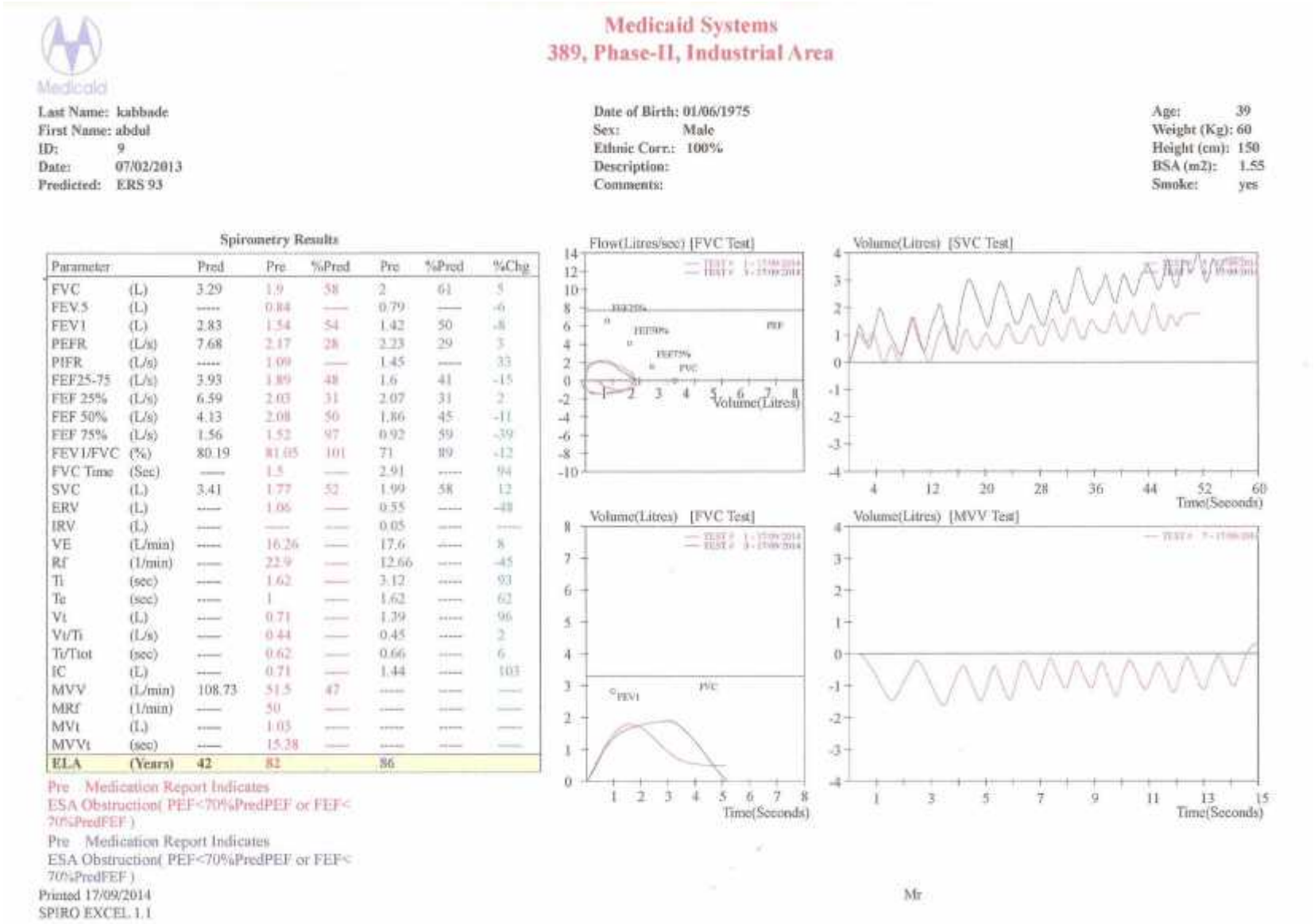
Graph 1- Recording of lung functions by Spiroexcel instrument in Study group



Medicaid Systems
389, Phase-II, Industrial Area

Medicaid

Last Name: kabbade
First Name: abdul
ID: 9
Date: 07/02/2013
Predicted: ERS 93

Date of Birth: 01/06/1975
Sex: Male
Ethnic Corr.: 100%
Description:
Comments:

Age: 39
Weight (Kg): 60
Height (cm): 150
BSA (m2): 1.55
Smoke: yes

Spirometry Results

Parameter		Pred	Pre	%Pred	Pre	%Pred	%Chg
FVC	(L)	3.29	1.9	58	2	61	5
FEV.5	(L)	-----	0.84	----	0.79	----	-6
FEV1	(L)	2.83	1.54	54	1.42	50	-8
PEFR	(L/s)	7.68	2.17	28	2.23	29	3
PIFR	(L/s)	-----	1.09	----	1.45	----	33
FEF25-75	(L/s)	3.93	1.89	48	1.6	41	-15
FEF 25%	(L/s)	6.59	2.03	31	2.07	31	2
FEF 50%	(L/s)	4.13	2.08	50	1.86	45	-11
FEF 75%	(L/s)	1.56	1.52	97	0.92	59	-39
FEV1/FVC	(%)	80.19	81.05	101	71	89	-12
FVC Time	(Sec)	----	1.5	----	2.91	-----	94
SVC	(L)	3.41	1.77	52	1.99	58	12
ERV	(L)	-----	1.06	----	0.55	----	-48
IRV	(L)	----	----	----	0.05	----	----
VE	(L/min)	-----	16.26	----	17.6	----	8
Rf	(1/min)	----	22.9	----	12.66	----	-45
Ti	(sec)	-----	1.62	----	3.12	-----	93
Te	(sec)	-----	1	----	1.62	-----	62
Vt	(L)	-----	0.71	----	1.39	-----	96
Vt/Ti	(L/s)	----	0.44	----	0.45	-----	2
Ti/Ttot	(sec)	----	0.62	----	0.66	----	6
IC	(L)	----	0.71	----	1.44	-----	103
MVV	(L/min)	108.73	51.5	47	-----	----	----
MRf	(1/min)	----	50	----	----	----	----
MVt	(L)	-----	1.03	----	-----	----	----
MVVt	(sec)	----	15.28	----	----	----	----
ELA	**(Years)**	**42**	**82**		**86**		

Pre Medication Report Indicates
ESA Obstruction(PEF<70%PredPEF or FEF<
70%PredFEF)

Pre Medication Report Indicates
ESA Obstruction(PEF<70%PredPEF or FEF<
70%PredFEF)

Printed 17/09/2014
SPIRO EXCEL 1.1

Flow(Litres/sec) [FVC Test]
Volume(Litres)

Volume(Litres) [SVC Test]
Time(Seconds)

Volume(Litres) [FVC Test]
Time(Seconds)

Volume(Litres) [MVV Test]
Time(Seconds)

Mr

IV. Recording of Electrocardiogram [27]

Instrument

Electrocardiograph is a sophisticated galvanometer. It is a sensitive electromagnet which can detect and record changes in electromagnetic potential. It has positive and negative poles. The wire extensions from these poles have electrodes at each end, a positive electrode at the end of extension from the positive pole and a negative at the end of extension from the negative pole. The paired electrodes together constitute an “Electrocardiographic Lead”.

When paired electrodes are oriented in any particular direction, the theoretical straight line joining the electrodes is known as “Axis” of that lead or “Lead Axis”. A Lead so placed will detect and transmit any changes in electrical potential which occurs between its electrodes. (Make: Maestros Magic R)

Electrocardiographic paper

The paper used is thermosensitive. The electrocardiographic recording paper has ruled lines. They are divided into large and small squares. The large squares are of width of 5mm. Each small square is 1mm in width. The squares with grid facilitate the measurement of:

1) Timed parameters (horizontal measurement) &

2) Deflection amplitude (vertical measurement)

Electrocardiogram is conventionally recorded at a speed of 25 mm per second. At this speed, five large squares represent one second, one large square represents 0.2 second (1/5 of second) and one small square represents 0.04 second (1/25 of second). In one minute, ECG paper moves a length of 1500mm. Each 1mm vertically represents 0.1mv.

Recording of ECG:

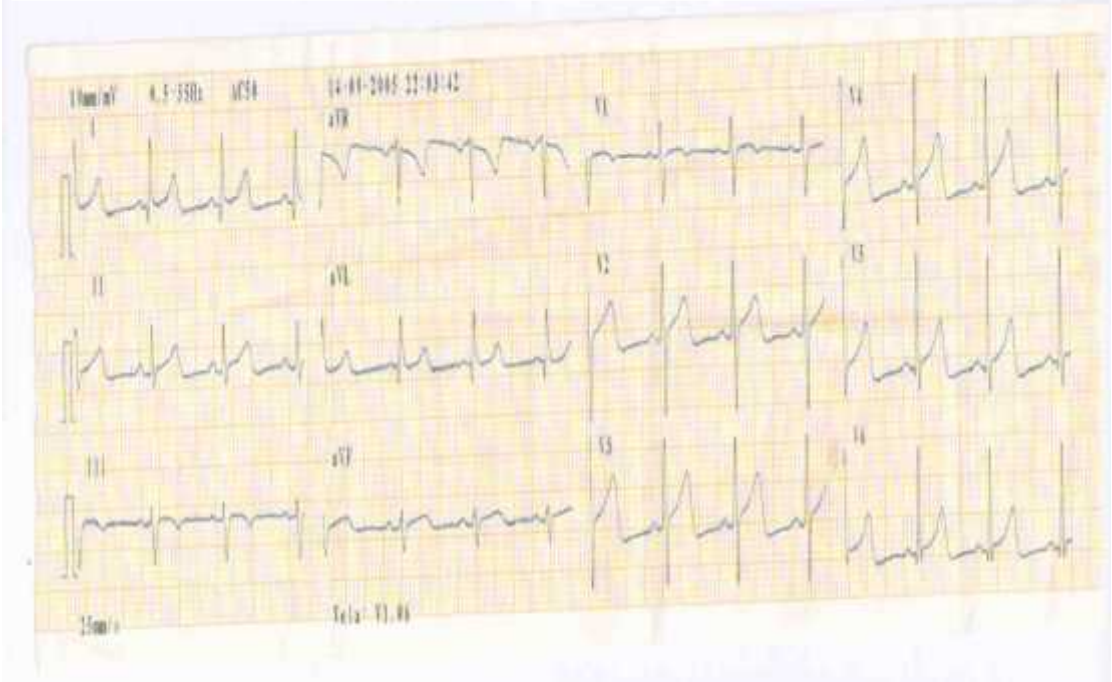
ECG was recorded after giving 5 minutes of rest to the subject to allay anxiety. ECG was recorded in all 12 leads i.e, 3 Standard Bipolar Limb Leads I,II & III, 3 Unipolar augmented limb leads: aVR, aVL, aVF and 6 Precordial leads: VI to V6 by connecting electrodes to left arm, right arm, left leg and right leg in supine position. Date of recording, name and age of the subject were written on ECG strip.

Analysis of ECG recording:

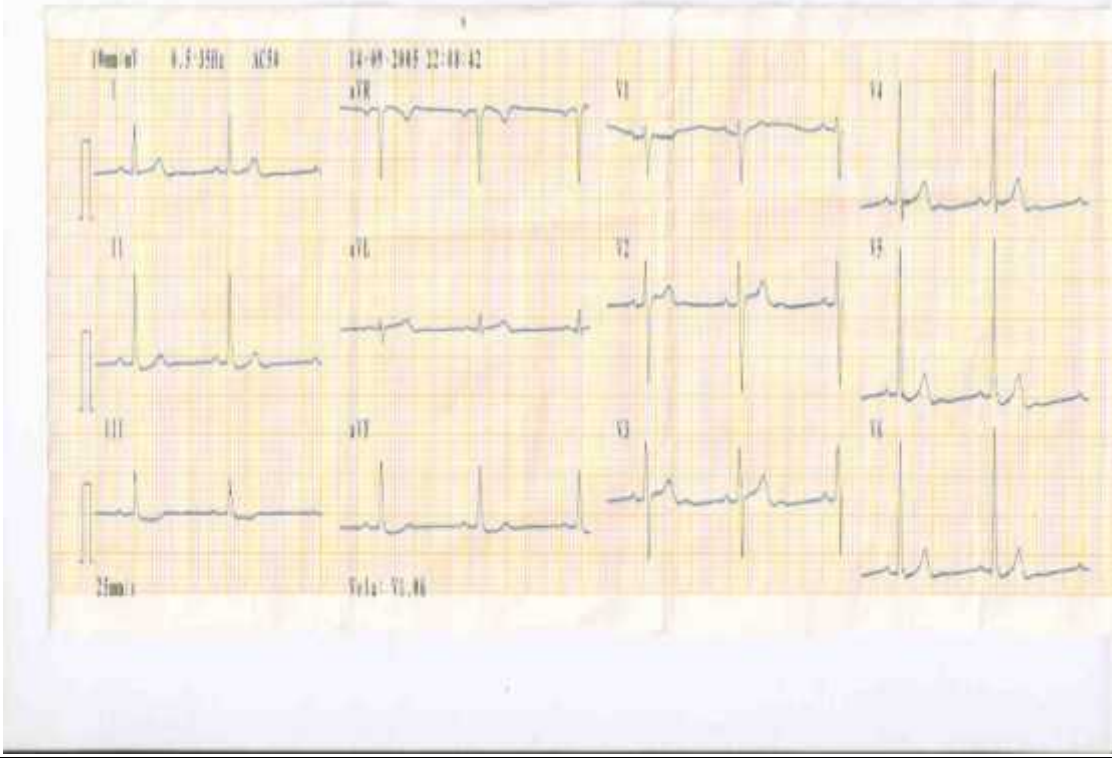
ECG recorded was evaluated for different parameters such as Heart Rate, P wave, PR interval, QRS complex, Q wave, T wave, QTc interval, axis deviation, R and S amplitudes and ST segment.

Picture of recording of ECG.

ECG of control group



ECG of study group



V. Measurement of size of sugarcane particles:

Cane particles were collected and sizes of particles were measured. The procedure was as follows: Three clean petridishes were randomly kept in sugarcane factory at 10 am in different places of maximum dust exposure. Then, these petridishes were collected neatly by covering with the lids at 6pm in the evening. The size of cane dust particles were measured by optical microscopic technique.

STATISTICAL ANALYSIS: [54, 55.]

The data obtained was analyzed in consultation with statistician.

Statistical measures used were

1. Mean, Standard deviation
2. Student‘s t test
3. Correlation

Pearson’s correlation analysis was used to investigate the relationship between PFTs and the duration of exposure among subjects of study group.

RESULTS

The Anthropometric parameters recorded included Age (years), Height (centimeters), Weight (kilograms), Body Surface Area (square meters), Body Mass Index (kilograms/meters). Total number of subjects in control group was 60. Total number of subjects in study group was 60.

I. Anthropometric Parameters

The mean value and standard deviation, level of significance of each parameter were calculated and presented in table No: 01.

Table No: 1 Anthropometric Parameters of Study group Vs control group (Values were Mean± SD).

Parameter	Control group(n=60)	Study group(n=60)	p value
Age (years)	37.6± 7.70	36.4 ±8.70	0.44
Height (cms)	163.18 ± 6.47	162.35±7.26	0.50
Weight (kgs)	68.1 ± 11.58	64.7 ± 9.70	0.09
BMI (kg/m^2)	25.42±3.65	24.7 ±3.85	0.31
BSA (m^2)	1.75±0.24	1.90± 1.72	0.57

BSA-Body Surface Area, BMI- Body Mass Index, cir -Circumference, $p<0.05$ Significant, $p<0.01$ highly significant, $p<0.001$ Very highly significant.

1. Age in years

Mean ± SD of age for study group was 36.4 ±8.70. Mean ± SD of height for control group was 37.6 ± 7.70. There was no significant variation between two groups (p=0.44). (Table1)

2. **Height in centimeters**

Mean ± SD of height for study group was 162.35±7.26. Mean ± SD of height for control group was 163.18 ± 6.47. There was no significant variation between two groups (p=0.50). (Table1)

3. **Weight in kgs**

Mean ± SD of weight for study group was 64.7 ± 9.70. Mean ± SD of weight for control group was 68.1 ±11.58. There was no significant variation between two groups p =0.09. (Table1)

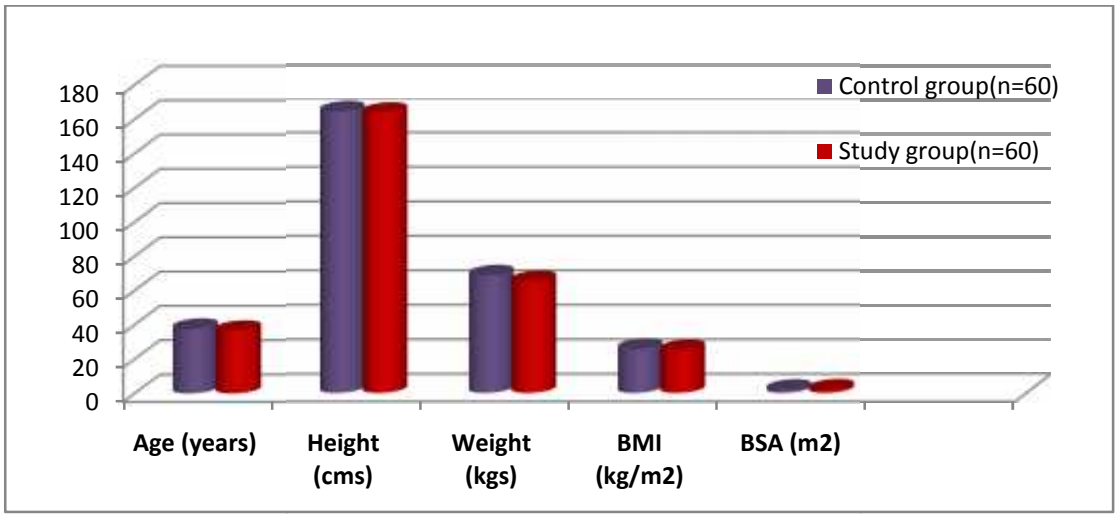
4. Body surface area in m^2

Mean ± SD of BSA for study group was 1.90 ±1.72m. Mean ± SD of BSA for control group was 1.75±0.24$m^{2.}$ There was no significant variation between two groups. p=0.57. (Table1)

5. Body mass index in kg/ m^2

Mean ± SD of BMI for study group was 24.7 ±3.85. Mean ± SD of BMI for control group was 25.42±3.65. There was no significant variation between two groups. p=0.31. (Table1)

Graph 4: Anthropometric parameters of Study group Vs Control group



II. Physiological Parameters

Recording of various Physiological Parameters in control and study groups were represented in table No: 02. The Parameters recorded included Pulse Rate (beats/min), Respiratory Rate (cycles/min), Systolic Blood Pressure (mm Hg), Diastolic Blood Pressure (mm Hg) and Mean arterial pressure (mmHg). The values were represented as Mean with Standard deviation of each Parameter in each group.

Table 2: Physiological Parameters of Study group Vs Control group. (Values were Mean± SD).

Parameter	Control group(n=60)	Study group(n=60)	p value
Pulse rate (bpm)	78.95±9.21	78.4±9.66	0.75
Respiratory rate (cpm)	19.56±2.36	19.31±2.48	0.57
SBP (mmHg)	128.06±9.81	126.7±9.54	0.44
DBP (mmHg)	80.08±7.82	79.2±7.95	0.57
MAP (mmHg)	96±7.6	95±1.65	0.49

MAP- mean arterial pressure. p<0.05 Significant, **p<0.01 highly significant, p <0.001 very highly significant.

1. Pulse Rate in beats/min

Mean ± SD of pulse Rate for study group was 78.4±9.66. Mean ± SD of pulse Rate for control group was 78.95±9.21. There was no significant variation between two groups, P=0.75. (Table2).

2. Respiratory Rate in cycles/min

Mean ± SD of respiratory Rate for study group was 19.31±2.48. Mean ± SD of respiratory Rate for control group was 19.56±2.36. There was no significant variation between two groups .p=0.57(Table2).

3. Systolic BP in mmHg

Mean ± SD of systolic BP for study group was 126.7±9.54. Mean ± SD of systolic BP for control group was 128.06±9.81. There was no significant variation between two groups. p=0.44(Table2).

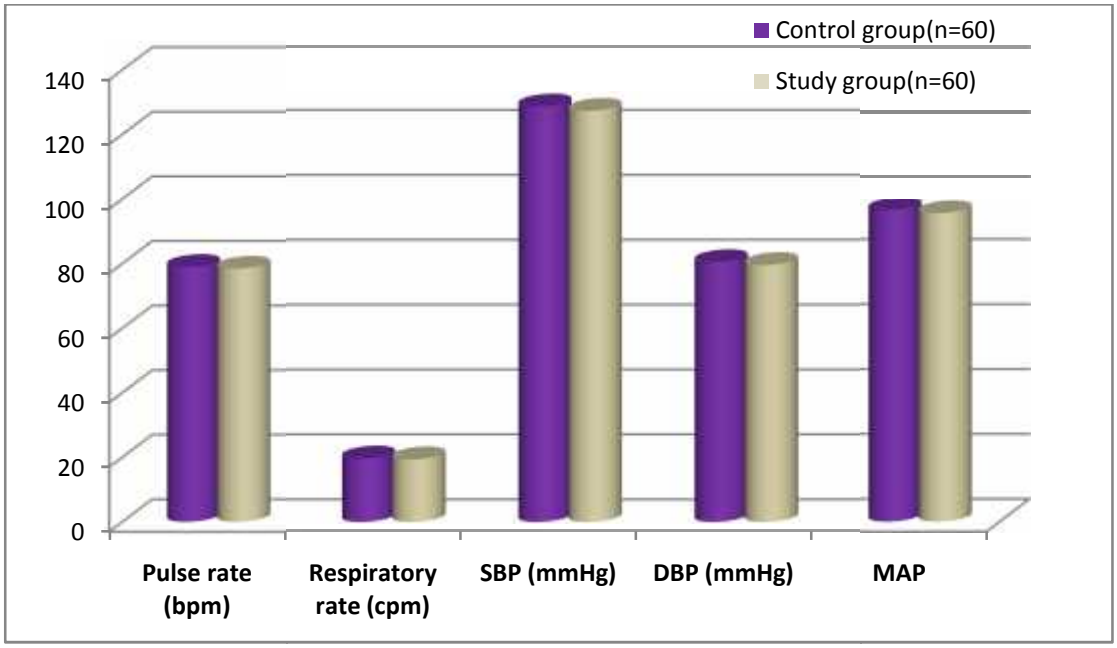
4. Diastolic BP in mmHg

Mean ± SD of diastolic BP for study group was 79.2±7.95. Mean ± SD of diastolic BP for control group was 80.08±7.82. There was no significant variation between two groups. p=0.57(Table2).

Mean Arterial Pressure in mmHg:

Mean ± SD of Mean arterial pressure for study group was 95±1.65. Mean ± SD for control group was 96±7.6. There was no significant variation between two groups. p=0.49(Table2).

Graph 5: Physiological parameters of Study group Vs Control group



III. Pulmonary function parameters in study and control groups

Recording of various pulmonary function parameters in control and study groups were represented in tables No: 03 The Parameters recorded included Forced Vital Capacity (ml), Forced Expiratory Volume in 1st second (ml), Percentage of Forced Expiratory Volume in 1st second(%), Peak Expiratory Flow Rate (L/min) and Mean Expiratory Pressure (mm Hg). The values were presented as Mean with Standard deviation of each Parameter in each group.

Table 3: Pulmonary Function Parameters of Study group Vs Control group. (Values were Mean± SD).

Pulmonary function parameters	Control group(n=60)	Study group(n=60)	p value
FVC (L)	2.92±0.49	2.75± 0.53	0.07
FEV_1(L)	2.59±0.43	2.43±0.46	0.04*
FEV_1 %	90.9±6.65	90.8±9.73	0.94
PEFR (L/min)	547.5±83	364±104.5	0.000***
MEP (mmHg)	84.3±23.3	77.25±20.5	0.08

*p<0.05 Significant, **p<0.01 highly significant, ***p <0.001 very highly significant.

Forced Vital Capacity (FVC) in Liters:

Mean± SD of FVC for study group was 2.75± 0.53. Mean± SD of FVC for control group was 2.92±0.49. There was no significant variation between two groups. (P=0.07) (Table3).

Forced Expiratory Volume at the end of 1st second (FEV1) in Liters:

Mean ± SD of FEV1 for study group was 2.43±0.46. Mean ± SD of FEVI for control group was 2.59±0.43. There was a significant decrease of 2L of FEV1 in study group compared to control group. p=0.04(Table3).

Forced Expiratory Volume in percentage (FEV1%) at the end of 1st second:

Mean ± SD of FEV1% for study group was 90.8±9.73. Mean ± SD of FEV1% for control group was 90.9±6.65. There was no significant variation between two groups. p=0.94 (Table3).

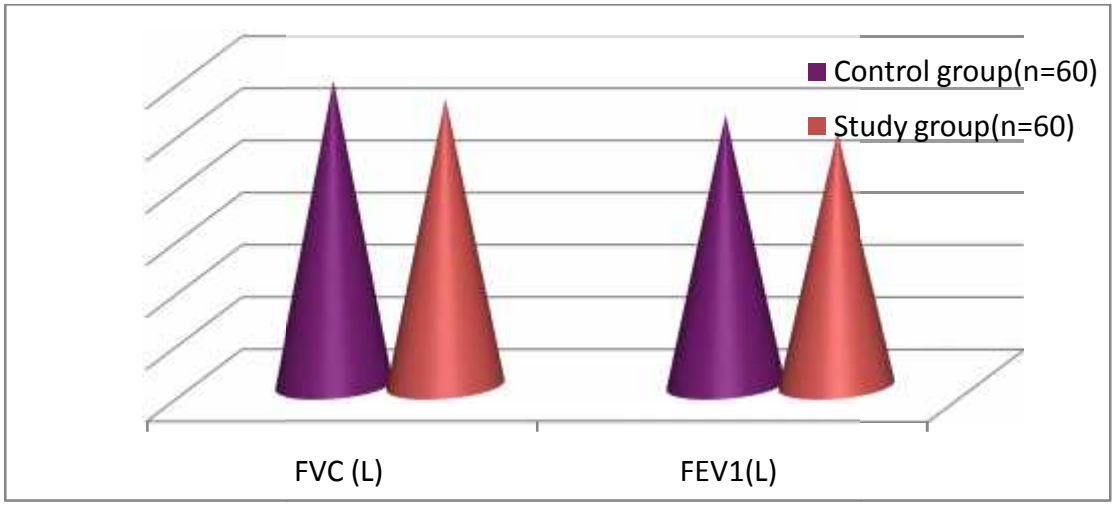
Peak Expiratory Flow Rate (PEFR) in Liters/min:

Mean ± SD of PEFR for study group was 364±104.5**.** Mean ± SD of PEFR for control group was 547.5±83. There was a highly significant reduction of 134L/min of PEFR in study group as compared to control group. p=0.000(Table3).

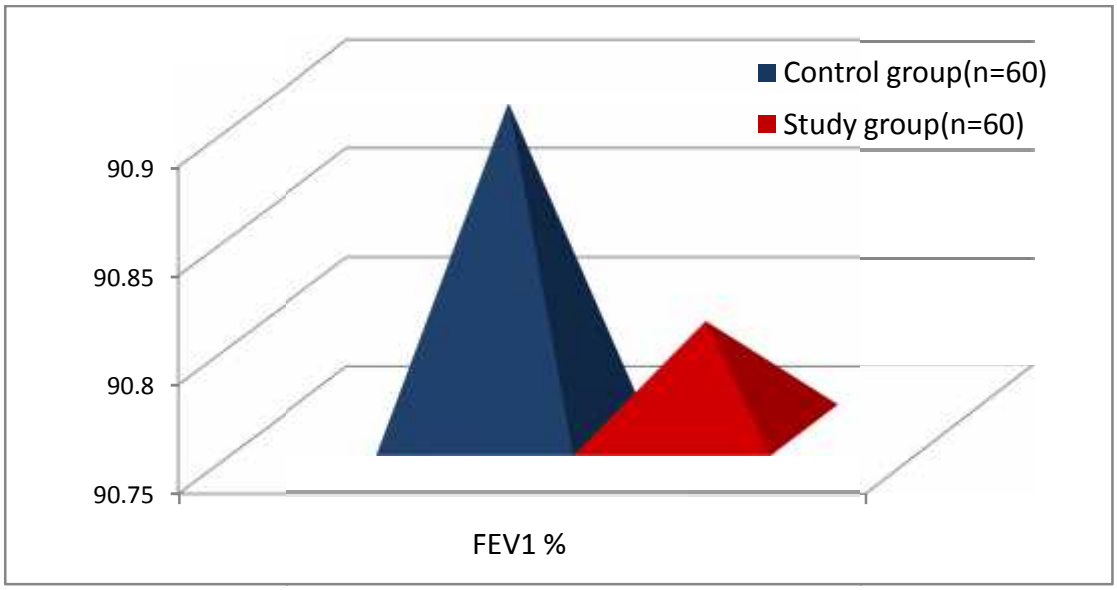
Maximum Expiratory Pressure (MEP) in mmHg:

Mean ± SD of MEP for study group was 77.25±20.5. Mean ± SD of MEP for control group was 84.3±23.3. There no significant variation between two groups p=0.08(Table3).

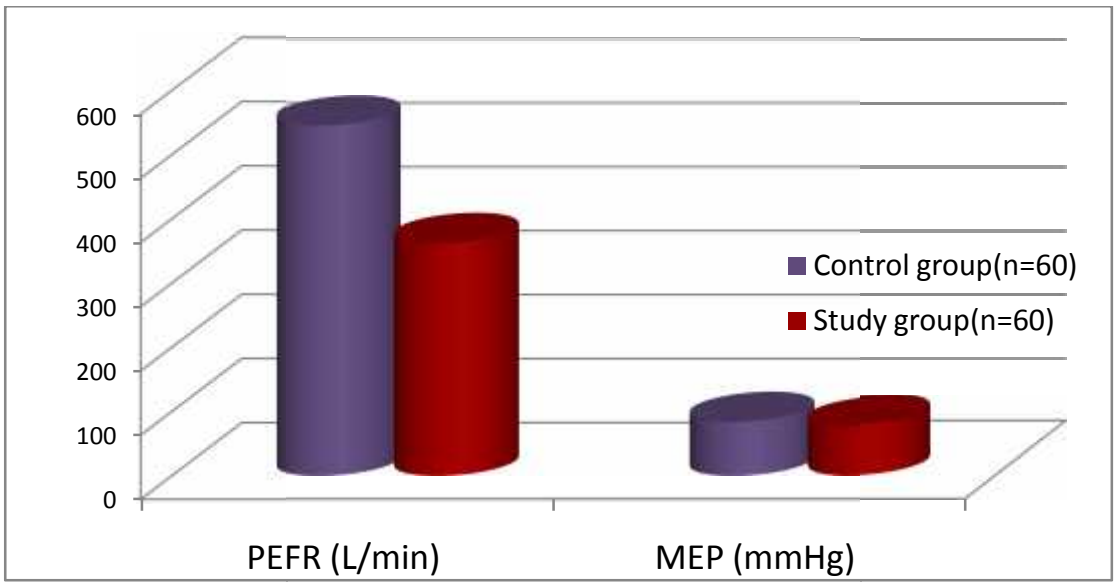
Graph 6: FVC & FEV1 of study group Vs Control group



Graph 7: FEV1% of study group Vs Control group



Graph 8: PEFR & MEP of study group Vs Control group



ELECTROCARDIOGRAPHIC PARAMETERS:

Recording of Electrocardiographic Parameters in control and study groups were represented in table No. 4. ECG recorded was evaluated for different parameters such as Heart Rate, P wave, PR interval, QRS complex, Q wave, T wave, QTc interval, axis deviation, R and S amplitudes and ST segment. The values were presented as Mean with Standard deviation of each Parameter in each group.

Table 4: ECG parameters of study group Vs Control group. (Values were Mean± SD)

ECG parameter	Control group(n=60)	Study group(n=60)	P- value
Heart rate,bpm(from RR Interval)	71.02± 10.4	68.2± 9.41	0.12
P wave (seconds)	0.29±1.53.	0.10±0.01	0.34
PR interval (seconds)	0.13±0.018	0.14±0.024	0.0015 **
ST segment(mm)	0.09±0.02	0.11±0.03	0.0019 **
QRS complex(seconds)	0.11±0.01	0.11±0.015	0.42
QT interval(seconds)	0.36±0.02	0.37±0.02	0.39
QTc interval(seconds)	0.40±0.03	0.39±0.02	0.06
T wave(seconds)	0.13±0.02	0.14±0.018	0.11
Amplitude ‘R’(mm)	0.98±0.41	1.07±0.38	0.23
Amplitude ‘S’(mm)	0.10±0.12	0.08±0.16	0.56

bpm- beats per minute. *p<0.05 Significant, **p<0.01 highly significant, ***p <0.001 very highly significant.

Heart Rate in (bpm):

Mean ± SD of heart rate for study group was 68.2±9.41. Mean ± SD of heart rate for control group was 71.02±10.4. There was insignificant decrease of 2.82 of heart rate in study group as compared to control group. p=0.12(Table4).

'P' wave in (sec):

Mean ± SD of P wave for study group was 0.10±0.01. Mean ± SD of P wave for control group was 0.29±1.53. There was no significant change. p=0.34(Table).

PR interval in (sec):

Mean ± SD of PR interval for study group was 0.14±0.024. Mean ±SD for control group was 0.13±0.018. There was a highly significant increase of PR interval in study group as compared to control group. p=0.0015(Table4).

ST segment in (mm):

Mean±SD of ST segment for study group was 0.11±0.03. Mean ± SD for control group was 0.098±0.02. There was a highly significant increase of ST segment in study group as compared to control group. p=0.0019(Table4).

QRS complex in (sec):

Mean± SD of QRS complex for study group was 0.11±0.015. Mean ± SD for control group was 0.11±0.01. There was no significant change. p=0.42(Table4).

QT interval in (sec):

Mean ± SD of QT interval for study group was 0.37±0.02. Mean ± SD for control group was 0.36±0.02. There was no significant change. p=0.39(Table4).

QTc interval in (sec):

Mean ± SD of QTc interval for study group was 0.39 ± 0.02. Mean ± SD for control group was 0.40±0.03. There was no significant change. p=0.06(Table4).

T wave in (sec):

Mean ± SD of T wave for study group was 0.14±0.018. Mean ± SD for control group was 0.13±0.02. There was no significant change. p=0.11(Table4).

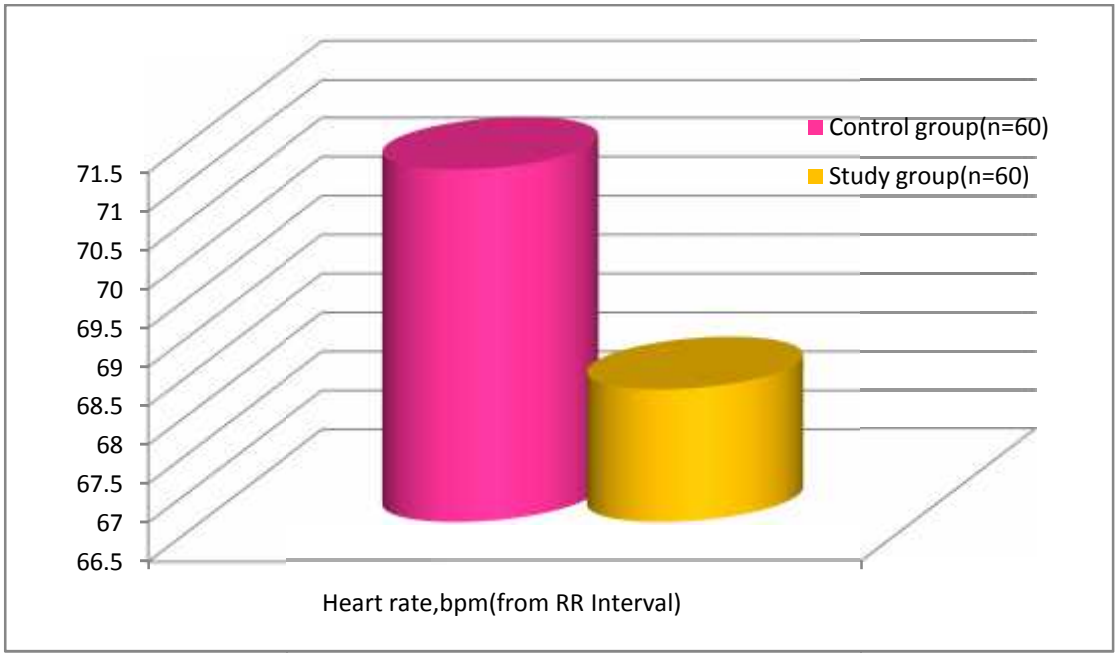
Amplitude of 'R' in (mm):

Mean ± SD of Amplitude of R wave for study group was 1.07 ± 0.38. Mean ± SD for control group was 0.98±0.41. There was no significant change. p=0.23 (Table4).

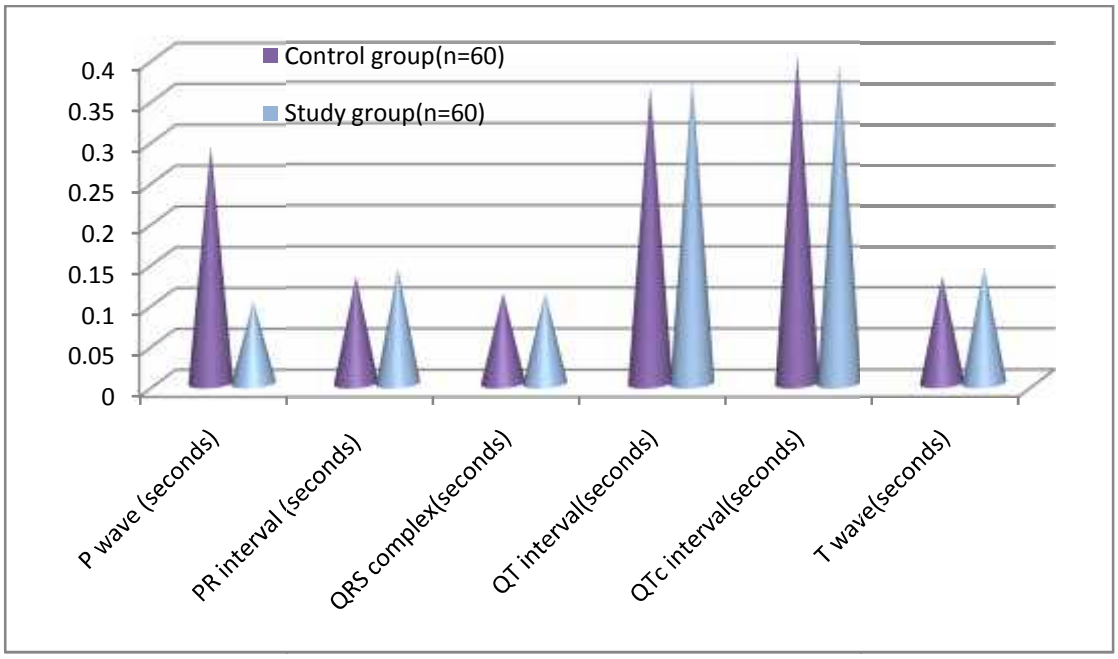
Amplitude of 'S' wave in (mm):

Mean± SD of Amplitude of S wave for study group was 0.08±0.16. Mean ± SD for control group was 0.10±0.12. There was no significant change. p=0.(Table)

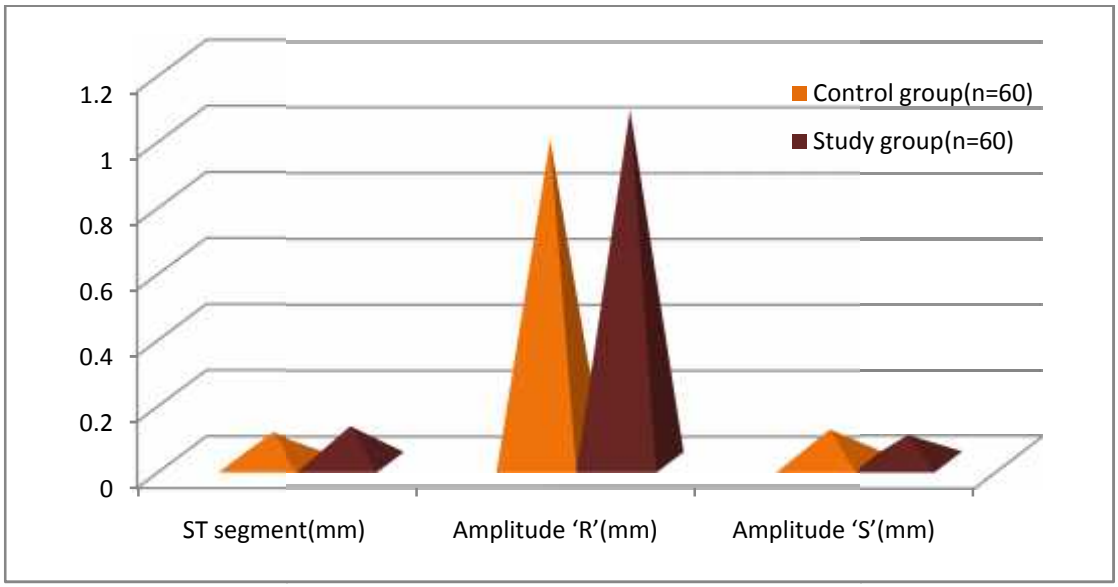
Graph 9: Heart Rate of Study group Vs Control group



Graph 10: ECG parameters of Study group Vs Control group

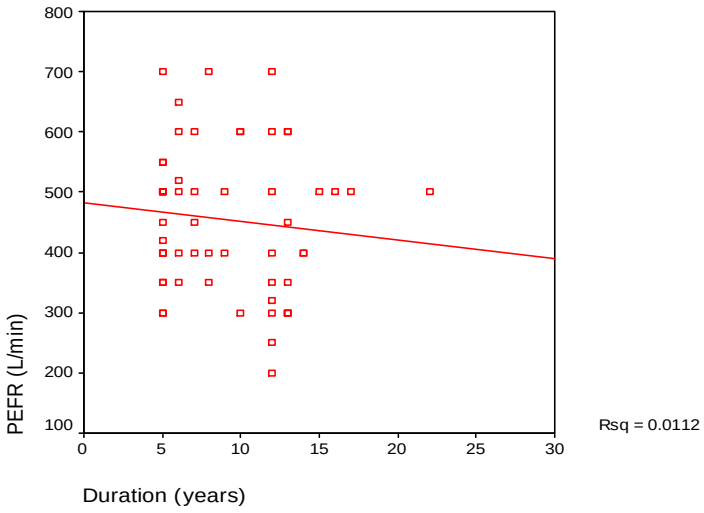


Graph 11: ECG parameters of Study group Vs Control group

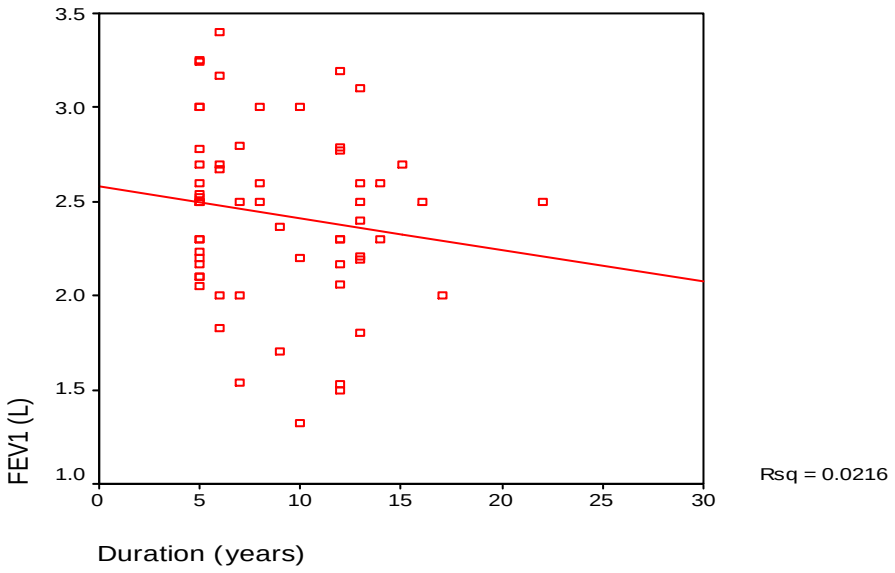


Linear Regression and coefficient of determination (r^2) were used to examine the strength of association of duration of exposure to sugarcane dust with lung function tests. A coefficient of determination with the maximum possible value of 1.0 would suggest a perfect predictability between dust exposure and non dust exposure. A coefficient of determination at a value of 0.07 would suggest that there is minor degree of correlation.

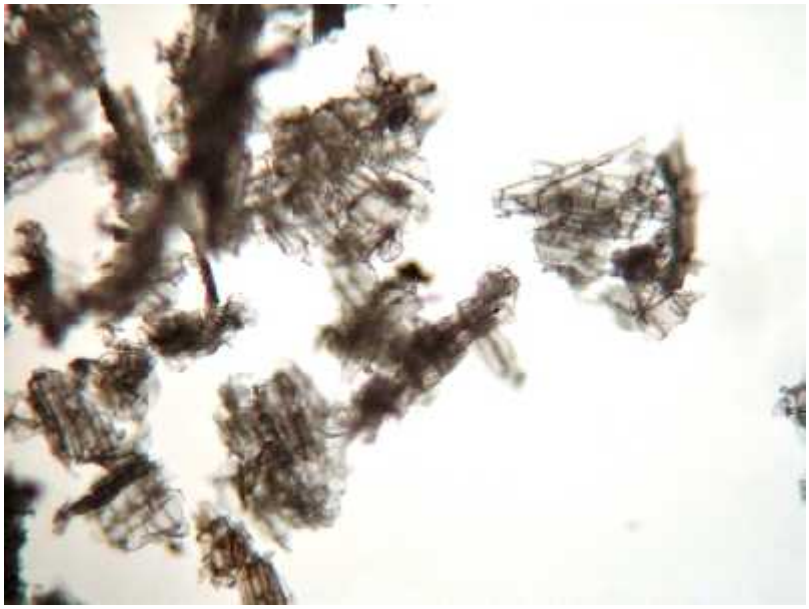
Graph 12 - Correlation between PEFR and Duration shows negative correlation. (R^2= -0.0112)



Graph 13 - Correlation between FEV1 and Duration Shows negative correlation. (R^2values= -0.0216)



Graph 14 – Sugarcane particle size



Sizes of particles ranged from 0.1 mm to 1mm

Average thickness of fibers ranged from 0.1 mm to 0.3 mm

Average thickness of fibers ranged from 1mm to 10mm.

DISCUSSION

The present study was undertaken on 60 sugarcane factory workers of North Karnataka who were exposed to sugarcane dust applying necessary inclusion and exclusion criteria as mentioned earlier. The subjects of study group (sugarcane factory workers with minimum of 5years exposure) were screened with proper history taking with special reference to history of occupation (questionnaire[66]). They were subjected to detailed clinical examination.

The experimental group was compared with 60 age matched sugarcane factory workers who were not exposed to dust from the same factory constituted control group.

Anthropometric Parameters

No significant changes were observed in Anthropometric parameters among study group compared to that of control group

Physiological Parameters

No significant changes were observed in Physiological parameters among study group compared to control group

Respiratory Parameters:

RR:

No significant changes were observed in respiratory rate among study group compared to control group

FVC:

No significant changes were observed in Forced Vital Capacity among study group compared to control group.

FEV1:

In the present study, significant reduction of FEV1 in Bagasse workers compared with controls indicated obstructive type of pulmonary abnormalities

Reduced FEV1 was earlier reported by Bohadana et al[56] They showed that workers who were exposed to sugar dust in the sugar cube manufacture workstation had significantly lower FEV1 than the non-exposed ones.

Goyal R.C. et al[57] also observed a decrease in FEV1 in workers actively involved in various plant operations of sugar factory.

A possible mechanism could be mobilization of Neutrophils into the airways and the subsequent release of tissue irritating substances either directly from Neutrophils via Platelets or by secretion of Prostaglandins from macrophages[58.]

FEV1%:

We did not find any significant reduction of FEV_1% in study group as compared to that of control group.

Insignificant change in FEV_1% among sugarcane factory workers exposed to sugarcane dust may be due to the fact that FEV_1% is more sensitive indicator of airway obstruction than FVC or FEV_1 alone in the later part of chronic obstructive lung diseases. Perhaps, our results of FEV_1% among sugarcane factory workers exposed to sugarcane dust indicate the early part of small airway diseases [59.]

PEFR:

The remarkable change was decrease in the values of PEFR in study group as compared to control group.

PEFR is one of the important and simple respiratory function tests. It is frequently used for the recognition of asthma, assessment of severity of airway obstruction in bronchial asthma and other obstructive airway diseases, in monitoring

the response to the treatment of patients with airway obstruction as well as in the early diagnosis of occupational lung diseases [60.]

The reduction in PEFR in workers might be due to inflammatory changes in the respiratory tract which led to an increased airway resistance and physically impeding the normal lung function as a result of the dust exposure.

As PEFR is more effort dependent and an index of expiratory airway resistance, it reflects the caliber of the bronchi and large bronchioles. Hence, the reduction in PEFR may be due to obstructive lesion.

A highly significant decrease in PEFR observed in our study. Is in agreement with observations made by Patil S.N, Fatusi and Erhabor (1996), Okwari et al (2005) and Ugheoke et al (2006)[61,62.]

Our results are similar to the findings of Mohammad Shadab et al[63] where a decrease in PEFR, decrease in FEV_1 with normal FVC were observed. Results of our study clearly indicate an obstructive pattern of impaired lung functions possibly at smaller airways among the sugarcane factory workers exposed to sugarcane dust working for more than five years.

A study conducted in the year 2013 showed a significant reduction in percent predicted values and mean values of PEFR between sweepers and their matched controls. Pulmonary function tests after sweeping showed a significant decrease. On comparing the pulmonary functions of sweepers before and after sweeping, it was concluded that inhalation of dust acutely affected the lung functions of sweepers and that sweepers were at a risk of developing occupation related lung function impairment.

In a study conducted in the year 2011, it was noticed that there was a significant reduction in the mean values of PEFR in demolition workers as compared

with their matched controls. An impairment in lung function parameters was in proportion to the duration of exposure was observed in study group.

According to a study in 2007, a significant gradual reduction of lung volumes and PEFR was observed as duration of exposure was increased in manufacturing workers. Among office workers, working experience did not significantly alter pulmonary functions and PEFR.

MEP:

No significant changes were observed in Mean Expiratory Pressure among study group compared to control group.

ECG changes:

The study also showed no significant change in the heart rate although significant increase in PP interval, PR interval and ST segment among the factory workers exposed to dust in comparison to control group.

The observed ECG changes were suggestive of possible slow atrio ventricular conduction in factory workers who were exposed to dust.

The observed ST segment elevation in case of factory workers who were exposed to sugarcane dust may be due to early repolarization[64.] The electrocardiographic observations may be considered as indicator of greater cardiac efficiency and healthy life style with humanization of work environment.

Dust particle:

Non skilled sugarcane factory workers were exposed to dust. Hence, dust particle size was evaluated using optical microscope. On an average, sizes of 50 dust particles were measured (Average size: 0.1mm, Thickness: 0.3-0.1mm and Length: 1-10mm). Dusts are finely divided solid particles with size ranging from 0.1 to 150

microns. They are produced in number of industries like- mines, foundry, quarry, pottery, sugarcane, textile, wood or stone working.

Dust particles larger than 10 microns settle down from air rapidly, while the smaller ones remain suspended indefinitely. Particles smaller than 5microns are directly inhaled into the lungs are retained there. This fraction of the dust is called 'respirable dust' and is mainly responsible for pneumoconiosis[1.]

According to Harrison[65] (2005), occupational asthma is a significant health problem. The agents responsible are classified into:

1) High molecular weight compounds: They induce asthma through the immunological mechanisms.

For example:

a) Stone and vegetable dust.

b) Pharmaceutical agents [Ex: Antibiotic]

c) Biological enzymes [Ex: Laundry detergents].

d) Animal and insect dusts [Ex: Sera and secretions].

2) Plastic and western red cedar: They serve as haptens or release bronco constrictor substance. The particles are classified two groups:

A. More than 10-15 micrometers: They do not penetrate beyond the upper air ways due to setting velocities in the air [Ex-Pollens, stone and blown dusts].

B. Less than 10 micrometers: They are subdivided into three groups:

a. 2.5 to 10 micrometers: They are coarse. Ex: Silica, Aluminum and Iron .They deposit in tracheo bronchial tree.

b. 0.1 to 2.5 micrometers : They are fine mode fraction or accumulation mode. They are carried to lower air ways.

c. Less than 0.1 micrometers: They are ultra fine fraction. They tend to remain in air stream and deposit in lungs only on a random basis as they come in contact with alveolar walls.

In addition to the size of the particles, other factors that play a role in nature of diseases are as follows:

1 .Solubility of gases

2. Actual chemical composition

3. Mechanical property

4. Immuno density

5. Infectivity.

PREVENTIVE ASPECT[1]

1. The workers should wear masks during processing & crushing of sugarcane.
2. Suppression of dust by technical control measures such as pre wetting & water sprinkling.
3. Pre employment medical examination & yearly medical checkup of workers.
4. Pulmonary function tests & X –ray chest should be done once in a year after one year of exposure
5. Sputum examinations should be done from time to time to make certain about other Lung infections.

CONCLUSION

The decline in FEV1 and PEFR in the present study is suggestive of obstructive changes in lungs. Decrease in these parameters were in linear relation to duration of exposure

These changes in parameters could be possibly due to physical & chemical nature of leading to airway obstruction and respiratory muscle weakness.

The study demonstrated significant pulmonary dysfunction in the sugar factory workers, thereby suggesting that occupational exposure to Bagasse led to pulmonary impairment. Longer the duration of occupational exposure to the organic dust (Bagasse) more is the pulmonary impairment in sugar factory workers.

Based on the present study, we conclude that airborne particulate materials like Bagasse, asbestos, lead, silica dust, concrete, cement, stone, sand and other dusts adversely affect the pulmonary function parameters such as FVC, FEV1, FEV1/FVC%, PEFR and FEF25-75% and cause an obstructive pattern of lung diseases [56.] Values of PEFR were significantly reduced as compared to that of control group. We attribute this reduction in lung function test to respiratory muscle weakness.

Hence, we propose repeated recording of simple, non invasive and dynamic lung function test like PEFR in subjects who are exposed to dust may help to assess the prognosis in clinical practice.

Breathing exercises may help in strengthening the respiratory muscles and will improve the lung functions.

All the Physiological parameters evaluated were within normal range. The changes in ECG parameters were suggestive of possible slow atrio ventricular conduction in factory workers who were exposed to dust.

The observed ST segment in case of factory workers who were exposed to sugarcane dust may be due to early repolarization. The electrocardiographic observations may be considered as indicator of greater cardiac efficiency and healthy life style with humanization of work environment.

SUMMARY

A study was carried out to determine the effect of sugarcane dust on pulmonary functions and ECG. The study group consisted of 60 male workers exposed to sugarcane dust with minimum of 5years of duration. The control group comprised of 60 age matched male workers from the same factory who were non exposed office workers.

Detailed anthropometric and physiological data were recorded. Pulmonary functions were recorded by using Computerized Spiro excel. The parameters pertinent to the study were Forced Vital Capacity (FVC), Forced Expiratory Volume in 1^{st} sec (FEV1) & FEV1 %, Peak Expiratory Flow Rate [PEFR was recorded by mini Wright's Peak flow meter in L/min] and Maximum Expiratory Pressure [MEP was recorded by Modified Black's apparatus in mmHg].

A 12 lead electrocardiogram was recorded using a BPL cardiaart 108T/MKECG machine in each subject in resting supine position.

Statistical analysis was done by calculating Mean±SD by using Student's t-test. Correlation between duration of exposure and pulmonary functions was done by Pearson's correlation.

No significant difference was observed in anthropometric and physiological parameters between the study and control groups.

PEFR and FEV1 were significantly reduced in study group as compared to controls. A significant negative correlation was observed between duration of exposure and values of FEV1% and PEFR.

All the Physiological parameters evaluated were within normal range. The observed ECG changes were suggestive of possible slow atrio ventricular conduction in factory workers who were exposed to dust.

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ANNEXURE - 1

B.L.D.E. UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103
INSTITUTIONAL ETHICAL COMMITTEE

BIJAPUR-586 103
OUTWARD
No. 0466/12
Date 18/10/12

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 18-10-2012 *at* 3-30pm *to scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis has been accorded Ethical Clearance.*

Title "A Study of effect of occupational exposure to Sugarcane dust on pulmonary functions & electro-cardiogram in Sugarcane factory workers of Bijapur and Bagalkot Districts"

Name of P.G. student Dr. Yogita Khade

Physiology

Name of Guide/Co-investigator Dr Manjunatha Asthala

Prof & HOD. Physiology

DR.TEJASWINI VALLABHA
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

ANNEXURE - 2

B. L. D. E. U SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE, BIJAPUR

RESEARCH INFORMED CONSENT FORM

Title of the project

"A STUDY OF EFFECT OF OCCUPATIONAL EXPOSURE TO SUGARCANE DUST ON PULMONARY FUNCTIONS AND ELECTROCARDIOGRAM IN SUGARCANE FACTORY WORKERS OF BIJAPUR AND BAGALKOT DISTRICTS"

Principal investigator/ P.G. Guide's name: **DR. MANJUNATHA AITHALA** MD

PROF AND HEAD, DEPARTMENT OF PHYSIOLOGY

1. PURPOSE OF RESEARCH: I have been informed that this study will test relationship between exposure to dusty environment and changes in respiratory function and ECG parameters in sugarcane factory workers.

This study will be useful academically to find out association between exposure of individual to dust and changes in pulmonary functions and ECG.

2. PROCEDURE: I understand that, the procedure of the study will involve determination of changes in Respiratory functions and ECG in sugarcane factory workers. The procedure will not interfere with any of my physiological parameters and they are non invasive

3. RISK AND DISCOMFORTS: I understand that, determination of changes in respiratory functions and ECG in sugarcane factory workers will not cause any discomfort to me and do not involve any risk to my health.

4. BENEFITS**:** I understand that my participation in the study may not have a direct benefit to me but this may have a potential beneficial effect in the field of Cardiorespiratory disorders.

5. CONFIDENTIALITY**:** I understand that medical information produced by this study will become part of institutional records and will be subject to the confidentiality and privacy regulation of the said institute. Information of a sensitive personal nature will not be a part of medical record, but will be stored in investigator's research file and identified only by a code number. The code key connecting name two numbers will be kept in a separate secured location.

If the data to be used for publication in the medical literature and for teaching purpose no names will be used and other identities such as photographs, audio and video tapes will be used only with my special written permission. I understand I may see the photographs and the video tapes and have the audio tapes before giving this permission.

6. REQUEST FOR MORE INFORMATION: I understand that I may ask more questions about the study at any time. Concerned researcher is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of this study which might influence my continued participation. If during the study or later, I wish to discuss my participation in all concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. A copy of this consent form will be given to me to keep for careful readings.

7. REFUSAL OR WITHDRAWAL OF PARTICIPATION: I understand that my participation is voluntary and may refuse to participate or may withdraw my consent and discontinue participation in the study at any time without prejudice to my present

or future care at this hospital. I also understand that researcher may terminate my participation in this study at any time after she/he has explained the reasons for doing so and had helped arrange for my continued care by my physician or physical therapist if this is appropriate.

8. INJURY STATEMENT: I understand that in unlikely event of injury to me resulting directly from my participation in this study, if such injury is reported promptly, then medical treatment will be available to me, but no further compensation would be provided. I understand that by my agreement to participate in this study I am not waiving any of my legal rights.

I have explained to _____ (Name of subject) the purpose of the research, the procedure required and the possible risk and benefits to the best of my ability.

Investigator/PG (Guide) Date

I confirm that Dr Yogita Khade has explained to me the purpose of research, the study procedure that I will undergo, and the possible risk and discomforts as well as benefits that I may experience. Alternative to my participation in the study, I have also been to give my consent form. Therefore, I agree to give consent to participate as a subject and this research project.

Participant Date:

Signature of witness Date:

Modified from Portney L.G. Watkins M.P., in Foundation of Clinical Research, Second Edition, New Jersey, Prentice Hall Health 2000.

ANNEXURE-3

QUESTIONNAIRE[66.]

Respiratory Questionnaire to exclude any respiratory function deterioration.

1. Occupational history (present and past job)

Industry and location, Type of job, Exposure in yrs.

a. Have you worked in dusty job? yes/no

In mine, quarry, foundry, pottery, cotton mill, sugarcane,

Glass plant or any other.

b.Have you worked with chemicals? yes /no

Solvents, acid, lead, plastic etc.

2. Previous illness yes /no

Asthma, chronic bronchitis, pneumonia, tuberculosis, Pleurisy and heart problems.

3.symotoms

a. Cough: yes/no

Do you usually cough first time in the morning?

Do you usually cough at other times during day or night?

Do you cough on most days for as much as three months of the year?

For how many years have you had this cough?

- ≤ 2years
- 2-5 years
- 5 years or more.

Do you cough more on any particular day of the week?

Do you cough during any particular season of the year?

b. Sputum: yes/no

Do you usually bring of phlegm, sputum or mucus from your chest first time in the morning?

Do you usually bring of phlegm or mucus from your chest at other times of the day or night?

Do you usually bring of phlegm, sputum or mucus from your chest on most days for as much as three months of the year?

From how many years have raised phlegm sputum or mucus from your chest?

- ≤ 2years
- 2-5 years
- 5 years or more.

a. Wheezing: yes/no

Does your breathing is wheezy?

Have you ever had a feeling of tightness in your chest?

Have you ever had attack of shortness of breath with wheezing?

At what age, did wheezing first occur?

How frequently does wheezing occur?

- Day or night
- A few times per week
- A few times per month
- Is it worse on any particular day of the week? which day

b.Breathlessness: yes/no

- Do you get short of breath while walking on ground?
- Do you get short of breath while walking up stairs?
- How many flights of stairs can you climb up without stopping?

≥1-2

≥1-3

More than 3

c.Haemoptysis yes/no

- Have your coughed blood from your chest?
- If yes, when was this last time happened?

B.L.D.E.U'S Shri B.M. Patil Medical College, Bijapur

Department of Physiology

CLINICAL PROFORMA

Title: "A STUDY OF EFFECT OF OCCUPATIONAL EXPOSURE TO SUGARCANE DUST ON PULMONARY FUNCTIONS AND ELECTROCARDIOGRAM IN SUGARCANE FACTORY WORKERS OF BIJAPUR AND BAGALKOT DISTRICTS"

Name:

Age:

Sex:

Address & phone no:

General physical examination

PR: BP: Wt: Ht:

Temperature: RR:

Systemic Examination:

Cardiovascular system:

Respiratory system:

Central nervous system:

Per abdomen

PARAMETERS FOR STUDY

Pulmonary function tests:	I	II	III	Best
1. FVC (in ml)				
2. FEV1(in ml)				
3. FEV 1%(%)				
4. PEFR (in L/min).				
5. MEP (in mmHg).				

II. Record of Electrocardiogram (ECG):

1. Heart rate:
2. Rhythm:
3. 'P' wave:
4. PR interval:
5. ST segment:
6. QRS complex:
7. QT interval:
8. QTc interval:
9. QRS frontal axis:
10. T wave:
11. Amplitude of 'R' wave:
12. Amplitude of 'S' wave:

Signature of PG student **Signature of Guide and HOD**

ANNEXURE 4a: MASTER CHART - CONTROL GROUP

SI.	AGE	HT	WT	BMI	BSA	PR	RR	SBP	DBP	MAP	FVC	FEV1	FEV1%	PEFR	MEP	HR	P	PR int	ST seg	QRS	QT	QTc	T	Amp 'R'	Amp 'S'
1	32	160	65	25.3	1.7	90	22	130	70	90	2.7	3.4	84.7	600	120	62.5	0.1	0.14	0.1	0.12	0.4	0.41	0.16	0.8	0
2	45	165	65	23.8	1.7	86	22	120	60	80	3.4	3.09	93	700	90	93.75	0.1	0.14	0.08	0.12	0.36	0.45	0.16	1.5	0.2
3	29	153	52	22.2	1.5	80	20	130	90	104	3.2	2.7	89.4	550	100	83.3	0.08	0.1	0.08	0.1	0.32	0.38	0.08	1	0.2
4	48	155	68	28.3	1.6	80	20	140	90	106	3.01	2.81	93.36	500	60	78.9	0.1	0.14	0.12	0.12	0.36	0.41	0.12	0.8	0.2
5	36	180	90	27.7	2.1	80	20	140	80	100	4.2	3.4	84.4	500	80	83.3	0.08	0.12	0.1	0.12	0.36	0.42	0.12	0.7	0.3
6	24	155	62	21.6	1.5	80	20	120	60	80	3.05	2.9	98	550	100	48.3	0.1	0.14	0.12	0.12	0.4	0.41	0.12	1.3	0.2
7	39	160	53	20.7	1.5	80	20	120	80	94	3.5	1.9	57.7	550	90	83.3	0.12	0.16	0.08	0.12	0.32	0.38	0.12	1.7	0
8	46	166	50	18.1	1.5	64	16	110	70	84	3	2.3	88.4	450	90	57.6	0.08	0.14	0.12	0.1	0.36	0.36	0.12	0.8	0
9	49	160	82	32	1.8	60	15	130	80	96	3	2.7	94	700	90	68.1	0.1	0.16	0.12	0.1	0.4	0.44	0.16	0.6	0
10	45	167	80	28.7	2	106	26	140	90	106	3.5	2.4	86.1	550	80	88.2	12	0.16	0.08	0.12	0.36	0.45	0.12	0.12	0.6
11	44	173	78	26	2	85	22	120	70	86	2.9	2.3	78.7	450	100	68.1	0.1	0.16	0.08	0.12	0.4	0.43	0.16	0.5	0.3
12	55	163	65	24.5	1.7	86	22	130	70	90	2.4	2.1	87.5	500	60	75	0.08	0.12	0.08	0.12	0.36	0.4	0.12	0.8	0
13	43	164	80	29.8	1.8	76	19	140	80	100	1.8	1.6	91.8	600	80	60	0.12	0.14	0.12	0.12	0.4	0.4	0.16	2	0
14	27	168	53	18.7	1.6	76	19	130	80	100	3.9	3.4	93.2	500	110	60	0.1	0.14	0.12	0.12	0.4	0.4	0.14	1.3	0.1
15	33	165	54	19.8	1.58	84	21	130	90	104	2.8	2.6	93	500	70	71.4	0.12	0.16	0.08	0.12	0.4	0.44	0.12	1.3	0.2
16	27	163	52	19.6	1.5	76	19	120	70	86	4	3.3	82.5	450	80	62.5	0.1	0.14	0.12	0.12	0.4	0.41	0.14	1.5	0
17	38	173	92	30.7	2.8	80	20	120	80	94	2.8	2.8	99	600	90	78.9	0.08	0.12	0.08	0.08	0.32	0.37	0.12	0.6	0
18	39	165	72	26.4	2	76	19	120	80	94	2.8	2.5	88	600	80	75	0.08	0.12	0.1	0.12	0.36	0.4	0.12	0.6	0.2
19	37	164	75	28	2	88	22	130	80	96	2.9	2.3	91.1	500	90	68.1	0.08	0.12	0.08	0.1	0.4	0.44	0.12	1	0
20	26	165	65	24	1.7	74	18	120	70	86	3	3	92.6	450	110	71.4	0.08	0.12	0.08	0.12	0.36	0.38	0.12	1.6	0
21	44	154	60	25.3	1.5	80	20	130	80	96	2.5	2.1	83	500	80	71.4	0.12	0.14	0.14	0.12	0.4	0.43	0.16	1.1	0
22	39	154	66	28	1.6	90	22	140	80	100	2.4	2.2	100	500	50	93.7	0.1	0.16	0.08	0.12	0.4	0.5	0.16	0.4	0.2
23	25	178	86	27.3	1.98	90	22	120	80	94	3.3	2.9	89	500	100	71.4	0.1	0.16	0.08	0.12	0.36	0.4	0.12	1.1	0.1
24	36	170	87	30.1	2	80	20	140	90	106	1.9	1.9	100	500	30	88.2	0.08	0.12	0.08	0.12	0.36	0.42	0.12	0.8	0
25	40	158	67	26	s	82	20	150	90	110	2.08	2	96	700	80	78.9	0.1	0.12	0.1	0.12	0.36	0.41	0.12	1.4	0
26	40	160	64	25	1.68	82	20	130	80	96	2.45	2	84.4	500	40	75	0.1	0.14	0.12	0.12	0.4	0.45	0.12	0.9	0
27	40	158	60	24	1.6	84	21	120	80	94	2.15	2	97	550	100	71.4	0.1	0.14	0.08	0.12	0.36	0.4	0.16	0.8	0.1
28	42	163	100	37.7	2.4	74	18	140	90	106	3.5	3.2	92	550	60	78.9	0.08	0.12	0.08	0.12	0.32	0.37	0.1	0.6	0.1
29	36	165	68	25	1.76	76	19	126	86	100	2.4	2	89	450	70	75	0.08	0.1	0.12	0.12	0.4	0.42	0.16	0.8	0.1
30	28	164	72	27.4	1.78	82	20	140	80	100	2.8	2.5	89	600	100	75	0.08	0.12	0.12	0.1	0.36	0.4	0.12	1	0.3

SI. No	AGE	HT	WT	BMI	BSA	PR	RR	SBP	DBP	MAP	FVC	FEV1	FEV1%	PEFR	MEP	HR	P WAVE	PR int	ST seg	QRS com	QT int	QTc int	T wave	Amp ‘R’	Amp ‘S’
31	36	155	55	22.9	1.54	90	22	120	80	94	3.4	2.8	84.8	600	60	75	0.08	0.1	0.08	0.1	0.3	0.36	0.16	0.7	0
32	26	168	62	21.9	1.7	74	18	128	86	100	2.5	2.5	99.4	600	70	65.2	0.08	0.12	0.08	0.12	0.4	0.44	0.16	1.4	0.3
33	26	160	48	18.7	1.48	67	17	100	65	74	3.1	2.6	86	500	100	57.6	0.08	0.12	0.12	0.12	0.4	0.4	0.14	1.5	0.2
34	43	165	73	26.8	1.6	65	16	130	80	96	3.4	2.72	87	550	60	57.6	0.12	0.14	0.12	0.12	0.4	0.4	0.12	1.1	0.05
35	28	165	75	27.5	1.82	70	17	130	70	90	3.6	3.1	94.3	600	70	68.1	0.08	0.12	0.08	0.12	0.36	0.4	0.12	1.6	0
36	46	160	65	25.3	1.68	88	22	110	70	84	2.45	2.3	94	600	50	75	0.1	0.16	0.08	0.1	0.36	0.4	0.12	0.9	0
37	34	160	54	21	1.56	52	13	120	80	94	3	2.5	91	500	70	50	0.1	0.12	0.12	0.1	0.4	0.37	0.16	0.9	0
38	35	180	84	25.9	2.41	68	17	120	80	94	3.41	3.1	91	700	120	75	0.08	0.12	0.12	0.12	0.4	0.44	0.14	1.1	0
39	39	160	75	29.2	1.78	75	19	130	90	104	3	2.75	96.7	700	120	62.5	0.08	0.12	0.1	0.1	0.36	0.38	0.16	1	0.1
40	48	172	80	27	1.94	89	22	140	80	100	2.66	2.4	90.23	500	40	75	0.1	0.16	0.08	0.12	0.36	0.41	0.12	1	0.1
41	27	164	63	22.6	1.7	79	20	120	80	94	3.2	3.2	92	600	70	83.3	0.08	0.12	0.08	0.08	0.32	0.38	0.12	0.4	0.3
42	23	170	75	25.9	1.88	73	18	136	80	96	3.4	3.38	99.7	650	120	68.1	0.08	0.12	0.16	0.1	0.4	0.43	0.12	0.9	0.1
43	30	160	66	25.7	1.7	85	21	120	80	94	3.09	2.51	83.39	500	120	75	0.12	0.16	0.08	0.12	0.36	0.4	0.12	1	0.1
44	33	170	82	28.3	1.94	79	20	120	80	94	3.13	2.94	99.31	650	80	71.4	0.1	0.12	0.08	0.12	0.36	0.4	0.12	1.3	0
45	48	160	60	23.4	1.62	94	23	140	90	106	2.51	2.44	97.21	550	80	78.9	0.08	0.12	0.08	0.12	0.4	0.46	0.14	0.5	0.2
46	48	152	52	22.5	1.48	70	17	140	90	106	1.72	1.59	93.1	300	30	60	0.08	0.1	0.08	0.12	0.36	0.4	0.12	0.5	0.2
47	32	155	60	25	1.58	65	14	140	90	106	2.72	2.36	93.28	400	80	55.5	0.1	0.14	0.12	0.12	0.36	0.35	0.12	0.4	0.1
48	42	155	68	28.3	1.66	86	21	130	80	96	2.78	2.55	89.79	600	140	75	0.08	0.12	0.08	0.12	0.36	0.41	0.16	1.2	0
49	50	160	70	27.3	1.74	80	20	140	90	106	3.13	2.81	96.56	600	90	71.4	0.12	0.16	0.12	0.12	0.4	0.44	0.12	1.1	0
50	41	158	71	28.5	1.72	82	20	140	90	106	2.7	2.67	98.89	500	90	60	0.1	0.12	0.08	0.1	0.36	0.36	0.14	0.8	0
51	41	168	82	30.1	1.9	87	22	130	90	104	2.64	2.5	94.7	600	120	71.4	0.1	0.14	0.08	0.12	0.36	0.4	0.16	0.8	0.1
52	37	156	66	27.1	1.68	70	17	130	70	90	3.17	2.46	83.11	600	110	62.5	0.08	0.1	0.08	0.12	0.4	0.42	0.12	1.8	0
53	37	170	68	23.5	1.8	95	24	140	80	100	2.98	2.66	95.2	700	100	83.3	0.1	0.16	0.08	0.12	0.36	0.42	0.16	1.6	0.2
54	40	158	70	28.1	1.72	80	20	120	80	94	3.01	2.6	91.2	600	70	71.4	0.12	0.16	0.12	0.08	0.36	0.4	0.12	0.5	0.2
55	34	163	62	23.3	1.66	78	18	130	80	96	2.5	2.4	90	500	90	53.5	0.1	0.12	0.1	0.1	0.36	0.34	0.16	1.2	0
56	40	160	65	25.3	1.68	82	21	120	80	94	3.2	2.8	92	450	90	75	0.12	0.16	0.12	0.1	0.3	0.4	0.16	1.7	0
57	42	160	62	24.2	1.68	76	19	130	90	104	3.15	2.51	89	400	80	88.2	0.1	0.14	0.12	0.12	0.36	0.45	0.16	0.3	0.3
58	38	161	61	23.5	1.64	75	19	114	82	92	2.8	2.75	92	500	90	60	0.12	0.16	0.12	0.08	0.36	0.36	0.16	0.5	0
59	30	172	79	26.6	1.94	70	17	120	76	90	3.2	3.2	93.26	600	70	60	0.1	0.14	0.08	0.12	0.36	0.36	0.16	0.8	0.1
60	50	166	50	18.1	1.54	66	16	120	70	86	2.5	2.4	91.2	550	100	60	0.08	0.12	0.12	0.1	0.36	0.36	0.16	1.2	0.1

ANNEXURE 4b: MASTER CHART - STUDY GROUP

SI.	AGE	HT	WT	BMI	BSA	PR	RR	SBP	DBP	MAP	FVC	FEV1	FEV1%	PEFR	MEP	HR	P WAVE	PR int	ST seg	QRS com	QT int	QTc int	T wave	Amp 'R'	Amp 'S'
1	37	150	60	26.6	1.56	80	20	150	90	110	2	1.5	81	400	70	37	150	60	26.6	1.56	80	20	150	90	110
2	31	158	58	23.3	1.58	90	22	130	80	96	3	2.5	84.6	400	110	31	158	58	23.3	1.58	90	22	130	80	96
3	46	157	76	30.4	1.78	80	20	130	90	104	3	2.5	86.1	400	70	46	157	76	30.4	1.78	80	20	130	90	104
4	28	176	71	23.6	1.8	90	22	120	80	94	4.25	2.2	52.47	300	90	28	176	71	23.6	1.8	90	22	120	80	94
5	46	184	95	28.1	2.2	84	21	140	90	106	2.98	2.8	41.12	200	100	46	184	95	28.1	2.2	84	21	140	90	106
6	40	160	71	27.7	1.74	70	17	130	90	104	2.66	2.2	90.13	550	110	40	160	71	27.7	1.74	70	17	130	90	104
7	39	153	62	26.4	1.6	80	20	130	90	104	3.21	2.8	90.75	500	110	39	153	62	26.4	1.6	80	20	130	90	104
8	35	153	70	29.9	1.68	70	17	130	80	96	2.35	2.2	96	600	90	35	153	70	29.9	1.68	70	17	130	80	96
9	39	165	63	23.1	1.7	62	15	130	80	96	2.33	2.2	94	450	50	39	165	63	23.1	1.7	62	15	130	80	96
10	41	165	65	23.8	1.72	70	17	130	90	104	2.9	2.6	92.1	500	40	41	165	65	23.8	1.72	70	17	130	90	104
11	38	154	64	27	1.62	71	17	120	80	94	2.5	2.2	91.9	500	90	38	154	64	27	1.62	71	17	120	80	94
12	50	155	60	25	1.6	76	19	140	90	106	2.5	2.5	97	500	110	50	155	60	25	1.6	76	19	140	90	106
13	25	173	68	22.7	1.8	77	19	140	80	100	2.9	2.5	90.2	400	60	25	173	68	22.7	1.8	77	19	140	80	100
14	27	170	65	22.4	1.7	77	19	120	80	94	2.7	2.3	94.3	300	80	27	170	65	22.4	1.7	77	19	120	80	94
15	35	167	73	26.2	1.8	88	22	140	90	106	2.7	2.5	95.8	400	60	35	167	73	26.2	1.8	88	22	140	90	106
16	31	155	50	20.8	1.5	81	20	100	60	74	2.9	2.7	98.8	350	70	31	155	50	20.8	1.5	81	20	100	60	74
17	35	163	64	24.1	1.7	77	19	120	80	94	2.86	2.5	97.5	400	100	35	163	64	24.1	1.7	77	19	120	80	94
18	25	165	50	18.3	1.54	95	24	120	64	80	3.6	3.3	93.3	300	70	25	165	50	18.3	1.54	95	24	120	64	80
19	28	170	73	25.2	1.86	94	23	120	80	94	2.43	2.2	90.5	250	70	28	170	73	25.2	1.86	94	23	120	80	94
20	25	177	63	20.1	1.78	82	20	120	74	86	3.35	2.8	87.1	200	70	25	177	63	20.1	1.78	82	20	120	74	86
21	39	160	70	27.3	1.74	75	19	134	76	96	2.29	2.1	89.52	400	50	39	160	70	27.3	1.74	75	19	134	76	96
22	32	160	54	21	1.58	97	24	130	80	96	2.88	2.7	97	400	80	32	160	54	21	1.58	97	24	130	80	96
23	35	153	65	27.7	1.62	66	16	130	72	90	2.2	1.8	93.4	250	90	35	153	65	27.7	1.62	66	16	130	72	90
24	39	153	68	29	1.66	81	20	128	76	94	2.6	2.6	98	350	90	39	153	68	29	1.66	81	20	128	76	94
25	33	155	62	26	1.6	76	19	120	80	94	2.8	2.4	86.5	350	60	33	155	62	26	1.6	76	19	120	80	94
26	43	165	70	25.7	1.7	78	19	130	90	104	2.9	2.5	89.9	450	100	43	165	70	25.7	1.7	78	19	130	90	104
27	24	160	55	21.4	1.6	90	22	120	80	94	3.2	3	95.5	500	80	24	160	55	21.4	1.6	90	22	120	80	94
28	34	165	60	22	1.6	72	18	120	80	94	2.8	2.7	98	400	60	34	165	60	22	1.6	72	18	120	80	94
29	31	155	78	28.6	1.8	78	18	110	70	84	3	2.6	93.8	350	60	31	155	78	28.6	1.8	78	18	110	70	84
30	30	160	53	20.7	1.5	62	15	110	60	76	2.8	2.5	89.3	250	60	30	160	53	20.7	1.5	62	15	110	60	76

Sl. No	AGE	HT	WT	BMI	BSA	PR	RR	SBP	DBP	MAP	FVC	FEV1	FEV1%	PEFR	MEP	HR	P WAVE	PR int	ST seg	QRS com	QT int	QTc int	T wave	Amp 'R'	Amp 'S'
31	25	172	54	18.2	1.6	74	18	110	70	84	2.8	2.5	94.2	400	70	62.5	0.12	0.2	0.12	0.12	0.4	0.42	0.16	1.4	0
32	49	156	60	24.6	1.6	72	18	140	90	106	2.2	2	91.4	400	80	71.4	0.12	0.16	0.12	0.12	0.4	0.42	0.16	1.5	0
33	34	160	65	25.3	1.6	66	16	110	70	84	2.4	2.1	93.7	300	60	53.5	0.12	0.16	0.14	0.1	0.4	0.4	0.16	0.6	0
34	35	158	90	36.1	1.9	78	19	130	80	96	2.8	2.6	97.5	200	100	62.5	0.12	0.16	0.16	0.1	0.4	0.41	0.16	0.3	0.2
35	33	170	50	17.3	1.5	80	20	120	80	94	2.6	2.3	96	400	70	71.4	0.08	0.12	0.12	0.1	0.36	0.4	0.16	0.7	0.3
36	48	152	52	22.5	15	70	17	130	90	104	1.7	1.5	93.1	100	30	78.9	0.12	0.16	0.12	0.12	0.4	0.4	0.16	1	0
37	40	165	62	22.7	1.6	72	17	140	80	100	2.4	2.3	97	200	40	71.4	0.12	0.16	0.12	0.12	0.36	0.38	0.14	1.3	0
38	54	155	87	36.2	1.8	98	24	130	80	96	2.7	2.5	90	200	70	78.9	0.12	0.2	0.1	0.12	0.32	0.38	0.12	0.6	0.1
39	43	156	65	26.7	1.6	94	23	130	80	96	2.3	2	89.1	300	100	83.3	0.1	0.16	0.08	0.08	0.32	0.38	0.12	1.2	0.05
40	35	165	58	21.3	1.6	76	19	120	80	94	2.5	2.3	97.5	400	100	60	0.08	0.12	0.12	0.1	0.36	0.36	0.16	1.4	0
41	25	168	79	28	1.9	88	22	130	70	90	3.9	3	96.5	500	100	60	0.12	0.16	0.08	0.16	0.36	0.36	0.16	1.5	0
42	37	168	66	23.7	1.7	80	20	120	80	94	3.2	3.1	98	500	80	75	0.08	0.1	0.1	0.1	0.36	0.38	0.16	1.1	0.3
43	31	175	69	23	1.8	70	17	120	80	94	3.4	3.4	98	500	80	71.4	0.12	0.16	0.08	0.12	0.36	0.39	0.16	1.1	0.2
44	25	168	60	21.2	1.7	84	21	120	80	94	3.4	3	87.6	450	50	65.2	0.12	0.16	0.12	0.12	0.4	0.43	0.16	1.4	0
45	28	158	68	27.3	1.7	97	24	140	80	100	2.2	2.1	95.5	500	60	75	0.12	0.16	0.08	0.12	0.36	0.36	0.16	0.9	0
46	46	158	63	25.3	1.6	96	24	140	80	100	2.4	2.1	83.4	300	100	75	0.12	0.16	0.08	0.16	0.36	0.4	0.12	1	0.1
47	46	158	66	26.5	1.7	80	20	130	70	90	2.7	2.3	94.4	300	110	71.4	0.12	0.16	0.12	0.12	0.4	0.44	0.12	0.8	0.1
48	30	160	62	24.2	1.6	74	18	130	80	96	3	2.7	92	300	80	60	0.12	0.16	0.16	0.12	0.36	0.36	0.14	1.3	0
49	45	160	54	21	1.6	80	20	120	80	94	1.8	1.7	93.4	400	80	78.9	0.08	0.16	0.12	0.08	0.36	0.4	0.16	1.4	0
50	42	163	74	28	2	78	19	140	80	100	3.2	3	87.5	450	80	62.5	0.12	0.2	0.12	0.12	0.4	0.42	0.16	1.1	0
51	24	155	43	17.9	1.4	60	15	120	70	86	2.1	2	97.6	420	90	60	0.08	0.12	0.12	0.12	0.38	0.37	0.14	1.8	0.1
52	33	160	60	23.8	1.62	71	17	120	70	86	2.6	2.4	91.4	300	70	68.1	0.12	0.16	0.12	0.14	0.36	0.38	0.12	1	0.1
53	38	162	60	31	1.64	80	20	130	80	96	3.54	3.2	90.1	300	100	68.1	0.08	0.12	0.12	0.12	0.4	0.43	0.14	1.4	0
54	36	163	67	25.2	1.72	74	18	130	80	96	3.31	3.2	95.77	400	70	60	0.08	0.12	0.12	0.12	0.4	0.4	0.12	1.4	0
55	25	173	69	23.1	1.84	65	16	122	68	86	3.74	3.2	95.69	350	50	62.5	0.08	0.12	0.12	0.12	0.4	0.44	0.14	2	0
56	26	168	69	24.4	1.76	93	23	118	86	96	2.49	2.2	99	220	70	83.3	0.1	0.16	0.08	0.12	0.36	0.45	0.12	0.7	0.2
57	52	162	48	18.3	1.48	81	20	140	90	106	2.13	1.5	72.5	300	30	60	0.08	0.12	0.12	0.12	0.4	0.4	0.16	1.7	0
58	65	159	71	28.2	1.72	65	16	130	60	84	1.61	1.3	90.08	250	75	60	0.1	0.16	0.12	0.12	0.4	0.4	0.14	0	1.04
59	45	165	68	25	1.76	75	19	120	80	94	2	1.8	94.33	250	100	90.9	0.12	0.16	0.12	0.12	0.36	0.4	0.12	0.5	0.1
60	35	173	71	23.7	1.86	64	16	130	90	104	3.54	2.8	80.92	350	90	62.5	0.1	0.14	0.1	0.1	0.36	0.38	0.14	1.3	0