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COMPARISON OF DYNAMIC LUNG FUNCTIONS AMONG FEMALE WORKERS OF BALLARI JEANS INDUSTRY WITH NON-WORKING GROUP OF FEMALES

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ABSTRACT

Among various health assessment tools for industrial workers, Pulmonary Function Test (PFT) is one of the most popular tools. PFT results are closely related to people's lifestyle. People who perform regular exercises are found to have good results in PFT. Physical activity demands strong cardiopulmonary system that is again responsible for the body's physiological condition. The objective of this study is to compare pulmonary functions among the female workers of jeans industry in Ballari with normal healthy subjects.50 females working in various jeans manufacturing units of Ballari and 50 housewives, each between ages 18-35 years were selected for the study. This study is a comparative study and was conducted over a period of 3 months i.e., December 2020 to February 2021, When Covid-19 crisis (first wave) had subsided completely. The study requires onetime assessment of lung functions of the 100 female participants (50 jeans factory workers and 50 housewives) using RMS Helios-401 PC based Spirometer which is owned by the principal investigator. In the research, the same effect has been observed among females working in a factory and the females not working in a factory. Here these females are potentially exposed to dirt and toxic chemicals, due to which the working of their respiratory function has reduced.

Keywords: Dynamic lung functions, Working, Non-Working, Female Ballari Jeans Industry

I. INTRODUCTION

Pulmonary Function Tests (PFTs) comprises of three different tests taken together. These are respiratory muscles test, chest wall test, and lungs function test. PFTs help to find total lung capacity and any discrepancy in the lungs condition. These tests help to find the existence of lung diseases and extent of those diseases. They also help to understand the possible outcome of any therapeutic interventions.

It is not easy to estimate the reference values for PFTs. As per the clinical guidelines, lung function interpretation is based on several proven anthropometric parameters such as body weight, age, comorbidity, gender, and physical activity level. As more and more research works have been done in this domain, several other factors have also gained importance and most importantly the physical parameters such as circadian rhythms, [1] menstrual cycle, [1] diameter of chest, [2] and size of trachea.Then there are social and environmental factors such as educational background,socioeconomic status, [3] workplace condition, air pollution,present climatic condition, [4] natural calamities,[5], height, [4] and ethnicity. Apart from that there are life style factors such as nutritional condition, [6] physical activities, [7] and smoking or non-smoking. Other parameters include, different diseases like diabetes,18 muscular disorders or hormonal imbalances, physical position, [1] genetic matters,[4]. Certain other factors like childhood experience, [8] and pregnancy [9] are also taken into consideration in certain situations.

It is true that you can get a considerable bibliography which will explain how all the mention factors can influence the phenomenon of lung morphology and relevant functions, none of the

recent reviews have talked about and have integrated all the mentioned aspect into a single all-inclusive source (Figure below).

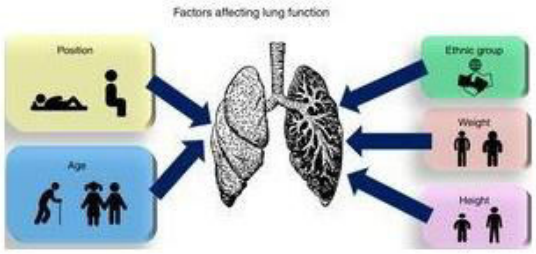


Figure 1.1: Factors affecting lung function.

Earlier investigation of lung functions was mostly confined to the measurement of vital capacity which was considered a very good test of pulmonary functions, expiratory reserve volume, inspiratory reserve volume, tidal volume, residual volume, functional residual capacity were also commonly considered as Pulmonary Function Tests. These tests all together are said to be static. Maximum Voluntary Ventilation is a dynamic test for testing pulmonary functions. Now-a-days many tests have evolved to be included in dynamic Pulmonary Function Tests. Forced vital capacity and flow rates at different points of force vital capacity and volume in 0.5, 1, 2 or 3 seconds of forced expiration are some of them. This transition from static to dynamic was very slow. In the dynamic ventilator test, it is observed how homogenously and efficiently one could fill and empty the lungs. The dynamic ventilator test is more dynamic than static in nature [10].

Lung functions are dependent on many other factors like birth weight, pollution in area of residence, smoking habits (both active and/or passive smoking) of households, level of physical activities etc. Therefore variations in lung functions are also unavoidable. Taking into considerations the above points and as per recommendations of a study group set up by World Health Organization (W.H.O.) in 1957, that for getting a detailed picture of any health problems or disease of any origin, more and more such studies needs to be undertaken [11].

Often regarded as 'Jeans capital of India', Ballari is a major source of employment in this region. Working class women employed in the jeans industry, spend 6-8 hours in dusty, confined spaces of their work place. The occurrence of chronic lung diseases due to cotton dust and chemical exposure in Denim factories has been topic of discussion in many parts of the world [12]. Workers remain unaware of the health risks of working in such dusty conditions. Hence, Pulmonary function testing (PFT) is important for early identification of breathing problems in workers that may be related to their work place [13]. The present study is undertaken, in order to assess lung functions in females working in jeans manufacturing units of Ballari, and create awareness about occupational safety and hygiene.

A. Lung Function

Spirometry

Spirometry is a way of measuring the pulmonary function. It is also the most common and speediest way of measuring that function. In simple term, with the help of a spirometer the volume of exhaled air is measured as per the scale of international standard [14]. It helps to measure the health condition of the lungs and the muscles directly involved in the respiratory

process. When tested with the help of a spirometer, the forced vital capacity (FVC) is an important aspect. This is the total volume of air exhaled with maximum force. The person tested is asked to use maximum force in breathing. It makes the respiratory stressed to the optimized level. Apart from FVC, the forced vital capacity in the first second of forced exhalation is also calculated. This is called forced exhalation volume in the first second or FEV1. The ratio of FEV1/FVC is used in calculating dyspnea, establishing the dysfunctions in the respiratory system, and occupation-related respiratory diseases. The calculation of FEV1/FVC establishes obstructive lung diseases. With FEV1/FVC ratio lower than 0.7 after a bronchodilation is the commanding measurement in diagnosis of COPD (42). The pathophysiological classification is not just limited to COPD but also includes other groups of lungs related issues such as asthma, acute and chronic bronchitis, emphysema, cystic fibrosis, and bronchiolitis. These all are somewhat related to airway obstructions with different symptoms.

Diffusing capacity of the lungs

Right after spirometry, another important Pulmonary Function Test is "Diffusing Capacity of lungs for Carbon Monoxide" (DLCO). Exchange of gases through alveolar capillary provides both qualitative and quantitative assessment of transfer of gases. See figure 1 for more clarity that depicts it is a reduced DLCO mirror diverse limitations [15].

This means, it's not possible to accept DLCO in isolation for spotting the issue and diagnostic purpose. The outcomes obtained here should be tallied with the other known medical parameters that can show the pre-test possibility of the illness in concern.

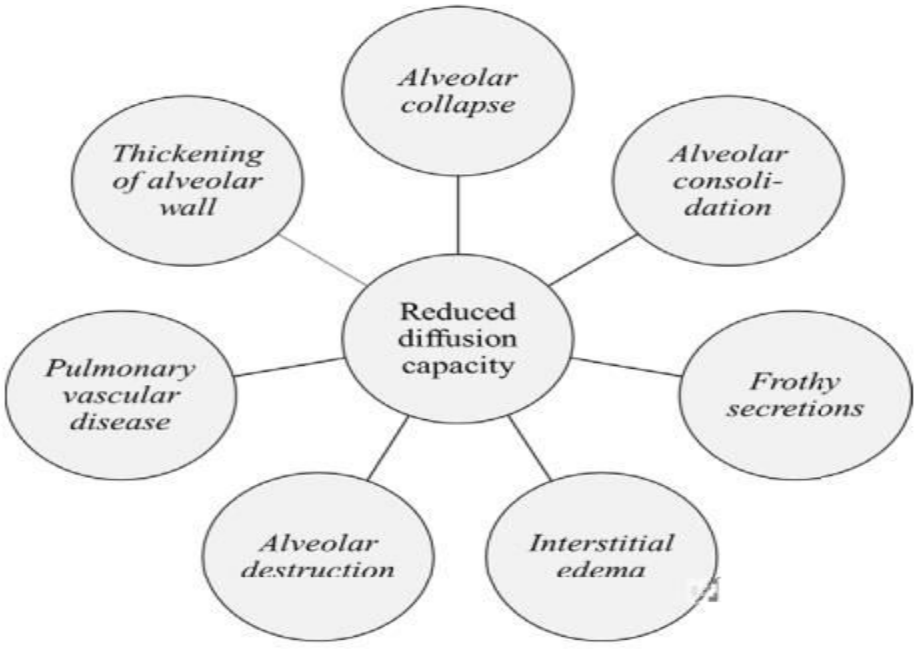


Figure 1.2: Factors related to reduced diffusion capacity of lungs

Determination of lung volume

Spirometry is one of the best methods that can be used to assess vital capacity or FVC. This does not mean that spirometry is useful to investigate about receivable volume and related capacities which include RV like total lung capacity or functional residual capacity. To determine the volume of the lung there happens to be several other methods like conducting a complete body plethysmography, dilution of helium and nitrogen washout is also much useful. This process can be used to investigate the occurrence of the existence of a restrictive disease of the lung. This same process can also be used to investigate cases of hyperinflation which needs knowledge of RV/TLC ratio. In this context inspiratory capacity has been found to be useful to substitute for investigating cases of lung hyperinflation. This process is quite frequently used to evaluate cases of dynamic and static hyperinflation. IC in the medical domain is explained as the total amount of air that the lungs can draw in soon after a normal expiration and inversely reflex FRC.

Reading of the total volume of lung capacity is an indication of the presence of any restriction in the organ. This is exactly why doctors like to keep a tab on reduced FVC in spirometry readings. TLC or total lung capacity reduction is one of the most distinct indications of restrictive lung ailment. If there is an obstructive lung ailment static hyperinflation is often checked by looking into the increase of the RV or residual volume along with the TLC[16].

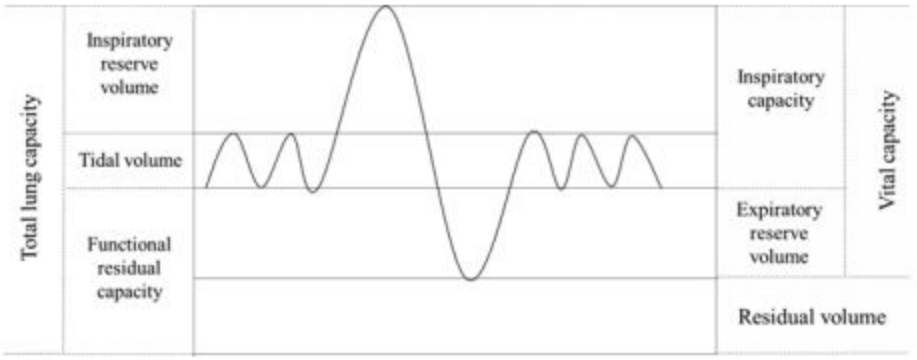


Figure 1.3: Lung volumes and capacities

B. Mechanics of Breathing

When a tidal expiration comes to an end human lungs have a tendency of recoiling inwards. At this time the chest wall tends to do just the opposite and makes outward recoil. The simultaneous forces that work in the opposite orders generate negative pressure in the region between the visceral pleurae and parietal pleurae. The negative intra-pleural pressure (Pp1) plays a rather important role in maintaining the small Airways patency. The mechanism is no longer needs any cartilaginous support. The systematic rhythm of contraction which occurs in the muscles of the inspiratory system creates a cycle of changes. These changes occur in the thoracic cage.

At the time of tidal inspiration Pp1 drops from -5 to that of -8 CM H2O. It forces more pressure in the intra alveolar region as a result of which one CM H2O drops below the level of the atmospheric pressure. This leads to the increase of flow of air in the alveoli. As the Pp1 drops the airways resistance also diminishes due to the dilation of the small airways. This helps to improve the flow of air. This entire process experiences a role reversal at the time of tidal expiration. As the muscles involved in inspiration relaxes the thoracic cage dimension happens to decrease.

This is why the Pp1 increases back to the level of -5 cm H2O. The about mentions phenomena clearly explain that the tidal expiration is a passive system that does not implicate any muscle contraction.

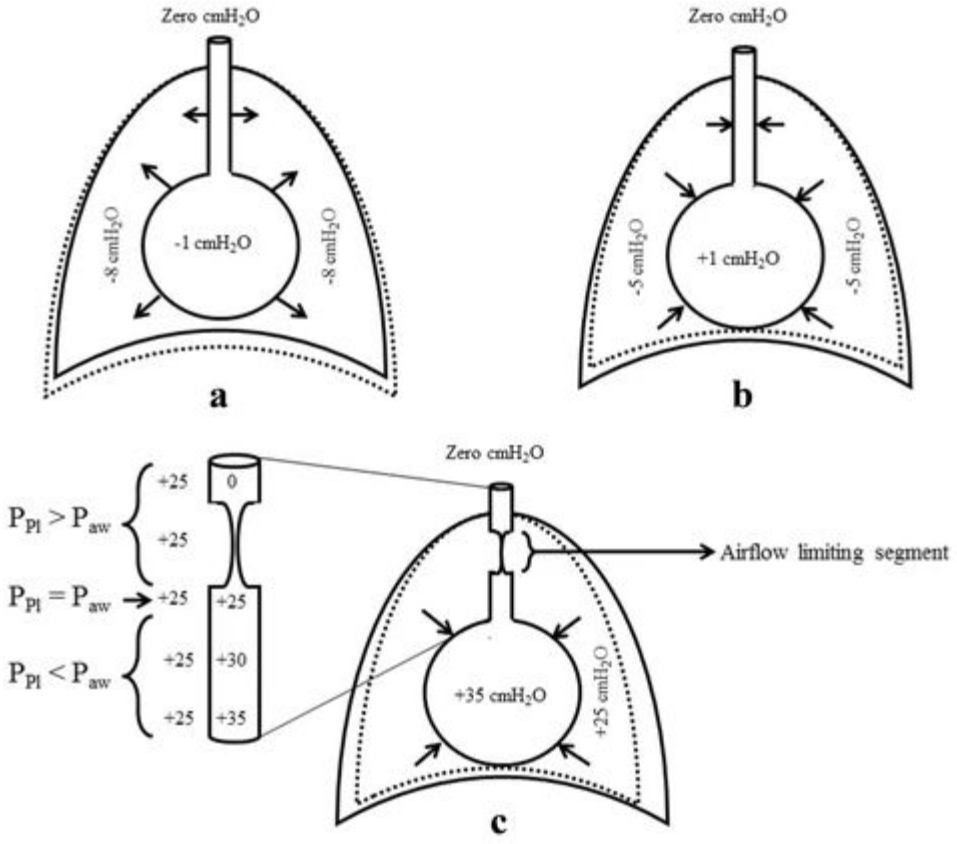


Figure 1.4: The alveolar and intra pleural pressure exerted at the end of the (a) Inspiration (b) Expiration (c) Forceful Expiration

In the figure above, the change in the thoracic dimension is indicated by the dotted line. During a, b and c compared with the previous phase of the respiratory cycle.

The accessory muscles in inspiration need to be activated if the inspiration has to be above the tidal limit. The expansion of the thoracic cage leads to a greater drop in the Pp1 as in comparison with the tidal inspiration. With the help of this mechanism, we understand the reason behind the enhanced quantity of air applied to alveoli in comparison with the tidal inspiration.

Expiration under the tidal level happens to be an active process and needs expiratory muscle contraction. When expiration is done in a forceful manner there is a compression of the thoracic cage to quite an extent the PPI and Palv rises above the Patm level. Nevertheless the Pp1 is still smaller than them Palv as a result of the elastic recoil pressure effect that occurs in the alveolar walls.

See Figure 3C:

The value of Paw drops starting from the area next to alveoli upwards. This steady drop in Paw is minor to concurrent rise in the air passage resistance in the direction of the trachea.

Considering the relatively constant value of PPl around the lung, each small air passage can be segmented into three categories (Fig. 2c):

- An overblown segment, where Ppl is lower than Paw.
- An equal pressure point segment, where Ppl is equal to Paw.
- An airflow preventive segment, where Ppl is higher than Paw.

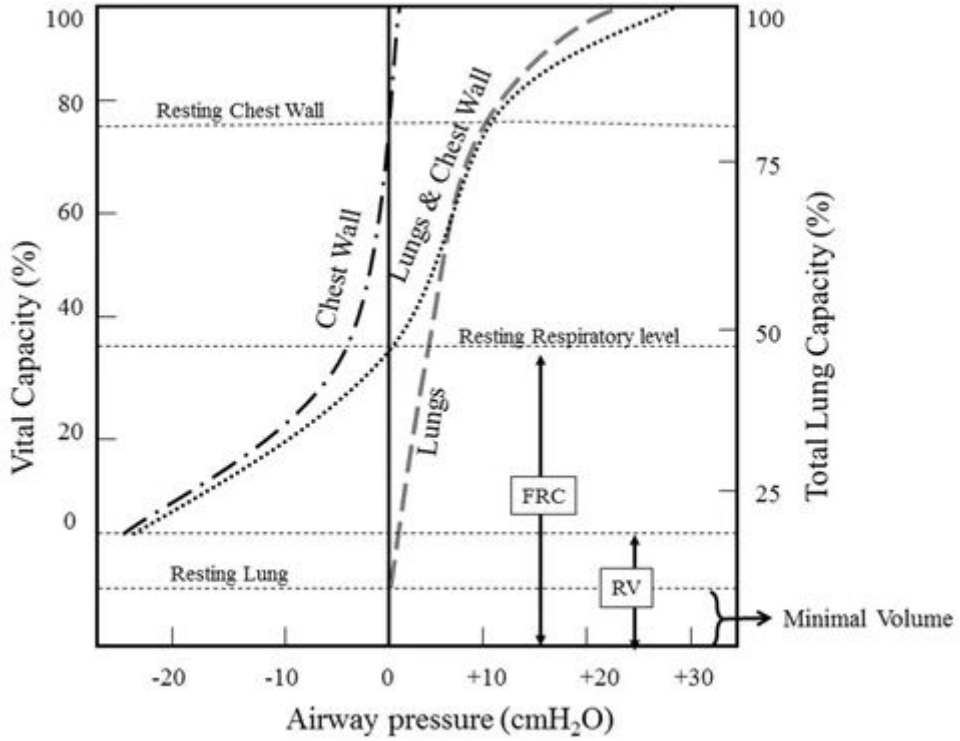


Figure 1.5: Static PVC of the lungs and chest wall. The lung and chest wall curve was plotted by the addition of the individual lung and chest wall curves

Limiting of air flow happens in small airways which has a lack of cartilaginous support. This also explains why the lungs are never fully empty. It has been explained that the development of choke point has limited the air flow on forceful expiration. In other words, in the points where the velocity of flow is equal to the local speed of wave pressure propagation airflow gets limited. The situation is quite similar to that of a waterfall in which the flow upstream and the height does not affect the speed of the free water. However if the breadth of the waterfall is increased an extra amount of water can fall through the increased space. It is important to understand that on addition the Palv increase is also accompanied by compression of gas in the lungs. This leads to the reduction in the volume of the lungs that decrease accentuates. It drives pressure right at the chocking point. With the help of this mechanism we understand why the quantity of expired air is less than what is counted with the help of plethysmograph [17].

After the development of airflow limiting segments expiration does not required more independent effort. When the small airway in the lungs begins to close what remains inside the lung is known as its closing capacity. Similarly RV is what remains inside the lung even went all

the small airways are closed. The air volume which is expired in between RV and CC is known as the closing volume.

The above explanation clearly reveals the fact that pulmonary ventilation is highly affected by the resistance from the airways to the expansibility of the lung airflow and the thoracic cage. We must understand these two important determinants of Pulmonary ventilation to understand the change pattern in static lung volume in the context of various lung ailments.

Airways resistance

When the airways becomes narrower the tracheobronchial tree experiences dichotomization successively. Airways get more distensible as it receives downwards. Simple laws of Physics are not really applicable in this context. As a result of respiratory Airways resistance cannot be understood through simple laws of Physics. For example Airways at the lowest point offers resistance on smallest bronchioles which is not seen in large Airways. Since these bronchioles are parallel arranged the resistance their offer will be influenced by the total cross section area of these bronchioles. They are not all that dependent on the radius of a single bronchiole.

The resistance of the Airways happens to be inversely proportional to the volume of the lung. At the time of inspiration the PPl decreases considerably. This enhances the distension of the Airways all the more in the small bronchioles. When the lung has a higher volume the alveolar walls attachments that pulls the small airways apart. This enhances the effect of PPl on decreasing the resistance of the airways. Opposite to the mentioned phenomena the resistance of the airways increases considerably during the time of forceful expiration. This happens due to the formatting of the flow limiting segments.

Compliance of the lung and the chest wall

The change in volume per unit is represented through compliance. This is a physical term used to indicate alteration in trans mural pressure or the difference of pressure that exist on two sides of a wall. From a physiological point of view the trans mural pressure in the case of lungs, respiratory system, chest wall, are often calculated by subtracting Palv – Ppl, Ppl – Patm and Palv – Patm respectively. Physics explain that trans mural pressure when is zero the system happens to be in a resting position or it is neither deflated nor inflated.

Lung compliance like lung volumes can be measured both in dynamic and static condition. The static pressure volume curves for PVC are shown in figure 3. It shows the curves in the case of the chest wall and the lungs. The figure 3 shows the entire lung PVC which falls in the positive length of Paw. This suggests that the lung have the tendency to collapse at any pulmonary inflation degree. Within the chest cage the lungs are never in a rested condition. This means that the trans pulmonary pressure is never at a level of zero. If the lungs are removed outside the body then the trans pulmonary pressure will reach the point of zero. However this does not mean that the lung will be completely empty.

If we compare this condition with the chest wall, it will be revealed that the chest wall has the tendency to retreat away when there is 80% of TLC or slightly less is present in the lungs. Otherwise \, chest wall will recoil inward.

The chest wall and lung systems are in a rested position when the Palv is equal Patm . At this junction the lungs are filled with FRC. Now the inward recoil tendency of the lungs will be same as the outward recoil tendency of the chest wall [18].

C. Comparison of Dynamic Lung Functions among Female and Male

Differences in lung growth amongst male and female begins at the very prenatal age. It has been seen that among females lung maturation happens at a much more advanced stage as compared in male foetus. Between 16th and the 26th weeks of gestation movement of the mouth begin which reflects the fetal breathing pattern. This is considered as a very important aspect that determines the development of the lung. There are also other fundamental regulators that indicate the maturation of the lung. These are the sex hormones along with the androgens which have an inhibitory effect and offers stimulation of oestrogen. Oestradiol is created by the placenta when the fetal testis releases the testosterone. The androgen delays the surge of surfactant lipids production. These oestrogens have a highly positive effect on both the alveologenesis and the production of fetal surfactant during the stage of neonatal and pubertal period [19].

The difference in the impact of oestrogen and androgen on the release of surfactant maybe one of the main reasons why premature female neonate have a lesser risk of developing respiratory distress syndrome as compared to the male neonates. The female neonates are found to have a better response when the male neonate when it comes to hormone accelerator that leads to the production of surfactant. This is exactly why premature your premature males who have respiratory distress syndrome have a greater tendency of morbidity[20].

In the time of birth females tend to have smaller lungs as compared to males and they also have lesser respiratory bronchioles. The difference in the lungs that has been observed on the basis of gender remains right from childhood to adulthood. This is also the same even during the period of adolescence when the females tend to grow taller than the male due to the onset of puberty [21].

Different approaches have been used to show that men tend to have bigger lung as compared to women. Some of the common methods used for the purpose are standard morphometric methods, three dimensional geometry morphometric methods, and chest radiograph. Some factors does not differ between men and women lungs like the number of alveolar per unit area volume, the number of alveoli for unit area individual land units and dimensions of the alveolar. Boys tend to have a greater number of alveoli also a bigger surface alveolar area at any given age [22].

The intrinsic elasticity of lung parenchyma is similar between sexes, whereas the recoil pressure differs because of the differences in lung size and in maximum distending forces [23].

The shape of the lung differs between males and females, being more pyramidal in the former and more prismatic in the latter [24].

D. Comparison of Dynamic Lung Functions among Working Female and Non-Working Female

People are now more interested in keeping themselves physically fit and active. Regular exercises including jogging, running, walking, and outdoor sports are considered vital in keeping an individual fit and strong. These activities help to enhance cardiopulmonary activity as well.
These days, people are too active in their professional arena. This is also a good way of improving the physical activity and cardiopulmonary capacity. That is why, the experts ask people to be physically active in the workplace as much as possible. It has multiple benefits and the human body adopts to changes quickly.
A greater number of people have become highly conscious about maintaining a healthy lifestyle. Naturally people are indulging more into activities like running, jogging, walking, and dynamic exercises. These activities help the person to maintain healthy existence and improve their respiratory and cardiac functioning. A school of Pulmonary physicians have pointed out that the active workplaces of modern times also helps to improve respiratory system and keeps diseases like Chronic Bronchitis away. It is important you take care of your health all throughout your life. The best way of doing this is to remain physically active in your work places. This helps you to remain healthy in your life.
One of the best ways of assessing your health is to conduct a pulmonary function test or PFT. It has been observed that PFT has a relationship with lifestyle like the habit of doing regular exercise on not doing any at all. One of the best ways of screening, doing a diagnosis and monitor respiratory ailments is through the method of spirometry. This is a practice highly popular in primary care cases. Both quantitative and qualitative assessment of Pulmonary condition can be done with PFT method. This method can be used in both restrictive and obstructive lung diseases.
It is medically established that cardiopulmonary functions may vary according to the physical characteristics of individuals including their age, height, weight, and altitude [25].
Regular job activities help in enhancing pulmonary capacity in the long run. This is the reason, women active in their jobs show more pulmonary capacity than women who are more or less inactive. Respiratory muscles determine the pulmonary functions of an individual. Other factors that also affect the strength of pulmonary muscles are air passage resistance, condition of thoracic cavity, elasticity of the lungs.
Remaining movements go with a number of advantageous physiological properties in the body. Physically active is known to improve overall performance and working capacity [26]. Current evidence suggests that regular practice of yoga also shows an improvement in cardiovascular and pulmonary functions [27].

E. Research Objectives

The objectives of the study are,

- To compare pulmonary functions among the female workers of jeans industry in Ballari with Normal healthy subjects.

F. Research Hypothesis

- H_0^1: Pulmonary lung functions of the non-working females don't work better than the working females in Ballari Jeans Industry.
- H_1^1: Pulmonary lung functions of the non-working females work better than the working females in Ballari Jeans Industry.

II. REVIEW OF LITERATURE

Jaffer, et al (2014) conducted lung function test in Jeans washer men of Ballari, and found significant number of workers had small airway obstruction [28].

A study conducted by Md Shohel Mahmud (2010) in females working in garment sector of Bangladesh, revealed that the majority of the female workers in the garment sector suffered from respiratory problems [29].

A study done by M Agkun, et al (2016) in former workers of Turkish denim industry showed that half of the participating subjects developed symptoms of COPD like Silicosis [30].

Hasan et al(2016) performed study where they followed the textile workers in Turkey for five years. As per their study, they came to the conclusion that the workers open to cotton dust for a long time are susceptible to pulmonary issues to some extent. This supports other studies of this kind [31].

According to Mishra et al (2018), PFT assesses the health condition as well as provides information on survival rate. PFT has a direct link to the lifestyle of the concerned population including their good and bad habits. Body feels most stressed when someone is physically active for a prolonged period. It makes cardiopulmonary system of the body highly functional. In primary care practices, spirometry is considered as one of the most useful tool for assessing the body's overall condition. Spirometry is one of the most prevalent tests for the assessment of the respiratory issues.

In the present study, the attempt was made to evaluate the functional levels of the lungs and difference in the pulmonary health of physically active and inactive females. 62 females participated in the survey. They were aged between 25 to 35 years. This sample was divided into Group A and group B. Group A consisted of actively working females and group B consisted of sedentary females. Both the groups were asked for pre-PFT readings and then they went for 6 min walk test. After the 6 min walk test, they were again asked for post-PFT readings. Several parameters were noticed such as FEV1, FVC, Peak Expiratory Flow Rate (PEFR), and FEV1/FVC. The data so obtained was analyzed with the help of SPSS Version 2.0. The Pre-PFT and Post-PFT readings were analyzed with the help if t-test. The result shows highly difference reading of parameters between the groups. However, it was significant that the result of the study shows that the parameters of Group B where sedentary females were placed had better numbers than the other group where working females were placed [32].

According to Rajput et al (2019), successes of ventilator test depends on the how speedily and efficiently the lungs are filled and emptied not on the actual size or movements of the lungs. They further opined that a dynamic test is more informative than a static test.

In the present study 185 males and females of age group 17 to 22 years were chosen to find and compare the outcomes of PFT among males and females. The members of the sample were clinically examined on different parameters especially for cardiopulmonary condition. The collected data were taken to find "Mean Value" and "Standard Deviation". Then, statistical analysis was accomplished with the help of t-test and p-value. It was found that all kinds of lung functions were significantly better in males than females irrespective of their ages. MVV is considered a good measure of the overall lung function especially because it is directly related to the increase in the ventilation while a person performs exercises. The pulmonary test values were better in sampled males than the sampled females. It was found that in the luteal phase, the lung function enhances significantly [33].

According to Bhattacharya and Subhramanian (2017), the pregnancy phase of women is a stressful physical condition during which the cellular activities enhance significantly to support the fetus. They further added that as the fetus grows, the physiological stress increases as the embryo needs to be fed properly. The researchers attempted to find the alternation in the pulmonary functionality of pregnant women in some parts of South Indian population. In the study, the researchers included uncomplicated singleton pregnant women in their 1st to 3rd trimesters (n= 10 for each of the three trimesters). Another group was formed with healthy non pregnant women (n= 10). PFT was carried out in computerized spirometer and data relevant to the research were collected. ANOVA test was done to analyze the data. In this test and in this condition $p<0.05$ was considered statistically significant standard.

Present study finds that on several parameters like Inspiratory Reserve Volume (IRV), Vital Capacity (VC), and Inspiratory Capacity (IC) were significantly higher in women in their different phases of pregnancy than normal women. However, it was found that Expiratory Reserve Volume (ERV) and PEFR decreased considerably in the sample. On the other hand, FEV1/FVC ratio and Tidal Volume (TV) of both pregnant group and non-pregnant group were almost similar. From these results, it can be concluded that the change in the pulmonary function and lungs' capacity during pregnancy is normal because of natural change in the physiological condition of pregnant women [34].

According to Ekstrom et al (2017), female workers face activity-related pulmonary issues more than twice of males. They generalized the matter across the industries where females work in higher numbers.

In the current research work, we attempted to test whether the Forced Expiratory Volume in 1 second has any relationship with gender and whether the Forced Vital Capacity (FVC) is women is higher? 3250 subjects with 51% women population were considered for the research. The subjects were within the age group of 38-67 years and distributed in 13 different countries in Europe. A modified Medical Research Council (mMRC) scale was used to scale the activity-related pulmonary issues. The data obtained was analyzed with the help of Logistic Regression Clustering after doing some adjustments on different parameters such as Body Mass Index (BMI), Existing Cardiopulmonary Diseases, Exercise habits, mental depression, and post-brochiodialator spidometry. mMRC more than or equal to 1 is considered as the standard. It was

found to be more prevalent in females than in males. 27% of female subjects and 14% male subjects were found to be affected with it. (Odds ratio (OR) 2.21, 95% CI 1.79−2.72). The sex difference was not reduced when controlling for FEV1 % predicted (OR 2.33), but disappeared when controlling for absolute FEV1 (OR 0.89, 95% CI 0.69−1.14). The absolute FEV1 explained 98-100% of sex difference with adjusting for confounders. However, instead of FEV1 when FVC was used no distinguishable difference was marked [35].

According to Lutfi (2017), the lung volumes can be static or dynamic. These subclasses are taken into consideration at different levels of inspiration and expiration. However, dynamic lungs depend on the rate of air flow. On the other hand, the static lungs volumes or capacities are further subdivided into four standard volumes called (a) Tidal (b) Inspiratory Reserve (IR) (c) Expiratory Reserve (ER) and (d) Residual Volumes. And four standard capacities in this realm are total Lung Capacity, Vital Lung Capacity, Functional Residual, and Inspiratory. Vital capacity is important in dynamic lung volumes or capacities. This is important in finding obstructive diseases in lungs. Again, static volumes also help in evaluating restrictive ventilator defects and obstructive defects.

In this review, the intention is to update the readers regarding clinical importance, physiological perspectives, and interpretative approaches for static lung volumes and capacities [36].

According to Barroso et al(2018), lung function parameters are basically based on anthropometric factors like sex, age, and weight. Both FVC and FEV1 reduces with age while other values like FRC increases with age. Height affects TLC, FVC, FEV1, etc. A tall person will have more decrease in the lung volume than a shrt height person.

Variables like FRC and ERV decrease significantly as the weight increases. Men's air passages are longer than women, causing greater specific resistance in the respiratory tract. The increased work of breathing to increase ventilation among women means that their consumption of oxygen is higher than men under similar conditions of physical intensity. When the subject stands the lung volume remains high while in the sitting condition it is lower. DLCO obtains higher value in supine posture. However, the anthropometric characteristics are not enough to distinguish the lung function among different ethnic groups. There are other conditions or parameters that should also be taken into consideration [37].

III. RESEARCH METHODOLOGY

A. Materials & Methods

The study was conducted behalf of Department of Physiology, VIMS, Ballari. Duration of the study was 3 months i.e., from December 2020 to February 2021, (when the first wave of COVID-19 pandemic had completely subsided). Planning and pilot study was conducted in December 2020.Data collection and statistical analysis was completed in January 2021. Finally, report writing and submission was done in February 2021.

B. Source of Data

Subjects for the study were selected from the general population attending Free Medical Camps arranged by the Principal investigator in his private clinic located in Bandimote, Ballari where several Jeans factories are located in the vicinity.

Sufficient Clinical material/sample available

(Declaration based on last 3 years average in hospital / department)? Yes

Is the study novel? Yes

Are the outcomes relevant to practice and benefit patients? Yes

C. Inclusion Criteria

- Women in the age group of 18-35 years, who are employed for at least 6 months in various jeans manufacturing units of Ballari.
- Women in the age group of 18-35 years, who are housewives.

D. Exclusion Criteria

- Women with known Respiratory illnesses and Cardiac disorders.
- Women with Neurological and Psychiatric illnesses, etc.
- Pregnant women.
- Women with history of tobacco consumption.

E. Method of Collection of Data

- **RMS Helios-401**

RMS Helios Series of Spirometers are available in PC Based and Stand-alone Versions capable of diagnosing, differentiating and measuring various pulmonary diseases. The Helios series comes with highly advanced and user-friendly Software offering 34 Parameter readings, Pre-Post Bronchodialation Results, Percentage Improvement and Lung Age Calculations. The interpretation of the test results, trends and pediatric incentives are also available in the software. RMS is the leading manufacturer of PC Based Spirometer and Portable Spirometers.
https://www.rmsindia.com/pulmonology.html

- **Ultra Violet C sanitizing apparatus**

There has been a lot of interest in the development of effective and more comprehensive environmental disinfection strategies and, in the last year, attention has been focused on improving “no touch” technologies, including the use of the mobile UV-light disinfection system, which has the advantages of not requiring changes in a room’s ventilation, not leave residue after treatment, and having a broad spectrum of action and rapid exposure times. The germicidal effects of UVC irradiation results in cellular damage by photo hydration, photo splitting, photo dimerization, and photo crosslinking, thereby inhibiting cellular replication. UVC can be generated from low-pressure mercury lamps that produce continuous UVC with a peak wavelength of 254 nm, and pulsed xenon lamps that emit pulsed light at high intensity, both in the spectrum of UVC (100–280 nm) and visible (380–700 nm) radiation, with a much broader microbicidal activity spectrum [14]. The UV-light disinfection system must operate in unoccupied rooms, after the patient discharge and in the absence of health personnel. Many devices have motion sensors that shut-off the device if any movement is detected inside the room being disinfected. Damage to materials in the room was not reported during the use of UV-light

disinfection systems, although in the Pulsed-UVC device operator manual, high pressure acrylic material may show degradation for prolonged periods of exposure to light UV (e.g., daily or weekly), therefore it is advised to cover them during the treatment.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6801766/

Selected Method of Collection of Data

50 females working in various jeans manufacturing units of Ballari and 50 housewives, each between ages 18-35years were selected for the study. Following a description of the nature and purpose of the study, willing subjects were enrolled to participate in the study, after obtaining their informed consent. A detailed history was collected from these women and their demographics, weight, height and Body mass index were noted. This was followed by thorough Clinical examination which was performed by the Co- investigator in presence of a female assistant. The subjects were screened using the inclusion and exclusion criteria. This study is a comparative study and will be conducted over a period of 3 months i.e., December 2020 to February 2021. When Covid-19 crisis (first wave) had subsided completely. The study was conceptualized and pilot study was conducted in December 2020. Data collection was completed in January 2021. After completion of report writing, it was submitted for publishing in February 2021.Institutional ethical clearance was obtained in January 2021.The study requiredone-time assessment of lung functions of the 100 female participants (50 jeans factory workers and 50 housewives) using RMS Helios-401 PC based Spirometer. Disinfection of the apparatus was done using the Ultra Violet C sanitizing apparatus. Both these equipments are owned by the principal investigator. Apart from using disposable mouth piece and sterilizing the parts of the spirometer after each use , all the guidelines of COVID appropriate behavior were strictly followed to prevent any kind of disease transmission. Recording of the lung parameters and sterilizing the instrument was performed by the Principal investigator. Using the standard laboratory procedure, pulmonary function tests like FVC, FEV1, FEV1/FVC, FEF 25-75% and PEFR were measured. Statistical analysis of the data collected was done by using SPSS version.21 software (Standard deviation, mean and unpaired student t Test). Microsoft Word 7 and Microsoft Excel 7 were used to create tables etc.

F. Design of the Study

This is a Case Control study.

G. Sample Size

Sample size is 100 participants. These participants will be selected from general population attending the Free health checkup camps set up by the Principal investigator. The health camps were arranged at the private clinic run by the principal investigator near Bandimote, Ballari. Since this place is located near the jeans cluster of Ballari, it is convenient for the jeans factory workers to attend the health camp after their working hours. 50 women jeans factory workers with minimum work experience of 6 months were added to the study group. Another 50 women were selected from the housewives willing to participate in the study and they were considered as the Control group.

H. Primary Outcome &Secondary Outcomes

Anticipated Primary Outcome at the end of the study will be the reduction in Dynamic lung parameters in Jeans factory workers. It would be expected that the control group shows no deviation from normal values.

IV. RESULTS

Methodology: Data of 100 females has been taken from the female attending Free Medical Camps arranged by the Principal investigator in the private clinic located in Bandimote, Ballari. Out of these 100 females, 50 of them are working in a jeans factory, and the remaining 50 participants are housewives. Random convenience sampling has been sued to collect data. SPSS software has been adopted to run statistical methods like paired t-test, frequency distribution, mean, standard deviation, skewness and kurtosis. The entire research work took three months for completion.

Data AnalysisResults:100 females (working and non-working) were approached to understand their lung functions. Out of 100, 50% of the femaleswork inthe Ballari jeans industry,and the remaining 50 females are housewives. These housewives have never worked in any industry before. Table-1 below talks about the descriptive statistics of these participants, in regards to their age, height (Ht (cm)), weight (Wt (kg)), body mass index (BMI) and Pulse rate (bpm).

According to the data, the age of these female participants is between 19 to 35 years, with a mean age of 27. Height and weight is close to 152.9&52.9 with a BMI of 22.4. The average pulse rate of these females is close to 77.5. Data skewness and kurtosis are also lying in between ±1. Hence it can be concluded that there is not much difference found in regards to the descriptive statistics of the participants.

Table 1:-Descriptive Statistics of the Study Subjects, based on the Participants

Variables	N	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Age (yrs)	100	19	35	27	4.8	-0.5	0.2	-1.2	0.5
Ht (cm)	100	119	167	152.9	8.3	-1.5	0.2	3.5	0.5
Wt (kg)	100	36	68	52.9	7.4	-0.2	0.2	-0.7	0.5
BMI	100	2.70	29.30	22.4	3.6	-1.7	0.2	8.4	0.5
Pulse (bpm)	100	28	92	77.5	8.0	-2.4	0.2	13.5	0.5

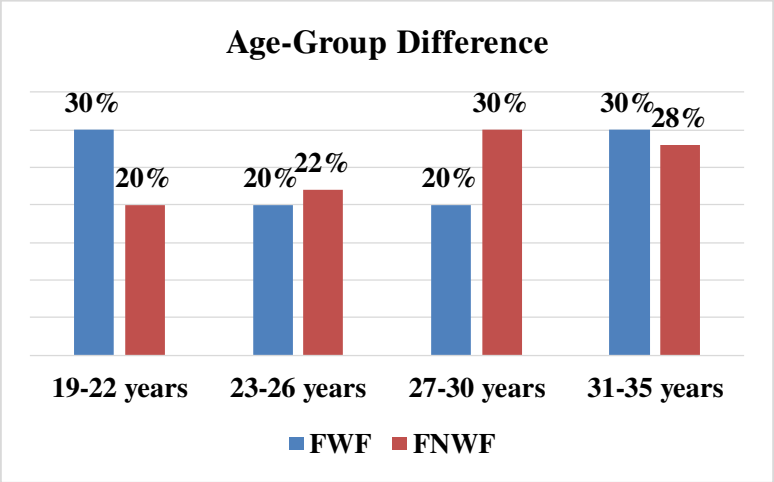
Further, in table 2, the frequency distribution of age, height and weight is presented wherein the interquartile method has been adopted to define the buckets of the sub-categories. As per the data, 29% of female participants' ages are between 31-35 years, followed by 27-30 years (25%) and 19-22 years (25%). Regarding height, 54% female height is close to 149-157 cms followed by 157-167 cms (24%), and weight for most (28%) of the female participants is between 36-47

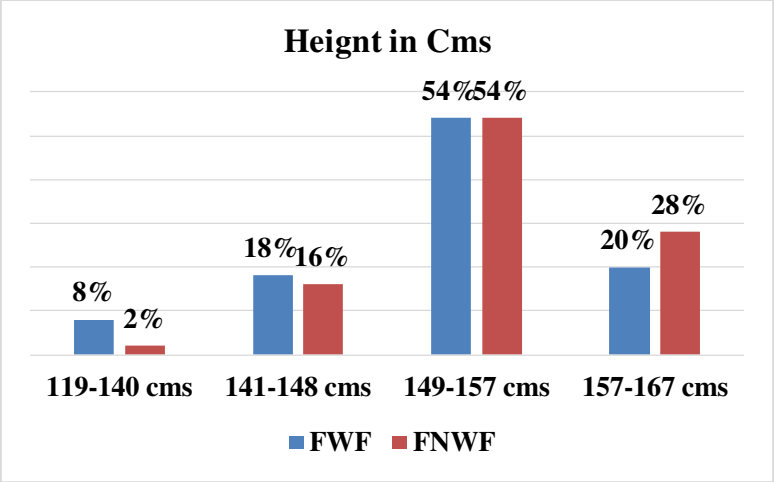
Kgs. Here data also reveals that females who are not working have slightly higher height and weight (153.82cms, 53.1kg)than those who are working (152 cms, 52.7kg).

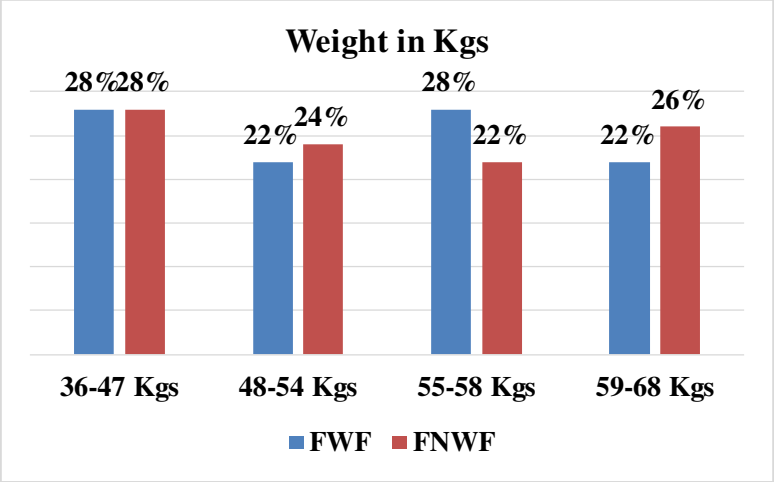
Table 2:-Distribution of the Study Subjects, based on the Female workers working and Not Working in a Factor

Category	Sub-Category	FWF		FNWF		Total	
		Frequency	%	Frequency	%	Frequency	%
Age (yrs)	19-22 years	15	30%	10	20%	25	25%
	23-26 years	10	20%	11	22%	21	21%
	27-30 years	10	20%	15	30%	25	25%
	31-35 years	15	30%	14	28%	29	29%
	Total	50	100%	50	100%	100	100%
Height	119-140 cms	4	8%	1	2%	5	5%
	141-148 cms	9	18%	8	16%	17	17%
	149-157 cms	27	54%	27	54%	54	54%
	157-167 cms	10	20%	14	28%	24	24%
	Total	50	100%	50	100%	100	100%
Weight	36-47 Kgs	14	28%	14	28%	28	28%
	48-54 Kgs	11	22%	12	24%	23	23%
	55-58 Kgs	14	28%	11	22%	25	25%
	59-68 Kgs	11	22%	13	26%	24	24%
	Total	50	100%	50	100%	100	100%

Source: Female attending Free Medical Camps arranged by the Principal investigator in the private clinic located in Bandimote, Ballari.







Where: FNWF: Female Not Working in a Factory, FWF: Female Working in a Factory

To evaluate the lung functionality of different types of females (working and non-working) in Ballari district, a paired t-test method has been adopted wherein significant levels have been checked at 95% confidence level. SPSS 25 version tool is used to present numbers in a statistical form. The bar chart demonstrates the mean value of all five lungs parameters for both types of women. Lung function values for females not working in the factor (FNWF) and females working in the family (FNF) are illustrated in table 3. Comparative mean values of lung parameters are as follows FVC (FNWF2.60±1.49, FWF2.28±0.37), FVE (FNWF1.88±0.39, FWF1.36±0.34), FEF 25-75 (FNWF1.99±0.85, FWF1.26±0.44), PEFR (FNWF 3.02±1.43, FWF1.78±0.63), and FEV1/ FVC (FNWF78.59±15.56, FWF61.08±15.12). Data clearly reveals that the mean value of all the five pulmonary functions has significantly decreased among the females working in the Ballari jeans factory insteadof the non-working females. Probability values for all five pulmonary are lesser than 0.05.

Regarding deviation, not much deviation from mean has been observed for listed parameters. The degree of freedom of the data is close to 49. Besides, the lower and upper limit of the mean difference is also within the range. Hence, from the collected data, inFree Medical Camps, it can be illustrated that pulmonary lung functions of the non-working femaleswork better than the

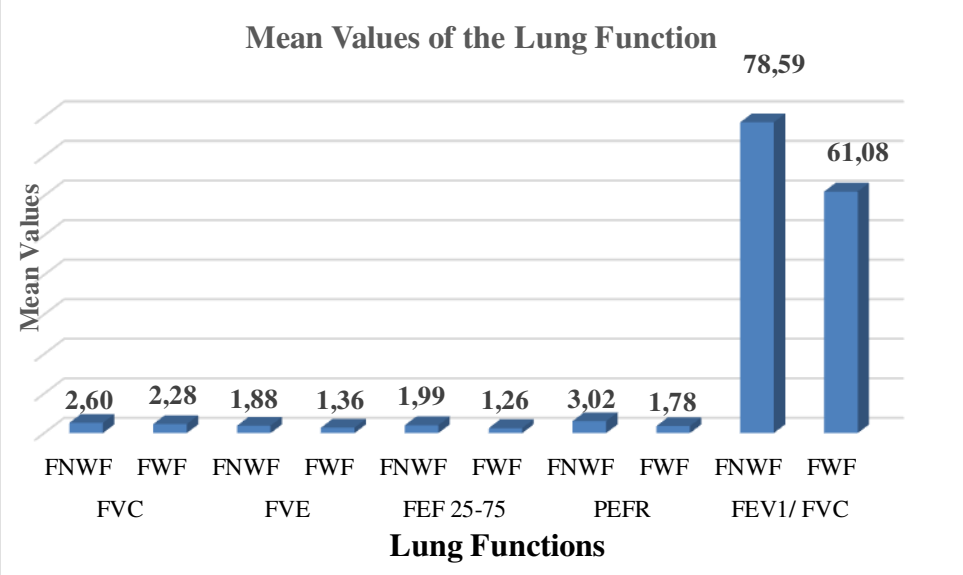
working females in BallariJeans Industry. As per the author (Atul Ajay Jagtap, Jyotsna S Deshmukh, 2019), working women suffer from restrictive or obstructive pulmonary disorder due to the accumulation of dirt elements in the air passage. The author further said that these dirt elements lodge-in the respiratory system and cause irritation. Later on, inflammation starts inthe small lung passage. Inflammatory process healing by fibrosis leads to airways thickening, ultimately leads to an obstructive change.

Table 3: Paired Samples Statisticsof the Study Subjects, based on the Female workers working and Not Working in a Factor

Lungs Parameters	Sample Group	**Paired Samples Statistics**			Mean Difference	95% CIof the Difference		T	df	Sig.
		Mean	N	Std. Dev		Lower	Upper			
FVC	FNWF	2.60	50	1.49	0.32	0.14	0.77	1.4	49	0.017
	FWF	2.28	50	0.37						
FVE	FNWF	1.88	50	0.39	0.53	0.39	0.66	7.8	49	0.000
	FWF	1.36	50	0.34						
FEF 25-75	FNWF	1.99	49	0.85	0.73	0.47	0.99	5.7	48	0.000
	FWF	1.26	49	0.44						
PEFR	FNWF	3.02	50	1.43	1.24	0.83	1.64	6.1	49	0.000
	FWF	1.78	50	0.63						
FEV1/ FVC	FNWF	78.59	50	15.56	17.52	11.71	23.33	6.1	49	0.000
	FWF	61.08	50	15.12						

FNWF: Female Not Working in a Factory, FWF: Female Working in a Factory,
FEV1: Forced expiratory volume 1, FVC: Forced vital capacity, FEF: 25–75: Forced expiratory flow, PEFR: Peak expiratory flow rate

Source: Female attending Free Medical Camps arranged by the Principal investigator in the private clinic located in Bandimote, Ballari



Discussion: Female workers employed in the jeans industry are significantly exposed to the hazardous dirtelements and chemical dye when sawing. Due to this, pulmonary lungs get widely affected. The target organ of the dirt element is the lungs.In the study, most female workers (29%) are from 31-35 years age group. This finding is in the sink with the author (Kent E. Pinkerton et. al, 2015). As per the author, the mean age of the female wooers who have COPD symptoms is31 years. Here data also reveals that females who are not working have slightly higher height and weight(153.82 cms, 53.1kg) than those working (152 cms, 52.7kg). In boththe groups, the average pulse rate is 77.5 with a BMI of 22.4. Further, coming to the Lungs parameters, forced vital capacity (FVC) has been examined, wherein females working in factors FVC is found towards the higher (2.28) side compared to the females not working in the factor (2.60). FVC is the percentage of the air, which should be forcibly exhaled from the lungs post taking a deep breath. This test supports in finding obstructive lung diseases, such as COPD,asthma etc.

The second essential test was FVE1 (Forced expiratory volume). In this test, any COPD or asthma person FVE results would be lower than any healthy person. In the study, FVE1 mean value for females working in the factor (1.36) is lower than the females not working in the factor (1.88). Therefore it can be concluded that female workers working in a factor are suffering from lung issues. Further, FEV1/FVC values were also examined, wherein as per the results, obstructive lung disease has been found for those working in factories.

As per the researcher (Bahram HARATI et.al., 2018), the reason for disorder in the respiratory system is an exposure to hazardous chemical substances and the inhalation of dirt particles. Researchers also mentioned that any pollutant exposure at the workplace will surely cause the respiratory disorder. Both workers and residents staying in an around the factory will indeed get exposed to these contaminants. This dirt element problem will not only cause respiratory problems but will also damage other organs such as eyes, lung, nose, etc. Any chemical-related product or products at the workplace will indeed have a sensitizing and irritant effect in the air, which can induce respiratory disorders and affect the lung functioning. In the research, the same effect has been observed among females working in a factory and the females not working in a factory. Here these females are potentially exposed to dirt and toxic chemicals, due to which the working of their respiratory function has reduced.

The third essential is FEF 25-75; the mean value for females working in the factor (1.26) is lower than the females not working in the factor (1.99). The same trend has been observed with the parameters like PEFR and FEV1/ FVC. This infers that all the lung parameters are lower for the females working in the jeans factory than those not working in the jeans factory.

V. CONCLUSION

Female workers employed in the jeans industry are significantly exposed to the hazardous dirt elements when sawing. Due to this, pulmonary lungs get widely affected. Female workers employed in the jeans industry are significantly exposed to the hazardous dirt elements and chemical dye when sawing. Due to this, pulmonary lungs get widely affected. The target organ

of the dirt element is the lungs. In the study, most female workers (29%) are from 31-35 years age group. This finding is in the sink with the author (Kent E. Pinkerton et. al, 2015). As per the author, the mean age of the female workers who have COPD symptoms is31 years. Here data also reveals that females who are not working have slightly higher height and weight (153.82 cms, 53.1kg) than those working (152 cms, 52.7kg). The second essential test was FVE1 (Forced expiratory volume). In this test, any COPD or asthma person FVE results would be lower than any healthy person. In the study, FVE1 mean value for females working in the factor (1.36) is lower than the females not working in the factor (1.88). Therefore it can be concluded that female workers working in a factor are suffering from lung issues. Further, FEV1/FVC values were also examined, wherein as per the results, obstructive lung disease has been found for those working in factories. In the research, the same effect has been observed among females working in a factory and the females not working in a factory. Here these females are potentially exposed to dirt and toxic chemicals, due to which the working of their respiratory function has reduced. It can be concluded that lung functions are useful tools for strengthening the lungs that in turn can treat many types of diseases related to lungs such as tuberculosis, allergic bronchitis, asthma, and different kinds of occupational diseases.

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