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ASSESSMENT OF LUNG CAPACITY IN CASHEWNUT FACTORY WORKERS USING 3 BALL SPIROMETER

[1]*Dr. M. Monitha Star, [2]Dr. J. Jaslin Edward, [3]T. Sherrington, [4]Reshma T., [4]Fagin Sam R. M., [4]Vishnu V. S., [4]Ashika M. D. and [4]Arun Kumar I.

[1]Pharm. D., (Asisstant Professor, Department of Pharmacy Practice).
[2]M. Pharm, Ph. D., (Principal, Department of Pharmacognosy).
[3]M. Pharm., (HOD, Department of Pharmacy practice).

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***Corresponding Author**
Dr. M. Monitha Star
Pharm. D., (Asisstant Professor, Department of Pharmacy Practice).
mohanmallika11@gmail.com

ABSTRACT

This study assesses lung capacity and evaluates co-morbidity in cashew nut factory workers using a 3-ball spirometer in Kanyakumari district. The objective is to determine lung capacity and assess respiratory health. The study is a prospective observational design, conducted over 3 months with a sample size of 200 workers, all above 30 years of age. Workers under 30 were excluded. All cashewnut factory workers below 30 years were excluded. In our study 30-70 years of cashewnut factory workers were included. The workers age distribution is 30- 50 years 73(36.5%), 50- 60 years 81(40.5%) and 46(23%) workers age range above 60. There are 11(5.5%) of workers have 1-10 years of experience 93(46.5%) have 10-20 years of work experience, 89(44.5%) workers have 20-30 years of experience and 7(3.5%) of workers have 30-50 years of experiences. Workers are employed in Shelling 70(35%), Peeling 57(28.5%), Grading 44(22%), Roasting 16(8%), Packing13(16.5%). The medical history reveals that 28(14%) of cashewnut factory workers have diabetic, 28(14%) of workers have hypertension, 8(4%) have skin related diseases, 7(3.5%) have asthma, 2(1%) of workers have arthritis, 27(13.5%) have thyroid condition, 1(0.5%) have CVD, 3(1.5%) have other diseases. Respiratory health problems experienced by cashewnut factory workers are chest tightness 13(6.5%), wheezing 14(7%), nasal/throat irritation 2(1%), frequent sneezing 7(3.5%), shortness of breathe 32(16%), cough for as long as 3 months 4(2%), phlegm from chest 9(4.5%). History of respiratory ailments 6(3%) and exposure of fumes, vapours, fuels and paints are 40(20%). In this study, 85(42.5%) workers have elevated 3 balls, 43(21.5%) workers have elevated 2 balls, 8(4%) workers have elevated 1 ball, 64(32%) workers does not respond for spirometric analysis. This study emphasizes the importance of early detection of respiratory issues and continuous monitoring of lung function to prevent chronic lung diseases and reduce the risk of respiratory complications among workers.

KEYWORDS: Cashewnut factory, Occupational exposure, Lung capacity, Spirometer, FVC/FEV1 ratio.

INTRODUCTION

The cashew plant belongs to the family "Anacardiaceae." The botanical name of cashew is 'Anacardium occidentale.' The nuts of cashew are 22 mm long, and it seems like a kidney. The outer skin of the shell is soft and leathery, and the thin, hard inner skin is about 3 mm. South Eastern America (Brazil) is the native of cashew; it was brought into India in the 16th century and got popular on the Malabar coast of India by the Portuguese (Sathyadas, 1991).[1]

Cashew processing is an important industry in India, particularly in the states of Kerala, Tamil Nadu, Karnataka, Goa, Andhra Pradesh, Maharashtra, and Orissa.[2]

India produces and exports the most cashew kernels in the world and accounts for over 60% of global cashew kernel exports. Cashews are sometimes called "nature's vitamin pill" due to their nutritional value.[3]

The document describes the process of cashewnut processing in the Manakavilai, Chemanvilai, Melpuram, and Kumarapuram villages in Kanniyakumari district, including the collection of raw cashews and the production of kernels, peeling, and grading.

It notes that the cashew industry provides important employment opportunities for rural and female workers but that working conditions need improvement in areas like the provision of protective gloves.

1.1. The process and challenges involved in making raw cashew nuts safe for consumption

1.1.1. Acidic content (Caustic oil)

Raw cashew nuts contain a highly acidic substance known as caustic oil, which is present in the shells surrounding the nuts. This oil is harmful and can burn the skin upon contact. Additionally, when the cashew shells are heated, the oil releases toxic fumes, which are dangerous to breathe in. This is why the raw cashew nuts are not immediately suitable for consumption; they need to be processed to make them safe to eat.[4]

1.1.2. Elaborate processing required

To remove the harmful effects of the caustic oil and prepare the cashew nuts for eating, an elaborate series of processes is required.[5] These processes include

- **Sun drying:** The cashew nuts are first dried in the sun to reduce moisture and prepare them for roasting.
- **Roasting:** The dried cashews are roasted to soften the shells and neutralize the caustic oil inside.
- **Breaking (Shelling):** The roasted cashews are then broken open, and the shell is removed to access the edible nut inside.
- **Heating:** After breaking the shells, the cashews are often further heated to help remove any remaining toxins or to enhance their flavor.
- **Peeling:** The final step involves peeling off the brown skin that surrounds the cashew nut, making it ready for consumption.[6]

1.1.3. Labor-Intensive Processes

Two of the most labor-intensive and time-consuming tasks in this process are the **breaking (shelling)** of the cashew nuts and the **peeling** of the brown skin that remains after the shells are removed. These steps require significant manual effort, as the shells are tough and the skins are delicate.[7]

1.1.4. Women as the Majority of Workers

The labor-intensive nature of shelling and peeling means that a large number of workers are involved in these processes. In many cashew processing industries, women make up the majority of these workers. This is often due to the traditional roles assigned to women in such industries, as well as the delicate nature of peeling the thin brown skin from the cashew nuts.[8]

1.2. CASHEW NUT SHELL AS AN ENERGY SOURCE

The use of residual products, specifically cashew nut shells (CNS), which are by-products left over from processing cashew nuts.[9] These shells, instead of being discarded, are being used as an energy source in certain industries.[10] The CNS contains a dark liquid fraction known as cashew nut shell liquid (CNSL), which is considered a valuable renewable resource for creating various functional products in both medical and industrial fields. This inedible raw material is a by-product of the cashew processing industry.[11] This practice is already being implemented in some places, where the cashew nut shells are burned to generate heat or power. Research has explored the use of CNSL as a raw material to create a variety of functional products. These include therapeutic agents such as neurotransmitters, antihypertensives, anticancer agents, and antitumor drugs, as well as sympathomimetic, vasoconstrictor, mydriatic, cardiotonic, and cardiac stimulant compounds, along with nonsteroidal anti-inflammatory drugs. CNSL is also being utilized in industrial applications, including the production of bioethanol, biodiesel, adhesives, dyes, resins, and rubbers.[12]

However, when CNS are burned as fuel, they release exhaust gases that may contain harmful emissions, such as toxic chemicals and pollutants.[13] The use of cashew nut shells as an energy source is beneficial; it requires appropriate technology, such as filters, to control and reduce harmful emissions resulting from the combustion process.[14]

1.3. OCCUPATIONAL EXPOSURE OF DUST PARTICLES

Occupational respiratory diseases occur when dust particles are inhaled and accumulate in the lungs over time.[15] This deposited dust can interfere with the normal process of breathing (inhalation and exhalation) by obstructing airflow. Several factors influence the severity of these diseases, including the amount of dust (concentration), the duration of exposure, the size of the dust particles (smaller particles tend to be more harmful), and genetic predispositions, which can make some individuals more susceptible to respiratory problems.[16]

Workers in the cashew nut industry, particularly those involved in processing, are at risk of developing respiratory health issues due to their exposure to dust in the workplace.

1.3.1. Types of dust are

a) Inhalable dust

b) Thoracic dust

c) Respirable dust

a) Inhalable Dust

This refers to dust that can be harmful when it settles anywhere in the respiratory system, including the mouth and nose.

b) Thoracic Dust

This refers to particles that are hazardous when they are deposited anywhere within the lung airways and the region responsible for gas exchange.

c) Respirable Dust

This is the fraction of dust that reaches the alveolar region of the lungs, where it can be harmful.[17] This dust can come from various sources, such as cashew nut shells and other by-products, and may be inhaled during activities like shelling, peeling, and packaging. Prolonged exposure to this dust can cause harm to the respiratory system, leading to various health problems. This may lead to chest tightness, shortness of breath, cough and phlegm production, chronic bronchitis, asthma, and emphysema.[17]

1.4.1. Respiratory Symptoms

Exposure to dust led to various **respiratory symptoms**, which include:

- **Chest pain:** Workers may experience discomfort or tightness in the chest due to inflammation or irritation in the respiratory system.
- **Phlegm production:** Chronic dust exposure can lead to the production of excess mucus, which the body produces to clear the airways of irritants.
- **Wheezing:** A high-pitched whistling sound when breathing, typically caused by narrowing of the airways due to inflammation or blockage from dust particles.
- **Coughing:** A common symptom as the body attempts to clear irritants from the lungs or airways.
- **Shortness of breath:** Difficulty breathing or a feeling of not getting enough air, which can result from impaired lung function caused by dust exposure.[19]

These symptoms may be indicative of a condition known as **occupational lung disease**, which can develop over time from continuous exposure to harmful particles like dust. If left untreated, this can lead to more severe respiratory diseases, such as chronic bronchitis, asthma, or even lung fibrosis.[20]

1.4. LUNG FUNCTION TEST

To assess the impact of dust exposure on workers respiratory health, lung function tests are commonly used to reflect the physiological properties of the lungs.

By measuring lung function, healthcare providers can determine whether dust exposure has caused any impairment to the lungs and help identify early signs of respiratory diseases.[18]

Pulmonary function testing (PFT) is used to assess lung functionality, with spirometry being the primary method of evaluation.[20]

1. 5. SPIROMETRY

Spirometry is a widely used and essential diagnostic tool in assessing lung function. It measures the amount and speed of air that a person can inhale and exhale, providing valuable information about the efficiency of the lungs. This test is particularly important for diagnosing lung abnormalities and categorizing their severity, such as chronic obstructive pulmonary disease (COPD), asthma, and other respiratory conditions.[21]

Three spirometry readings were taken for each subject, and the best reading out of the three was chosen. A variation of less than 5 was considered acceptable as the final reading. To minimize inter-investigator variability, only one investigator conducted all the subject interviews and performed the lung function tests (LFT). After applying strict inclusion criteria, Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) and the FEV1/FVC ratio were recorded using an automated spirometer, following all standard protocols.[22]

1.6. SPIROMETRY IN DIAGNOSING LUNG ABNORMALITIES

Spirometry plays a key role in detecting lung diseases by providing objective measurements of lung function.[23] During the test, a person is asked to take a deep breath and exhale as forcefully and completely as possible into a device called a **spirometer**.[26] Spirometers are non-invasive diagnostic tools used for screening and basic pulmonary function testing.[24] They provide valuable diagnostic information regarding the type and severity of lung function impairment and can be performed quickly and at a relatively low cost. Normal spirometry results suggest a high likelihood of long-term survival, while abnormal results indicate a poorer prognosis. Simple spirometric measurements provide valuable data for both primary care physicians and specialists. For instance, a patient presenting with a cough and shortness of breath, potentially linked to their occupation, can benefit from prior spirometry results as a baseline for comparison. Additionally, results from testing already conducted in certain occupational groups can be incorporated into a functional database, enabling cost-effective and efficient medical health surveillance.[25]

The spirometer records various parameters related to airflow, which help in diagnosing and determining the severity of respiratory conditions.[27] Some of the key measurements taken during a spirometry test include

a. Forced Vital Capacity (FVC)
b. Forced Expiratory Volume in 1 second (FEV1)
c. FEV1/FVC Ratio
d. Peak Expiratory Flow (PEF)

a. Forced Vital Capacity (FVC)

This is the total amount of air a person can exhale after taking the deepest breath possible. It helps in determining lung capacity.[28]

b. Forced Expiratory Volume in 1 second (FEV1)

This is the amount of air a person can forcefully exhale in the first second of the exhalation. FEV1 is a critical measure used to assess the severity of obstructive lung diseases, like asthma and COPD.[28]

c. FEV1/FVC Ratio

The ratio of FEV1 to FVC is crucial in diagnosing obstructive and restrictive lung diseases. A lower ratio (typically less than 70%) indicates obstructive lung diseases, where the airflow is limited, while a normal or higher ratio suggests restrictive lung diseases, where the lung capacity is reduced but the airflow is not significantly obstructed.[29]

d. Peak Expiratory Flow (PEF)

This measures the highest speed at which a person can exhale, providing insight into the immediate function of the airways. This measurement is often used in monitoring asthma, especially to assess the degree of airway narrowing during a flare-up.[30]

1.7. ROLE OF SPIROMETRY DATA FOR HEALTH CARE PROFESSIONALS

Spirometry test results are a crucial data source for healthcare professionals, including general physicians and **occupational health specialists**. These professionals use the data to:

- **Diagnose lung conditions:** Spirometry helps in identifying conditions such as asthma, chronic bronchitis, emphysema, and other chronic obstructive pulmonary diseases (COPD).[31]
- **Monitor disease progression:** Regular spirometry testing is useful in tracking the progression of lung diseases and evaluating the effectiveness of treatments.
- **Assess lung health in occupational settings:** Occupational health specialists use spirometry to screen workers who are exposed to hazardous substances (such as dust, chemicals, and fumes) to prevent work-related respiratory diseases.

By comparing a patient's results with established normal values, healthcare providers can evaluate whether lung function is within the expected range for age, gender, height, and ethnicity. Abnormal results, such as a reduced FEV1 or FEV1/FVC ratio, help physicians to diagnose specific respiratory diseases and categorize their severity.[32]

1.8. SPIROMETRY AS A SCREENING TOOL

Spirometry is not only used for diagnosis but also for routine medical screening, especially in individuals with symptoms of lung disease or those who are at risk due to their occupation, lifestyle (e.g., smokers), or family history. The test is simple, non-invasive, and can detect early signs of lung diseases before symptoms become severe.[33]

- **Early detection of lung conditions:** By identifying abnormal lung function early, spirometry enables timely interventions, which can prevent the worsening of respiratory diseases.
- **Risk assessment for occupational exposure:** Spirometry is used in workplaces to identify employees who may be at risk of developing respiratory diseases due to exposure to harmful substances (e.g., dust, chemicals, or fumes).[34]

1.9. TYPES OF SPIROMETERS

There is a wide range of spirometers available on the market. Basic handheld spirometers provide forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) values, which can be manually compared to predicted normal values. More advanced spirometers display graphs, typically volume-time curves, which may or may not be accompanied by printouts. The latest electronic spirometers calculate the percentage of predicted normal values using pre-programmed reference values, which are entered after patient details and the test are performed. Many of these modern spirometers come with built-in printers and can also be connected to a computer.

When choosing a spirometer, it is important to ensure that it meets the American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines for spirometry, which are updated regularly. Since air volume is influenced by environmental conditions, spirometry results should be presented at body temperature and ambient pressure, saturated with water vapor (BTPS). Calibration, maintenance, and infection control practices (such as using disposable mouthpieces or filters) should follow the manufacturer's recommendations. Many of the newer spirometers no longer require daily calibration or calibration after a certain number of tests, as was previously necessary. Respiratory technicians or physicians conducting spirometry tests must receive proper training. It is recommended that individuals maintain competency by performing at least five tests a week (20 per month).[35]

1.10. HOW TO PERFORM SPIROMETRY

Step 1: A disposable mouthpiece is attached, and the patient is instructed to sit or stand in a comfortable, stable position.

Step 2: The test is typically performed in a relaxed and controlled manner to ensure accurate results.

Step 3: The patient is then asked to take a deep breath and exhale forcefully and steadily into the spirometer. As the patient exhales, the airflow causes the three balls in the spirometer to rise, each representing different aspects of the airflow.

Step 4: The movement of these balls indicates the volume of air exhaled, and the height to which each ball rises helps to evaluate the force and volume of the patient's exhalation. The higher the balls rise, the stronger the exhalation, indicating a better respiratory performance.[36]

It's important for the person performing the test to observe the balls closely during the maneuver, ensuring that the patient is exhaling correctly. If the patient's exhalation is weak or inconsistent, it may result in inaccurate readings. The test should be repeated a few times to obtain consistent results. Throughout the procedure, the technician should ensure the patient is using the correct technique, including maintaining a tight seal on the mouthpiece, avoiding premature inhalation, and ensuring a full, forced exhalation. After applying strict inclusion criteria, Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) and the

FEV1/FVC ratio were recorded using an automated spirometer, following all standard protocols.[37]

NEED OF THE STUDY

- Occupational exposure is a leading cause of pulmonary disorders with asthma and bronchitis being two of the most common conditions resulting from prolonged inhalation.[38]
- Prolonged exposure to cashew dust can lead to chronic respiratory problems, reduced lung function, and decreased quality of life.
- Early detection of lung function abnormalities can help prevent long-term damage and improve treatment outcomes.
- The study contributes to the understanding of the respiratory health risks associated with cashew dust exposure, enhancing occupational health research and practice.

AIM AND OBJECTIVES

Aim of the study

- To assess the lung capacity using 3 ball Spirometer in cashew nut industry workers in Kanniya kumari district.

Objectives of the study

- To find the lung capacity of the cashew nut factory workers.
- To evaluate the co-morbidity in the cashew nut factory workers.

METHODOLOGY

Study design

- Prospective observational study.

Study site

- Manakkavilai
- Chemanvilai
- Kumarapuram
- Melpuram

Study period

- 3 months

Sample size

- Sample size of 200 workers in cashew nut factory were taken in this study.

Inclusion criteria

- All cashew nut factory workers above 30 years were included.
- All department cashew nut factory workers were included.

Exclusion criteria

- All cashew nut factory workers below 30 years were excluded.

Material used

- The standard questionnaires were used.

Data collection

- The data entry included the information of cahewnut factory workers such as age, sex, marital status, work experience, department of working, Past medical history, past medication history, family medical history, life style habits, working hours, and respiratory health problems, spirometric analysis.

PLAN OF WORK

The entire study is planned for a period of 3 months. The study design is given below.

Phase 1

- Identify the scope
- Conduct literature review
- Design the questionnaire
- Obtain consent from the cashew nut factories

Phase 2

- Identify the knowledge of lung capacity in workers when expose to dust or polluted air
- Determine the cause and risk factors of respiratory infections
- Describe the demographic status and complications associated with the workers
- Collecting the datas based on questionnaire

Phase 3

- Evaluate the data
- Documentation

RESULTS

- We have randomly selected 200 workers in cashew nut industry for the assessment of lung capacity using 3- ball spirometer.
- After knowledge assessment we have followed the case study in our study period.
- During follow up period

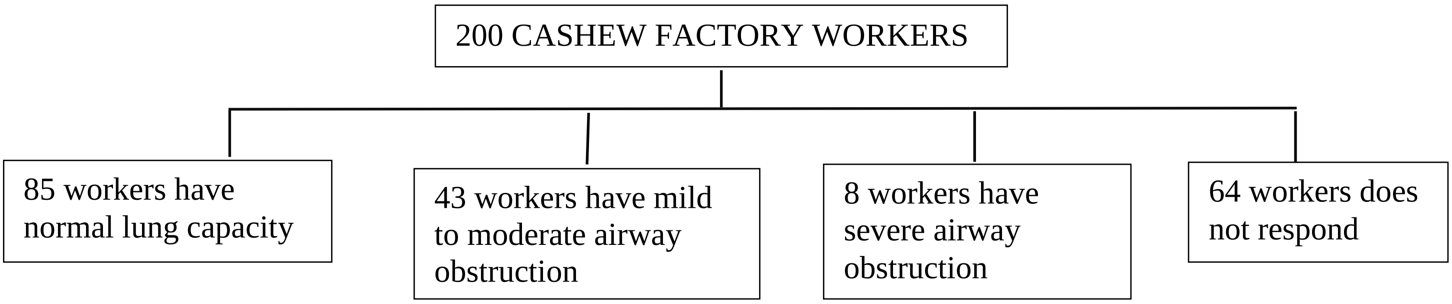


Table 1: Personal details – Age.

S.No	Age limit	Number of workers	Percentage (%)
1.	20-30	0	0%
2.	30-50	73	36.5%
3.	50-60	81	40.5%
4.	Above 60	46	23%

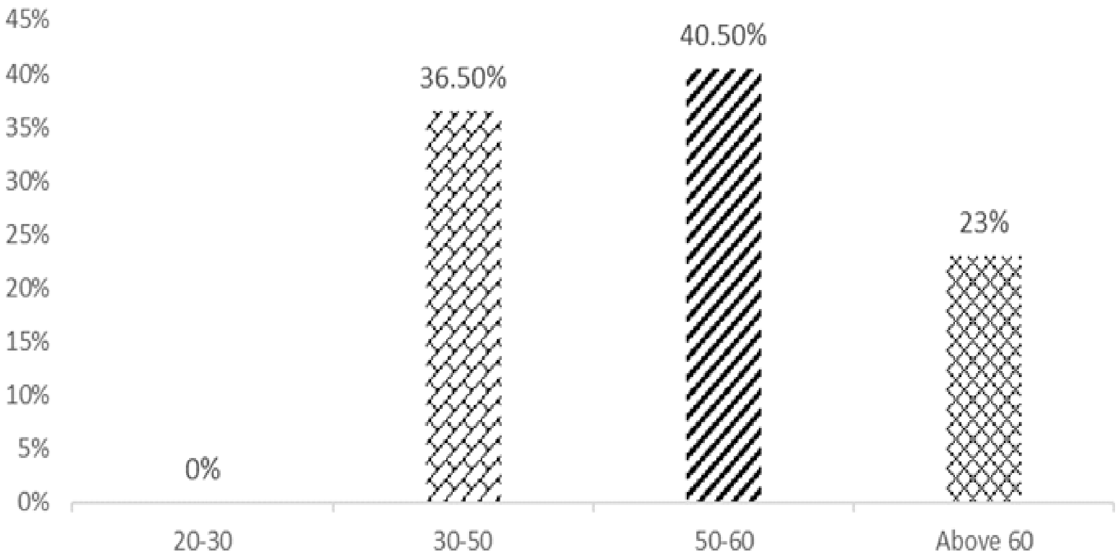


Figure 1: Age limit.

Table 2: Personal details – Sex.

S.No	Sex	Number of workers	Percentage (%)
1.	Male	29	14.5%
2.	Female	171	85.5%

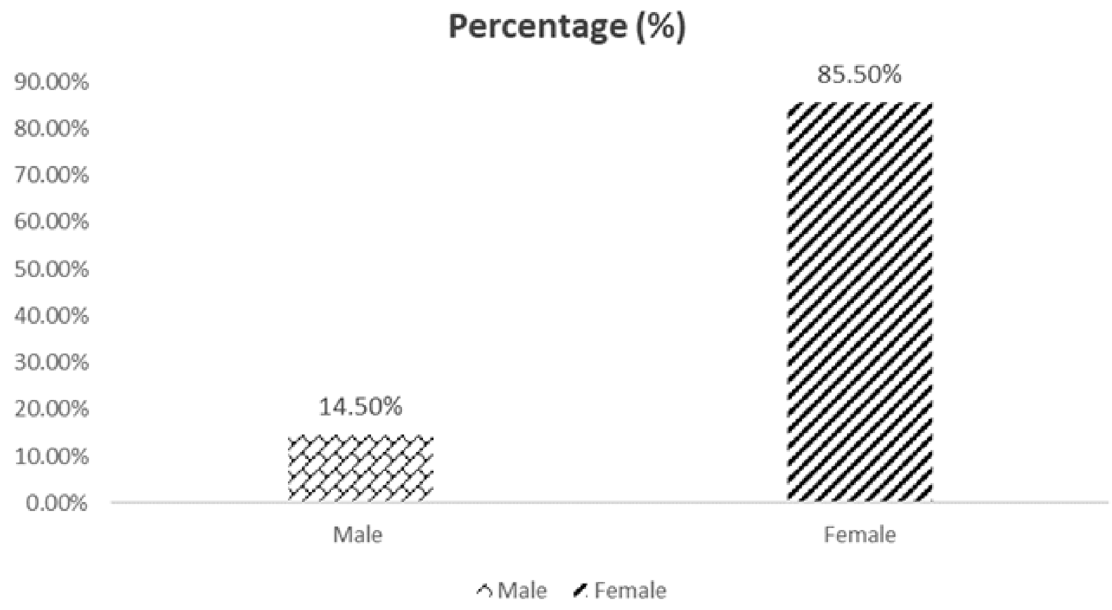


Figure 2: Personal details – Sex.

Table 3: Marital status.

S.No	Marital Status	Number of workers	Percentage (%)
1.	Married	200	100%
2.	Unmarried	0	0%

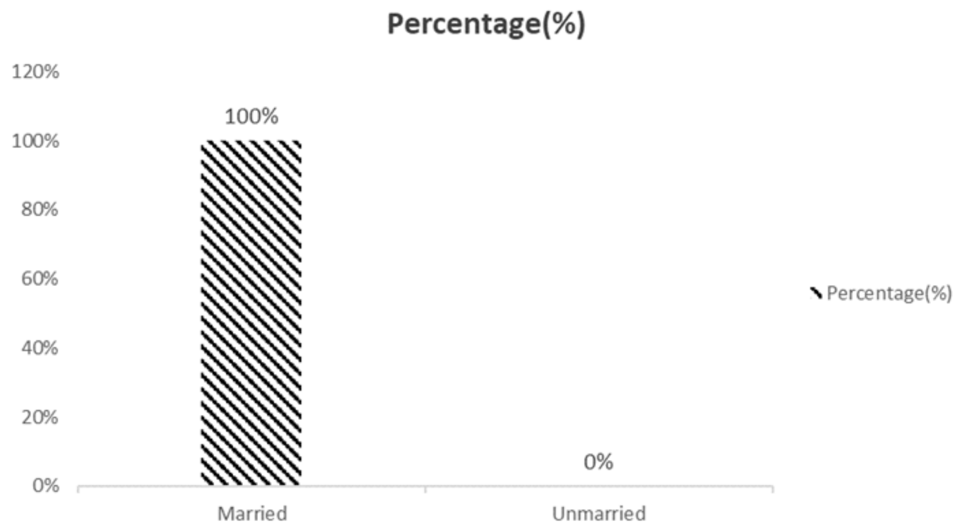


Figure 3: Personal details - Marital status.

Table 4: Working Experience.

S.No	Work experience in years	Number of workers	Percentage (%)
1.	1-10	11	5.5%
2.	10-20	93	46.5%
3.	20-30	89	44.5%
4.	30-50	7	3.5%

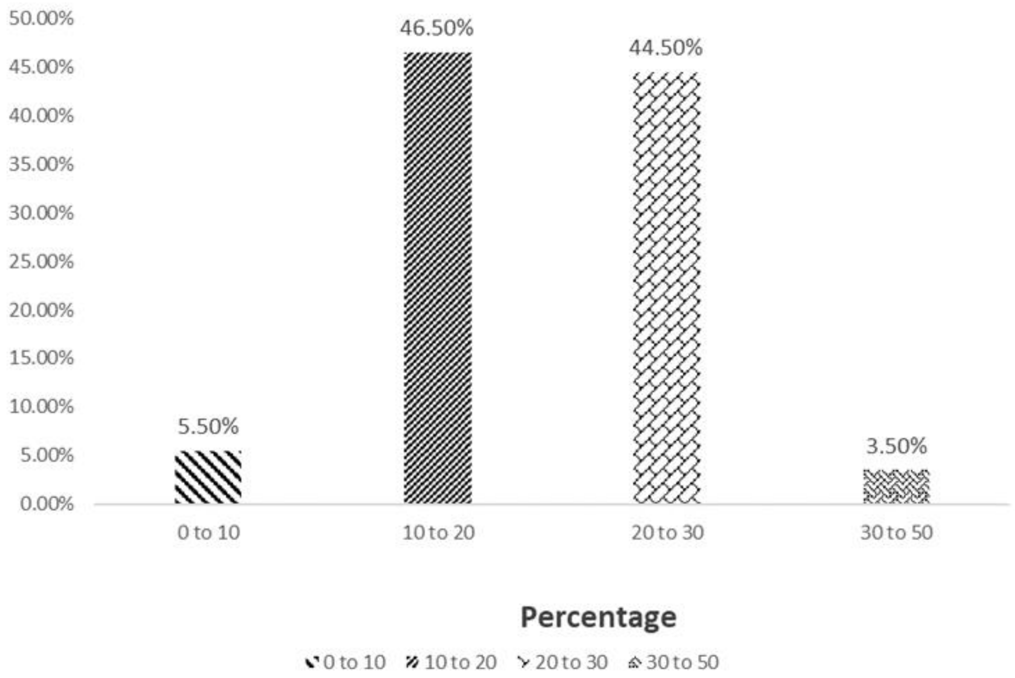


Figure 4: Work experience.

Table 5: Educational status.

S.No	Educational status	Number of workers	Percentage (%)
1.	Early education	152	76%
2.	Primary education	40	20%
3.	Secondary education	8	4%
4.	Post-education secondary	0	0%

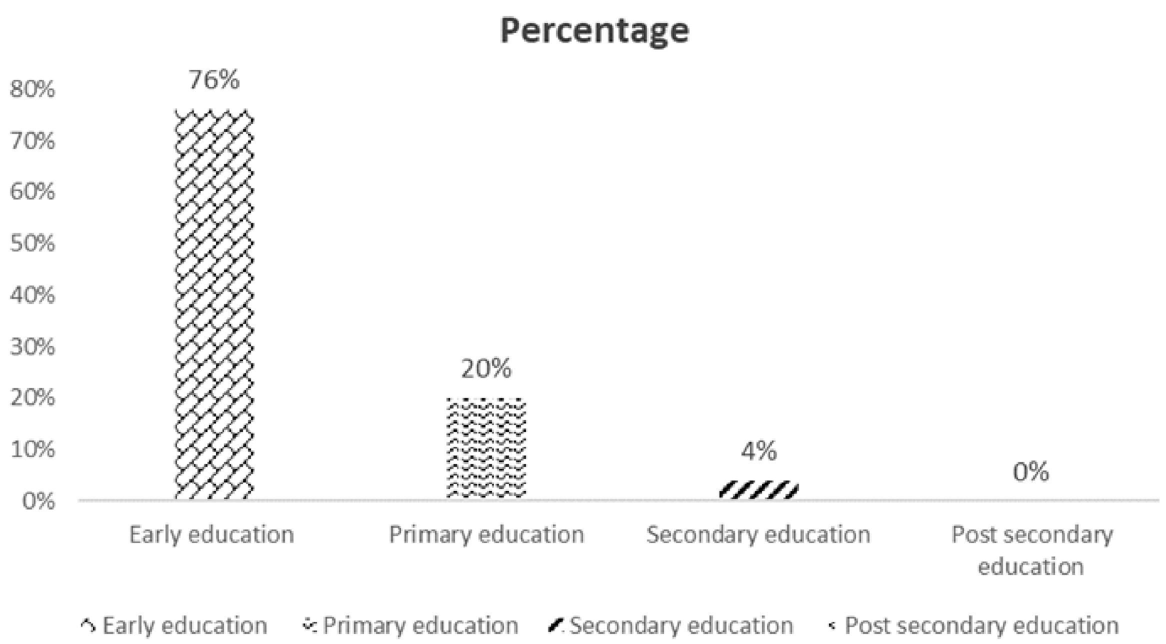


Figure 5: Educational status.

Table 6: Department of working.

S.No	Department of working	No.of.workers	Percentage(%)
1.	Shelling	70	35%
2.	Peeling	57	28.5%
3.	Grading	44	22%
4.	Roasting	16	8%
5.	packing	13	6.5%

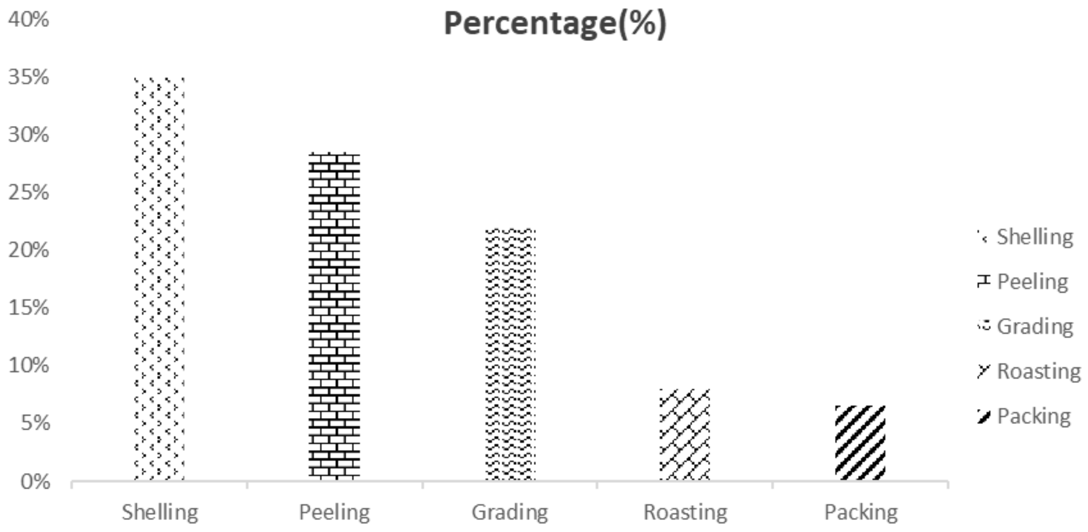


Figure 6: Department of working.

Table 7: Past medical history.

S.No	Past medical history	Number of workers	Percentage (%)
1.	Diabetes Mellitus	28	14%
2.	Hypertension	28	14%
3.	Skin disease	8	4%
4.	Asthma	7	3.5%
5.	Arthritis	2	1%
6.	Thyroid disease	27	13.5%
7.	Cardio Vascular Disease	1	0.5%
8.	Others	3	1.5%

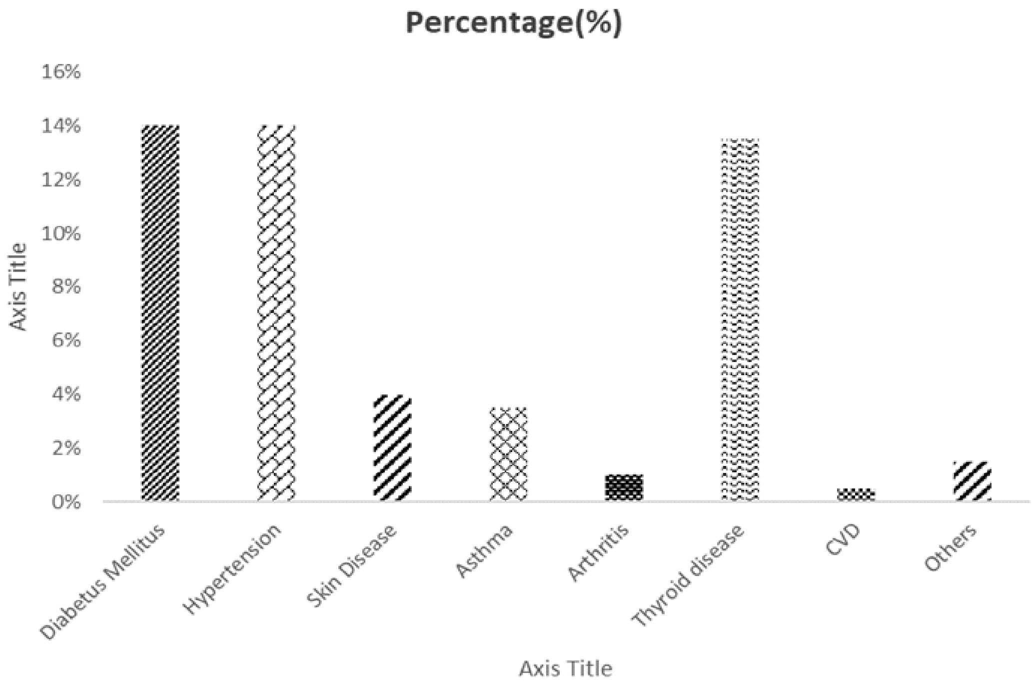


Figure 7: Past Medical History.

Table 8: Life style Habits.

S.No	Life style habits	Number of workers	Percentage (%)
1.	Tea/ Coffee	200	100%
2.	Smoking	3	1.5%
3.	Alcohol	5	2.5%
4.	Others	0	0%

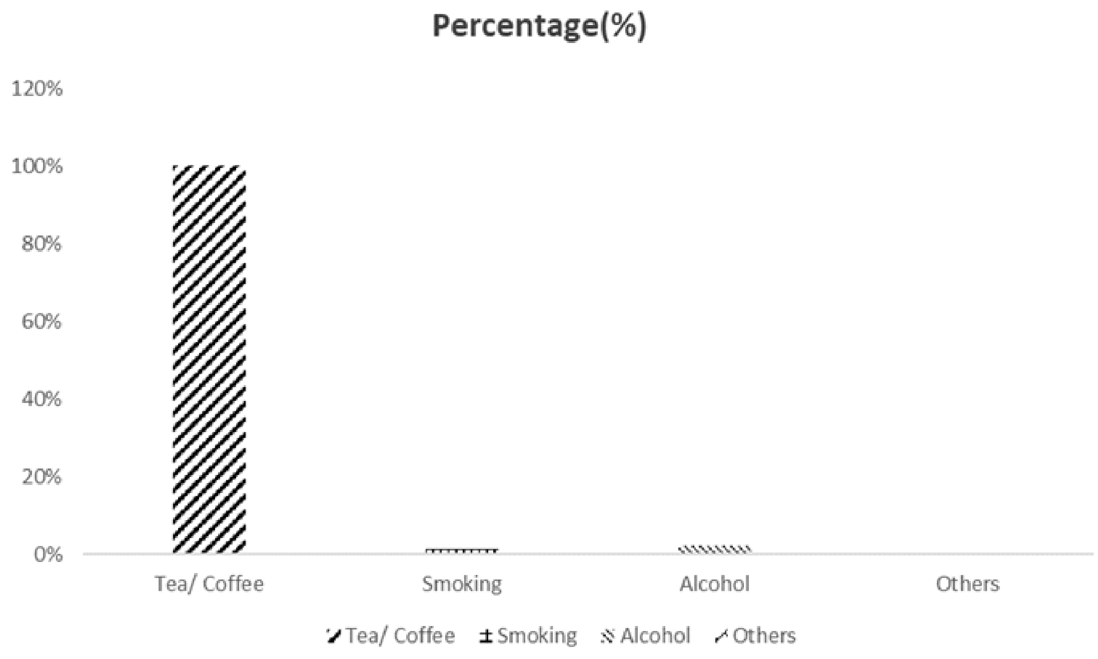


Figure 8: life style habit.

Table 9: Respiratory health problems.

S.No	Respiratory Problems	Number of workers	Percentage (%)
1.	Chest Tightness	13	6.5%
2.	Wheezing / Whistling in chest	14	7%
3.	Nasal / Throat irritation	2	1%
4.	Frequent sneezing	7	3.5%
5.	Shortness of breath	32	16%
6.	Cough for as long as 3 months	4	2%
7.	Phlegm from chest	9	4.5%
8.	History of respiratory ailments	6	3%
9.	Exposures of fumes, vapours, fuels and paints	40	20%

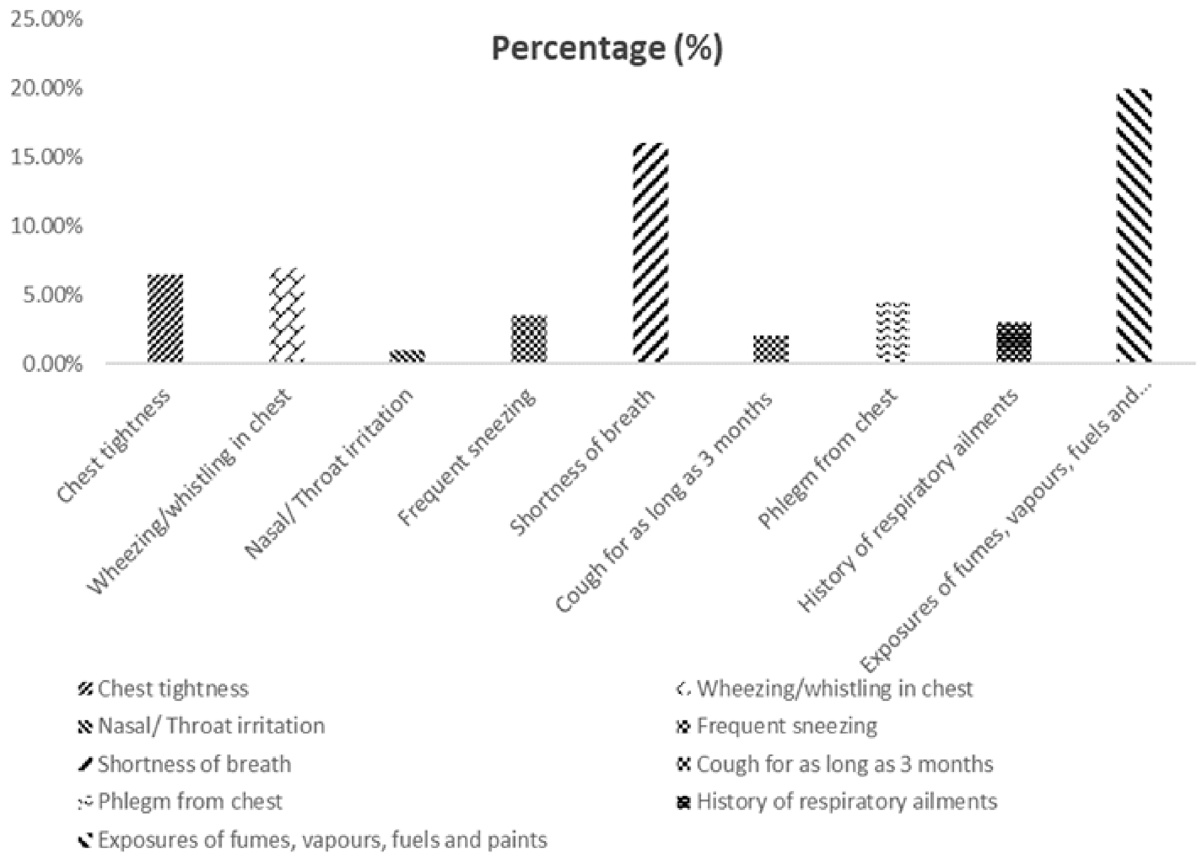


Figure 9: Respiratory health problem.

Table 10 A: Spirometric analysis.

S.No	Ball movement	Number of workers	Percentage (%)
1.	3 balls	85	42.5%
2.	2 balls	43	21.5%
3.	1 ball	8	4%
4.	Not responded	64	32%

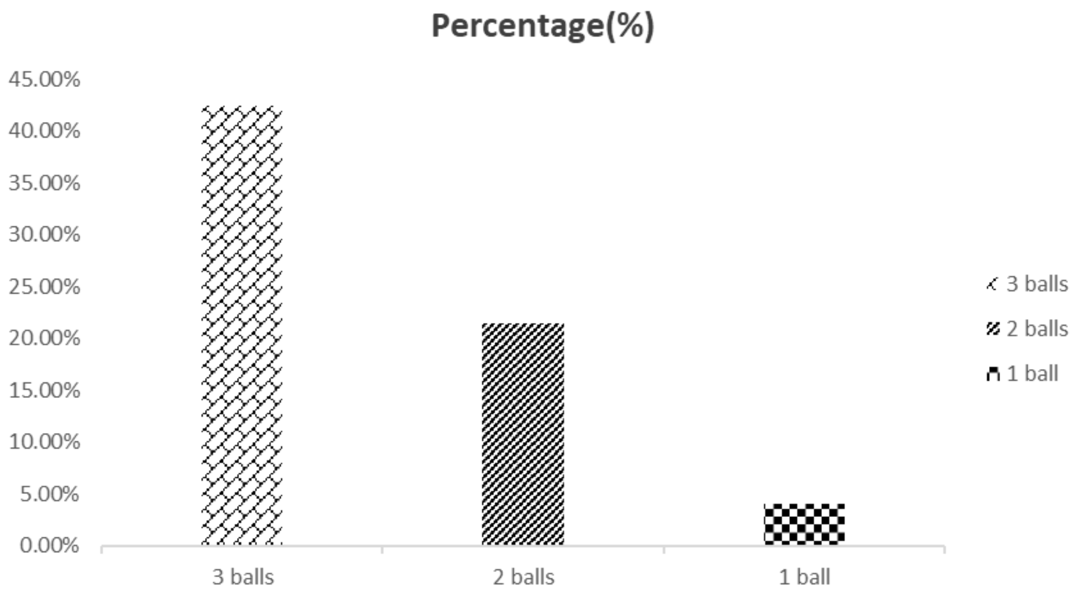


Figure 10 A: Spirometric analysis.

Table 10 B: FVC (Forced Vital Capacity)

S.No	FVC (liters) based on ball movement	Number of workers	Percentage (%)
1.	≥4.0 liters 3 balls moving rapidly	85	42.5%
2.	2.5 to 3.9 liters Top 2 balls moving rapidly	31	15.5%
3.	1.5 to 3.9 liters Top ball moving rapidly, middle ball moving slowly	12	6%
4.	<1.5 liters Top ball moving slowly	8	4%
5.	Not responded	64	32%

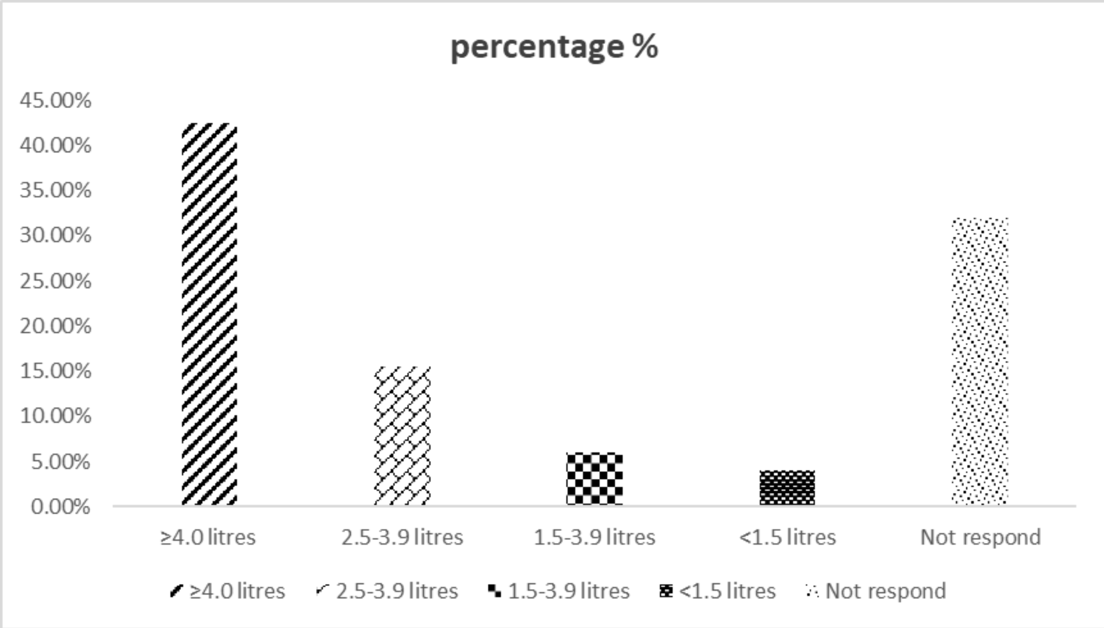


Table 10 C: FEV1 (Forced Expiratory Volume in 1 second)

S.No	FEV1 (liters) based on ball movement	Number of workers	Percentage (%)
1.	≥3.0 liters 3 balls moving rapidly	85	42.5%
2.	2.0 to 2.9 liters Top 2 balls moving rapidly	31	15.5%
3.	1.0 to 1.9 liters Top ball moving rapidly, middle ball moving slowly	12	6%
4.	<1.0 liters Top ball moving slowly	8	4%
5.	Not responded	64	32%

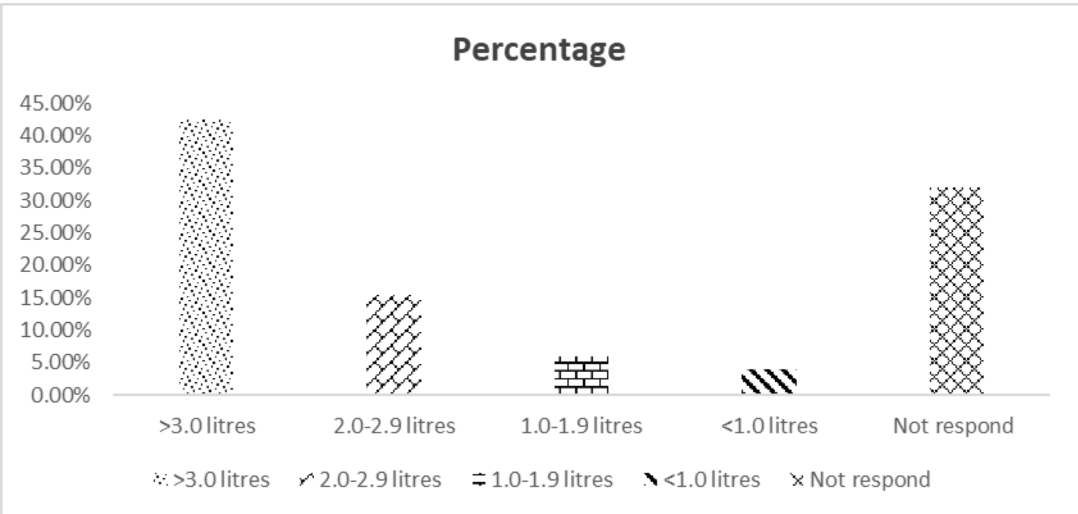
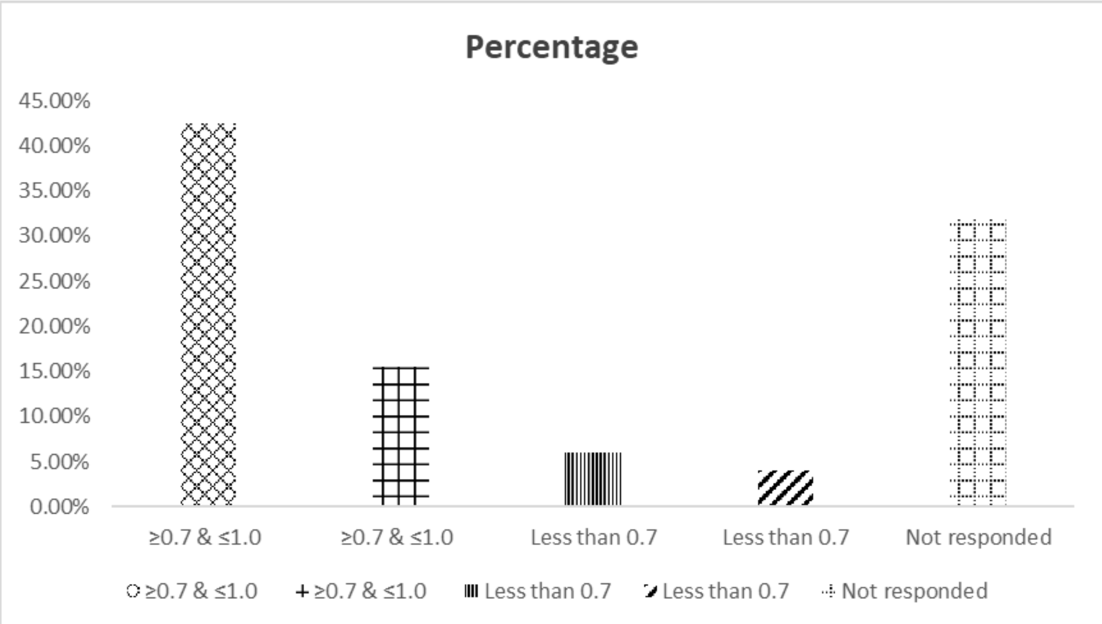


Table 10 D: FEV1/FVC ratio.

S.No	FEV1/FVC ratio	Number of workers	Percentage (%)
1.	≥0.7 and ≤1.0 3 balls moving rapidly (normal lung capacity)	85	42.5%
2.	≥0.7 and ≤1.0 Top 2 balls moving rapidly (possible restrictive lung disease)	31	15.5%
3.	Less than 0.7 Top ball moving rapidly, middle ball moving slowly (Possible obstructive lung disease)	12	6%
4.	Less than 0.7 Top ball moving slowly(Possible obstructive lung disease)	8	4%
5.	Not responded	64	32%



DISCUSSION

In our study regarding the knowledge assessment questionnaire, we came to know that a few cashew nut factory workers have low lung capacity when exposed to dust and fumes from the cashew nut factory.

The total number of workers included in the study was 200. Occupational exposure to dust and fumes may lead to reduced lung capacity. The assessment of lung capacity can be measured by using a 3-ball spirometer. Our study result is supported by the previously conducted study by Janana Priya et al. (2021).[39]

In our study, 30-70 years of cashew nut factory workers were included. In that about 73 (36.5%) workers are in the age range of 30-50, workers in the age range of 50-60 are 81 (40.5%), and 46 (23%) workers are in the age range above 60 (Table 1).

About 29 (14.5%) of male workers and 171 (85.5%) female workers were included in this study (Table 2). The marital status of workers is 200 (100%) (Table 3). The study result is supported by the study conducted by R. Sivanesan (2013).[40]

Among 200 workers, there are 11 (5.5%) workers who have 1-10 years of experience, 93 (46.5%) have 10-20 years of work experience, 89 (44.5%) workers have 20-30 years of experience, and 7 (3.5%) workers have 30-50 years of experience. Our study result is supported by the study conducted by Devika G. Nair et al. (2024).[41]

Cashew factory workers who completed early education were 152 (76%), completed primary education were 40 (20%), and completed secondary education were 8 (4%) (Table 5). Our study report is supported by the study conducted by Nelson V et.al., (2016).[42]

The cashew nut factory workers work under different departments such as shelling (70, 35%), peeling (57, 28.5%), grading (44, 22%), roasting (16, 8%), and packing (13, 6.5%) (Table 6). The study result is supported by the study conducted by Surya Lekshmi Prasad et al. (2016).[43]

In our study, most of the workers have a past medical history; about 28 (14%) of the cashew factory workers have diabetes, 28 (14%) of the workers have hypertension, 8 (4%) have skin-related diseases, 7 (3.5%) have asthma, 2 (1%) of the workers have arthritis, 27 (13.5%) have thyroid conditions, 1 (0.5%) has CVD, and 3 (1.5%) have other diseases (Table 7).

Life style habits of cashew factory workers are 200(100%) had a daily habits of taking Tea/Coffee, 3(1.5%) had smoking habit, 5(2.5%) of workers take alcohol.

Respiratory health problems experienced by cashew factory workers are chest tightness (13 [6.5%]), wheezing (14 [7%]), nasal/throat irritation (2 [1%]), frequent sneezing (7 [3.5%]), shortness of breath (32 [16%]), coughing for as long as 3 months (4 [2%]), phlegm from the chest (9 [4.5%]), a history of respiratory ailments (6 [3%]), and exposure to fumes, vapors, fuels, and paints (40 [20%]). Our study result is supported by the study conducted by Ijaz Ahmad et al. (2020).[20]

The spirometric analysis is one of the important aspects of this study. The movement of balls is used to determine the lung capacity. About 85 (42.5%) of workers have elevated 3 balls, 43 (21.5%) have elevated 2 balls, 8 (4%) have elevated 1 ball, and 64 (32%) workers did not respond for the spirometric study. When the 3-ball rises, it shows the normal lung capacity; the 2-ball rise shows mild to moderate airway obstruction, and the 1-ball rise shows severe lung obstruction.

85 (42.5%) have an FVC ≥4.0 litres, indicating normal or above-normal lung function, 31 (15.5%) have an FVC of 2.5-3.9 liters, suggesting mild to moderate reduction,12 (6%) have an FVC of 1.5-2.4 liters, indicating significant restrictive lung disease or early COPD, 8 (4%) have an FVC <1.5 litres, suggesting severe lung restriction and 64 (32%) did not response the test.

About 85 (42.5%) of individuals have an FEV1 > 3.0 liters, indicating healthy lung function. 31 (15.5%) have an FEV1 between 2.0 and 2.9 litres, suggesting mild to moderate airway obstruction, 12 (6%) have an FEV1 bewteen < 1.0 and 1.9 liters, indicating moderate obstruction. 8 (4%) have an FEV1 < 1.0 liters which suggests severe airway obstruction. 64 (32 %) did not response to perform the test.

85 (42.5%) with a normal FEV1/FVC ratio (Typically ≥ 0.7 and ≤1.0), indicating no significant obstruction, 31 (15.5%) have slightly decreased FEV1 / FVC ratio (Typically ≥ 0.7 and ≤1.0) suggesting early obstructive lung disease, 12 (6%) have reduced FEV1/FVC ratio (less than 0.7), indicating moderate obstructive lung disease. The FVE1/FVC ratio is typically low (less than 0.7) is 8 (4%) indicate severe obstructive lung disease. 64 (32%) did not responded for this test.

CONCLUSION

The assessment of lung capacity in cashew nut factory workers using a 3-ball spirometer provides valuable insights into the respiratory health of workers exposed to potential airborne hazards in their working environment. The 3-ball spirometer is a commonly used tool for evaluating lung function, specifically measuring the FVC, FEV1 and other related respiratory parameters. Although occupational exposure may impact some workers, the majority of the workforce does not experience severe respiratory issues directly related to this exposure.

Based on the results from the spirometry tests, it is likely that factory workers may experience some degree of pulmonary impairment due to prolonged exposure to dust, chemicals, or allergens present in the factory environment. Any deviation from normal lung function, especially if it shows reduced FVC or FEV1, may indicate a restrictive or obstructive lung conditions. Though some workers are affected by respiratory issues, the majority seem to have either normal lung capacity or only mild issues, highlighting that the occupational exposure might not be as detrimental to the overall workforce as feared.

The findings underscore the importance of implementing occupational health measures in the cashew nut factory. This includes regular lung function assessments, improved ventilation systems, the use of personal protective equipment (PPE) such as dust masks, and limiting exposure time to hazardous environments. Early detection of respiratory issues can help in taking preventive measures to reduce the risk of chronic lung conditions among workers.

Continuous monitoring of lung function over time can help to identify the progression of any pulmonary conditions. Further research could focus on investigating the relationship between specific workplace exposures and the degree of respiratory impairment, as well as the effectiveness of various interventions.

LIMITATIONS

- The results may be misinterpreted without the proper clinical background or follow-up testing.
- The device cannot measure conditions such as lung fibrosis, emphysema, or restrictive lung diseases.
- The accuracy of the results is highly dependent on the proper technique. Workers might not always follow the correct procedure for optimal measurements, which can lead to inconsistent results.
- The 3-ball spirometer provides a basic measurement of lung capacity. More advanced spirometers provide a detailed analysis of FVC, FEV1, tidal volume, inspiratory reserve volume, and respiratory reserve volume air flow patterns, which are essential for diagnosing early lung disease.

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