JIMMA UNIVERSITY

INSTITUTE OF HEALTH

DEPARTMENT OF BIOMEDICAL SIENCES

Comparative Cross-Sectional Study on Pulmonary Function Status among Petrol Filling Workers in Jimma Town South West Ethiopia, 2018

By: LeylaTemam (Bsc)

A Research Thesis Submitted to Department of Biomedical Sciences (Physiology), Institute of Health, Jimma University, In Partial Fulfillment of the Requirement for the Degree of Masters Science in Medical Physiology.

October, 2018

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Abstract

Background*: Petroleum is a complex mixture of hydrocarbons which has marked effect on human health especially on respiratory system due to high accessibility and excellent absorption surface of respiratory system. Exposure to petroleum may lead to decrements in pulmonary function and number of clinical signs and symptoms. However, there is no published data available to assess pulmonary function status among petrol filling workers in Ethiopia.*

Objective*: To Assess Pulmonary Function Status among Petrol Filling Workers in Jimma Town South West Ethiopia, 2018.*

Materials and Methods*: Comparative cross-sectional study was conducted among a total of 132 study participants (66 petrol fill workers and 66 controls) from April 2 to May 2, 2018. Ethical clearance was obtained. An interviewer administered pre-tested structured questionnaire (BMRC) was used to collect data. Anthropometric measurements were carried out. Pulmonary function was measured using portable digital spirometer. SPSS version 20.0 was used for data analysis. Frequencies, means, percentage and chi-square were used for descriptive analysis. Independent sample t-test was used to compare mean and logistic regression was used to assess relevant associations. From multivariate logistic regression, independent variables having a p-value <0.05 at 95% CI were considered as statistically significant.*

Results: *The mean age of petrol filling workers and non-exposed group were 29.12 ± 8.40 and 29.21 ± 6.51 respectively. The mean BMI among petrol filling workers was 22.90 ± 2.47 while it was 23.37 ± 2.55 in non-exposed group. Among Petrol filling workers the mean and standard deviation of 3.56 ± 0.70 for FVC (L), 2.87 ± 0.77 for FEV (L),, 80.40 ± 11.36 for FEV1 %, 3.77 ± 1.09 for FEF25-75%(L/S) and 6.60 ± 1.90 for PEFR (L/S) was recorded while 3.95 ± 0.77 for FVC, 3.33± 0.68 for FEV1, 84.38 ± 9.19 for FEV1 %, 4.33 ± 1.15 for FEF25-75 % and 7.55 ± 2.31 for PEFR were recorded among controls. A significant reduction (p<0.05) was found in the above pulmonary function parameters among petrol filling workers compared to non-exposed group. The prevalence of lung function impairment is 37.9% and 15.2% among petrol fill workers and controls respectively. The predominant ventilatory impairment found in this study is restrictive. The study revealed the of prevalence of cough, phlegm, wheeze, breathlessness and chest pain was 39.4%, 22.7%, 30.3%, 19.7% and 16.7% for petrol filling workers respectively while 21.2%, 13.1%, 15.2%, 6.1% and 12.1% for non-exposed respectively. Petrol filling workers who worked for greater than 5 years were six times (AOR=6.321; 95%CI=2.100, 19.022) more likely to have lung function impairment compared to those who worked for less than or equal to 5 years.*

Conclusion: *This study concluded that petrol filling workers are at greater risk of pulmonary function impairment than non-exposed group. A Significant reduction was observed in the mean values of FVC, FEV1, FEV1%, PEFR and FEF25-75% in petrol filling workers compared non-exposed group. Duration of exposure was found to be factor for impaired pulmonary function. The prevalence of cough, phlegm, wheeze, breathlessness and chest pain was higher among petrol filling workers compared to non-exposed group.*

Key Words: *pulmonary function test, respiratory symptoms, petroleum filling workers*

Acknowledgement

My deepest gratitude goes to Jimma University, Institute of health, and department of Biomedical Sciences for providing a better learning environment and Wachemo University for giving me the chance to join MSc program in Medical physiology covering the necessary costs.

I would like to give my sincere credit to my advisor, Mr. Samuel Tadesse for his unreserved guidance and comments starting from topic selection till the development of this thesis report, as well as Mrs. Almaz Ayalew for her valuable support in commenting and advising, during the development of the thesis.

I am grateful to my study participants for their willingness to participate in this study. I am also grateful to Jimma town Trade and Industry office for providing me with all the necessary information concerning petrol stations. Finally, I would like to appreciate all my colleagues, especially Mekonin Tesfa, who supported me by sharing their ideas and comments on the work of this thesis.

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List of Acronym

ATS: American Thoracic Society

BETEX: Benzene, Ethyl benzene, Xylene

BMI: Body Mass Index

BMRC: British Medical Research Council

COPD: Chronic Obstructive Pulmonary Disease

FEF25-75%: Forced mid Expiratory Flow between 25% and 75% of the FVC

FEV1: Forced Expiratory Volume in one second

FEV1%: FEV1 to FVC ratio x 100

FVC: Forced Vital Capacity

IARC: International agency for research on cancer

LMIC: Low and Middle Income Countries

PEFR: Peak Expiratory Flow Rate

PFT: Pulmonary Function Test

PPE: Personal Protective Equipment.

PM: Particulate Matter

PPM: Parts Per Million

Yrs: Years

WHO: World Health Organization

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Petrol station is a facility where fuel and lubricants are sold. Fuels sold at petrol stations include petrol, diesel, liquefied natural gas (LNG) and kerosene(1). Petrol filling station workers are exposed to both petrol/diesel vapors and the vehicular exhaust(2,3).

The rising trend of urbanization has led to a precipitous hike in the vehicular traffic density, consequently, the establishment of more and more petrol pumps to cater for the growing demands of society(4,5). Petroleum pump stations are not only indispensable in modern technological society, but also lifeblood to modern appliances. However, they pose numerous risks and threats to employees and the environment. Any one of the petrol stations presents a wide range of challenges to the health and safety of people and their environments(6). As a result of the multitude of hazards in such workplaces and the overall lack of attention given to health and safety by many employers, work-related accidents and diseases continue to be serious problems in all parts of the world(7).

Petroleum is a complex mixture of hydrocarbons that occurs in the earth in liquid, gaseous, or solid forms. It is a naturally-occurring brown to black flammable liquid which was formed from the remains of tiny sea plants and animals that died millions of years ago. It consists of hydrocarbons(aromatic, saturated and unsaturated) and non-hydrocarbons including N, S, O_2, vanadium and nickel(7–9). Petroleum and diesel fumes, which contain Particulate Matter (PM2.5 and PM10), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Carbon Monoxide (CO), and Ozone (O3), form the major source of these air pollutants(10).

The common mechanism by which the most air pollutants exert their adverse effects is through their ability to act directly as prooxidants of lipids and proteins or as free radicals generators, promoting oxidative stress and the induction of inflammatory responses(11). For instance, exposure to vanadium oxides may alter alveolar macrophage integrity and function to the detriment of pulmonary defense. The effect of vanadium compounds on the function of alveolar macrophages may result in an impairment of the lung’s resistance to secondary bacterial infection, bronchitis and pneumonitis in human(12). Moreover, contact with nickel compounds can cause a variety of adverse effects on human health, such as nickel allergy in the form of dermatitis, lung fibrosis, cardiovascular and kidney diseases and cancer of the respiratory tract.

The suggested mechanism for this is production of reactive oxygen metabolites and inhibition of DNA repair at doses comparable to environmental exposures (13).

Petrol/gasoline and diesel fuel are a distillate of petroleum(14,15). About 95% of components in petrol vapor are aliphatic and acyclic compounds and less than 2% are aromatics(2,3,16). However, the exact mixture of which types of hydrocarbons are present in petrol depends entirely on the specific sample of gasoline(what type of oil it was made from, which company refined it and what additives were used)(17). Aromatic hydrocarbons present in gasoline are important in maintaining high octane number and for best anti-knock properties. Refined petroleum products generally contain 2–3% benzene by volume(18).

Among the numerous constituents of petroleum products, Petrol/gasoline constituents BTEX (benzene, toluene, ethyl benzene and xylene) are designated as the most toxic compounds to humans(19). Petrol pump workers are coming in contact with these compounds through inhalation, ingestion and dermal route. However, the main route of exposure is the respiratory system(16).

The volatile nature of petrol makes it readily available in the atmosphere whenever it is dispensed, especially at petrol filling stations. Petrol evaporates more readily in tropical countries than in temperate ones(15,20).

Petroleum fill workers are not only exposed to petrol vapors but also to car exhaust. Components of car-exhaust as a result of internal combustion of petrol are CO_2, NO_2, SO_2, benzene, formaldehyde and polycyclic hydrocarbons(9). In combination with particulate pollutants SO2 and NO2 have a greater chance to reach the deeper parts of the lung. These gaseous pollutants may also alter the concentration and properties of surfactant. This may contribute to early closure of small airways(21).

1.2 Statement of the problem

In occupational context, the lung is the most exposed organ as toxic materials in the workplace usually gain entry to the body via an airborne route(22). Occupational diseases are recognized in petrol filling workers for many years, and are still problems in all parts of the world. The numbers of cases and types of occupational diseases are increasing in both developing and industrialized countries(14). It is a well-known fact that the polluted air causes ill effect on the health. Epidemiological studies have shown that a sudden increase in air pollution has often been associated with immediate increase in morbidity and mortality(4). Globally, 3 million deaths were attributable to ambient air pollution in 2012 in which petroleum is one of the contributors to ambient air pollution. About 87% of these deaths occur in low and middle income countries (LMICs), which represent 82% of the world population. From these, about 211,000 deaths occur in Sub-Saharan Africa(23). Several studies have been conducted to assess the effect of polluted air on the respiratory tract(24). Exposure to air pollutants for longer duration (in years) results in hazardous effects on the respiratory system. Petrol filling workers are constantly exposed to the vapors of petrol(25).

During fuelling of vehicles, the concentration of gasoline vapor in the air is between 20 and 200 ppm. Atmospheric concentration of petrol vapor (approximately 2000 parts per million) is not safe when inhaled even for a brief period of time(7). Several epidemiological studies on human populations exposed to petroleum vapors have shown that there is an increased incidence of respiratory diseases(20). In addition to this, workers are also at risk of inhaling automobile exhaust fumes. The combined effects of the two may result in accelerated decline of pulmonary function. High ambient air concentrations of solvents and pollutants had well defined and marked systemic pulmonary inflammatory response with decreased forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), inspiratory and expiratory flow rates(9,24). A study conducted in Zambia showed a prevalence of lung function impairment among fuel attendants (29.0%) than non-exposed participants (7.4%) with significant reduction in mean of FVC (95.6), FEV1% (98.8) and peak expiratory flow rate (PEFR) (61.5) in exposed and FVC(104.9), FEV1%(109.0) and PEFR(69.1) in non-exposed group with corresponding 0.004, 0.010 and 0.031 p value respectively(26). Moreover, petrol-pump workers who are exposed to the petrol fumes may exhibit a number of clinical signs and symptoms like chronic cough, sputum production, wheezing and breathlessness have also been reported on exposure to these

pollutants which may be due to benzene toxicity. However, these clinical signs may arise after a long time, as respiratory diseases may take long to give signs(4,26,27). Petrol pump workers spent 8-12 hours at their work place. Most of them are not using protective devices. This makes station workers to likely have grave ill effects on their health(25). Despite the fact that working at petroleum station has such serious health effect on body systems especially on respiratory system, in Ethiopia, there is no published article conducted to assess the pulmonary function status of petrol filling workers. Hence, the crux of this paper is to evaluate the pulmonary functions and respiratory symptoms in subjects working in petroleum station.

1.3 Significance of the Study

Over the years, there has been a global increase in the emergence of many petroleum stations to meet the increasing demands of a fast-growing population and due to globalization, urbanization, and accelerated economic development. Health problem caused by exposure to chemical agents (organic solvents) has become a major concern in the workplace especially in petroleum work station. Exposure to petroleum for a prolonged period of time leads to serious pulmonary function impairment before the appearance of respiratory symptoms Therefore, this helps concerned bodies to take appropriate measures as early as possible. Moreover, it will help the stakeholders to set rule and regulations in order to protect the wellbeing of workers so as to minimize the effect of petroleum fuel vapor on lung function. It can also serve as a baseline data for other researchers to conduct further study in similar setting.

CHAPTER 2: LITERATURE REVIEW

2.1 Petrol

Petrol is a generic term for petroleum fuel which is mainly used for internal combustion engines. Its key aromatic hydrocarbon constituents are toluene, xylene, ethylbenzene and benzene. Other compounds found in petrol are manganese, naphthalene, trimethylbenzene and Methyl tert-butyl ether (MTBE)(28).

2.2 Health Problems Associated With Petroleum In General

Exposure to petroleum cause several health problems. Acute exposure to petrol/gasoline, benzene and toluene has been associated with mild skin and sensory irritation, central nervous system depression and respiratory problems, whereas chronic exposures lead to increase in severity of these problems. Chronic exposure is also associated with kidney, liver and blood abnormalities. Constituents of petrol pose serious health problem particularly benzene is well studied to be the most hematotoxic(7,28,29). The International Agency for Research on Cancer (IARC) has classified benzene as class 1 carcinogenic to humans. The nervous system is the critical target of toluene toxicity following acute, intermediate, or chronic inhalation(17). At low concentration, petrol vapor causes irritation of the eyes, respiratory tract and skin. Exposure to higher concentrations of vapor may produce CNS effects such as staggered gait, slurred speech and confusion. Very high concentrations may result in rapid unconsciousness and death due to respiratory failure(8).

2.3 Effect on Respiratory System

Besides being the major route of human exposure, the respiratory tract is highly vulnerable to gasoline toxicity due to its high accessibility and excellent absorption surface which ensures that the hydrocarbons of gasoline are readily absorbed by the lungs(30). The inhalation of toxic particles and gases targets the natural defenses of the lung by increasing epithelial permeability, decreasing mucociliary clearance and depressing macrophage function(31).

The most important proposed pathophysiological mechanism that has been used to explain the association of particulate matter exposure and occurrence of respiratory infections, lung cancer, and chronic cardiopulmonary diseases are oxidative stress. Beside this, PM(particulate matter) initiates inflammatory damage and upregulation of proinflammatory mediators(32). In human

lung, the major site of impact and injury for the particulate matter is at the level of terminal bronchioles and the adjacent 1st generation respiratory bronchioles(33).

Azeez et al conducted blood assay for the lung tissue malondialdehyde (MDA), superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and histo-morphology of lung tissue in some experimental animals (rats) exposed to the petroleum hydrocarbons and observed that petroleum hydrocarbons causes lipid peroxidation with a consequent rise in malondialdehyde (MDA), and a decrease in superoxide dismutase (SOD) and catalase (CAT) activities and glutathione (GSH) level that serve as a primary line of defense in destroying the free radical. Exposure to the petroleum hydrocarbons also impairs the type II pneumocytes resulting in a decreased production of surfactant and consequently alveolar collapse, ventilation-perfusion mismatch, and hypoxemia. This leads to hemorrhagic alveolitis, interstitial inflammation, intra alveolar hemorrhage and edema, bronchial necrosis and vascular necrosis causing defective lung parenchyma. This may be due to the leakage of fluid into the extravascular space(34).

It has been observed that there is increased susceptibility to lung infection in fuel attendants compared to the controls(26). Petroleum product and its exhaust are causing significant health problem symptoms like chronic cough, breathlessness and wheezing. In high concentration they cause marked systemic pulmonary inflammatory response. Occupational exposure to such product cause impairment of functions of various parts of the body(24,35).

Studies have shown that benzene is an exaggerating cause for lung function derangements in petrol pump workers as its content in petrol is in the range of 1-5%. It has also been reported that petrol pump workers are vulnerable to develop restrictive lung disease especially those who are involved in the occupation for long duration of more than 5 years(26).

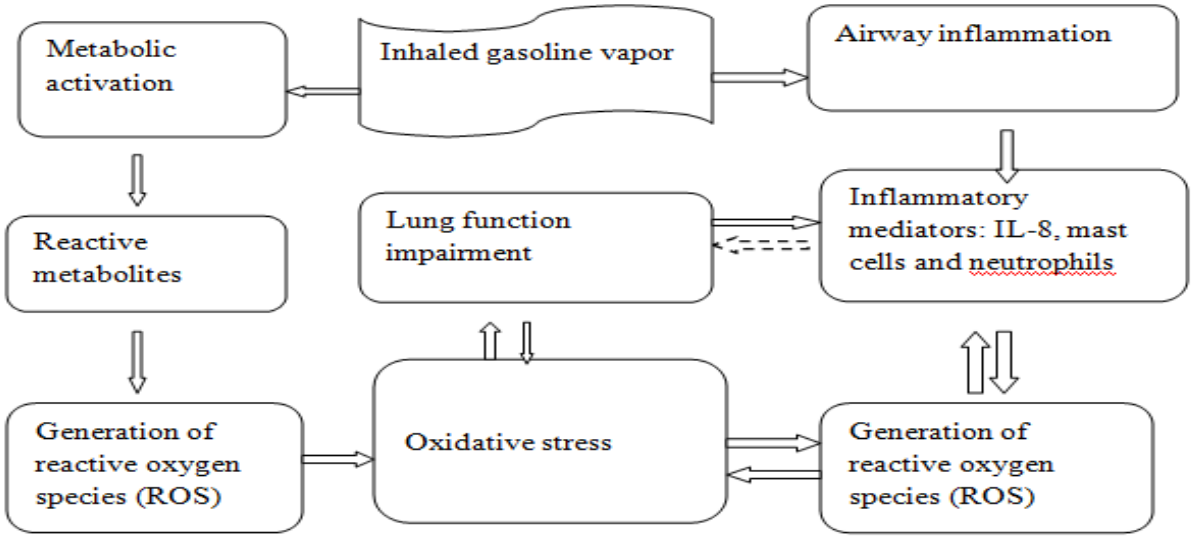

Figure 1. Mechanism of petrol gasoline induced respiratory function impairment (36)**.**

2.3.1Obstructive and Restrictive Lung Disease

2.3.1.1 Obstructive Lung Disease

Obstructive respiratory diseases are abnormal respiratory conditions characterized by difficulty in expiration and resistive work of breathing. Obstruction of the airways leads to airflow limitation(37). Disproportionate reduction in the FEV_1 when compared to the FVC is reflected in the FEV_1/FVC ratio and is the hallmark of obstructive lung diseases. This physiologic category of lung diseases includes asthma, acute and chronic bronchitis, emphysema, bronchiectasis and cystic fibrosis (38). Obstruction is characterized by reduced FEV1, normal (or reduced) VC, normal or reduced FVC, reduced FEV1/FVC ratio and concave flow–volume loop(39).

2.3.1.2 Restrictive Lung Disease

Restrictive respiratory diseases are abnormal respiratory conditions characterized by difficulty in inspiration. Large amount of elastic work is needed to inflate the lungs (37). This abnormality is common in pulmonary fibrosis, pleural disease, chest wall disorders (kyphoscoliosis), neuromuscular disorders, pneumonectomy, pulmonary edema and obesity. Restriction is characterized by reduced FVC, normal to-high FEV1% and normal looking shape on spirometry trace possibly a relatively high PEFR(39).

2.4. Pulmonary Function Status

Different studies have shown evidence of obstructive (3), restrictive or mixed pattern(16) of lung function impairment among petroleum station workers. However, most studies reported restrictive type of lung function impairment(4,21,25,30).

A cross-sectional study conducted in Karad City, India among petrol filling workers revealed a statistically significant reduction in FVC, FEV1 and PEFR among the exposed compared to the unexposed group(25).

Sumathi P *et al.,* in their study reported a significant decline in FVC, FEV1, FEF25-75% and PEFR among petrol-pump workers as compared to controls. Decrements in pulmonary functions were worsened by increased years of exposure(4).

Kittad S *et al.,* in the city of Sangli observed statistically significant decrease in mean value of FVC (3.48 and 4.19), FEV1(3.03 and 3.73) and PEFR (3.80 and 4.09) with p-value of 0.0001, 0.0001 and 0.029 in petrol fill workers as compared to controls respectively(40). Sharma N *et al., study* in Jammu city and its outskirts showed similar results(41).

Anuja A *et al.,* also reported significant decline in FEV1and PEFR petrol pump workers vs. individuals unexposed to petrol fumes. There was also a decrease in mean FVC but the difference was insignificant between petrol fill workers and controls. Similarly, there was a significant decline in the values of FVC, FEV1 and PEFR in exposed group with increase in the duration of exposure(42).

Patilsmita V *et al.,* study among petrol pump Workers(filling workers) of Western Maharashtra revealed that dynamic pulmonary function tests (FVC, FEV1, FEV1 %, FEF 25-75 and PEFR) were significantly decreased among petrol filling workers compared to controls(16). Chakraborty D *et al*. in Agartala (43), Madhuri B. *et al., in* Kanchepuram (44) also reported a significant decline in mean FVC, FEV1, FEV1 %, FEF 25-75 and PEFR among petrol filing workers compared to controls.

Meo S. *et al*., evaluated pulmonary function among petroleum refinery workers. They observed a significant decline in pulmonary function parameters with a mean value of FVC (4.76and 5.21),

FEV1 (3.08 and 3.99), FEV1 %(67.19 and 76.66), PEFR (4.80 and 6.89) and FEF25 (4.45 and 6.39) in the oil refinery workers and control groups respectively but not in FEF 75% (45).

Sharma H. *et al.,* conducted a study in Jhalawar and Jhalarapatan city and reported a significant decline in FVC and FEV1 in petrol fill workers as compared to controls. However, FEV l and FVC both decreased in petrol pump workers but their ratio did not differ between the two groups (35). Similarly, Vella J. and Borg M. in Malta observed statistically significant decrease in FEV1, FVC and FEV1/FVC ratio in the petrol filling workers when compared to the control(46).

Furthermore, Mehta J. *et al.,* done pulmonary function test in petrol filling workers (petrol pump workers) in Anand district. The pulmonary function test found to be significantly decreased among petrol filling workers compared to controls with mean value of FEV1 (1.3782 and 2.0090), FEV6 (1.4646 and 2.5880), FEV1/FEV6 (0.9526 and 0.7752) and PEFR (246.60 and 403.60) (47). Alam *R et al.,* also found a significant decrease in FVC, FEV1, PEFR and FEV1% among petrol filling workers compared to controls in Karachi, Pakistan (48).

Begum S. and Rathna M. in Mysore city reported that pulmonary function test were significantly decreased (p=0.000) with mean value of FVC (2.86 and 3.33), FEV1 (2.58 and 3.01) in petrol filling workers. However, their ratio (FEV1%) and PEFR didn't differ between the comparison groups(21). Similarly, Singhal M. *et al.,* (49) and Rahul *et al.,* in Jaipur city, Rajasthan, India (5) found a significant decrease in FVC, FEV1, FEF 25–75 and PEFR in petrol filling workers. However, FEV1% didn't differ between the comparison groups.

Study conducted in Western Maharashtra by Patilsmita V. *et al.,* showed a significant (p=0.001) decline in PEFR around petrol pump workers (389.17) as compared to control (534.2). This study also showed that the mean PEFR of the petrol fill workers was decreased significantly with increased years of exposure(50).

Santhalingam S. and Mahajan M. found that pulmonary function abnormalities are increased if the duration of work in the petrol pumps is more than five year. PEFR was decreased in those worked for more than 5 years compared with those who worked less than 5 years(33). Bhide A. et al., found mean values of FEF25-75% for the >5 years exposure group was 3.15 and for the <5 years exposure group was 3.31 and for controls it was 3.94 and the differences was statistically significant(51).

2.5. Prevalence of Respiratory Symptoms

A study done in Karachi, Pakistan showed higher prevalence of respiratory symptoms among petrol filling workers when compared to control group. The most common symptoms recoded among pump workers and the comparison groups were cough (80.7%) and 19.3%, shortness of breath 89.8% and 10.2% and breathlessness during walking 90.1% and 9.9%, respectively(2).

A study by Minov J. *et al.*, revealed a higher prevalence of respiratory symptoms among petroleum refinery workers with a statically significant difference for cough (30% vs. 13.7%, p=0.018) and wheezing (21.1% vs. 8.6%, p=0.029)(52). Another study by Stoleski S. *et al.*, reported that petrol refinery workers had a significantly higher prevalence of cough with phlegm (31.3%), dry-cough (18.1%), wheezing (11.4%), dyspnea (4.1%), and nasal symptoms (8.3%) than the control group ($p<0.05$)(53). Studies done by Zuskin et al.,(54)and Lee et al.,(55) showed exposure to solvents at work place had significantly more respiratory symptoms than control group. Kesavachandran et al., reported that high prevalence of respiratory symptoms was primarily a consequence of exposure to the petrol vapors found in the workplace(56).

2.6 Conceptual Framework

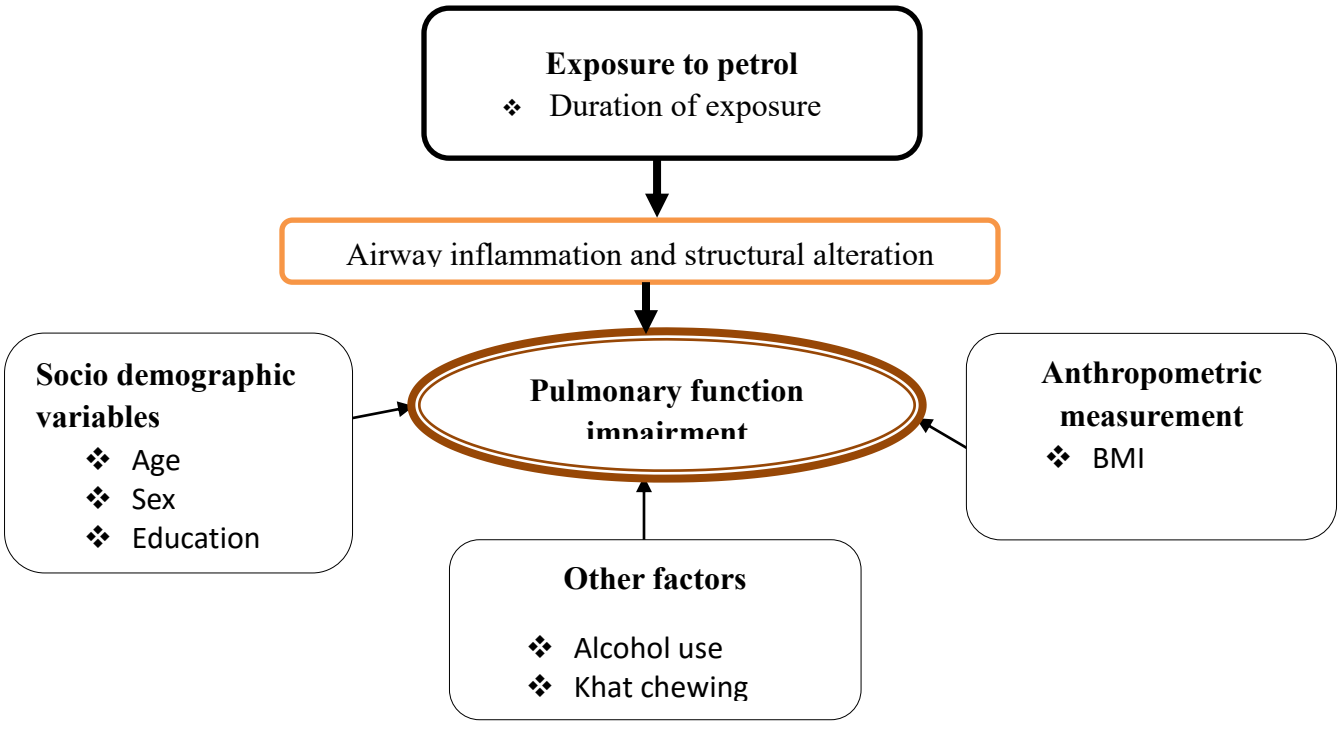

Figure 2. Conceptual framework for factors affecting pulmonary function status

CHAPTER 3: OBJECTIVES AND HYPOTHESIS

3.1 General Objective

To assess pulmonary function status among petrol filling workers in Jimma town, South West Ethiopia, 2018

3.2 Specific Objectives

- To determine pulmonary function status of petrol filling workers
- To determine prevalence of respiratory symptoms among petrol filling workers
- To identify the type of ventilatory impairment among petrol filling workers
- To identify factors associated with pulmonary function status among petrol filling workers

3.3 Hypothesis

Ho: there is no difference in mean lung function test parameters between exposed group and non-exposed group.

CHAPTER 4: MATERIALS AND METHODS

Materials

Digital Spirometer (model SP10 Ltd-Germany) was used to measure lung function tests. Digital balance and measuring tape were used to measure weight and height of the subjects, respectively. A standardized questionnaire was used to assess personal information, occupational history, respiratory symptoms, past illness and use of personal protective equipment (PPE).

Methods

4.1. Study Area and Period.

The study was conducted in Jimma town from April 2 to May 2, 2018. Jimma town is located in Oromiya regional state, 354 km South West of the capital Addis Ababa. It has a population of 128,330. Its temperature ranges from 20-30 ^{o}C and with average annual rainfall of 800-2500 mm^3. The town has an altitude of 1750-2000 m above sea level. There are 12 filling stations in the city which are owned by private companies.

4.2 Study design

Comparative cross-sectional study was employed to assess pulmonary function status among petroleum station workers in Jimma town.

4.3 Population

4.3.1 Source Population: All petrol filling workers working in Jimma town in 2018.

4.3.2 Study Population:

Exposed Group: All petrol filling workers of Jimma town who was available during data collection period.

Control Group: non-smoking, age, sex, height, weight and educational status matched security guards were selected from Jimma University and other governmental institutions in Jimma town population.

4.4 Inclusion and Exclusion Criteria

4.4.1 Inclusion Criteria

- For study group: the person working in the petrol pump as petrol filling attendant station

- For control group: non-smoking, age, sex, height, weight and educational status matched security guards who have no history of working in petroleum station or any other petrochemical industries were included in the study.

4.4.2 Exclusion Criteria

Study participants with history of diabetes mellitus, hypertension, pulmonary tuberculosis, asthma, chronic bronchitis, and those who were drug addicts, cigarette smokers, those who had undergone major abdominal or chest surgery, and unable to perform Spirometry were excluded from the study.

4.5 Sample Size Determination

Using double proportion formula below the calculated total sample size was 110(55exposed and 55 non-exposed). However, because of manageable sample size all petrol filling (81) workers working in 12 stations and the same number of (81) non- petrol filling workers were considered to be included in the study. Therefore the final sample size was 162

$$n = \frac{(\bar{p})(1-\bar{p})\,(Z_{\alpha/2} + Z_{\beta})^2}{E^2}\left[\frac{r+1}{r}\right]$$

4.6 Data Collection Procedures

Interviewer administered standardized questionnaire based on British Medical Research Council questionnaire was used to obtain information on socio- demographic characteristics, respiratory, symptoms, any smoking and alcohol habit and use of personal protective equipment (PPE)(57). The questionnaire was translated to Afaan Oromo (local language) and retranslated back to English to keep consistency of question and administered to all control and exposed subjects. Data was collected by two BSc nurses and supervised by the investigator.

- **Anthropometric Measurements**

After the interview anthropometric and PFT measurements were done, height was measured and weight also measured with light clothing. The subjects stood straight against the erect measuring scale and their head, shoulder, buttocks and heels were touching the scale and the subject's axis of vision was horizontal. Body mass index (BMI) was calculated through this formula: Weight/squared height (kg/m^2)

Measurement of Respiratory System Variables

Spirometry

Using the digital spirometer FVC (L), FEV_1 (L), FEV_1 /FVC, $FEF_{25-75\ \%}$(L/S) and PEFR (L/S) was measured.

The subjects took 10-15 minutes of rest before performing the spirometry. The participants were instructed to sit in upright position in a chair with arm rest and feet in dependent position in order to avoid unexpected falling during the procedure. Participants were introduced to the instruments and the test was repeated at least thrice and the best result (the highest) was considered for analysis as per guidelines of American Thoracic Society. All pulmonary function tests were carried out from 8:00-10:30pm based on the ATS(58).

4.7 Study Variables

4.7.1 Dependent Variables

- ✓ Pulmonary function status

4.7.2 Independent Variables

- ❖ Age
- ❖ Sex
- ❖ Weight
- ❖ Height
- ❖ Educational status
- ❖ Duration of working in petrol station per year
- ❖ Duration of working hours in petrol station per day
- ❖ Use of personal protective devices
- ❖ Khat chewing
- ❖ Alcohol use

4.8 Operational Definitions

Exposed subject: a person who is working in petroleum station as petroleum pump attendant

Non-exposed subject: a person who is not working in petroleum station.

Respiratory symptoms: presence of cough, wheezing, Phlegm, Breathlessness and Chest illnesses

Cough: experience of cough occurring 4–6 times per day for most days of the week

Phlegm: sputum expectoration as much as twice a day for most days of the week (≥4days)

Wheeze: Chest sound whistling on expiration

Chest pain: chest pain that kept off work of the workers.

Personnel protective Equipment: materials used by petrol fill workers to protect themselves from different inhalation of petrol.

Classification of lung function pattern(59,60)

Normal: FEV1and FVC above 80% predicted and FEV1/FVC ratio above 0.7

Abnormal: FEV1<80% predicted, FVC <80% predicted and FEV1/FVC ratio <0.7

Obstructive: FEV1 below 80% predicted and FEV1/FVC ratio below 0.7

Restrictive: FVC below 80% predicted and FEV1/FVC ratio normal - above 0.7.

Mixed: combined obstructive and restrictive

4.9 Data Analysis Procedures

Data were entered in to EPI-data version 3.1, and SPSS version 20 was used for analysis. Descriptive statistics was used to summarize service year and anthropometric measurements of subjects. Chi-square test was used to compare the prevalence of respiratory symptoms among exposed and non-exposed group. Independent sample t-test was used to compare the mean respiratory scores of exposed and non- exposed groups. Logistic regression was used to evaluate relationship between dependent and independent variables. Odds ratio was used to determine association between pulmonary function test and independent variables.

4.10 Data Quality Management

Before the actual data collection, pre-test was conducted on (5% of study population) petroleum station workers of Agaro town. Training was given to data collectors. Data collectors were instructed to fill every question completely and also the supervisor checked the completeness of the questionnaire immediately after submission.

4.11 Ethical Consideration

Ethical clearance was obtained from Institute of Health Science Ethical Review Committee of Jimma University to conduct the study and permission was obtained from fuel station owners. Prior to data collection each study subject or participant was adequately informed about the purpose of the study and the importance of their participation to confirm willingness for participation. Participant's confidentiality was maintained by not reporting data about individuals without their explicit permission, and anonymity was ensured by using codes instead of names and any personal identifier of the participants.

4.12 Dissemination Plan

The result of this study will be submitted to Department of Biomedical Science (Medical Physiology), Institute of Health, Jimma University and presented to Jimma University community as a part of master's thesis. The hard and soft copy of findings will be available in the library of Jimma University. It will be also published on international scientific journals and presented on workshops and symposiums to the scientific community.

CHAPTER 5: RESULTS

5.1 Socio-demographic characteristics and Anthropometric Data

The number of petrol fill workers determined to be studied was 81. Nevertheless, 1 of the petrol station which had 8 filling workers was not giving service at the time of data collection. While 3 subjects were unable to perform spirometry, 2 subjects were in annual leave and 2 subjects were having concurrent medical/surgical illness (1 was known asthmatic and another was with recent cesarean section). As a result of this the number of petrol fill workers from which data were collected was 66. Adding 66 controls gives a total of 132 study subjects with 81.48 response rate. Of these 108 were male participants (54 exposed and 54 non-exposed) and 24 female participants (12 exposed and 12 non-exposed).

The age of study participants ranges from 19 to 60 years with a mean age of 29.12 ± 8.40 for petrol fill workers and 29.21 ±6.51 for controls. Regarding educational status 31(47%) and 35(53%) of petrol fill workers; 28 (42.4%) and 38(57.6%) of controls educated to high school level and diploma holders respectively. Of exposed group 34(51.5%) were married and 32(48.5%) were single whereas 30(45.5%) were married and 36(54.5%) were single among non-exposed.

The service years of exposed participants ranges from 1 to 19. And 41(62.1%) of cases were having 1-5 years of exposure to vapors of petrol while the remaining 25(37.9%) were having greater than 5 years of exposure.

Table 1. Socio-demographic characteristics of study participants in Jimma town, South West, Ethiopia, 2018

Variables	Exposed n(%)	Non-exposed n(%)
Age		
<=25 year	25(37.9)	23(34.8)
26-29 year	22(33.3)	18(27.3)
>30 year	19(28.8)	25(37.9)
Sex		
Male	54(81.8)	54(81.8)
Female	12(18.2)	12(18.2)
Marital status		
Single	32(48.5)	36(54.5)
Married	34(51.5)	30(45.5)
Educational status		
High school	31(47%)	28(42.4%)
Diploma	35(53%)	38(57.6%)
Work experience		
<=5 years	41(62.1%)	47(71.2%)
>5 years	25(37.9%)	19(28.8%)

Matched variables showed no significant difference among exposed and their matched controls. The variables matched were summarized below in **table 2**.

Table 2. Comparison of matched variables among exposed and non-exposed group in Jimma town, South West, Ethiopia, 2018

Variables	**Exposed Mean ±SD**	**Non-exposed Mean ±SD**	**P value**
Age(yrs)	29.12 ± 8.40	29.21 ±6.51	0.945 NS
Weight(kg)	64.91 ±7.32	66.44 ± 8.03	0.255 NS
Height(cm)	168.39 ± 6.24	168.59 ± 6.47	0.859 NS
BMI	22.90 ± 2.47	23.37 ± 2.55	0.287 NS

NS =none significant

5.2 Pulmonary function status

An independent sample t-test was used to compare Spirometric measurement of pulmonary function (FVC, FEV1, FEV1%, FEF25-75% and PEFR) of exposed and non-exposed group. Accordingly, FVC, FEV1, FEV1%, PEFR and FEF25-75% were higher in control respondents than in exposed respondents and the mean difference was found to be statistically significant ($p< 0.05$). There is difference in mean lung function test parameters between exposed group and non-exposed group. Hence the stated null hypothesis was rejected (**Table 3)**.

Table 3Comparisons of Spirometric measurements among petrol fill workers and controls in Jimma town, South West Ethiopia, 2018. (Independent sample t-test)

Parameters	**Exposed Mean ±SD**	**Non- exposed Mean ±SD**	**P value**
FVC(L)	3.56 ± 0.70	3.95 ± 0.77	0.003*
FEV1(L)	2.87±0.77	3.33± 0.68	0.000**
FEV1%	80.40 ± 11.36	84.38 ± 9.19	0.029*
FEF25-75%(L/S)	3.77 ± 1.09	4.33 ± 1.15	0.005*
PEFR(L/S)	6.56 ± 1.90	7.55 ± 2.31	0.010*

SD: Standard Deviation, *: p value < 0.05, **: p value < 0.001

An increase in duration of exposure to volatile organic compounds was associated with decrease in pulmonary function parameters. As presented in table below FVC, FEV1, FEV1%, FEF-25-75% and PEFR showed significant difference ($p<0.05$).

Table 4. An independent sample t-test for association of duration of exposure and lung function in Jimma town, South West, Ethiopia, 2018.

Parameters	**<=5 Years**	**>5 years**	**P value**
FVC(L)	3.75 ± 0.656	3.24 ± 0.70	0.004*
FEV1(L)	3.11 ± 0.66	2.47 ± 0 .77	0.001*
FEV1 %	83.34 ± 8.18	75.60 ± 14.11	0.006*
FEF25-75%(L/S)	4.06 ± 0.97	3.30 ± 1.13	0.005 *
PEFR(L/S)	7.12 ± 1.71	5.73 ± 1.92	0.003*

Regarding their working hour's (8 hours and >8 hours) pulmonary functions doesn't show any significant difference among petrol fill workers.

The type of lung disorder mostly evident in exposed group is restrictive. About 3(4.5%), 16(24.2%), 6(9.1%) and 4(6.1%), 4(6.1%) 2(3%) develop obstructive, restrictive and mixed type of lung disorder in petrol fill workers and controls respectively. FVC and FEV1 are affected in the above lung disorders but FVC is more affected in restrictive and FEV1 more affected in obstructive.

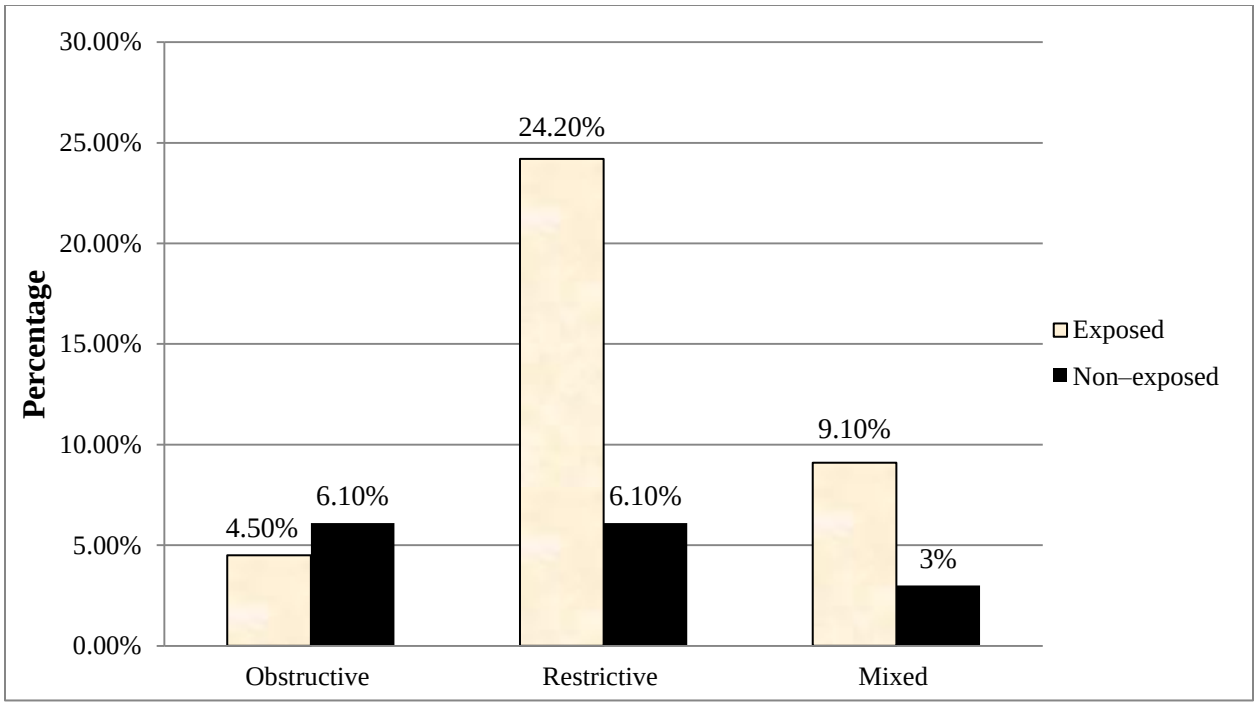

Figure 3. Ventilatory impairment among exposed and non-exposed participants in Jimma town, South West, Ethiopia, 2018

5.3 Prevalence of respiratory symptoms

The prevalence of respiratory symptoms among exposed and non-exposed participants was cough 39.4% and 21.2%, phlegm 22.7% and 13.1%, wheezing 30.3% and 15.2%, breathlessness 19.7% and 6.1% and chest pain 16.7% and 12.1 % respectively.

As shown in **figure 4** the prevalence of respiratory symptoms was compared by using chi-square between exposed and non-exposed. The result showed significant difference ($p< 0.05$) for cough, wheezing and breathlessness with p value of 0.023, 0.038 and 0.019 respectively.

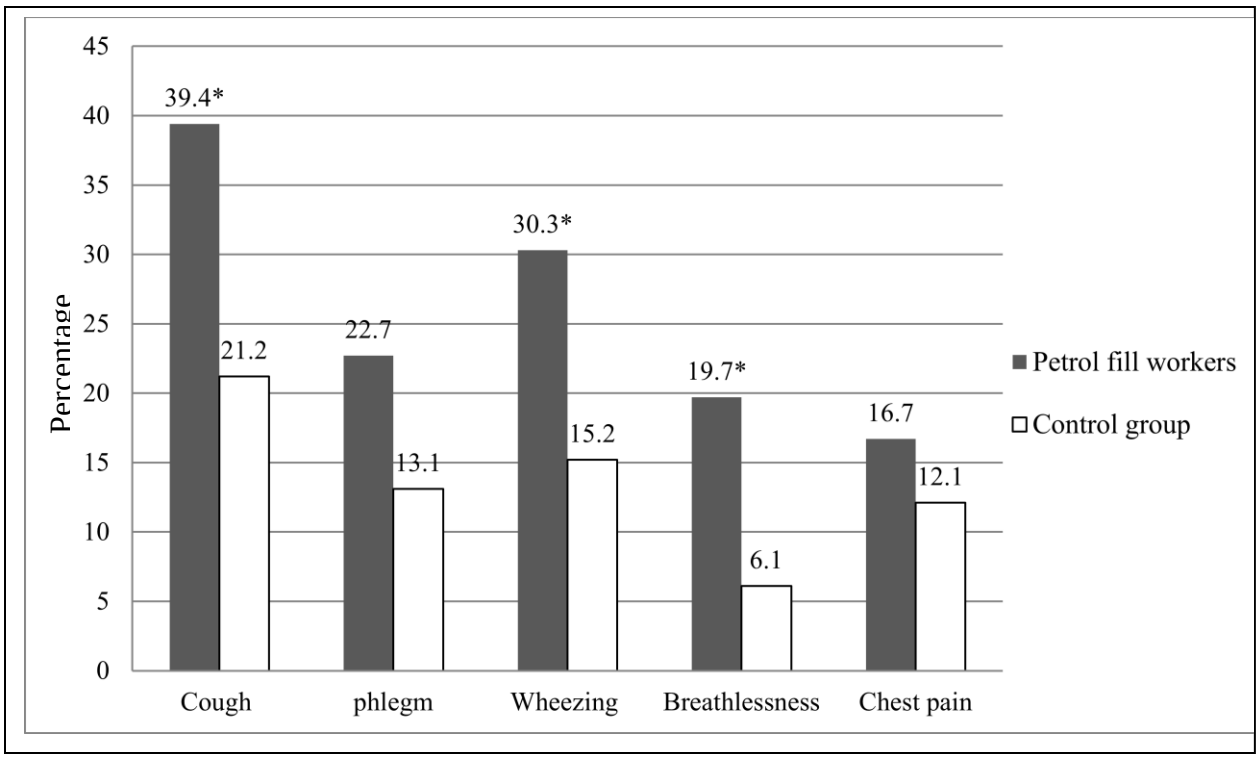

Figure 4.Prevalence of respiratory symptoms among exposed and non-exposed group in Jimma town, South West, Ethiopia, 2018.

5.4 Utilization of personal protective equipment

Regarding personal protective equipment use 45(68.2%) of petrol fill workers agreed on the idea that they should wear PPE. The participants were asked "do you know the negative health effect of petrol?" Accordingly only 24(36.4%) responded yes to this question. Cancer, skin problem (itching, allergy, and rash) and respiratory problem (cough, asthma) respectively were health problems mentioned by the respondents **(Figure 5)**.

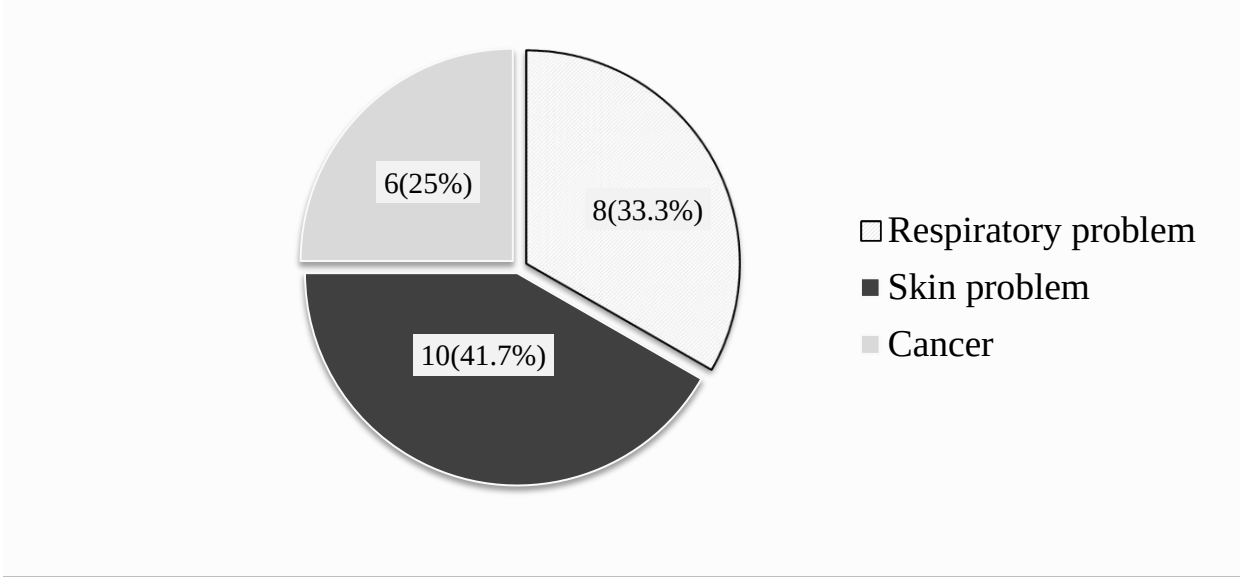

Figure 5. Health problems of petrol mentioned by petrol fill workers in Jimma Town, South West, Ethiopia, 2018.

The participants were asked the type PPE they use while filling the petrol and stated that all of the workers didn't use any PPE that prevent inhalation of volatile organic compounds.

5.5 Factors associated with pulmonary function

The variables that showed statistically significant association (at p-value <0.25) in the bivariate analysis were transferred and further analyzed in multivariable logistic regression to adjust for potential confounders and to identify factors associated with pulmonary function. In multivariable logistic regression, variables with p-value less than 0.05 were considered as factors for pulmonary function.

The model was tested for multicollinearity (VIF=1.012-1.799 for exposed) and Hosmer-Lemeshow test goodness of fit (p=0.678 for exposed) as a result the model was fit and no multicollinearity exist.

The result of multivariable logistic regression indicated that work experience was the only variable independently associated with pulmonary function. Petrol fill workers worked for greater than 5 years were six times (AOR=6.321; 95%CI=2.100, 19.022; P=0.035) more likely to have lung function impairment compared to those worked for less than or equal to 5 years (Table 6).

Table 5. Factors associated with pulmonary function pattern among petrol filling workers in Jimma town, south west Ethiopia, 2018.

Variable		Lung function pattern		COR (95%CI)	AOR	P-value
		Abnormal	Normal			
Age	<=25 years	6(24)	19(76)	1		
	26- 29 years	6(27.3)	16(72.7)	6.861[1.808, 26.033]	2.423[0.387,15.152]	0.344
	>=30 years	13(68.4)	6(31.6)	5.778[1.501, 22.234]	2.942[0.573, 15.118]	0.196
BMI	<=24.9	17(32.7)	35(67.3)	1		
	>=25	8(57.1)	6(42.9)	2.745 [0.821,9.175]	1.617[0.350, 7.471]	0.538
Sex	Male	20(37)	34(63)	1		
	Female	5(41.7)	7(58.3)	0.824 [0.230, 2.943]		
Duration of exposure to petrol	<= 5 years	11(25.6)	32(74.4)	1		
	>5 years	14(60.9)	9(39.1)	4.525 [2.100, 19.022]	6.019[1.131, 32.018]	0.035*
Average time spent per day in petrol station	8 hours	18(46.2)	21(53.2)	1		
	> 8 hours	7(25.9)	20(74.1)	0.408 [0 .141, 1.186]	0.307 [0.078, 1.203]	0.090
Educational status	High school	8(25.8)	23(74.2)	0.368 [0.130, 1.044]	0.282[0.073, 1.091]	0.067
	Diploma	17(48.6)	18(51.4)	1		
Khat chewing	Yes	18(40)	27(60)	1.333 [0.450, 3.949]		
	No	7(33.3)	14(66.7)	1		
Alcohol intake	Yes	4(26.7)	11(73.3)	1.925[0.539, 6.875]		
	No	21(41.2)	30(58.8)	1		

**: Statistically significant at 95% CI with P- value <0.05; 1 -reference; COR- Crude odds ratio; AOR-Adjusted odds ratio*

CHAPTER 6: DISCUSSION

The present study found a higher prevalence of respiratory symptoms such as cough, phlegm, wheezing, and shortness of breath and chest pain among exposed workers than non-exposed. Similarly study conducted in Karachi, Pakistan showed higher prevalence of respiratory symptoms among petrol filling workers. Cough (80.7%) and 19.3%, shortness of breath 89.8% and 10.2% and breathlessness during walking 90.1% and 9.9%, respectively among petrol filling workers and controls(2). Stoleski S. *et al.,* reported that petrol refinery workers had a significantly higher prevalence of cough with phlegm (31.3%), dry-cough (18.1%), wheezing (11.4%), dyspnea (4.1%), and nasal symptoms (8.3%) than the control group ($p<0.05$)(53). The result of the current study is also in agreement with studies done by Zuskin *et al.*,(54) and Lee *et al.*(55), which showed the exposure to solvents at work place had significantly more respiratory symptoms than control group. Kesavachandran et al., reported that high prevalence of respiratory symptoms was primarily a consequence of exposure to the petrol vapors found in the workplace(56).

The result of present study found a decrease in pulmonary function parameters in petrol fill workers when compared to controls. The prevalence of pulmonary function impairment was found to be 37.9% (95% CI=23.4, 50) and 15.2% among petrol fill workers and controls respectively. The prevalence of pulmonary function impairment observed in current study is in line with the prevalence observed in Ndola, Zambia (29%)(26). However, study conducted in Jaipur city reported a higher prevalence of lung function impairment (57.5%)(5). The possible reason for higher prevalence may be the minimum duration of exposure taken in this study was three years but in our study it was 1 year.

In this study 3(4.5%), 16(24.2%), 6(9.1%) developed obstructive, restrictive and mixed type of lung disorder in petrol fill workers while it was 4(6.1%), 4(6.1%) 2(3%) among controls respectively. The type of ventilatory impairment mostly evident in exposed group is restrictive which is in agreement with studies done by Sinha A. and Shrirang N. (25), Alam R et al(48) and Rahul et al(5). The higher lung function impairment can be explained on the basis that petroleum hydrocarbons cause an increase in lung tissue malondialdehyde (MDA), an index of lipid peroxidation(3).

In present study a significant (p=0.003) decrease in the mean value of FVC (3.56) among petrol fill workers was observed as compared to controls (3.95). Begum S. and Rathana M. in Mysore city found similar finding where the mean of FVC (2.86) decreased significantly(p= 0.000) in petrol fill workers in comparison to controls (3.33) (21). This finding was also in consonance with studies done by Sumathi P. *et al*.,(2.398 among exposed and 3.186 among non-exposed)(4), Madhuri B. *et al*.,(1.97 in exposed and 2.24 in non-exposed)(44) and Chakra borty D. *et al*., (3.0700 in exposed and 3.4184 in non -exposed) (43).

In this study there is highly significant (p=0.000) decrease of FEV1 in petrol filling workers (2.87) when compared to non-exposed (3.33). Mehta J. *et al.,* in Anand district observed similar finding where the mean value of FEV1 (1.3782±0.7769) are significantly lower (p<0.001) in petrol fill workers in comparison to controls (2.0090±0.5653)(47). Sinha A. and Shrirang N. (2.55 and 2.80) (25), Patilsmita V *et al.,(* 2.705 and 3.572*)*(16), Kittad S. *et al., (*3.03 and 3.73*)*(40), Rahul *et al.,(* 2.84 and 3.17*)*(5) and Sharma N. e*t al. (* 2.20 and 2.86)(35) reported similar result.

In current study there is a significant (0.029) decrease in FEV1% in petrol pump workers (80.40) when compared to controls (84.38). Meo S. *et al.,* observed similar finding where the mean FEV1% is significantly (0.013) decreased in petrol fill workers (67.19±3.15) in comparison to controls (76.66±2.01)(45). Vella J. and Borg M(76.28 and 81.15)(46), Patilsmita V *et al.,(* 83.701 and 89.236)(16), Chakraborty D. *et al*., (82.8203 and 91.5528)(43)and Madhuri B. *et al*.,(3.68 and 3.85)(44) were reported similar observation.

The flow rates at low volumes i.e. FEF25-75% indicates flow rates in small airways i.e. those with internal diameters of less than 2mm(4). In this study there is a significant (p=0.005) decrease in FEF25-75% in petrol fill workers (3.77) in comparison to controls (4.33). This study coincides with study conducted by Salvi S. *et al.,* who observed that there was a significant(0.000) decrease in FEF25-75% in petrol fill workers(1.67 ± 0.40) when compared to controls (4.28 ± 0.81) (30). This study is also in agreement with studies done by Rahul *et al*.,(2.95 and 3.47)(5) and Singhal M. *et al.,(* 3.48 and 4 . 8 3*)* (49).

In the present study there is a significant decrease (0.010) in mean PEFR in petrol pump workers (6.60) when compared to controls (7.55). Similar observations were reported by Kittad S. *et al*.,

who concluded that there was a significant (0.029) decrease in PEFR petrol fill workers (3.80±1.68) in comparison to controls (4.09±1.34)(40). Furthermore Sharma N. e*t al.(* 6.44 and 8.55*)*,(41), Patilsmita V.*et al., (*389.17 and 534.29)(50) and also observed similar result. Regarding working hours our study showed non-significant decrease in all pulmonary function parameters. This is in accordance with study done by Rahul et al., in Jaipur city found statically non- significant decrease in FVC,FEV1,FEV1% and PEFR(5).

The present study also showed that pulmonary function (FVC (3.24), FEV1(2.47), FEV1%(75.60), FEF - 25-75%(3.30) and PEFR(5.73)) decreases significantly if the duration of service is more than five years compared with less than five years(FVC(3.75), FEV1(3.11), FEV1%(83.34), FEF-25-75%(4.06) and PEFR(7.12)). Similarly Anuja A. et al., found statistically significant decline in the mean values of FVC (1.87), FEV1(1.78 and PEFR(3.35) in those exposed less than five years in comparison to those exposed more than five years(FVC(3.03), FEV1(2.57) and PEFR(5.48))(42).

Similarly Patilsmita V., found a significant reduction in the FEV1, FVC PEFR, FEF 50 %, FEF75 % pump workers who were exposed to more than 5 years(16). Bhide A. et al., found mean values of FEF25-75% for >5 years exposure group was 3.15 and for the <5 years exposure group was 3.31 and for controls it was 3.94 and the differences was statistically significant(51). Santhalingam S. and Mahajan M. also found that pulmonary function abnormalities are increased if the duration of work in the petrol pumps is more than five year. PEFR was decreased in those worked for more than 5 years compared with those who worked less than 5 years(33).

In general it was observed that the mean value FVC, FEV1, FEV1%, FEF25-75% and PEFR were significantly reduced in petrol fill workers when compared to their matched controls.

The researcher couldn’t find study done on factors associated with pulmonary function among petrol fill workers; as a result, it couldn’t discuss.

Limitation of the study

Air analysis was not done so that the quantity of fuel vapor inhaled by the subject is not known. The respiratory symptoms were subjectively reported which may lead to over or under estimation of the prevalence. Even though history of respiratory disease was asked, the detailed clinical examination was not done and other investigations like a chest x-ray were not obtained.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Conclusion

According to the current study petrol filling workers are at greater risk of pulmonary function impairment than non-exposed group. There was significant reduction in the mean values of pulmonary function parameters like FVC, FEV1, FEV1%, PEFR and FEF25-75% in petrol fill workers compared to non-exposed group. Also, the present study showed that the pulmonary function abnormalities are increased if the duration of work in the petrol station is more. The prevalence of respiratory symptoms was higher among petrol fill workers compared to non-exposed group. Petrol fill workers do not wear PPEs that prevent inhalation of petroleum vapor**.** Duration of exposure was found to be factor for impaired pulmonary function. Petrol fill workers who worked for greater than 5 years were six times (AOR=6.321; 95%CI=2.100, 19.022) more likely to have lung function impairment compared to those who worked for less than or equal to 5 years.

7.2 Recommendation

As per the finding of this study the following recommendation are forwarded to concerned stakeholders.

- Pre-employment medical observation and periodic medical checkup after employment should be organized by petrol station management.
- The petrol station management should organize training program to their workers emphasizing on potential health effects on exposure to petroleum and use PPEs (especially oro-nasal masks).
- Control strategies should be used to minimize inhalation of petroleum products like installation of vapor recovery system. Introduction of the vapor recovery system will be capable of reducing up to 80% benzene emission.
- Large population and follow up studies may give more insights in to the result.

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9. ANNEXES

9.1 Annex I English version of information sheet and Consent Form

Information sheet

Hello dear, my name is Leyla Temam I am student in Jimma University and working on my thesis for partial fulfillment to the degree of Masters of Science in Medical Physiology. You are kindly requested to participate in my research work. Your participation in this study is entirely voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether to participate or not to participate.

The study is designed to assess pulmonary function status petrol station attendants as well as to examine the extent of damage due to the effect of these petrol fumes , so that after completion of the study different recommendations will be made depending on the finding from the study.

If you are volunteer to participate in this study, you will be asked to do the following things.

- Respond to the questionnaire
- There is a procedure of measuring your lung function using a Spirometer which needs your full cooperation (you will be given an explanation and some sort of orientation about the procedure).

The length of time for participation will not take more than an hour and the place where the entire procedure takes place will be around your working area. Any information that is obtained in connection with the study and that can be identified with you will be kept confidential and will be disclosed only with your permission. You can choose to participate or not to participate in this study.

If you have any uncertainty or question about the request you can contact the principal investigator with the address below at any time.

Investigator contact address,

Name: LeylaTemam, Mobile: 0916394114 Email: namesty44@gmail.com

Consent form

The data collector explains information about the study to me. I have understood the objective of this study. I have been told that participation in this work do not result in any health problem. And also I have been told about how the data collection is proceeding and the time it takes to complete the data collection. I am assured that there will be confidentiality of my response. It has also been explained to me that I have the right to stop participation at any time. Therefore, I have now consented to participate in the study by signing this form.

Name of Subject_____

Signature of subject_____ date_____

9.2 Annex II English version the questionnaire

Thank you for your willingness to participate; your cooperation is very important to the success of the study. This is a questionnaire you are asked to respond as frankly and accurately as possible. Your name remains anonymous and all information obtained in the study will be kept confidential.

Code _____No_____

Part I Socio demographic characteristics				
101	Sex	----------		
102	Age	----------		
103	Marital status	1. Married 2. Single 3. Divorced 4. Separated 5. Others		
104	Level of education	1. Illiterate 2. Elementary 3. High school 4. Diploma and above		
105	Do you work in petrol station	1. Yes 2. No		If **No** skip to 108
106	How long you stay working in petrol station per day?	1. 8hrs 2. greater than 8hrs 3. less than 8hrs		
107	How long you have been working in petrol station	_____ yrs		
108	Have you ever worked for a year or more in any dusty job other than petrol station	1. yes		If No skip to

		2. No		201
109	Specify type of dust	_____		
110	Specify job	_____		
111	Total years worked	_____yrs		
Part II Past history/current medical problem				
201	Have you ever had any of the following?	1. Hypertension 2. Diabetes 3. Pneumonia 4. Chronic bronchitis 5. Asthma 6. Any other chest Illness 7. Any other chest Injury 8. Abdominal or chest surgery		
Part III Habit of substance use				
202	Have you ever been smoking?	1. Yes 2. No		If **No** skip to 205
203	Are you currently smoking?	1. Yes 2. No		
204	How many cigarettes do you smoke per day?	----------		
205	Have you ever been drinking alcohol?	1. Yes 2. No		If No skip to

				210
206	Are you currently drinking alcohol?	1. Yes 2. No		
207	What type of alcohol do you drink	----------		
208	How frequently you drink alcohol?	1. Every day 2. Twice a week 3. Weekly 4. Monthly 5. Others specify ---		
209	How much alcohol do you consume per day	----------liter ----------bottle		
210	Do you chew khat?	1. Yes 2. No		If No skip to 301
211	How frequently do you chew khat?	1. Every day 2. Twice a week 3. Weekly 4. Monthly 5. Others specify----		
212	How many gram of khat do you chew per day	----------grams		
Part IV Respiratory symptoms				
Cough				
301	Do you usually have a cough	1. Yes 2. No		**If No skip to 303**
302	How many days per week do you cough?	_____		
	At what time of the day do you cough?	1. Morning 2. Day 3. Night		

	Do you have a cough for 3 months or more in total during a year?	1. Yes 2. No		
	For how many years you have had this Cough?	_____ (years)		
Phlegm				
303	Do you usually bring up phlegm from your Chest?	1. Yes 2. No		**If No skip to 307**
303	At what time you usually bring up any phlegm from your chest	1. day 2. night		
304	How many days per week do you bring up phlegm??	_____day		
305	Do you have phlegm for 3 months or more in total during a year?	1. Yes 2. No		
306	For how many years have you had trouble with phlegm?	_____ yrs		
Wheezing				
307	Does your chest ever sound wheezy or whistling?	1. Yes 2. No		If No skip to 312
309	Have you had attacks of wheezing in your chest at any time in the last 12 months?	1. Yes 2. No		
310	Have you ever had an attack of wheezing that has made you feel short of breath?	1. Yes 2. No		
311	Have you at any time in the last 12 months been woken at night by an attack of shortness of breath?	1. Yes 2. No		

Breathlessness				
312	Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill?	1. Yes 2. No		
313	Do you have to walk slower than people of your age on the level because of breathlessness?	1. Yes 2. No		
	Do you ever have to stop for breath when walking at your own pace on the level after a few minutes?	1. Yes 2. No		
	For how long have you been this short of breath?	_____		
Chest illnesses				
314	During the past three years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed for as much as a week?	1. Yes 2. No	If No skip to 316	
315	Did you produce phlegm with any of these chest illnesses?	1. Yes 2. No		
	In the last 3 years, did you have such illnesses, with (increased) phlegm which lasted a week or more?	1. Yes 2. No		
316	Does your chest ever feel tight or your breathing become difficult?	1. Yes 2. No		
Part V. Worker's Knowledge, Attitude and Practice on health effect of exposure to petrol and Protective Measures (Only for study subjects)				
401	Do you think that petrol station attendants should wear personal protective devices (PPE) at work?	1. Yes 2. No		
402	Do you have access to PPEs in your	1. Yes	**If No skip to 405**	

	working area?	2. No		
403	How often you wear PPE?	1. Always 2. Occasionally 3. Never		
404	Type of devices you use during your work hours	1. Protective Mask 2. Respirator 3. hat 4. Glove 5. Google 6. Safety shoes		
405	Do you know that exposure to Petrol fume can affect your health negatively?	1. Yes 2. No	If No skip to 407	
406	What kind of health effects they will cause	Specify _____		
407	Have you ever told by the petrol station management about the importance of PPDs and their application?	1. Yes 2. No		

Part VI. Questionnaire for weight, height and PFT measurements

Subjects:

Sex	**Age**	**Weight in kg**	**Height in cm**

PFTs

Pulmonary function indices	**1st trial**	**2nd trial**	**3rd trial**	**Best selected**	**% predicted**
FVC					
FEV1					
FEV1/FVC %					
FEF25-75%					
PEFR					

Thank you very for your participation!!!

9.3 Annex 3. Afaan Oromo version of information sheet and Consent form

Information sheet

Helloomaqaankoon_____jedhama.BarattuudigiriilammaffaaYuunivarsiitiiJimmaati.Qorannoo kana irrattiakkahirmaattankabajaanisingaafanna.Hirmaannaakeessaanguutumattifedhiirrattikanhundaa'edha.Odeeffannooarmaangadiikandubbisiigaaffiiyooqabaatteosoohinhirmaatinduragaafachuudandeessa.

Qorannoonkunhaalafayyaasombaa fi dhiibbaahurkapeetrooliidhaafsaaxilamuuirrattinamootabuufataboba'aamagaalaaJimmaakeessattihojjatanirraattigochuufkanyaaddameedha.

Yooqorannoo kana keessattihirmaachuufhirmaachuffedhaqabaattan:

- ❖ Gaaffiiarmaangadii kana deebiftu
- ❖ Meeshaaspiromeetiriijedhamuunhaalasombakeessaniisafarra

Yeroonqoranichaawaliigalaansa'aatiitokkokanhincaallee fi bakkiqorannoonkunittigaggeeffamuimmoobakkumaittihojjatanuttita'a.Ragaanisinkennitaniccitiin isaakaneeggamuu fi qo'annoo kana qofaafkanooluta'a.Maqaani fi eenyummaankeessangaaffii kana irrattihinibsamu.Koodiiaddaaqofatufayyadama.Hirmaannankeessanguutumattifedhaankanta'ee fi yeroobarbaaddanittidhaabuudandeessu.Garuuragaanisinkennitanmilkaa'inaqo'annookanaatifgumaachaol'aanaanuufkenna.Hirmaannaakeessaniifbaayyeeisingalateeffanna.

- ➢ Gaaffiiyooqabaattankaraakanaanabbaaqorannoo kana gaggeessuargachuudandeessu:
  Maqaa :LeyilaaTemaam, Bilbila: 0916394114 Email: namesty44@gmail.com

Foormiiwaligaltee

Ragaafunaanaanwaa’eeqoranichaahundanaafibseera.Kaayyoonqorannookanaanaafgaleera.Akkan attihimamettiqorannoo kana keessattihirmaachuunrakkooqaamaatokkolleehinqabu.Haalaragaafunaanuuirrattiibsafudhachuunh angiqorannoonkunfudhatusnattihimameera.Iccitiinkoohundisakkanaafeeggamuu fi yeroonbarbaadettidhaabuuakkandanda’uhundanaafibsameera.Kanaafuufedhakootinhirmaachuuk ootifnanmirkaneessa.

Maqaahirmaataa_____

Mallattoohirmaataa_____ guyyaa_____

9.4 Annex 4. Afaan Oromo version of the questionnaire

Koodii _____ Lakka_____

Kutaa I waa'eeuummataa fi hawaasummaailaalchisee				
101	Saala	----------		
102	Umrii	----------		
103	Haalafuudhaa fi heerumaa	1. Hinfuune/heerumne 2. Kanfuudhe/heerume 3. Addaanbahe 4. Kophaa 5. others		
104	Sadarkaabarumsaa	5. Hinbaranne 6. Kutaa 1-8 7. Kutaa 9-10 8. Diplomaa fi isaaol		
105	Buufataboba'aakeessanihojjattu?	3. Eeyye 4. Miti		**Miti**yoota'egara 108 darbi
106	Guyyaattisa'aatiimeeqaafbuufataboba'aakeessa hojjattu?	4. Sa'aatii 8 5. Sa'aatii 8 ol 6. Sa'aatii 8 gadi		
107	Waggaameeqaafbuufataboba'aakeessahojjattan ?	_____ waggaa		
108	Buufataboba'aanalattibakkadhukkee/dikeeqabu keessattihojjatteenoibeektaa?	1. Eeyye 2. Miti		**Miti**yoota'egara 211 darbi
109	Gosadhukkee/dikeeaddaanbaasi	_____		
110	Gosahojiiaddaanbaasi	_____		
111	Waggaawaliigalaahojjatte	_____waggaa		
Kutaa II seenaadarbe/ rakkoomedikaalaaammajiru.				
201	Dhukkubootakanneenkeessaakamqabdu?	9. Dhiibbaadhiigaa 10. Dhibeesukkaaraa 11. Qorra/michiisombaa		

		12. Chronic bronchitis 13. Asmii 14. Dhibeelaphee 15. Balaalapheeirraga'e 16. Baqaqsaniiyaaluugara ayknlaphee		
KutaaIII .Amalatambooxuuxuu fi alkooliidhuguunwalqabatee				
202	Tamboonixuuxxeenibeektaa?	3. Eeyyee 4. Miti		**Miti**yoota'egara 205 darbi
203	Yerooammaa kana nixuuxxaa?	1. Eeyyee 2. Miti		
204	Guyyaattihangamxuuxxa?	----------		
205	Aalkooliidhugdeenibeektaa?	1. Eeyyee 2. Miti		**Miti**yoota'egara 209 darbi
206	Gosaalkooliifudhattu?	_____		
207	Aalkoolichaakkamiinfudhatta?	6. Guyyahunda 7. Torbanittiyeroo lama 8. Torbeedhaan 9. Ji'aan 10. Kanbiraa_____		
208	Guyyaattihangamdhugdu?	_____Liitira _____qaruura		
209	Jimaaniqamaatu?	1. Eeyyee 2. Miti		**Miti**yoota'egara 301 darbi
210	yeroomeeqaqamaatu?	1. Guyyahunda 2. Torbanittiyeroo lama 3. Torbeedhaan 4. Ji'aan 5. Kanbiraa_____		

211	Tilmaamanguyyaattigiraamameeqaqamaatu?	---------- giraama		
Kutaa IV rakkoleehargansuudhanwalqabatan				
Qufaa				
301	Yeroobaayeesiqufaasisaa?	3. Eeyyee 4. Miti		**Miti**yoota'egara 303 darbi
302	Torbanittiguyyaameeqafsiqufaasisa?	_____		
	Yerookamsiqufaasisa?	4. Ganama 5. Guyyaa 6. Galgala		
	Waggaa kana keessattiutaallooji'a 3 fi isaaoltureniqabdaa?	3. Eeyyee 4. Miti		
	Waggaameeqafutaalloo kana waliinturte?	_____ (waggaa)		
Hancufafurriinwalmake				
303	Yeroobaay'eehancufafurriiqabusitufsiisaa?	3. Eeyyee 4. Miti		**Miti**yoota'egara 307 darbi
303	Yerookamhancufafurriilapheekeerraatufta?	3. Guyyaa 4. Halkan		
304	Torbanittiguyyaameeqahancuffurrii kana situfsiisa??	_____guyyaa		
305	Waggaakeessattihancufafurrii kana ji'a 3 fi isaaolniqabaattaa?	3. Eeyyee 4. Miti		
306	Waggootameeqafsirakkisaature?	_____ waggaa		
Sagaleeyerooharganssuu				
307	Lapheenkeeyerooharganttusagaleenidhagessisaa?	3. Eeyyee 4. Miti		**Miti**yoota'egara 312 darbi
309	Sagalee kana ji'ootadarban 12 keessattinidhageessature?	3. Eeyyee 4. Miti		

310	Akkaafuurakutuunsittidhaga'amusikangodhusagaleelapheeirraadhaga'amuniqabdaa?	3. Eeyyee 4. Miti		
311	Ji'oottan 12 darbankeessattisababaafuurakutuutinhirribakeessakaateenibeektaa?	1. Eeyyee 2. Miti		
Afuurakutuu				
312	Yeroodafteedeemtuyookintabbabaatuafuurakutuunsittinidhaga'amaa?	1. Eeyyee 2. Miti		
313	Sababaafuurasikutuufyeroodeemtuhiriyootaketetirrasuutadeemuunidirqamtaa?	1. Eeyyee 2. Miti		
	Daqiiqaamuraasaboodahargansuudhaafnidhaabattaayeroodeemsarrajirtu?	1. Eeyyee 2. Miti		
	Afuurakutuuergasijalqabeehangamta'e?	_____		
Dhukkubbiilaphee				
314	Baroota 3 darbankeessattitorbeetokkoofdhukkubbiilaphehojiirraasihambise, manattisihambiseyknsiciibseniqabdaturee?	1. Eeyyee 2. Miti		**Miti**yoota'egara 316 darbi
315	Dhukkubalaphee kana waliinhancufafurriiqabusitufsiiseraa?	1. Eeyyee 2. Miti		
	Baroota 3 darbankeessattitorbeetokkoofyknisaaoliifdhukkubaakkasiihancufafurriiqabusitufsiiseniqabdaa?	1. Eeyyee 2. Miti		
316	Hargansuunsittiniulfaataa?	1. Eeyyee 2. Miti		
Kutaa V. Beekumsa, ilaalcha fi shaakalahojjattootaabu'aafayyaasaaxilamuupeetrooliitti fi ittisaisaairratti				
401	Hojjattoonnibuufataboba'aakeessahojjatanme	1. Eeyyee		

	eshaaleeittisaqaamaauffachuuqabanjettaniiniyaadduu?	2. Miti		
402	Meeshaaleeittisaqaamaabakkahojjattankanaaniargattuu?	3. Eeyyee 4. Miti		**Miti**yoota'egara 405 darbi
403	Meeshaaleeittisaqaamaa kana yerookamfayyadamtu?	4. Yeroohunda 5. Darbeedarbee 6. Hinfayyadamu		
404	Gosameeshaayeroosa'aatiihojiifayyadamtan?	7. Maaskii 8. Respiratorii 9. Gonfoo/ qoobii 10. Gilaavii 11. Googilii 12. Kophee		
405	Hurkapeetrooliittisaaxilamuunfayyaanamaaakkamiidhunibeektuu?	3. Eeyyee 4. Miti		**Miti**yoota'egara 407 darbi
406	Rakkooleefayyaaakkamiinamarraangeessisu?	Addaanbaasi _____		
407	Maanajimentiinbuufataboba'ichaafaayidaameeshaaleeittisaqaamaa fi akkataafayyadamaisaasinittinihimuu?	1. Eeyyee 2. Miti		

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in this or any other university and that all sources of materials used for the thesis have been fully acknowledged.

Name of the student: **LeylaTemam**

Signature: _____

Name of the institution: **Jimma University**

Date of submission: _____

This thesis has been submitted for examination with my approval as University advisor

Name and Signature of the first advisor

Mr. Samuel Tadesse (MSc, Assistant professor of Medical Physiology)

_____

Name and Signature of the second advisor

Mrs. Almaz Ayalew (MSc, Lecturer of Medical Physiology)

_____

Name and Signature of the external examiner

_____

_____

Name and Signature of the internal examiner

_____

_____