UNIVERSITY of RWANDA

FACTORS ASSOCIATED WITH ABNORMAL LUNG FUNCTION AMONG UNIVERSITY STUDENTS IN KIGALI-RWANDA, CASE OF UR-CMHS.

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DECLARATION

I do hereby declare that this dissertation entitled **"Factors associated with abnormal lung function among university students in Kigali-Rwanda, Case of UR-CMHS".** In partial fulfillment of the requirement for the master's degree in Public Health, in University of Rwanda College of Medicine and Health Sciences (UR/CMHS), School of Public Health is my original work and has not previously been submitted elsewhere. I do declare that a complete list of references is provided indicating all the sources of information quoted or cited.

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DEDICATION

Dedicate this dissertation to Almighty God for everlasting love and protection. I can't forget my wife Assumpta MUHORACYEYE, my child Kenneth MUHIRWA, my parents, my lovely brothers, family members, all friends and colleagues.

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My thanks are addressed to the almighty God for his inconsiderable mercy, the University of Rwanda which gave the precious opportunities of upgrading my level to the Master's degree. My great thanks are addressed to the staff of Master's program.

I am highly beholden my Supervisor: **Dr. Kevin Nwanna Uchechukwu** and Co-supervisor: **Mr. RUBUGA Kitema Felix** and even academic staff, mainly **Professor Cyprien MUNYANSHONGORE** and **Mr. Michael Habtu Fissehaye** for their continuous, help, guidance, support, and encouragement that greatly contributed to the completion of this dissertation. I also forward my gratitude to my fellow classmates for their authentic cooperation, moral and physical support during the route of study especially public health students. Ending I thank everybody who contributed in whatever means either morally or materially to the achievement of this dissertation especially my wife.

ABSTRACT

Background: Determinants of abnormal lung function among students living in hostels have not been evaluated. University students commonly come into contact with residential pollution and others different factors in their dorms, which are known to increase the risk of respiratory illnesses including Chronic Obstructive Pulmonary Diseases (COPD). COPD are estimated to have contributed to 3 million deaths worldwide which is 5% of all fatalities; and over 90% of these deaths occurred in low- and middle- income countries (LMICs), with a global prevalence of 10.3%. The recent study in Rwanda found COPD prevalence of 4.5%. This study aims to find the "Factors associated with abnormal lung function among university students in Kigali- Rwanda". **Methods:** The minimum sample size were 220 subjects after the exclusion criterion to be used in this study. Validated questions were used to assess self-reported physical health status like, cough, fatigue, respiratory problems. Spirometry for lung function tests was used to identify abnormalities as the measurement of outcome variable. A typical statistical data analysis method, descriptive, bivariate and multivariate analysis were employed to assess the degree to which a dependent variable and one or even more independent variables have a linear relationship.

Results: The analysis of this study showed that 119(54.09%) participants were female while 101(45.91%) were male, and the prevalence of abnormal lung function were 20.9%. Risk factors for abnormal lung function were found to be building characteristics such as frequency of window opening, freshness of air in the room, and physical wellbeing (OR:4.5; CI: 1.771744-11.45793, *P*=0.002) were 4.5 times of having abnormal lung function for those who reported poor compared with those who said excellent within specified period before the survey.

Conclusion: This is the first research on abnormal lung function conducted in a Rwandan university residence. The prevalence of abnormal lung function showed that, it is the problems for public health which needed a great consideration for the associated factors mainly in the enclosed microenvironment like in the university campuses where students spend much of their time to alleviate the proportion of abnormal lung function.

Key terms: *Lung function, Risk factors, Spirometry, COPD.*

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LIST OF SYMBOLS AND ACCRCONYMS/ABBLEVATIONS

UR: University of Rwanda

UR-CMHS: University of Rwanda, College of Medicine and Health Sciences

PFT: Pulmonary Function Test

LLN: Low Limit of the Normal

AQG: Air Quality Guideline

IAQ: Indoor Air Quality

PM: Particulate Matter

$PM_{2.5}$: Particulate Matter, which consists of particles with an aerodynamic diameter of 2.5μm or less.

PM_{10}: Particulate matter that has particles with aerodynamic diameters of at least 10μm

LMI: Low Middle Income

UFP: Ultra-Fine Particles

IHD: Ischemic Heart Disease

COPD: Chronic Obstructive Pulmonary Diseases

CRD: Chronic respiratory diseases

BMI: Body Mass Index

ILD: Interstitial lung disease

EAC: East African Community

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OPERATIONAL DEFINITION OF KEY TERMS

Abnormal lung function is defined as the proportion of air that is released in the first second, less than 70% indicate lung abnormality. It is figured by splitting **Forced Expiratory Volume** by **Vital Capacity** and multiplying by 100 and got Less than 70% of the total amount of air blown out in one second, indicated by having either Restrictive or Obstructive abnormalities (1).

Normal lung function: the percentage of air blown out in the first second is which is equals or above 70%. This is calculated by dividing **Forced Expiratory Volume** by **Vital Capacity** and multiplying by 100. This will be 70% or above. Which is an indication of absence of either Restrictive or Obstructive abnormalities.

CHAPTER I: INTRODUCTION

1.1. Background

Pulmonary function testing is a valuable tool for evaluation of abnormal lung function (Restrictive or Obstructive) lung diseases for an early detection and alleviation of Chronic Obstructive Pulmonary Diseases (COPD). The FEV1/FVC ratio is used to classify the two main forms of abnormalities (obstruction vs. restriction). Those with restrictive lung disorders struggle to fully expand their lungs with air, whereas those with obstructive lung diseases have trouble exhaling all of the air from their lungs. Reduced FEV1/FVC ratios are indicative of obstruction(1). In the US, restrictive lung disorders and chronic obstructive pulmonary disease (COPD) are major sources of morbidity and mortality and increased functional impairment is linked to the existence of respiratory symptoms, obstruction or restrictive lung illness(2). Particulate matters are the primary indoor air contaminant at university student hostels by which could affect more the airway, as people are susceptible to particulate matter that persists in the breathing zone and cause abnormalities of lung function such as obstructive and restrictive. With one significant exception, individuals may quit smoking but not inhaling contaminated air, making air pollution a more lethal killer than tobacco(3). PFTs are the gold standard for diagnosing COPD, according to the 2023 Global Initiative for Chronic Obstructive Lung Disease (GOLD) publication(5). Certain respiratory illnesses affect young people more frequently than they do children or the elderly, and symptoms of allergic rhinitis and asthma are most common in these age groups 6% and 22%, at 15-29 and 25-44 years respectively, by quantifying the health hazards and evaluating their distribution are the first stages in seeking to decrease the risk factors for lung abnormalities(4)(6). Chronic obstructive pulmonary disease (COPD) and bronchial asthma are among the obstructive lung diseases while Interstitial lung disease (ILD) as well as other extrinsic restrictive disorders are examples of restrictive pulmonary abnormalities(7).

Globally, the Global initiative for Chronic Obstructive Lung Diseases in their report in 2023 in collaboration with Burden of Obstructive Lung Diseases (BOLD), showed that the prevalence of COPD was 8.5% for women and 11.8% for males, which lead to the global prevalence of COPD of 10.3%. There are around 3millions deaths annually globally from Chronic Obstructive pulmonary Diseases which is 5% of all fatalities(5). The third greatest cause of mortality globally is COPD(8). A study from the US National Health and Nutrition Examination Survey (US

NHANES) illustrate that 5.7% and 13.4% of the general population had restrictive and obstructive impairment respectively. More precise estimates of the prevalence of COPD are being made possible by new data. The prevalence of COPD was much greater in smokers and former tobacco users compared to nonsmokers in those over 40 years compared to those under 40 years old, and in males compared to women, according to a number of published systematic reviews and meta-analyses(5). Students at universities frequently stay in hostels, it is crucial for society to comprehend how issues with public health, such obesity, smoking, and indoor air pollution, influence students' lung function. Students' respiratory function may decline due to a variety of risk factors which final lead to COPD. The majority of these issues may be avoided(9). Gender, age, height, Body Mass Index(BMI), smoking status, asthma history, educational level, and air quality are significant risk factors(6)(10). According to estimates, between 10 and 15 percent of avoidable deaths in the USA can be reduced by measures related to healthcare, while around 40 percent of avoidable fatalities are linked to possibly alterable behavioral habits, and also according to another estimate, the direct delivery of medical care accounts for 95% of U.S. health spending, with public health spending accounting for the remaining 5%(11).

For Indoor Air Quality, as many universities' dormitories lack integrated air conditioning units for heating, cooling, and ventilation due to their lengthy construction histories, it may be more challenging to offer students with a comfortable interior thermal climate and good indoor air quality(12). Due to the fact that the fresh air solely relies on air penetration, Indoor Air Quality will worsen, particularly in transition season when windows and doors are closed. As a result, awareness about the problem of pollution of the indoor environment in dorm rooms has grown among university students who reside in that microenvironment positively(12). Air pollution has become a significant issue on a global scale. One of the biggest environmental dangers in the world today is air pollution. 4.2 million people die worldwide each year as a result of its over 90% percent people who live in areas with bad air to breathe(13). The particulate matter $PM_{2.5}$ and PM_{10} that makes up this pollution mix is thought to be responsible for 3.8 million annual fatalities. Of the 3.8 million fatalities, 27% were attributable to IHD, 18% to stroke, and 43% to COPD, 28% of adult pneumonia fatalities are a result of household air pollution(14). While protecting the quality of the outdoor air is imperative, maintaining the quality of the inside air is just as important. This is owing to the fact that we spend the majority of our time indoors and that indoor pollution accounts for over half of the 8 million fatalities worldwide caused by poor air quality(13). WHO

standards are not met by the indoors or outdoors air that three-quarters of the world's population breathes(13)(3). Which was updated for $PM_{2.5}$ and PM_{10} for annual mean of 5µg/m^3 and 15 µg/m^3 and 24hours mean 15µg/m^3 and 45µg/m^3 respectively(15). Given that the majority of individuals spend between 80% and 90% of total time indoors, these concentrations of indoor air quality may be of great concern(16)(17). Air pollutants in residential buildings for the general public may come from within the structure itself or may be pulled in from the surrounding area. Yet, it is most probable that human activities, such as fuel combustion, smoking, using kerosene and gas stoves, and pollutants from garage exhaust gases, are the key causes causing the majority of indoor air pollutants(18). East Asia and Pacific, as well as South Asia, were the regions where 70% of the deaths due to air pollution occurred. China and India were responsible for 52% of all $PM_{2.5}$-related fatalities worldwide(14). 83% of people in the African Region are affected by the use of petroleum products and technology for cooking, building materials, which is virtually exclusively a concern in low and middle income countries (LMICs)(3).

In Africa, across many countries in sub-Saharan Africa, a significant public health issue is COPD, which causes aberrant lung function(20). Evidence from Nigeria shows that 9.2% of African nations would have COPD prevalence by 2022 and the range of COPD prevalence is 1.7% to 24.8%(21). The prevalence of COPD was 16.2% in Uganda according to a cross-sectional spirometry-based study conducted in 2015. The highest spirometry-based survey estimate in Africa was 23.8% in Cape Town, South Africa, in 2005(21). Systematic analysis in Africa showed an association between age and COPD spirometry results (22). Air pollution as a main factor of abnormal lung function caused one million fatalities in 2019 in Africa, from which 697000 were caused by household indoor air pollution from 361,000 in 2015 to 383,100 in 2019. 394000 fatalities were caused by ambient air pollution, more deaths were attributed to ambient air pollution, with the most significant increases happening in the most industrialized countries(23) contributing to the overall of over 90% of these deaths occurred in low- and middle-income countries (LMICs)(24). The study in Ghana 2021 showed that a consequence of sickness and mortality brought on by air pollution mainly respiratory diseases such as Chronic Obstructive Pulmonary Diseases (COPD), Ethiopia lost $3.02 billion in 2019, Ghana lost $1.63 billion and Rwanda lost $349 million. The burden of pulmonary abnormalities and preventable deaths has increased as a result of risk factors linked to exposures to indoor pollution, Poor indoor air quality has indeed been related to a variety of consequences on respiratory health, including the onset and

worsening of asthma, bronchitis, respiratory infections, and symptoms of the lower and upper respiratory tracts. According to reports, IAQ issues cost more 1.6 million lives and left over 38.5 million people incapacitated(25).

The observational study which have been done in Rwanda by Musafiri Sanctus in 2011 a pulmonary function test for abnormal lung function found COPD Prevalence of 4.5% for the general population and higher prevalence was found among smokers(26). Meta-analysis study for Sub-Sahara Africa in 2022, found the same prevalence for Rwanda as it was referred to the prevalence proven by Awokola BI and Musafiri(8). This is the only one article on this aspect, the mean age was 38.3years. According to estimates from WHO, Rwanda experienced over 3000 thousand fatalities due to ambient air pollution as great contributor of COPD in 2016. However, because exposure is derived from satellite estimations, such estimates may be unreliable. In significant cities like Kigali, there hasn't been any ongoing ground-based surveillance to verify estimates(27). A second research in Rwanda used information from a small number of inexpensive sensors to examine the temporal and geographical variation of poor air quality in Kigali(27). Due to few published works on air pollution in Rwanda(28)(29) and no study on determinants contributing to the abnormal lung function with no study in Rwanda focused on university dormitories that are a part of public structures cause this emphasis. The purpose of this research study is to ascertain any of the factors which could be associated with abnormal lung function by making mainly emphasis on the indoor air quality in university hostels in Kigali, Rwanda. Determining the factors associated with abnormal lung function is helpful for developing protective and productive measures for Rwandan University students in the future.

Physiology and anatomy of respiratory system

The exchange of gases between both the respiratory system and its outside environment is carried out by the respiratory system, which is housed in the thorax. Upper airways, lower airways, tiny bronchioles, and alveoli sacs in the lung tissue are where air (oxygen) is inhaled(10). Whether or not one's respiratory system is in good working order is one of the primary indicators of one's health. The functioning of the respiratory system is significantly influenced by a wide range of social, environment, and economic factors. Students living in university dorms who are susceptible to such significant risk factors or poor social standing may experience the health consequences of a damaged or impaired respiratory system(12). Health and cultural concerns make it necessary to

identify respiratory risk factors that frequently affect university student in their hostels. The goal of this study is to investigate the connection between various risk factors and respiratory function. This study used primary data collected in public University of Rwanda, College of Medicine and Health Sciences dorms in Kigali-Rwanda, to explore the cause and impact on respiration.

I.2. PROBLEM STATEMENT

Chronic Obstructive Pulmonary Diseases continue to be a problem for its boosting prevalence with a significant frequency of seasonal allergies, asthma-like symptoms, and respiratory infections Obstructive and restrictive among university students(9). The recent study in Rwanda on abnormal lung function was curried by Musafiri.S.2011 in observation cohort study, the prevalence of COPD was 4.5% for the population established and higher prevalence was found among smokers(26). Kigali, Rwanda' University schools are mostly situated in only 100-300 m of main roads, which is concerning (29). Final Report on Ranking of Higher Education Institutions in Rwanda shows that hostel facility on campus is 31%, off campus is 10%, both 21% those with hostel facility available comprise 38%(30). According to a research on indoor pollution exposure in people, indoor pollution levels can sometimes be up to 100 times greater than outside levels(25). It is reported that 98% of students in Africa are susceptible to quantities over the WHO limit for PM2.5, comparing to 52% in industrialized nations, even if precise figures for Rwanda are not available(3).

Rwanda nowadays has exceeding the WHO Air quality guidelines for particulate matter (PM2.5) which is 8times WHO guidelines values, means instead of approaching 5μg/m^3 recommended is 39μg/m^3 and this particulate matter contribute more on Chronic Obstructive Pulmonary Diseases (COPD)(29)(23). Only one article on lung function was established as the recent carried in 2011 on general population, that why this study will be concerned with microenvironment UR-CMHS student hostels where no study related to lung function have been done in this setting.

1.3. OBJECTIVES

1.3.1. Main objective

Factors associated with abnormal lung function among university students in Kigali-Rwanda.

1.3.2. Specific objectives

1.To determine the Prevalence of abnormal lung function among university students

2.To identify the socio-demographic determinants contributing to the abnormal lungfunction among University students.

3.To determine physical health status contribution to abnormal lung function.

4.To identify different behavioral factors that contribute to abnormal lung function

5.To establish the relationship between building characteristics and abnormal lungfunction.

1.3.3.Research questions

1.How far is the prevalence of abnormal lung function among university students?

2.Are there any socio-demographic factors contributing to abnormal lung function among universitystudents who reside in Hostels in Rwanda?

3.Do physical health status contribute to the abnormal lung function?

4.Do behavioral factors have any relation with abnormal lung function?

5.Is there any building characteristic which could impact lung function?

1.4. SIGNIFICANCE OF THE STUDY

The different determinants inside the rooms and behavioral factors like smoking, wearing cloths, diets, materials inside the room contribute to the occurrence of Obstructive or restrictive which lead to COPD. A study of Kigali households found a significant relationship between human particle exposure and indoor air quality (31)(32). This particulate matter and being in indoor in prolonged periods lead to airway problems. According to several studies, the interior air quality of hostels is negatively impacted by air contaminants in the air that are produced by industrial processes, traffic, and biomass burning. These pollutants enter the building through infiltration(33). Since university and higher institution are situated close to major industrial environments, substantial commercial facilities, and highways with high traffic densities, university student hostels may be particularly affected. These findings will particularly relevant to managing students hostels wellness who are vulnerable to air pollution exposure in such settings and alleviate from behavioral risk factors. It will provide the ideas on which intervention could be implemented in university hostels, which could impact learners positively in terms of IQ improvement and even reduction of chances of getting obstructive and restrictive lung impairment for learners which lead to economic development of the country in general.

1.5. SCOPE OF THE STUDY

Rwanda's capital city, Kigali, lies almost in the middle of the nation, at latitude 10°57' South and longitude 300°04' East. It is known as one of the cleaner, greenest, and safest cities in Africa and serves as the economic, cultural, and transportation center of the nation of Rwanda. The city has a total area of 730 km2, of which 30% is built-up urban area and 70% is rural. Three districts make up Kigali City: Gasabo, Kicukiro, and Nyarugenge. Additional divisions of the districts include 35 sectors, 161 cells, and 1183 Imidugudu (villages)(34).

University of Rwanda was established in 2013 through a merger of the former seven Higher Learning Institutions to form 6 colleges among which College of Medicine and Health Sciences (CMHS) is included from which this study is on concern. CMHS is located in Kigali City, Gasabo District. Most of the students mainly undergraduates spend most of their time in campus and live in Hostels of the campus(35). With a vision of leading university that develops highly enterprising graduates prepared and dedicated building a more just and sustainable society locally, nationally and globally, with appropriate innovations that advance quality of life.

*Figure 1**:** University of Rwanda, college of medicine and health sciences (source: Google map)*

This study emphasized in Kigali university student hostels where they spend much of their time, for assessing the levels of air quality and living behavioral risk factors in that microenvironment that may lead to the abnormal lung function as many universities in Kigali are near traffic and high travels.

1.6. CONCEPTUAL FRAMEWORK

In this study they are different factors for abnormal lung function

Socio-demographic factors

Gender: Being male is one of the factors for poor lung function, and this appears to fall within restrictive lung impairment much like other variables, including symptoms suggestive like sputum, cough night also have damaged lung function(7). **Age**, for instance, it is evident that people are aging in the majority of low- and middle-income nations, where Rwanda included, despite the existence of several unresolved infrastructure-related issues. Chronic and handicapping illnesses are a process of aging. The majority of cases of chronic respiratory disorders occur in older people and are among the most common and severe of all(2) and even have been identified to be associated with abnormal lung function. **Status on the campus based on their levels:** People with low education are mostly to have low income and live in poor condition and sophisticated life which can lead them to be exposed more. **Religion:** Religious behaviors and norms lead to a contribution or not on a given prevention measurement which could adversary affect negatively or positively on some of the strategies taken. Body mass index (BMI), a proportional figure that is calculated from a person's weight and height, is a valid measure of overweight and obesity(11)(37).

Example, the health of Americans is severely challenged by obesity and overweight. Its prevalence is a feature of American life with social, cultural, political, and cultural changes particular food and physical activity, which combined comprise primary causes of early death as well as causes and effects that go outside the purview of the health system(11).

Physical health status: an ability of person to show some of symptoms of COPD include feeling out of breath whether at rest or during physical exercise, having nausea, eye irritation, skin irritation, vomiting, fatigue, respiratory problem, rate of physical wellbeing, coughing, and/or persistent mucus production was assessed by using questionnaire for better analysis.

Behavioral factors

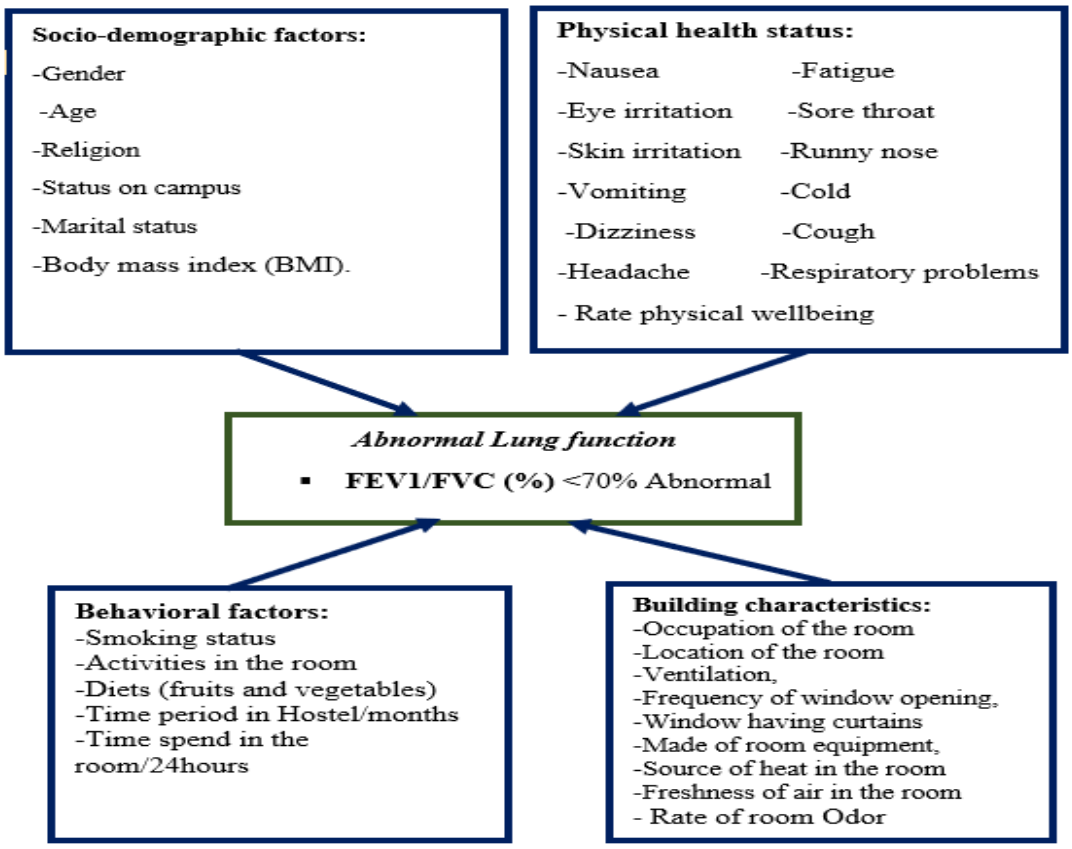
Asthma and cigarette smoking are significant risk factors for respiratory impairment among students living in dormitories, which can lead to chronic obstructive pulmonary disease. Every society's first priority should be to improve women's health Smoking habits contribute to the abnormal lung function, where being ex-smokers, passive or current smokers, it has been showed

that the activities curried out inside the room including dressing habit has effect on lung function(38). Dietary uptake mainly fruits and vegetables servings per day are also the behavioral act that contribute to the worsening of the heath. For sleeping hours, the usual advice for individuals between the ages of 18 and 60 to get at least seven hours of sleep every night on an ongoing basis to support good health. Genetic, behavioral, medical reasons, and external factors all have an effect on an individual's variability in their need for sleep(39).

Building characteristics

Indoor Air Quality (IAQ) is mainly influenced by Ventilation, frequency of window opening, hostel equipment, Student density, is also a factor of abnormal lung function. And also, as many universities locate near industries**,** near high traffic, industries, and even either paved or unpaved it have been found to be linked with respiratory abnormalities. As many universities' dormitories lack integrated air conditioning units for heating, cooling, and ventilation, particulate Matter can be concentrated inside the room and lead to insufficient of air getting in the lung.

Displaying of conceptual framework



CHAPTER 2: LITERATURE REVIEW

The View of Literature chapter analyzes how scholars and experts knows and said about the concepts of abnormal lung function, different factors including particulate Matters and theoretical perspectives and other related studies.

2.1 Socio-demographic factors and lung function

The Region of Americas had the greatest incidence of COPD among all WHO areas (14.53%), while the Western Pacific and South-East Asia regions had the lowest prevalence (8.80%). Global prevalence of Men is around 5% more likely than women to have COPD. condition 1 of COPD is the most common condition(40). Eighty percent of persons in the National Health and Nutrition Examination Survey from 2012 in the US who were aged 20 to 79 had normal pulmonary function tests, whereas 5.7% had restrictive impairments, 7.9% had mild obstructive problems, and 5.5% had moderately or severe/very severe obstructive impairment(41). The use of fuel derived from biomass has also been linked to the incidence of obstructive airways diseases. Age was revealed to be a factor in COPD prevalence and incidence(42).

2.2 Physical health status

American Thoracis Society in its factsheets 2023, clinical history and the primary symptoms of COPD include feeling out of breath whether at rest or during physical exercise, coughing, wheezing, exhaustion, and/or persistent mucus production was also discovered to be the factors in poor pulmonary function (7)(50).

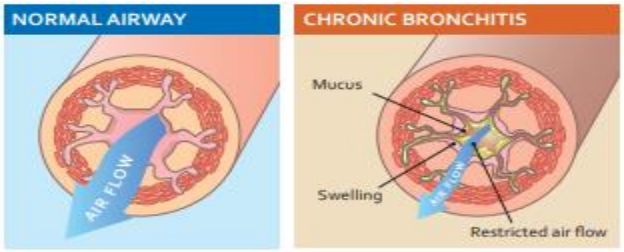


Figure 2: Showing normal bronchial airway(left) and abnormal airway(right), adopted from American Thoracic Society factsheet(50).

2.3 Behavioral factors

Tobacco usage is by far the main risk factor for COPD, and the prevalence of the condition in different nations is connected to the rate of smoking and the time when cigarette smoking was first introduced(42)(43). McHugh J 2020 complehensive study on lung function in Canada, shows that fruits and vegetable consumption and even physical activities have to be considered as factors contributing to lung function(44).

2.4 Building characteristics

According to a WHO fact sheet, low- and middle-income countries (LMIC) within the World Health Organization's European Region have household air pollution deaths that are more than ten times higher than high-income countries (HIC), which disproportionately affect the most underprivileged population groups and those who are socially disadvantaged(45).

Particulate matter in particular have been linked to early human mortality due to ambient air pollution. Around 556 000 early deaths in the WHO European Region were caused by air pollution in 2016. Each individual in the WHO European Region has a reduced life expectancy after exposure to particulate matter, which is mostly due to an increased risk of lung cancer, cardiovascular illness, and respiratory infections (45). High levels of air pollution exposure in students have also been linked to negative health effects and inadequate academic performance(14). The level of window opening and ventilation of the rooms lead to the indoor Air Quality change as a results, the upper respiratory tract can be penetrated by particulate matter with sizes less than 10 μm, which can have detrimental health implications and on the other hand, PM2.5 can induce lower respiratory tract infections by penetrating deeply into the lungs and cause lung diseases (46).Since traffic-related pollutants are increased in only 100-400 m of major roadways and long-term exposure to traffic-related polluted air has been linked to many negative health consequences the major one to be respiratory problems. The prevalence of COPD is

increasing throughout Africa as a result of escalating cigarette usage. Between 8 and 43% of males and 5% to 30% of women smoke in African nations, and the tobacco industry is making significant attempts to open up new African markets. The primary contributory factor for COPD is smoking(20). Obaseki et al. 2016, in the study of Global Obstructive Lung Diseases demonstrates that past severe lung illnesses like TB and occupational dust exposure are additional risk factors. Patients and doctors frequently fail to detect COPD, which results in underdiagnosis and

undertreatment, especially in many Sub-Saharan African settings where the focus is still mostly on communicable illnesses(47). The lack of air quality real - time monitoring in hostels makes it difficult to identify the underlying causes of poor air quality there and, consequently, to implement targeted strategies to reduce students exposure (48)(49).

In Rwanda, only one study had done on abnormal lung function (obstruction and restriction), in 2011 by Musafiri Sanctus and show a prevalence of COPD OF 4.5% in general population for Kigali City and Huye(26). Working to enhance wellbeing by reducing a risk of respiratory illness among students in hostels should be as vital as enhancing teaching strategies or the educational system since it is a crucial component of the learning process and most of urban schools are situated in loud, dirty areas (51). There is no study on the associated factors of COPD among university students and even no filtering infrastructure in place at hostel, which might lead to very high pollution levels.

CHAPTER3: METHODOLOGY

3.1 Materials and methods

The present study was performed by using a spirometry for Pulmonary Function Test (PFT) version, Contec SpirometerSP80B-11 helped by a medical doctor on how to interpret the results recorded. The spirometer output data and questionnaire administered to participants for physical health symptoms. STATAVersion 15.1 software was used for analysis of independent variables with dependent variable. Daily perceptions and behaviors were conducted at the CMHS campus.

3.2 Study Design

A Cross-Sectional study design was used, which involved Universities of Rwanda, College of Medicine and Health Sciences (UR-CMHS).

Each subject was provided a consent form based on the agreement and their willingness. Participants were requested to produce 3 appropriate flow-volume after the technician, a medical doctor has explained the processes and performed a demonstration in the local tongue. The best spirometry, which had the highest FEV1/FEV ratio values was chosen for analysis. A quantitative research approach, which describes and analyzes relationships and changes, causes and effects, and linkages among variables were applied in this study. A total of 220 individuals was randomly recruited in the UR-CMHS hostels. Participants was chosen based on the number of participants in hostel based on the sample size calculation formulae through administered questionnaire.

3.3 Target population

This study is emphasized on students who reside in universities hostels where 466 subjects for both hostels namely male and female from UR-CMHS were invited to fill questionnaire. This is one of the seven colleges of the University of Rwanda which is situated next to a major main road, a transport interchange, and a commercial area in the heart of the city Gasabo district Kimironko sector and the rooms of each Hostel was selected randomly.

3.3.1 Inclusion criteria

Student with 18years old and above, be a student of CMHS campus was sampled, a student who was able to complete at least 3times spirometry test from different maneuvers was included in this study after the agreement of signing consent form. These students will be chosen randomly from the randomly selected rooms.

3.3.2 Exclusion criteria

Student with health-related pulmonary diseases history reported by physician like tuberculosis, chest related diseases, heart diseases, asthma, breathing difficulties and be a student of selected campus will not be sampled and no consent form was provided.

3.3.3 Sample size calculation

Sample size formula for random sampling:

The sample size formula for finite population was obtained and used for sample size calculation from Cochran's formula(52)(53) adapted to cross-section studies.

Where: $no = Z^2P(1-P)/e^2$

n: Minimum sample size required based on population; **Z:** Z-score corresponding to the level of confidence (95%) with which it is desired to be sure that the true population lies with ± D percentage points of the sample estimate (assume 2-sided test with α = 0.05; Z = 1.96); *P:* precision, here is 0.50, **N:** population size ***d*:** margin of error.

$no = \frac{(1.96)^2 * 0.5(1-0.5)}{(0.05)^2} = 384,$ Where no = required return sample size according to Cochran's formula= 384

Therefore, 384 samples are needed for an overall population of 466. The final sample size should be determined using Cochran's (1977) adjustment calculation because the number of participants exceeds five percent of the population (466*0.05=23). The finite population correction formula has to be applied These calculations look like this:

$\mathbf{n} = \frac{no}{1+\text{no/population}} = \frac{384}{1+384/466} = 210,$ Where n = required return sample size because sample > 5% of population**.**

Sample size was calculated based on the formula of simple random sampling for finite population above. which were based also on the number of population in the stated setting for better find the minimum sample size for this study (54). In male and female hostels in a stated campus a minimum sample size is were 210, with a proportion(P) of 0.50 and marginal of error or precision of 5% at confidence interval of 95%.

3.3.4 Sampling technique

Simple random sampling was used to select participants where in every picked number of the labeled subject is taken to participate in the study(55). From the total population of 466. 220 participants were chosen randomly and included in this study after all exclusion criteria.

3.4 VARIABLES

3.4.1 Independent variables

The independent variables considered in this study were: 1. sociodemographic factors: Gender Age, Religion, Status on campus, Marital status, Body mass index (BMI). 2 Physical health status: -Nausea, Eye irritation, Skin irritation, Vomiting, Dizziness, Headache, Fatigue, Sore throat, Runny nose, Cold**,** Cough**,** Respiratory problems, Rate physical wellbeing.3 Behavioral factors**:** -Smoking status, Activities in the room, Diets (fruits and vegetables)**,** Time period in Hostel/months**,** Time spend in the room/24hours. 4 Building characteristics: -Occupation of the room**,** Location of the room**,** Ventilation, Frequency of window opening, Window having curtains**,** made of room equipment, source of heat in the room**,** Freshness of air in the room**,** Rateof room Odor**.**

3.4.2 Dependent variable

The dependent variable was based on whether a student lung is abnormal functioning according to the output from the analysis.

3.5. EXPLANATORY VARIABLES AND ANALYSIS PLAN

A questionnaire about respiratory symptoms and the history of respiratory illnesses, tobacco use history, exposure to different air pollutants, and exposure to dust was given to each participant.

Weight (in kilos)/ height (in meters) squared was used to compute Body Mass Index (BMI), it was categorized as follow, those with a ratio or BMI of <18.5; 18.5-24.9 ;25-29.9 and >30 was considered as underweight, normal, overweight and obese respectively. In terms of smoking history, nonsmokers were those who had never smoked, smokers were those who smoked a minimum of a single cigarette per day, former smokers were those who said they had smoked regularly up until five months before quitting and the reference was based on the number of packs per year. Subjects who were routinely (daily) exposed to ambient tobacco smoke for at least the

previous 12 months were considered passive smokers. For Diets it was categorized on relative to 6 or more servings/day, 4-5; 3-2; and being served 2 or less, mostly when you take 6 servings of fruits and vegetables/day or more recommended by American Heart Association could be crucial for respiratory health(56)(57).

3.5.1 Lung Function Measurements

The following spirometry measurements was made: forced vital capacity (FVC), volume of forced expiration in one second (FEV1), and FEV1/FVC ratio. Every day, spirometers was calibrated. According to the Global Initiative of Chronic Lung Disease (GOLD) recommendations, abnormal lung function is characterized as having a FEV1/FVC ratio less than 70%. Instead of using a fixed cut-off of 0.70, we further characterized chronic airway obstructions for supplemental analysis by having an FEV1/FVC below or equal to the lower threshold of normal levels, that was is the fifth percentile, or 1.645 SD below predicted which is equivalent to 10% substrate from predicted. For each participant in this study, the lower limits of the normal parameters were determined, and the existence of abnormal lung function was indicated by a FEV1/FVC ratio that was below the LLN. After descriptive analysis, bivariate and multivariate analysis are the three different forms of analysis for this study. In the descriptive analysis an individual characteristic in terms of sociodemographic was described and anthropometric measurement were taken. In bivariate analysis a single independent factor is used in simple linear regression to forecast the value of the dependent variable. In multivariate analysis, the value of a dependent variable is predicted using a number of independent variables. The number of independent variables distinguishes the two. There is just one dependent variable in each scenario. Lung function changes was quantified using spirometry data. To investigate how these risk variables, impact lung performance and function, descriptive and regression analysis was used. A typical statistical data analysis method is linear regression. It was employed to assess the degree to which a dependent variable and one or even more independent variables have a linear relationship.

3.5.2 Ethics-related matters

Ethical approval was gained from the University of Rwanda College of Medicine and Health Sciences Ethics Committee, Institutional Review Board (IRB) with the reference: CMHS/IRB/276/2023. The study was only open to participants who signed a written consent agreement.

CHAPTER 4: RESULTS

4.1 DESCRIPTION OF PARTICIPANTS CHARACTERISTICS

A total of 270 sample who were 18 years of age or older were randomly selected from a total population of 466 and asked to participate. Unfortunately,24 of the participants were unable to complete the questionnaires in a proper manner. The remaining 247 participants performed spirometry, at least three spirometry measures that satisfied ATS standards were taken by the subjects. 26people were left out of the analysis because of their spirograms couldn't be done correctly. We continued with 220 subjects as our sample size, of which 119 (54.09%) were female and 101 (45.91%) were male. 175 (79.55%) of the individuals had a normal BMI while 3 (1.36%) were underweight. Table 1 displays the participant characteristics. Of the participants, 49.09% were under the age of 30, while 13% were 30 years of age or older; this reflects the age distribution of undergraduate students at the University of Rwanda.

Table 1 a. Descriptive analysis of participant's socio-demographic factors.

Variables	**N=220**	**%**
1.Gender		
Females	119	54.09
Males	101	45.91
2.Age (years)		
18-29	207	94.09
30-44	13	5.91
3.Religion		
Catholic	96	43.64
Protestant	63	28.64
Adventist	36	16.36
Islamic	8	3.64
Jehovah witness	7	3.18
No religion	10	4.55

4.Status on campus (Level of study)		
Level 1	44	20.00
Level 2	60	27.27
Level 3	41	18.64
Level 4	45	20.45
Level 5	30	13.64
Marital status		
Single	220	100
5.Body Mass Index (BMI)		
<18.5	3	1.36
18.5-24.9	175	79.55
25-29.9	42	19.09

4.1.1 Physical health status

According to the Physical health status and wellbeing rate table 1b, recognition of respiratory problem and rate their physical wellbeing within 4 weeks before the survey 109 (49.55%) reported yes and 106(48.18%) rate it poor respectively. Among those who reported poor for physical wellbeing, 39.62% of participants possess respiratory problem most of them were from level2 and level4 with 24.77% and 23.85% respectively.

Table1b. Descriptive analysis of the information about user's respiratory physical symptoms

Variables	**N=220**	**%**
1.Nausea		
No	212	96.36
Yes	8	3.64
2.Eye irritation		
No	210	95.45
Yes	10	4.55
3.Skin irritation		

No	216	98.18
Yes	4	1.82
4.Vomiting		
No	218	99.09
Yes	2	0.91
5.Dizziness		
No	210	95.45
Yes	10	4.55
6.Headache		
No	110	50.00
Yes	110	50.00
7.Fatigue		
No	109	49.55
Yes	111	50.45
8.Sore throat		
No	213	96.82
Yes	7	3.18
9.Runny nose		
No	148	67.27
Yes	72	32.73
10.Cold		
No	201	91.36
Yes	19	8.64
11.Cough		
No	127	57.73
Yes	93	42.27
12.Respiratory problem		
No	111	50.45
Yes	109	49.55
13. Rate physical wellbeing		

Excellent	41	18.64
Good	73	33.18
Poor	106	48.18

Behavioral factors are the other factors which contribute to lung function by which 218 (99.09%) participants had never smoked cigarettes, 0.91% were passive smokers. The time spend in the room within 24hrs, >9hours were reported by 9(4.09%) participants, activities in the room like reading were highly reported by 177 (80.45%) of participants. The fruits and vegetable serving per day, where 101 (945.91%) were between 2-3servings/day, See Table 1c.

1.c. Descriptive analysis of participant's Behavioral factors

Variables	**N=220**	**%**
1. Smoking status		
Never smoked	218	99.09
Passive smokers	2	0.91
2.Activities in the room		
None	43	19.55
Reading	177	80.45
3.Diets (fruits and vegetables), servings/day		
4-5 servings	64	29.09
2-3 servings	101	45.91
<2 servings	55	25.00
4.Time period in Hostel in (months)		
<4months	127	57.73
5-8months	31	14.09
>8months	62	28.18
5.Time spend in the room/24hrs		
<4hrs	189	85.91
7-9hrs	22	10.00
>9hrs	9	4.09

Based on the building characteristics the freshness of the air in the room 86 (39.09%) report that the air was fresh while 134(60.91%) reported that it was stuffy, reason could be the rate of window opening and activities which is curried indoor. see table 1c.

Table1d: General information about building characteristics of the hostel's room

Variables	**N=220**	**%**
1.Occupants of the room		
2students	30	13.64
>2 students	190	86.36
2.Location of the room		
Other floors	172	78.18
Ground floor	48	21.82
3.Ventilation		
Yes	28	12.73
No	192	87.27
4. Frequency of window opening		
All parts	62	28.18
Half	144	51.82
Small part	44	20.00
5.Window having curtains		
Yes	116	52.73
No	104	47.27
6.Made of room equipment		
Metal	41	18.64
Woody	179	81.36
7.Source heat in the room		
None	167	75.91
Electric bulb	19	8.64
Direct sun light	34	15.45
8.Freshness of Air in the room		

Fresh	86	39.09
Stuffy	134	60.91
9. Rate of room Odor		
Very clean	188	85.45
Smelly	32	14.55

Table1e. Spirometry test (outcome variable) based on gender (Mean)

Characteristics	**Male (N= 101)**	**Female (N= 119)**
FEV1 in L	2.56	2.38
FVC in L	3.48	3.35
FEV1/FVC in %	72.91	70.40

- ✓ Normal and abnormal lung function of the study participants

Lung function status	**Normal lung function (%)**	**Abnormal lung function (%)**
	174(79.09)	46(20.91)

4.2 BIVARIATE ANALYSIS

4.2.1 Significance of different risk factors

According to the spirometry output showed that females had a lower FEV1/FVC ratio than males. We used the LLN criteria to classify lung function as normal or abnormal, with the latter having 46 cases (20.91%) of abnormality and 174 cases (79.09%) of normality. In this study, an effort was undertaken to identify participants who would meet the Gold criteria for airflow restriction (fixed ratio: FEV1/FVC <0.70) for comparison. A total of 81 patients (36.82%) were identified as having abnormal lung function using this criterion. The different factors showed their significance where sociodemographic showed that BMI for subjects with overweight has 4.4 times more likely to have abnormal lung function (OR:4.46, CI:.3706456-53.7042; P=0.239) compared to those who are underweight and behavioral factors fruits and vegetable servings/day, rate of window opening, and even building characteristics like freshness of air in the room and odor in the room were significantly with (p< 0.001). (Table 2a, c, d).

Table 2. a. Abnormal lung function and its associated factors (Chi-square)

Variables	**Normal lung function**	**Abnormal lung function**	***P-value***
1.Gender			0.969
Females	78.99	21.01	
Males	79.21	20.79	
Age			0.227
18-29	78.26	21.74	
30-44	92.31	7.69	
3.Religion			0.441
Catholic	78.13	21.88	
Protestant	85.71	14.29	
Adventist	69.44	30.56	
Islamic	75.00	25.00	
Jehovah witness	71.43	28.57	
No religion	90.00	10.00	
4.Status on campus (Level of study)			0.371
Level 1	77.27	22.73	
Level 2	78.33	21.67	
Level 3	70.73	29.27	
Level 4	82.22	17.78	
Level 5	90.00	10.00	
Marital status			
Single	79.09	20.91	
5.Body Mass Index (BMI)			**0.024**
<18.5	33.33	66.67	
18.5-24.9	82.29	17.71	
25-29.9	69.05	30.95	

Among the factors of the abnormal lung function include physical health status and physical wellbeing within 4weeks before the study was assessed. From the different physical respiratory

symptoms, physical wellbeing rate were found to be highly significance with ($p<0.001$) for this study the rest of the associated factors can be seen in table 2b.

Table2b: Bivariate analysis of the information about user's respiratory physical symptoms

Variables	**Normal**	**Abnormal**	***p-value***
1.Nausea			**0.039**
No	80.19	19.81	
Yes	50.00	50.00	
2.Eye irritation			0.469
No	79.52	20.48	
Yes	70.00	30.00	
3.Skin irritation			0.299
No	78.70	21.30	
4.Vomiting			0.465
No	78.90	21.10	
5.Dizziness			0.148
No	79.52	20.48	
Yes	70.00	30.00	
6.Headache			**0.003**
No	87.27	12.73	
Yes	70.91	29.09	
7.Fatigue			**0.004**
No	87.16	12.84	
Yes	71.17	28.91	
8.Sore throat			0.1918
No	78.87	21.13	
Yes	85.71	14.29	
9.Runny nose			**0.005**
No	84.46	15.54	
Yes	68.06	31.94	

10.Cold			0.566
No	78.61	21.39	
Yes	84.21	15.79	
11.Cough			**0.004**
No	85.83	14.17	
Yes	69.89	30.11	
11.Respiratory problem			**0.002**
No	87.39	12.61	
Yes	70.64	29.36	
12.Physical wellbeing rate			**<0.001**
Excellent	51.22	48.78	
Good	80.82	19.18	
Poor	88.68	11.32	

The way the students behave at the campus can play a part in the occurrence of abnormal lung function including activities in the rooms, fruits and vegetables served a day showed to be significant in this study with ($p<0.05$). Fruits and vegetables are very crucial for our daily life asit help almost all organs to function properly from which respiratory system is included. WHO recommend at least 6servings/day(56).

Table2c: Bivariate analysis of participant's Behavioral factors.

Variables	**Normal**	**Abnormal**	***P-value***
1. Smoking status			0.309
Never smoked	79.36	20.64	
Passive smokers	50.00	50.00	
2.Activities in the room			0.094
None	69.77	30.23	
Reading	81.36	18.64	
3.Diets (fruits and vegetables), servings/day			**<0.001**
4-5 servings	60.94	39.06	

2-3 servings	82.18	17.82	
<2 servings	94.55	5.45	
4.Time period in Hostel in (months)			**0.025**
<4months	83.46	16.54	
8-9months	61.29	38.71	
>9months	79.03	20.97	
5.Time spend in the room/24hrs			0.969
<4hrs	79.37	20.63	
7-9hrs	77.27	22.73	
>9hrs	77.78	22.22	

The way any building had built mostly where crown people meet like in the schools most of small particulate matter are concentrated inside the room, that is why the ventilation of the room has to be sufficient as much as it could be, by well opening the window in proper orientation, that why a table 2d showed more significance of abnormal lung function with different building factors. Frequency of window opening (OR:17.29, CI: 3.84298-77.82671, P<0.001) for those who open small part compared to those who open all parts of the window was also found to be significantly associated with abnormal lung function.

Table2d: General information about building characteristics of the hostel's room

Variables	**Normal**	**Abnormal**	***p-value***
1.Occupants of the room			0.188
2students	70.00	30.00	
>2 students	80.53	19.47	
2.Location of the room			**0.017**
Other floors	82.56	17.44	
Ground floor	66.67	33.33	
3.Ventilation			0.8511
Yes	85.71	14.29	
No	78.13	21.88	
4.Frequency of window opening			**<0.001**

All parts	54.84	45.16	
Half	85.96	14.04	
Small part	95.45	4.55	
5.Window having curtains			**0.025**
Yes	73.28	26.72	
No	14.42	85.58	
6.Made of the room's equipment			**0.006**
Metal	63.41	36.59	
Woody	82.68	17.32	
7.Source of heat in the room			**<0.001**
None	85.03	14.97	
Electric bulb	52.63	47.37	
Direct sunlight	35.29	35.29	
8.Freshness of Air in the room			**<0.001**
Fresh	58.14	41.86	
Stuffy	92.54	7.46	
9.Rate of room odor			**0.007**
Very clean	76.06	23.94	
Smelly	96.88	3.13	

4.3. MULTIVARIATE ANALYSIS

4.3.1 Associated Risk factors

As the study deals with university students we didn't have any smokers only passive smokers and they were not significance as they were only 2 participants 0.91%.

For bivariate analysis BMI, fruits and vegetable servings, location of the room, having curtains, source of heat in the room, made of room materials, freshness of air in the room and activities in the room were found to be associated with abnormal lung function. We did not find any correlations between abnormal lung function and gender, marital status as all participants were single, abnormal lung function was clearly associated with BMI (OR:4.46, CI: 0.3706456-53.7042, *P*=0.239) for those with overweight compared with those who are underweight, location of the

room, source of heat in the room, window having curtains, made of room equipment and even source of the heat in the room were found to be associated with abnormal lung function (Table.2b).

By multiple logistic regression risk factors of abnormal lung function were found to be rate of window opening (OR: 7.06, CI: 0. 1.271353-39.30378, *P*=0.025) were found to be 7times of having abnormal lung function for those who open a very small part compared to those who open all parts of the window and freshness of air in the room (OR:4.78, CI: 1.76005-12.99514, *P*= 0.002) were found to be 4.78times of having abnormal lung function for those who reported stuffy compared with those who reported fresh see table 3a.

Table 3a: Outcome variate correlation with its associated factors

Abnormal lung function	**Odds ratio**	**95%Conf. Interval**		***p-value***
BMI		**Lower**	**Upper**	
Underweight	Ref			
Normal	10.43	0.4538395	240.1167	0.143
Overweight	5.50	0.230108	131.824	0.292
Activities in the room				
None	Ref			
Reading	0.43	0.1528247	1.259586	0.126
Diets (fruits and vegetables), servings/day				
4-5servings	Ref			
2-3servings	1.81	0.6824353	4.828334	0.232
<2servings	3.48	0.7667599	15.83588	0.106
Time period in Hostel in (months)				
<4months	Ref			
8-9months	0.34	0.1136704	1.051579	0.061
>9months	0.97	0.3748842	2.530175	0.957
Location of the room				
Other floors	Ref			
Ground floor	0.98	0.3864723	2.48793	0.967

Frequency of window opening				
All	Ref			
Half	1.82	0.7315807	4.532704	0.198
Small part	7.06	0. 1.271353	39.30378	**0.025**
Window having curtains				
Yes	Ref			
No	0.72	0.2935387	1.805568	0.493
Made of the room's equipment				
Metal	Ref			
Woody	1.24	0.4807942	3.217092	0.653
Heat-source				
None	Ref			
Electric bulb	0.35	0.099058	1.237378	0.103
Direct sun light	0.90	0.2987823	2.770881	0.868
Freshness of Air in the room				
Fresh	Ref			
Stuffy	4.78	1.760051	12.99514	**0.002**
Rate of room odor				
Very clear	Ref			
Smelly	2.58	0.3007851	22.14785	0.387

For physical health status multiple logistic regression table3b. Showed that physical wellbeing (OR: 4.5; CI: 1.771744-11.45793) were found to be 4.5 times of having abnormal lung function for those who reported poor compared to those who reported excellent within specified period was found to be risk factors of abnormal lung function.

Table3b: Multivariate analysis of the information about user's respiratory physical symptoms

Abnormal lung function	**Odds ratio**	**95%Conf.Interval**		***P-value***
Nausea		**Lower**	**Upper**	
No	Ref			
Yes	0.32	0. 0648445	1.617612	0.169
Headache				
No	Ref			
Yes	0.66	0.2857166	1.556858	0.349
Fatigue				
No	Ref			
Yes	0.60	0.2623574	1.396895	0.239
Runny nose				
No	Ref			
Yes	0.57	0.2660921	1.229388	0.152
Cough				
No	Ref			
Yes	0.51	0.2417175	1.104889	0.089
Respiratory problem				
No	Ref			
Yes	0.56	0.2555565	1.270032	0.169
Physical wellbeing rate				
Excellent	Ref			
Good	3.23	1.306636	8.006004	**0.011**
Poor	4.50	1.771744	11.45793	**0.002**

DISCUSSION

Because of their prevalence, severity, anticipated trends, and financial effect, chronic respiratory illnesses provide an obstacle to public health in Rwanda, as well as in other developing nations(58).

This study's objective was to identify the risk factors for impaired lung function in Rwanda's university dormitory by utilizing spirometry and questionnaires. Because of a shortage of skilled technicians, medical professionals, and equipment, spirometry is not commonly performed in Rwandan medical settings.

Different factors such as socio-demographic, physical health status, behavioral, building characteristics was substantially correlated with lung function, from which abnormalities was detected in 46(20.91%) of the individuals. Few researches on the functioning of the lungs have been undertaken in Africa, and other authors have seen an increase in abnormalities and COPD. They also identified physical wellness status, satisfaction with indoor air quality and odor, fruit and vegetable intake as key risk factors for abnormal lung function(56). The development of aberrant lung function, which can result in COPD and allergy disorders, is heavily influenced by behavior choices of an individual (21). The Kenyan study found strong connections between high particulate matter levels and deteriorated lung function(59)(60).

The most frequent allergies identified in our study were those related to indoor air quality satisfaction and dust-related odor. Previous research from Europe demonstrated that high elevations seldom experienced home dust. Kigali is situated at a height of 1568 meters. Differences in the ambient humidity caused by climatic variations may be to blame. The most prevalent allergens were found to be indoor dust mites in other African investigations. According to estimates, cutting PM10 levels by 20% to 80% might save 1,200–3,500 fatalities, 80–235 million occurrences of illness, and save US$169–492 million(61). According to WHO fact sheet, low- and middle-income countries (LMIC) within the World Health Organization's European Region have household air pollution deaths that are more than ten times higher than high-income countries (HIC), which affect the most underprivileged population groups and those who are socially disadvantaged(45).

We demonstrated a link between frequency of window opening of the dorm room and poor lung health. We hypothesize that this can be partially supported by the fact that the students at campus

have equal opportunities for learning but live within distinct rooms on different floors with different lifestyles. Freshness of air in the room were also found to be a risk factor of abnormal lung function were those who reported stuffy were 4.78times of having lung abnormalities compared to those who reported fresh.

The major city of Rwanda is Kigali, which is more-populated and dirty. High levels of emissions from traffic have been linked to an increase in the prevalence of respiratory allergies, and outdoor air pollution has been researched as a risk factor for COPD(26). None of the participants smoked, we believe that exposure to passive smoking may be one of the probable reasons of impaired lung function in non-smokers, even if it did not have a statistically significant impact. Prior research has suggested a link between being exposed to indoors pollutants and the emergence of aberrant lung function, including COPD(8).

The overall of abnormal lung function prevalence for all participants (220 individuals) was 20.91% for LLN criterion used and risk factors of abnormal lung function for this study were frequency of window opening, freshness of air in the room, and general rate of physical wellbeing. The recent study on COPD in Rwanda showed the prevalence of 4.5% with the overall population urban and rural which were fairly similar tothe results from other studies (26). The low mean age in our sample contributes to the low overall prevalence of abnormal lung function.

Limitations

We faced different limitations like funds, finding appropriate tools for data collection the available are very expensive and can only be found abroad, awareness of the participants about respiratory problems and COPD is steal inefficiency. There is a severe lack of published information on abnormal lung function and COPD in Africa, particularly among university students.

5.CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This is the first investigation on impaired lung function conducted in a Rwandan university residence. The prevalence of abnormal lung function showed that, it the problems for public health which needed a great consideration mainly in the enclosed microenvironment like in the university campuses where students spend much of their time.

Social demographic factors

Body Mass Index (BMI) shows a significance with abnormal lung function with subjects who were overweight compared to underweight but with less frequency. This indicated that the more the weight of individual increase is proportion to the decrease of lung capacity.

Physical health status

Respiratory symptoms are on the key factors which can orient different researchers thinking whether they contribute to the lung impairment, for this study physical wellbeing rate showed association with abnormal lung function, for that physical health status need to be putted under consideration when studying airway abnormalities

Behavioral factors

The decreased daily servings of fruits and vegetables is directly proportional to abnormal lung function the more servings the lesser having abnormalities, and time period spend in the hostel showed a significance relationship with abnormal lung function, which showed on what orientation forward in this microenvironment and measures to be taken.

Building characteristics

Decreased satisfaction with freshness of air in the room. Individuals who lived on the ground floor had a larger percentage of impaired lung function than participants who lived on other floors due to that on ground there can be dust as small particles which can be inhaled.

5.2 RECOMMENDATION

Sociodemographic factors

Recommend to the Government and policy makers to organize a manner and provide means of financial for improving respiratory screening and care by including a basic, successful respiratory treatment package at the primary care and referrals levels throughout the healthcare system, paying special attention to boarding educational institutions and undergraduates who live in hostels.

Physical health status

Respiratory problems and rate of physical wellbeing take the first-place students at university need to consider different unusual symptoms, like runny nose, headache and persistent cough, has to take care of that and make check-up as early as possible.

Behavioral factors

Implementing secure study and a sleep conditions where necessary, increase the amount of fruits vegetables served/day steal less WHO recommend at least 6 or above servings/day, time spend in the room need to be minimized. Establishment of behavior change could contribute a considerable change in respiratory systems healthy.

Building characteristics

Meeting unmet needs such as ensuring clean air indoors and in all environments through hostel facilities and comfort rooms, facilitating/encouraging a reduction in the number of indoor activities that can result in the decline of released small particles, make a regular check-up on the deteriorated room equipment for replacement, where possible provide air conditioning (ventilators), without forget curtains on every window and regular window opening. Enhancing community and student participation for suitable beliefs and action for the development of their respiratory health for the following health benefits, Improved reduction of lung diseases, Improved quality of life, Reduced mortality, Reduced morbidity.

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7.0 APPENDICES

7.1 APPENDIX 1: INFORMED CONSENT FORM(ICF)

PARTICIPANT INFORMATION SHEET

Title: FACTORS ASSOCIATED WITH ABONORMAL LUNG FUNCTION AMONG UNIVERSITY STUDENTS IN KIGALI.

Investigators: MVUYEKURE Leonidas

Sponsor: none

Language: English

This Informed Consent Form has two parts:

- Information Sheet (to share information about the study with you)
- Certificate of Consent (for signatures if you agree to take part)

You will be given a copy of the full Informed Consent Form

Introduction

Good day, my name is MVUYEKURE Leonidas, I am a **Candidate of Masters in Public Health at the University of Rwanda**. I would like to ask you if you would be able to take part in an assessment related the Identification of the Factors Associated with the Abnormal Lung Function (ALF). It will take approximately 5minutes for me to explain the study to you.

Research studies are designed to obtain and take new measures to reduce the pulmonary diseases risk factors that might help people in the future. Details about this study are discussed below. You can ask me any question you might have about this study.

It is up to you if you want to join this study or not. You may decide not to join without any consequence. Before you decide, you may take time to talk to your relatives or friends about the study. If you are less than 20years you will not be allowed to participate in this study.

I will now give you some more information about the study. If my words are not clear, please ask me to stop and I will take time to explain. If you have questions later, you can ask me, at any time.

Background

This assessment is not supported financially. We identifying the" Factors **Associated with Abnormal Lung Function among University Students in Kigali-Rwanda, Case of UR-CMHS."**

. That is why we are asking you to help us today by answering the questions of this identification.

Purpose of the study

Over 3 million premature deaths worldwide were attributable to poor ambient air quality in 2012, making poor air quality the "biggest single environmental health concern" in the globe. Around 87% of these fatalities took place in low- and middle-income nations. 211,000 (7%) of the three million deaths prematurely in 2012 that were caused by ambient air pollution occurred in Sub-Saharan Africa(14). The indoor air quality is one of the factors that contribute more to the health of the duelers mostly pulmonary health as they spend more time inside their houses. This is why we aim at identifying the factors associated with pulmonary lung function among University students hostels in Kigali.

The study will last for about 1 month, however, for you as an individual, your time in the study will be from when you accept to be part of the study and sign this form, until the study questionnaire is completed. This will take about 1 to 2 hours.

Study Procedures

If you agree to participate in the study, the study investigator will ask you to respond to the questionnaire developed to this effect.

What are the Risks and Benefits?

If you decide to be in this assessment there will be no risk for you. You may benefit directly by participating in this study with increased awareness about house you could reduce the risks of

being infected by pulmonary diseases. You may benefit indirectly by possibly helping to identify factors contributing to correct or incorrect prevention measures practice.

The assessment may be beneficial for your community as a whole.

What are the costs?

You will not be paid to take part in the study, and it will not cost you anything to take part.

How will confidentiality be respected?

We will not share any of your personal information. Your name will not be mentioned on any questionnaire or on the data collected during the study. You will be given a unique number, which will be used to identify the data collected. If the results of this study get published in a scientific journal, your name will not appear on the publication. Any study staff or members of the ethics committee overseeing this study and the regulatory authority(ies) will be given access to your personal information, however, all these people have to respect the confidentiality, and your personal information will not be revealed publicly.

Your participation is entirely voluntary

It is your choice to decide whether you want to participate in this assessment or not. You can decide to be in the study, and later on change your mind.

Whom to contact in case of problem or question?

For any problem or question related to the study you may contact me ON TEL 078…….

or the CHMS school of public health ethics committee Director Tel: 078XXXXXXX

If you have any questions on your rights as a study participant, contact the CMHS, SPH Ethics Committee.

PARTICIPANT CONSENT FORM

I have read the Participant Information Sheet concerning this study or have understood the verbal explanation and I understand what will be required of me if I take part in this study.

I understand that the study consists of answering questions related to abnormal lung function risk factors identification and prevention and their application in my daily life and what influences correct or incorrect practice.

I understand that study staff and members of the ethics committee overseeing this study and the regulatory authority(ies) will be given access to the provided personal identifying information, so they can verify what was done and look at the data.

I understand that I may drop out of this study at any time, for any reason, without penalty of any sort.

Participant (for Literate Participant):

I voluntarily agree to participate in this study.

Participantname,(printed):

_____

_____ _____

Participant signature Date (day-month-year)

7.2 APPENDIX: 2 QUESTIONNAIRES

University of Rwanda, College of Medicine and Health Sciences **(UR-CMHS), Department of Environmental Health, School of Public Health (SPH).**

Questionnaire on indoor air quality and self-reported physical health in student hostels (Sample)

A student from University of Rwanda, College of Medicine and Health Sciences in its school of PUBLIC HEALTH hereby conducting a research on Factors associated with abnormal lung function among the selected University Hostels in Kigali City. For the research few of the information on the relevant issues is necessary and which we would like to collect from you. Your cooperation in this regard will definitely enable us to conduct the research smoothly. All the information will be used for research purpose only and will be regarded as confidential. Thanks for extending your hands and welcoming us.

Time of interview: Commencement…… Ending…….

1.Name of Hostel: _____

1.Birth Province: _____

Section A: information about Socio-demographic factors

1. what is your gender?

1. Male	2. Female

2.What is your age group?

1. 15-29years	2. 30-44years	3. 45-60 years	4. 60 years or above

3. What is your marital status?

1. Single	2.Married	3.Divorced	4.Separated	5.widowed

4. What is your Religion

1.Catholic	2.Protestant	3.Adventist	4.Islamic	5.Jehovah witness	6.No religion

5. In which level do you study?

1. Level 1	2. Level 2	3.Level 3	4. Level 4

Section B: Information about the room users' behavioral factors and lifestyle

1.what is your smoking status?

1. Non-smoker	2. Smoker	3. Former smoker	4. Passive smoker

If yes continue to 2nd question

2.how many cigarettes smoked/year

1. <1pack	2. 1-10 pack	3. >10pack

3.How long have you been staying in the room?

1. Less than 1 month	2. 1-4 months	3. 5-8months	4. 9-12months	5. Above 12months

4.Within the 24hours of a day how long on the average do you usually spend in the room?

1. 0-4 h	2. 5-8 h	3. 9-12 h	4. 13-16 h	5. 17-20 h	6. 21-24 h

5. How would you describe your mode of dressing while in the room?

1.Formal /Official	2.Casual	3.Others specify

6.How many fruits and vegetables servings /day?

1. <2 servings	2. 2-3servings	3. 4-5servings	4. >6servings

Section C: General information about building characteristics and activities in the hostel's room

1.How many students sleep in your room regularly?

1. <2	2. 2	3. >2

2. What activities are mainly carried out INSIDE the room? (checking more than one is allowed)

1. Reading	
2.Sleeping	
3.Eating	
4.Cooking	
5.Laundry	
6.None	
7. Conversation	
8.Sweeping	
9.Gaming	
10. Others	

3.Do you have mosquito net in your room? If yes go to question 4

Yes	No

4. What is the status of the mosquito net fly-screen in the room?

1. 100% in order	2. Fairly in order	3. In total disrepair	4. No mosquito net at all

4. Do the windows in the room have curtains?

1. Yes	2. No

5. Is there any type of ventilation in the room?

1. Yes	2. No

6. What percentage of the window area do you open most times?

1. Small part	2. Almost half	3. Half	4. More than half	5. All

7.What made the materials used in the room?

1. Woody	2. Metal	3. Both

8.what do you regard as the most prominent **heat source** in the room?

1. Cooking stove	2. Electric bulb	3. Direct sun light	4. None	5. Others specify

9. Please rate level of satisfaction with the quality of the indoor air for the **past 4weeks**

i) Freshness of the air in the room	1. Very stuffy	2. stuffy	3. Fair	4. Fresh	5. Very fresh
ii) Odor in the room	1.Very smelly	2. smelly	3. Fair	4. Odorless	5. Vey clear

10. What do you regard as the **most prominent source of air pollutant for the room?**

1. Toilets	**2. Waste bin inside /outside**	**3. Dirty carpet/ laundry**	**4. Open gutter**	**5. Cosmetics**	**6. Occupants body odor**	**7. None**	**8. Others specify**

Section D: information about user's respiratory physical status

1.How often have you observed the following **physical health symptoms within 4 weeks?**

	Symptoms	**1.Not at all**	**2.occasionally**	**3.More than half of the period**	**4.Almost every day**
A	Nausea				
B	Eye irritation				
C	Skin irritation				
D	Vomiting				
E	Dizziness				
F	Headache				
G	Fatigue				
H	Sore throat				
I	Runny nose				
J	Cold				
K	Cough				
L	Respiratory problem				

2. How often did you visit the health Centre to complain about the following respiratory physical health symptoms **within the las 4 weeks?**

	Symptoms	**1.Not at all**	**2. occasionally**	**3.More than half of the period**	**4.Almost every day**
A	Nausea				
B	Eye irritation				
C	Skin irritation				
D	Vomiting				
E	Dizziness				
F	Headache				
G	Fatigue				
H	Sore throat				
I	Runny nose				
J	Cold				
K	Cough				
L	Respiratory problem				

4. In general, how would you rate your physical health status **or physical well-being for the past 4 weeks?**

1. Excellent	**2.Fair**	**3.Good**	**4.Very good**	5. Poor

Time of ending filling questionnaire…….

End of questionnaire!

Thank you for your participation on sustainability of hostel occupant's wellbeing!

7.3 APPENDIX 3: CMHS ETHICAL CLEARENCE (IRB)

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES
DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 23/06/2023
Ref: CMHS/IRB/276/2023

MVUYEKURE Leonidas
School of Public Health, CMHS, UR

Dear MVUYEKURE Leonidas,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled ***"Factors Associated with Abnormal Lung Function among University Students Hostels, UR-CMHS in Kigali".***

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in this important study.

Assoc. Prof. Stefan Jansen (PhD)
Acting Chairperson Institutional Review Board
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

Email: researchcenter@ur.ac.rw P.O Box 3286 Kigali, Rwanda www.ur.ac.rw

7.4 APPENDIX4: AUTHOLIZATION LETTER

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE & HEALTH SCIENCES

OFFICE OF THE PRINCIPAL

Kigali, ...23/6/.... /2023
Ref.No: ..983.../UR-CMHS/2023

Mr. MVUYEKURE Leonidas
PG Student
School of Public Health
Reg: 220003989
E-mail: lmvuye87@gmail.com
Tel: +250 782095612

Dear MVUYEKURE,

Re: YOUR AUTHORIZATION TO COLLECT RESEARCH DATA AT REMERA CAMPUS

Reference is made to your application for authorization to collect data for your research entitled: Factors associated with Abnormal Lung Function Among University Students in Hostels, UR-CMHS in Kigali"

Reference is also made to the Ethical Clearance No –CMHS/IRB/276/2023 issued by the UR-CMHS Internal Review Board for your research with the above mentioned title.

This is to inform you that your request is granted for two months starting from the date this letter is issued, and you are advised to work closely with University of Rwanda Students Union (URSU) for an assured facilitation

Sincerely,

Prof. Abraham HA. Mitike, MD
Principal of the College of Medicine and Health Sciences,
University of Rwanda

Cc:
- Remera Campus Administrator, UR-CMHS
- URSU, UR-Remera Campus