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ESTIMATION OF PEAK EXPIRATORY FLOW RATE IN BANK EMPLOYEES EXPOSED TO AIR-CONDITIONED ENVIRONMENT – AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Peak Expiratory flow rate (PEFR) has been widely studied in the general population. However , there is limited research on PEFR among bank employees working in air-conditioned environment. Previous study has focused more on laboratory workers and School children, with less attention to sedentary occupational groups like bank employees.
Aims: To evaluate the breathing effectiveness (lung function) of bank employees exposed to air-conditioned environment.
Objective: The present study aims to measure the Peak Expiratory Flow Rate (PEFR) in bank employees aged 49–55 years. Pulmonary function will be assessed using a Mini-Wright Peak Flow Meter to obtain accurate PEFR readings. The study will further compare PEFR levels by categorizing them into normal and reduced values within the selected population. Additionally, it seeks to explore the potential impact of long-term exposure to air-conditioned working environments on the respiratory health of these employees.
Results and Analysis: 18.39% of respondents had normal PEFR scores, 81.61% had borderline low, slightly lower, or lower PEFR values. These findings indicate reduced respiratory efficiency in a large proportion of bank employees working in air-conditioned environments. The results suggest that prolonged exposure to such environments may negatively affect lung function, even in individuals without prior respiratory disorders.
Conclusion: long-term exposure to air-conditioned working conditions may adversely affect lung function in bank employees. A significant proportion of otherwise healthy individuals showed reduced PEFR levels.
Implication: Routine respiratory screening is important for bank employees. Preventive strategies should be encouraged including: Breathing exercises, Regular physical activity, Employee health education programs.

KEYWORDS: Air-conditioned Environment, Bank Employees, Mini-Wright Peak Flow Meter, Lung Function.

INTRODUCTION

Air-conditioned workplaces have become an integral component of modern occupational environments, primarily aimed at enhancing employee comfort, productivity, and operational efficiency. Among such environments, banks represent a prominent sector where employees are required to spend prolonged working hours in enclosed, temperature-controlled spaces with minimal exposure to natural ventilation. These indoor settings are typically maintained through centralized Heating, Ventilation, and Air Conditioning (HVAC) systems, which regulate temperature and humidity to create a consistent and comfortable working atmosphere. While these systems contribute significantly to workplace comfort, they may also inadvertently alter key air quality parameters, including humidity levels, ventilation rates, and the circulation of airborne particles. Such alterations can have subtle yet clinically relevant effects on respiratory health, particularly in individuals who are continuously exposed to these conditions as part of their daily occupation. Prolonged exposure to air-conditioned environments has been associated with several physiological changes within the respiratory system. Low humidity levels, commonly observed in air-conditioned spaces, can lead to drying of the respiratory mucosa, resulting in irritation of the airways and reduced mucociliary clearance. The mucociliary mechanism plays a crucial role in defending the respiratory tract by trapping and removing inhaled particles, pathogens, and pollutants. When this mechanism is compromised, individuals may become more susceptible to respiratory discomfort and potential infections. Additionally, the recirculation of indoor air, especially in poorly ventilated systems, can contribute to the accumulation of indoor pollutants such as dust, microbial agents, and volatile organic compounds. Over time, continuous exposure to these factors may influence bronchial responsiveness, increase airway sensitivity, and potentially contribute to subtle impairments in pulmonary function. In this context, the assessment of respiratory function becomes essential in identifying early physiological changes that may not yet present with overt clinical symptoms. One of the most practical, reliable, and widely used parameters for evaluating pulmonary function is the Peak Expiratory Flow Rate (PEFR). PEFR is defined as the maximum speed at which an individual can exhale air following a full inspiration. It primarily reflects the functional status of the large airways and provides valuable information regarding airway patency, expiratory flow limitation, and the strength of expiratory muscles. Due to its simplicity, cost-effectiveness, and non-invasive nature, PEFR is commonly measured using a portable device known as a peak flow meter, making it highly suitable for use in both clinical and field-based occupational health assessments. In physiotherapy practice, PEFR serves as an essential tool for evaluating respiratory efficiency and monitoring changes in pulmonary function over time. It is frequently used in the assessment and management of respiratory conditions such as asthma and chronic obstructive pulmonary disease, as well as in general health screenings. One of the key advantages of PEFR is that the obtained values can be easily compared with standardized predicted values based on an individual's age, sex, and height. This allows clinicians to identify deviations from normal respiratory function even in asymptomatic individuals. Early detection of reduced PEFR values can facilitate timely intervention, thereby preventing the progression of respiratory dysfunction and improving overall health outcomes. In occupational settings such as banks, employees often lead sedentary lifestyles characterized by prolonged sitting, limited physical activity, and suboptimal posture. These factors can have a negative impact on respiratory mechanics by reducing chest wall mobility, impairing diaphragmatic function, and decreasing overall ventilatory efficiency. Poor posture, particularly forward head posture and rounded shoulders commonly observed during desk work, can further restrict lung expansion and compromise breathing patterns. When these lifestyle factors are combined with continuous exposure to air-conditioned environments, the risk of developing subtle respiratory impairments may increase. Although these changes may not immediately manifest as clinical symptoms, they can gradually affect breathing performance and overall respiratory health. Air-conditioned environments are specifically characterized by controlled temperature, reduced humidity, and regulated air circulation through HVAC systems. While these systems are designed to enhance indoor comfort, they may inadvertently create conditions such as inadequate fresh air exchange and the accumulation of indoor contaminants. Over extended periods, such environmental conditions can influence respiratory physiology by altering airway hydration, impairing mucus clearance, and increasing airway reactivity. These changes may contribute to a gradual decline in pulmonary function, emphasizing the importance of routine respiratory assessment in individuals exposed to such environments. Despite the potential impact of air-conditioned workplaces on respiratory health, bank employees are often considered a low-risk occupational group and are frequently underrepresented in respiratory and occupational health research. Most studies in this domain tend to focus on high-risk populations, such as industrial workers, miners, or individuals exposed to hazardous airborne substances. As a result, the respiratory health of individuals working in seemingly "safe" indoor environments may be overlooked. This highlights a significant gap in the existing literature and underscores the need for studies that evaluate pulmonary function in sedentary occupational groups with prolonged exposure to controlled indoor environments. The concept of breathing performance extends beyond basic lung function and encompasses the overall efficiency and effectiveness of the respiratory system in maintaining adequate ventilation and gas exchange. It involves the coordinated interaction of respiratory muscles, lung compliance, airway resistance, and neural control mechanisms. In physiotherapy, breathing performance is assessed using various parameters, including respiratory rate, chest expansion, oxygen saturation, and PEFR. Among these, PEFR remains one of the most practical and sensitive indicators for detecting early changes in airway function, particularly in large airways. Evaluating PEFR in bank employees working in air-conditioned environments can provide valuable insights into their respiratory status and help identify individuals who may be at risk of developing pulmonary impairments. Regular assessment of PEFR can serve as an effective screening tool for early detection, enabling timely implementation of preventive strategies such as breathing exercises, postural correction, and workplace modifications. Furthermore, increasing awareness about the potential impact of occupational environments on respiratory health can encourage individuals to adopt healthier lifestyle practices and seek early medical attention when necessary. The need for the present study arises from the observation that a significant proportion of the working population spends extended periods in enclosed, artificially controlled environments with limited ventilation and physical activity. Although these environments are designed for comfort, their long-term effects on respiratory health remain inadequately explored. Understanding the relationship between occupational exposure to air-conditioned environments and pulmonary function is essential for developing evidence-based guidelines aimed at promoting workplace health and preventing respiratory complications. Therefore, this observational study aims to evaluate the breathing performance of bank employees working in air-conditioned environments by assessing their Peak Expiratory Flow Rate. By analyzing PEFR values and comparing them with predicted norms, the study seeks to identify any deviations indicative of compromised pulmonary function. The findings are expected to contribute to the growing body of knowledge in occupational health and physiotherapy, emphasizing the importance of early assessment, preventive strategies, and regular monitoring of respiratory function even in populations considered to be at low risk. Ultimately, this study aims to reinforce the role of physiotherapy in promoting respiratory health, enhancing functional capacity, and improving the overall quality of life among individuals working in modern indoor occupational settings.

MATERIALS AND METHODS

The present study was conducted in a bank setting, focusing on employees working in air-conditioned environments for approximately 8–10 hours per day. It was designed as an observational study carried out over a duration of six months. The study population comprised bank employees, including both males and females. Participants were included if they had a minimum of one year of continuous employment in air-conditioned indoor workspaces within banks. Individuals were excluded from the study if they had any known respiratory diseases such as active asthma, COPD, or bronchiectasis, or if they were smokers.

Detail study procedure:
A standardized assessment tool; THE (PEF) Peak Expiratory Flow Meter will be used for collecting the data. Ethical approval will be obtained from the Institutional Ethics Committee of the concerned institution after reviewing the proposal. The motive behind conducting this study will be explained to the study participants and written informed consent will be obtained from them for the same. The study will commence following approval from the scientific and institutional committee. Participants aged 49- 55 years will be recruited. Eligibility will be assessed using specific inclusion and exclusion criteria.

PROCEDURE
1. The demographic data will be collected from the participant.
2. Participants should seated upright.
3. A nose clip will used (if needed) to ensure the breathing is done only through the mouth.
4. The calibrated "Mini-wright peak flow meter" should be used.
5. The participants will asked to take a deep breath and then exhale forcefully into the peak flow meter.
6. The three reading should be recorded with the rest of "1" minute between attempts.
7. The best reading should be recorded as the peak expiratory flow rate for participant.

Outcomes measures:
The primary outcome measure of this study is the Peak Expiratory Flow Rate (PEFR), which is used to assess the respiratory function of bank employees working in air-conditioned environments. PEFR is measured in liters per minute (L/min) using a peak flow meter and reflects the maximum speed of expiration, thereby indicating the functional status of the large airways, airway patency, and expiratory muscle performance. For accuracy, three readings are recorded for each participant, and the highest value is considered for analysis. The obtained PEFR values are then compared with predicted normal values based on age, sex, and height to determine deviations. Based on these comparisons, PEFR is categorized into normal, mild reduction, moderate reduction, or severe reduction, which helps in identifying early airflow limitations and potential respiratory impairment. Additionally, anthropometric parameters such as height and weight are recorded to support interpretation of PEFR values. This outcome measure provides a simple, non-invasive, and reliable method for evaluating breathing performance and detecting early changes in pulmonary function among the study population.

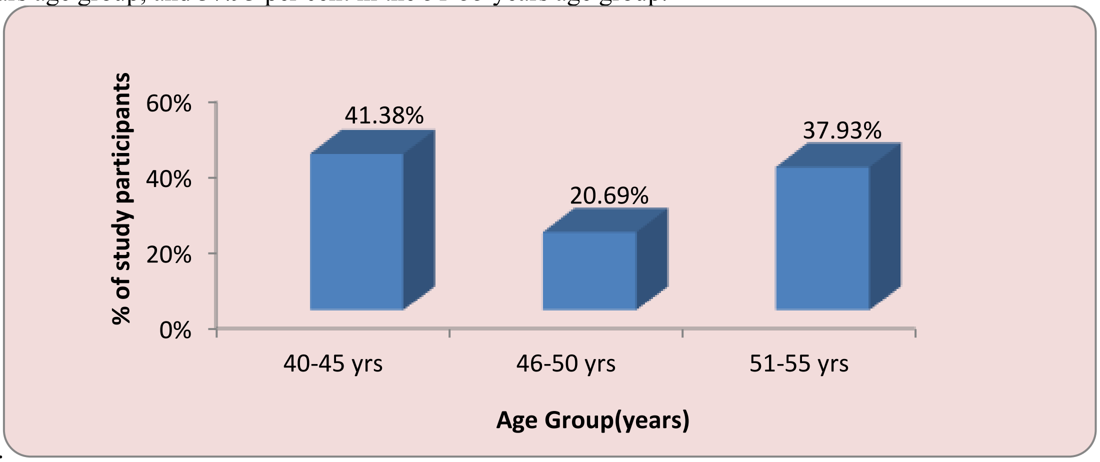
Statistical Analysis and Results :
Data were analyzed using appropriate descriptive and inferential statistical methods. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The results were expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables. A total of 87 bank employees participated in the study, with a mean age of 47.49 ± 4.97 years. Gender distribution was nearly equal, and the mean Body Mass Index (BMI) was 24.40 ± 4.68 kg/m². The participants had a mean occupational exposure of 12.79 ± 4.99 years in air-conditioned environments, with an average daily exposure of 8.96 ± 1.99 hours. The mean Peak Expiratory Flow Rate (PEFR) was found to be 484.95 ± 72.67 L/min. Inferential statistics were applied to determine the association between variables. The Chi-square test was used to assess the relationship between categorical variables such as PEFR categories and factors like BMI and duration of air-conditioned exposure. The analysis indicated a statistically significant association between reduced PEFR and higher BMI as well as longer duration of exposure ($p < 0.05$). Furthermore, one-way Analysis of Variance (ANOVA) was used to compare the mean PEFR values across different BMI groups and exposure durations. The ANOVA results demonstrated a significant difference in mean PEFR among these groups, with lower PEFR values observed in individuals with higher BMI and prolonged exposure to air-conditioned environments. Overall, the statistical analysis suggests that factors such as increased BMI and long-term exposure to air-conditioned environments have a significant impact on pulmonary function, as reflected by reduced PEFR values.

RESULT
The study included a total of 87 middle-aged individuals working in air-conditioned environments. Descriptive analysis revealed that the mean age of participants was 44.31 ± 8.35 years. The average height and weight were 171.45 ± 10.96 cm and 71.47 ± 12.42 kg, respectively, with a mean Body Mass Index (BMI) of 24.6 ± 5.24 kg/m². Participants had substantial occupational exposure, with an average of 16.94 ± 8.03 years working in air-conditioned settings and a mean daily exposure of 7.92 ± 2.22 hours. The mean Peak Expiratory Flow Rate (PEFR) was recorded as 451.47 ± 63.14 L/min. In terms of gender distribution, 53 participants (60.92%) were male and 34 (39.08%) were female. The study population comprised various job roles, with the most common positions being accountant and cashier (each 12 participants, 13.79%), followed by managers (11 participants, 12.64%), and clerks and receptionists (each 10 participants, 11.49%). Other roles such as IT support, assistant manager, customer service staff, loan officers, and security personnel were represented in smaller proportions. Regarding PEFR interpretation, 44 participants (50.57%) demonstrated normal values, while the remaining participants showed varying degrees of reduction: 16 (18.39%) had reduced PEFR, 9 (10.34%) were slightly reduced, 8 (9.2%) were mildly reduced, another 8 (9.2%) were categorized as borderline low, and 2 (2.3%) exhibited moderately reduced values. Overall, these findings indicate that although half of the participants had normal respiratory function, a considerable proportion showed some degree of decline in PEFR.

Graphs :
Result : **Table 1: Distribution of study participants according to their age in years.**

Age group (years)	No. Of study participants	Percentage
40-45 yrs	36	41.38
46-50yrs	18	20.69
51-55	33	37.93
Total	87	100
Means ±SD	47.49±4.97 (40-55years)	

The study participants consisted of 41.38 percent of study participants in the 40-45 years age group, 20.69 percent in the 46-50 years age group, and 37.93 per cent in the 51-55 years age group.

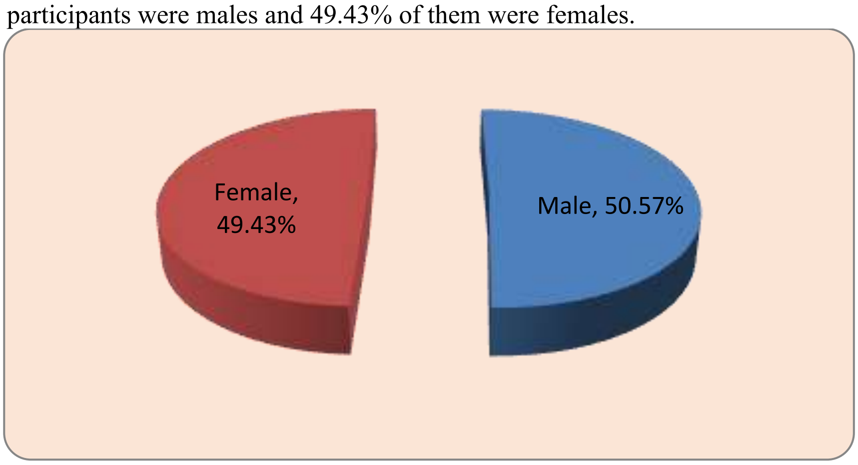


Graph 1: Distribution of study participants according to their age in years.

Table 2: Distribution of study participants according to their Gender

Gender	No. Of study participants	Percentage
Male	44	50.57
Female	43	49.43
Total	87	100

50.57% of the study participants were males and 49.43% of them were females.

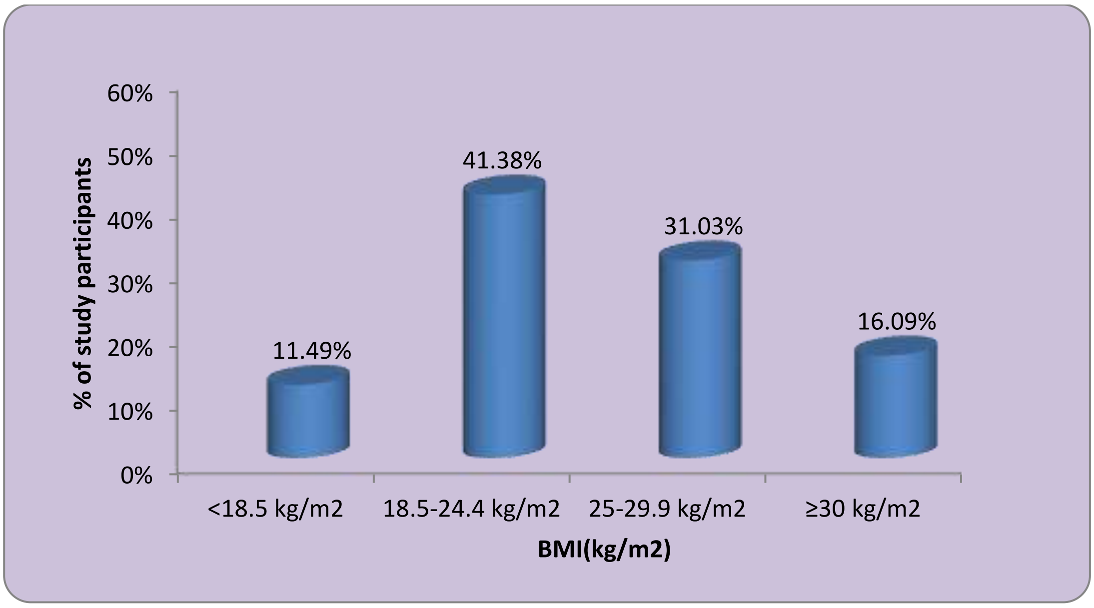


Graph 2: Distribution of study participants according to their Gender.

Table 3: Distribution of study participants according to BMI(kg/m2).

BMI (kg/m2)	No. Of study participants	Percentage
<18.5kg/m2	10	11.49
18.5-24.4 kg/m2	36	41.38
25-29.9 kg/m2	27	31.03
_>30kg/m2	14	16.09
Total	87	100
Means ±SD	24.40 ±4.68 (15.70 -33.70 kg/m2)	

The study participants were 41.38 percent of the study participants in the 40-45 years age group, 20.69 percent in the 46-50 years age group, and 37.93 per cent in the 51-55 years age group.

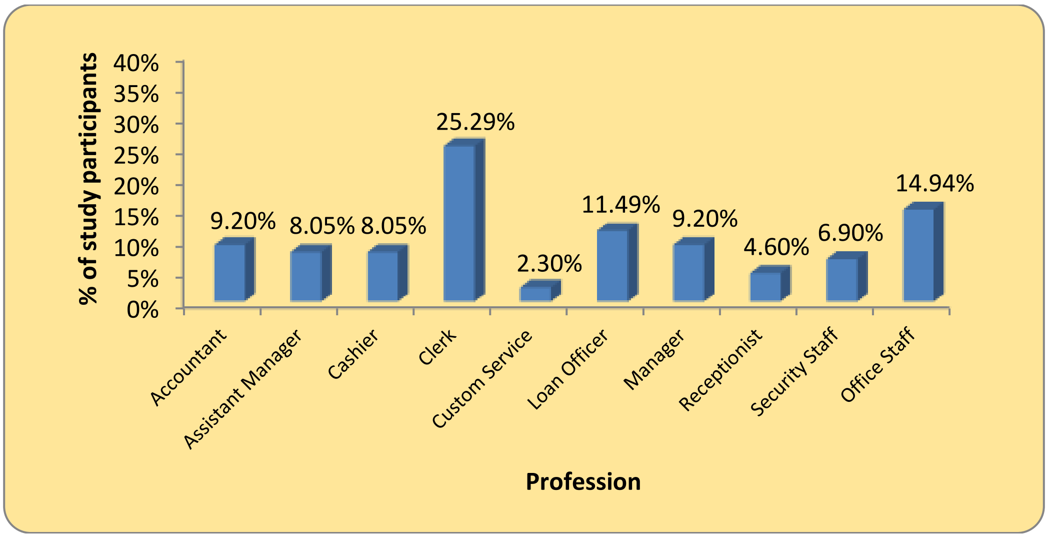


Graph 3: Distribution of study participants according to BMI(kg/m2)

Table 4: Distribution of study participants according to Profession.

Profession	No. Of study participants	Percentage
Accountant	8	9.20
Assistant manager	7	8.05
Cashier	7	8.05
Clerk	22	25.29
Customer service	2	2.30
Loan Officer	10	11.49
Manager	8	9.20
Receptionist	4	4.60
Security staff	6	6.90
Office Staff	13	14.94
Total	87	100

The study participants included 9.20% who were accountant, 8.05% each assistant manager and cashier, 25.29% clerk, 11.49% loan officer and 9.20% manager, 6.90% security staff and 14.94% of the study participants were office staff.



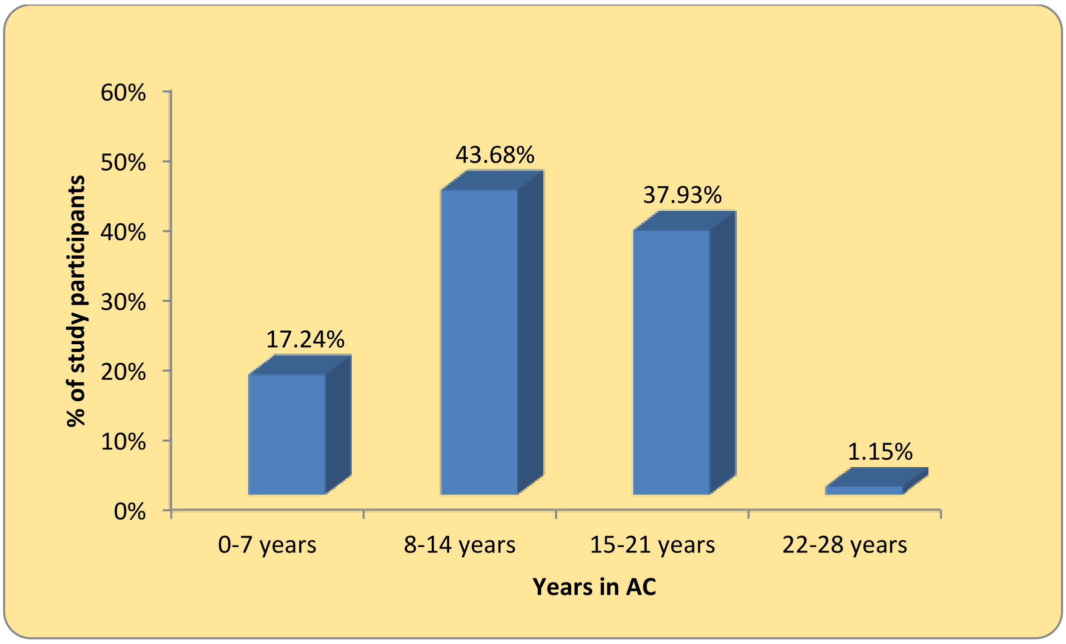
Graph 4: Distribution of study participants according to Profession

Table 5 : Distribution of study participants according to number of years in AC.

Years in AC	No. Of study participants	Percentage
0-7 years	15	17.24
8-14 years	38	43.68
15-21 years	33	37.93

22-28 years	1	1.15
Total	87	100
Mean±SD	12.79±4.99(5-28 years)	

17.24% of the participants of the study were on AC since 0-7 years, 43.68% participants of the study were on AC since 8-12 years and 37.93% participants of the study were on AC since 15-21 years.

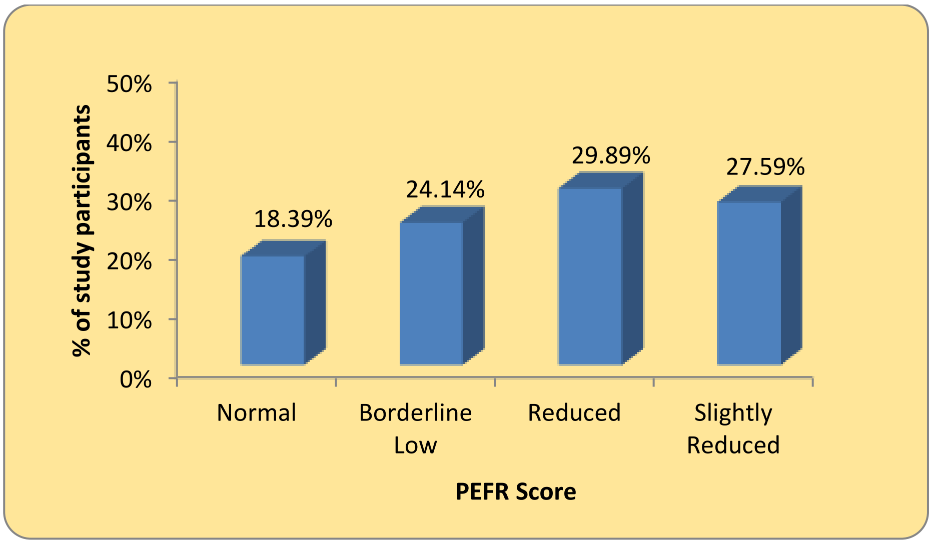


Graph 5: Distribution of study participants according to number of years in AC.

Table 6: Distribution of study participants according to number of hours in AC.

Hours in AC	No. Of study participants	Percentage
6-8 hours	37	42.53
9-12 hours	50	57.47
Totals	87	100
Means ±SD	8.96±1.99(6-12hours)	

Forty two point five three percent of the study participants were taking AC and 6-8 years a day and fifty seven point forty-seven percent were taking it 9-12 hours a day.



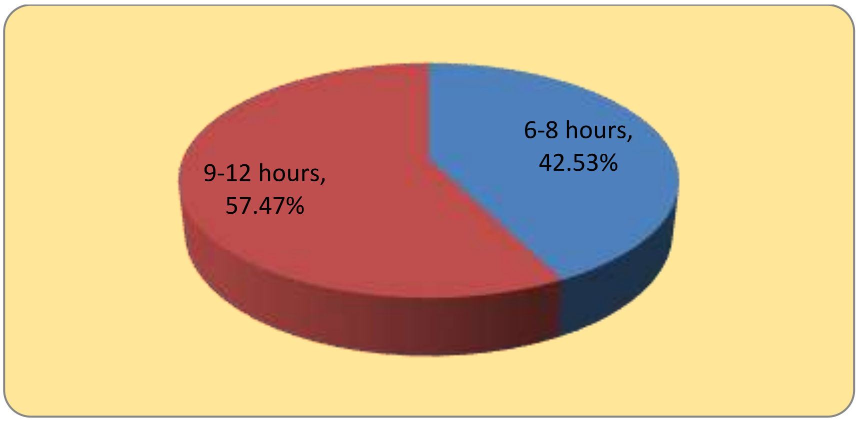
Graph 6: Distribution of study participants according to number of hours in AC.

Table 7: Distribution of study participants according to PEFR Score.

PEFR Score	No. Of study participants	Percentage

Normal	16	18.39
Borderline Low	21	24.14
Reduced	26	29.89
Slightly reduced	24	27.59
Total	87	100
Means ±SD	484.95 ±72.67 (348-601)	

PEFR score was normal in 18.39 percent of the subjects in the study, borderline low in 24.14 percent of the study subjects, reduced in 29.-89 percent of the study subjects and marginally reduced in 27.59 percent of the study subjects.



Graph 7: Distribution of study participants according to PEFR Score.

DISCUSSION

The findings of the present study show that 50.57% of participants had normal pulmonary function, while a nearly equal proportion (49.43%) demonstrated varying degrees of PEFR reduction, ranging from borderline to moderate. This suggests that although not all individuals working in air-conditioned environments experience respiratory impairment, a significant number may be at risk. The presence of 18.39% participants with reduced PEFR, along with additional individuals showing mild or borderline reductions, indicates a possible gradual decline in airway function associated with long-term exposure. Participants in this study had prolonged exposure, averaging around 17 years in air-conditioned settings and nearly 8 hours daily. Such chronic exposure may affect respiratory health due to low humidity, recirculated air, and potential accumulation of indoor pollutants, leading to airway dryness, irritation, and reduced mucociliary clearance. Over time, these factors may contribute to decreased airway caliber and reduced ventilatory efficiency, reflected in lower PEFR values. The mean BMI (24.6 kg/m²), falling within the normal to slightly overweight range, may also influence respiratory function. Increased BMI can affect lung mechanics, reduce chest wall compliance, and contribute to variability in PEFR. Additionally, the middle-aged group of participants may experience age-related decline in lung function, which, combined with sedentary work patterns, could further impact breathing performance. These findings are consistent with previous studies suggesting that prolonged exposure to air-conditioned and enclosed environments may contribute to airway hypersensitivity and reduced respiratory capacity. Although causation cannot be established, the results highlight a potential occupational health concern. Regular screening using simple tools like PEFR, along with preventive strategies such as improving workplace ventilation, maintaining optimal humidity, and incorporating physiotherapy interventions, may help in early detection and management of respiratory changes in this population.

Limitations :

The study has several limitations. It included a relatively small sample from a specific occupational group, which may limit the generalizability of the findings. Being cross-sectional in design, it does not establish a cause–effect relationship between air-conditioned exposure and reduced PEFR. The absence of a control group further restricts the ability to attribute changes solely to AC exposure. Additionally, potential confounding factors such as smoking status, physical activity, environmental pollution, allergies, and past respiratory conditions were not fully controlled. The study relied only on PEFR as an outcome measure, without incorporating more comprehensive pulmonary tests like spirometry (FEV_1, FVC). Since PEFR is effort-dependent, there may be variability in the results. Lastly, environmental parameters such as indoor air quality, humidity, and ventilation were not objectively measured.

Suggestions :

Future studies should include a larger and more diverse sample across multiple workplaces to improve generalizability. A longitudinal study design is recommended to assess long-term effects and establish causal relationships. Including a control group of non-AC-exposed workers would strengthen the findings. Additionally, comprehensive pulmonary assessments such as spirometry should be incorporated for a more detailed evaluation. Consideration of confounding variables like smoking, physical activity, and medical history is important for accurate analysis. Workplace modifications, including proper maintenance of air-conditioning systems, adequate ventilation, and optimal humidity levels, should also be emphasized.

- Health promotion: Encourage regular respiratory screening, physical activity, and breathing exercises among employees.
- Awareness programs: Educate employees about occupational risks and preventive strategies for maintaining respiratory health.

CONCLUSION

The study found that normal PEFR was observed in 50.57% of participants, while nearly half (49.43%) demonstrated some degree of reduction. Participants had prolonged exposure to air-conditioned environments, averaging around 17 years and 8 hours per day. These findings suggest that chronic exposure to air-conditioned settings may be associated with a decline in expiratory flow rates in a significant proportion of the middle-aged working population.Although a majority maintained normal pulmonary function, the considerable proportion with reduced PEFR highlights the potential impact of occupational and environmental factors on respiratory health. This underscores the importance of regular respiratory monitoring, early screening, and timely intervention to prevent further decline. Additionally, promoting workplace modifications, improving indoor air quality, and encouraging healthy lifestyle practices such as physical activity and breathing exercises may help in maintaining optimal pulmonary function. Overall, the study emphasizes the need for increased awareness and preventive strategies to safeguard respiratory health among individuals working in air-conditioned environments.

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