The Relationship between Characteristics of Chronic Obstructive PulmoNary Disease Patients and Spirometry Results (FEV1) in the Treatment Room of Waled Regional Hospital, September 2023-September 2024

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Abstract.
Chronic Obstructive Pulmonary Disease (COPD) is the fourth leading cause of global mortality with a high prevalence in Indonesia (3.7%), dominated by demographic factors such as advanced age and occupational exposure in rural areas such as Cirebon Regency, however, analytical studies of the relationship between patient characteristics and lung function (FEV1) are still minimal. This study aims to analyze the description and relationship of age, gender, and occupational history of COPD patients with FEV1 spirometry results. Using a cross-sectional analytical observational design on medical record data of 131 adult patients (>26 years) at Waled Regional Hospital from September 2023–September 2024 via total sampling, bivariate analysis was performed using Spearman Rank and Chi-Square tests (SPSS 26, α=0.05). The results showed that the majority of patients were elderly (>65 years, 45.04%), male (67.94%), construction workers (31.30%), and very severe (<30% FEV1, 62.60%); There was a weak positive significant association between age (p=0.040; r=0.180) and gender (p=0.045; r=0.176), but no significant association was found for occupation (p=0.450). The study concluded that demographic factors influence COPD progression, recommending routine risk-based spirometry screening to optimize prognosis in primary care settings.

Keywords: *Chronic Obstructive Pulmonary Disease, FEV1 Spirometry, Occupational Risk, Patient Characteristics and Risk Factors.*

I. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous lung disorder characterized by chronic respiratory symptoms such as shortness of breath, cough, and phlegm production, due to abnormalities in the airways (chronic bronchitis, bronchiolitis) and alveoli (emphysema), which cause persistent and progressive airflow obstruction (Global Initiative for Chronic Obstructive Lung Disease [GOLD], 2024). Globally, COPD contributed 5% of total global deaths in 2021 (3.5 million cases), ranking fourth among causes of mortality, with a projected increase in prevalence until 2060 due to air pollution and population aging (World Health Organization [WHO], 2023). In Asia Pacific, the estimated number of moderate-severe cases reached 56.6 million by 2022, driven by biomass and occupational factors (The Asia Pacific COPD Round Table Group, 2022). Its scientific relevance lies in understanding the pathophysiology of chronic inflammation to irritant particles, while its practicality supports prevention and management strategies to reduce the economic burden on health (Polosa et al., 2023).

In Indonesia, the prevalence of COPD reached 3.7% (9.2 million people) in 2021, the highest in West Java (4.0%), with 589 hospitalizations in Cirebon Regency in 2018, which correlates with decreased quality of life and high mortality (Ministry of Health of the Republic of Indonesia, 2022). The Indonesian Biomass Study (2023) reported a 6.3% prevalence in those aged ≥40 years (5.4% urban, 7.2% rural), dominated by non-smokers exposed to biomass. Field observations at Waled Regional Hospital showed progressive COPD resulting in hyperinflation and acute exacerbations, emphasizing the urgency of spirometry screening for early prognosis (Susanto et al., 2024).

Previous studies have confirmed spirometry as the gold standard for COPD diagnosis, with the criteria being FEV1/FVC <70% post-bronchodilator (GOLD, 2024). Bhatt et al. (2023) found high agreement (0.89) between GOLD stage and FEV1/FVC in a large cohort, while Backman et al. (2024)

reported a moderate correlation (0.461) between FEV1/FVC vs. FEV1% predicted with mortality in the general population. Farelim et al. (2023) described the characteristics of COPD patients in Indonesia, including low lymphocyte counts, while Tarigan et al. (2019) found no association between bacterial patterns and the degree of obstruction ($p>0.05$) (Bhatt et al., 2023; Farelim et al., 2023).

However, inconsistencies emerge: Kakavas et al. (2021) highlight the crucial role of FEV1 in COPD phenotype, but Asian studies have underexplored local demographic factors such as biomass occupation versus smoking (70% of cases in developed countries vs. 30–40% in developing countries). Limitations of previous studies include descriptive designs (Farelim et al., 2023), a microbiological focus (Tarigan et al., 2019), limited urban samples, and minimal multivariate analysis in rural contexts like Cirebon, thus disclosing the causal relationship between characteristics (age, sex, occupation) and FEV1 (Nguyen et al., 2022; Kakavas et al., 2021).

An explicit research gap is the lack of analytical studies on the relationship between COPD patient characteristics (age, gender, occupational history) and FEV1 spirometry in post-pandemic rural Indonesian hospitals, where biomass exposure dominates. Problem statement: Without this understanding, prognosis and intervention are less accurate, especially in Waled Regional Hospital with a high caseload in the 2023–2024 period. This study aims to analyze the characteristics and relationship between age, gender, and occupational history of COPD and FEV1; the urgency of optimizing screening in primary care facilities; the novelty of local multivariate analysis; theoretical contributions enriching the GOLD risk model, and practical support for prognosis prediction and occupational prevention in West Java (Susanto et al., 2024; Polosa et al., 2023).

II. METHOD

This study used a quantitative approach with a cross-sectional observational analytical design to identify the relationship between COPD patient characteristics and spirometry results (FEV1) in hospitalized patients. This approach was chosen because it allows for simultaneous data collection over a specific time period, making it suitable for analyzing the association of independent and dependent variables without researcher intervention (Sugiyono, 2021; Machali, 2021). The scope of the study encompassed internal medicine and respiratory medicine, with a theoretical basis based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2024) criteria and recent studies confirming the superiority of cross-sectional designs in screening for COPD risk factors in primary healthcare facilities (Susanto et al., 2024; Nguyen et al., 2022).

The target population of the study was all adult COPD patients in the treatment room of Waled Regional Hospital, Cirebon, while the accessible population focused on medical record data from September 2023–September 2024. The sampling technique used total sampling of a non-probability sampling type, where the entire population that met the inclusion criteria was included as a sample to maximize the representation of secondary data without selection bias (Sudaryono, 2021; Suriani et al., 2023). Inclusion criteria included medical records of COPD patients aged >26 years with a single spirometry result, while exclusion criteria included cases of active pulmonary tuberculosis, pneumonia, or repeated spirometry to avoid data dependency. This approach aligns with recommendations for observational studies in regional hospitals, where total sampling is effective for limited populations (Creswell & Creswell, 2023; Farelim et al., 2023).

The main research instrument was secondary data from patient medical records, which included independent variables such as age (categorized ordinally: 26–35, 36–45, 46–55, 56–65, >65 years), gender (nominal: male/female), and employment history (nominal: farm laborer/farmer, construction worker, housewife, self-employed, unemployed), as well as the dependent variable of spirometry results (FEV1) (ordinal according to the GOLD classification: ≥80% mild, 50–79% moderate, 30–49% severe, <30% very severe). FEV1 measurements were based on the forced expiratory volume one second post-bronchodilator from the first visit, according to the GOLD standard (2024). No additional validity-reliability testing was required because the data were sourced from verified medical records, although editing and cleaning were performed to ensure accuracy (Emzir, 2022; Azwar, 2012).

The research procedure began in the preparation phase with consultation with the supervisor, preliminary studies, hypothesis formulation, and variable determination, followed by the submission of ethical clearance and permits to Waled Regional Hospital. In the implementation phase, coordination was carried out with the medical records department to access secondary data based on inclusion-exclusion criteria, with data collection throughout the study period through systematic extraction. The completion phase included data processing through editing, coding, processing, tabulating, entry, and cleaning using structured worksheets, prior to the main analysis, ensuring traceability and replicability according to the observational protocol (Sugiyono, 2021; Creswell & Creswell, 2023).

Univariate data analysis was performed to describe the frequency distribution and percentage of each variable using tables and diagrams, while bivariate analysis tested the relationship between variables using non-parametric tests: Spearman Rank for age and gender against VEP1 (significant if $p < 0.05$), and Chi-Square for employment history (with Kolmogorov-Smirnov as an alternative if the assumptions were not met). Data processing used SPSS version 26, with a significance level of $\alpha = 0.05$, to support causal inferences according to the research objectives (Sudaryono, 2021; Machali, 2021).

This study adheres to the ethical principles of health research through ethical clearance from the Health Research Ethics Commission of Waled Regional Hospital (number 000.9.2/110/KEPK/1/2025), guaranteeing the confidentiality of medical record data without personal identification and the anonymity of participants. All procedures adhere to the Declaration of Helsinki and Indonesian secondary data ethics guidelines, with the researcher responsible for handling sensitive data (Creswell & Creswell, 2023; WHO, 2023).

III. RESULTS AND DISCUSSIONS

Age Overview of COPD Sufferers

Table 1. Age Overview of COPD Sufferers

No	Age	n	%
1	Early adulthood 26-35 years	2	1.53
2	Late adulthood 36-45 years	12	9.16
3	Early elderly 46-55 years	16	12.21
4	Late elderly 56-65 years	42	32.06
5	**Elderly (senior citizens) >65 years**	**59**	**45.04**
	Total	131	100.00

Based on Table 1, it can be seen that the age profile of COPD sufferers at Waled Regional Hospital for the period September 2023-September 2024 based on the age range, the most were in the elderly >65 years, with 59 patients (45.04%) and the least were in the early adult age range of 26-35 years, with 2 patients (1.53%).

Table 2. Age Overview Based on COPD Degree

Age	Spirometry Results VEP1%								Total n (%)
	n	Mild COPD VEP1 ≥ 80%	n	Mod-erate COPD 50% - 79%	n	Severe COPD 30% - 49%	n	Very severe COPD < 30%	
Early adulthood 26-35 years	0	0	0	0	1	0.8	1	0.8	2 (1.5)
Late adulthood 36-45 years	0	0	8	6.1	1	0.8	3	2.3	12 (9.2)
Early elderly 46-55 years	0	0	4	3.1	5	3.8	7	5.3	16 (12.2)
Late elderly 56-65 years	1	0.8	1	0.8	7	5.3	33	25.2	42 (32.1)
Seniors (elderly) >65 years	0	0	9	6.9	12	9.2	**38**	**29.0**	59 (45.0)
Total	1		22		26		82		131 (100.0)

Table 2 shows that the majority of COPD patients were elderly (>65 years) with 38 cases (29%) with very severe degrees. This finding is consistent with the theory of respiratory structural degeneration with age

and studies by Al Wachami et al. (prevalence of 24.03% in those ≥70 years) and Kaifang et al. (99.7 million global cases ≥70 years, an increase of 162.2% since 1990). (3,35,36).

Table 3. Gender Description of COPD Patients

No	Gender	n	%
1	**Man**	**89**	**67.94**
2	Woman	42	32.06
	Total	131	100.00

Based on Table 3, it can be seen that the gender description of COPD at Waled Regional Hospital for the period September 2023-September 2024 was mostly male (67.94%) compared to female (32.06%).

Table 4. Gender Description Based on COPD Degree

Gender	Spirometry Results VEP1%								Total n (%)
	n	Mild COPD VEP1 ≥ 80%	n	Moderate COPD 50% - 79%	n	Severe COPD 30% - 49%	n	Very severe COPD < 30%	
Man	0	0	7	5.3	19	14.5	**63**	**48.1**	89 (67.9)
Woman	1	0.8	7	5.3	11	8.4	23	17.6	42 (32.1)
Total	1		14		30		86		131 (100.0)

Table 4 shows that the majority of COPD patients were men, with 63 cases (48.1%) having very severe degrees. This finding is consistent with the study by Al Wachami et al., which reported a higher prevalence in men (15.70%) than women (9.93%), due to the dominant smoking rate and occupational dust exposure in men.(35).

Table 5. Overview of the Work History of COPD Patients

No	Employment history	n	%
1	Farm laborers/farmers	6	4.58
2	**Construction workers**	**41**	**31.30**
3	Housewife	36	27
4	Self-employed	35	26.72
5	Doesn't work	13	9.92
	Total	131	100.00

Based on Table 5, it can be seen that the work history of COPD sufferers at Waled Regional Hospital for the period September 2023-September 2024 was mostly construction workers (31.30%) and the least number of employees (0%).

Table6. Overview of Work History Based on the Degree of COPD

Employment history	Spirometry Results VEP1%								Total n (%)
	n	Mild COPD VEP1 ≥ 80%	n	Moderate COPD 50% - 79%	n	Severe COPD 30% - 49%	n	Very severe COPD < 30%	
Farm laborers/farmers	0	0	0	0	1	0.8	5	3.8	6 (4.6)
Construction workers	0	0	7	5.3	6	4.6	**28**	**21.4**	41(31.3)
Housewife	1	0.8	8	6.1	7	5.3	20	15.3	36 (27.5)
Self-employed	0	0	4	3.1	12	9.2	19	14.5	35 (26.7)
Doesn't work	0	0	2	1.5	1	0.8	10	7.6	13 (9.9)
Total	1		21		26		78		131 (100.0)

Table 6 shows that the majority of COPD sufferers were construction workers, with 28 cases (21.4%) having very severe degrees. This finding aligns with the theory that exposure to air, gases, and occupational pollution increases the risk of COPD, as reported by Grahn et al., who reported that 10.3% of 316,023 worker deaths (mining, construction, and transportation) were related to COPD due to dust, smoke, and gases in the work environment.

Table 7. Overview of Spirometry Results (FEV1) in COPD Patients

No	VEP1% Value	n	%
1	Mild COPD VEP1 ≥ 80%	1	0.76
2	Moderate COPD 50% - 79%	22	16.79
3	Severe COPD 30% - 49%	26	19.85
4	**Very severe COPD < 30%**	**82**	**62.60**
	Total	131	100.00

Table 7 shows the dominance of very severe COPD (<30% VEP1) at 62.60% of the total spirometry cases at Waled Regional Hospital from September 2023 to September 2024, while mild COPD (≥80%) was the least (0.76%). These findings reflect the characteristics of elderly age, male gender, and high-risk occupations (construction workers) which accelerate the decline in lung function due to exposure to dust, gases, and environmental pollution, as reported by Youlim et al. that these environmental factors trigger faster progression of obstruction.

Table 8. Relationship between Age Characteristics and Spirometry Results (FEV1)

Age	Spirometry Results VEP1%								Total n (%)	p-value	value (r)
	n	Very severe COPD < 30%	n	Severe COPD 30% - 49%	n	Moderate COPD 50% - 79%	n	Mild COPD VEP1 ≥ 80%			
Early adulthood 26-35 years	1	0.8	1	0.8	0	0	0	0	2 (1.5)		
Late adulthood 36-45 years	3	2.3	1	0.8	8	6.1	0	0	12 (9.2)		
Early elderly 46-55 years	7	5.3	5	3.8	4	3.1	0	0	16 (12.2)	**0.040**	**0.180**
Late elderly 56-65 years	33	25.2	7	5.3	1	0.8	1	0.8	42 (32.1)		
Seniors (elderly) >65 years	**38**	**29.0**	12	9.2	9	6.9	0	0	59 (45.0)		
Total	82		26		21		1		131(100.0)		

Table 9 shows a statistically significant correlation between the age of COPD patients and spirometric VEP1 (p=0.040 <0.05), with a correlation coefficient of r=0.180 (a weak positive correlation). This unidirectional correlation indicates that with increasing age, VEP1 values tend to increase, although the strength of the correlation is very weak.

Table 9. Relationship between Gender Characteristics and Spirometry Results (FEV1)

Gender	Spirometry Results VEP1%								Total n (%)	p-value	Value (r)
	n	Very severe COPD < 30%	n	Severe COPD 30% - 49%	n	Moderate COPD 50% - 79%	n	Mild COPD VEP1 ≥ 80%			
Man	**63**	**48.1**	19	14.5	7	5.3	**0**	**48.1**	89 (67.9)	**0.045**	**0.176**
Woman	23	17.6	11	8.4	7	5.3	1	17.6	42 (32.1)		

Total	86	30	14	1	131 (100.0)

Table 9 shows a statistically significant correlation between the gender of COPD patients and spirometric VEP1 (p=0.045 <0.05), with a correlation coefficient of r=0.176 (a very weak positive correlation). This unidirectional correlation indicates that men have slightly better spirometry results than women, although the effect is very small and statistically significant but with a weak correlation.

Table 10 Relationship between Employment History and Spirometry Results (VEP1)

Employment history	Spirometry Results VEP1%				Total n (%)	p-value
	n	GOLD 1-2	N	GOLD 3-4		
Farm laborers/farmers	0	0	6	4.6	6 (4.6)	**0.450**
Construction workers	7	5.3	34	**26.0**	41(31.3)	
Housewife	9	6.9	27	20.6	36 (27.5)	
Self-employed	4	3.1	31	23.7	35 (26.7)	
Doesn't work	2	1.5	11	8.4	13 (9.9)	
Total					131 (100.0)	

Table 10 shows the results of the Chi-Square test, which shows no statistically significant association between the occupational history of COPD sufferers and spirometry VEP1 (p=0.450 > 0.05). This absence of association is due to the measurement of occupation based solely on the type of profession without actual exposure data (dust, gas), making it less sensitive to detect associations with the degree of pulmonary obstruction.

IV. DISCUSSION

1. Relationship between Age Characteristics of COPD Patients and Spirometry Results (FEV1)

Based on the research results obtained from medical records with a total of 131 samples, it shows that the age of COPD sufferers in the Waled Regional Hospital treatment room is mostly elderly >65 years old with a very severe degree of COPD seen from the results of VEP1 <30%. The relationship between age characteristics and spirometry results (VEP1) seen from the p-value in the Spearman Rank test has a value of 0.040 (p<0.05) with a correlation coefficient (r) of 0.180 which shows a very weak positive relationship between age and spirometry results (VEP1). Therefore, the hypothesis can be accepted because there is a significant relationship between the age characteristics of COPD sufferers and spirometry results (VEP1) seen from the p-value <0.05.

The results of this study indicate a significant, very weak, inverse relationship with spirometric values of FEV1. Physiologically, this is related to changes in parenchymal structure that will affect the respiratory system such as decreased lung elasticity, respiratory muscle weakness and changes in lung tissue structure. The result of this process causes a decrease in pulmonary ventilation capacity including FEV1 in assessing lung function. Gao et al.'s study of a healthy population in Southeast China reported that FEV1 increases with growth until the age of 20-25 years and then decreases progressively thereafter, the FEV1 value indicates normal lung function due to the physiological aging process.

Further research from Liu, et al in a multicenter study in China that developed a prediction model for the VEP1/FVC ratio based on impulse oscillometrics found that age had a significant negative correlation with the VEP1/FVC value with a regression coefficient of -0.00137 (p<0.0001). (40) This indicates that increasing age is a predictor of decreased lung function. Similar research was also found in the study of Frantz, et al with research on the impulse oscillometric index in relation to respiratory symptoms and spirometry of the Swedish cardiopulmonary bioimage study that the VEP1 value tended to decrease in individuals with older age compared to younger age even with a population without respiratory complaints. This decrease was more pronounced in individuals with risk factors such as a history of smoking or exposure to dust.

Previous research results have shown that age is one of the characteristics that must be taken into account in interpreting spirometry values in COPD sufferers so that it can be seen that as age increases, the degree of COPD will worsen.

2. Relationship between Gender Characteristics of COPD Patients and Spirometry Results (FEV1)

Based on the research results obtained from medical records with a total of 131 samples, it shows that the gender of COPD patients in the Waled Regional Hospital treatment room is mostly male with very severe COPD degrees <30%. The relationship between gender characteristics and spirometry results (FEV1) seen from the p-value in the Spearman Rank test has a value of 0.045 ($p<0.05$) with a correlation coefficient (r) of 0.176 which indicates a weak positive relationship, meaning that if the value of one variable increases, the other variable will follow. Therefore, the hypothesis can be accepted because there is a significant relationship between the gender characteristics of COPD patients and spirometry results (FEV1) seen from the p-value <0.05.

In general, men tend to have a larger lung volume capacity than women due to differences in airway anatomy, lung size, and respiratory muscle mass. Referring to the 2018 Basic Health Research data, men are more likely to smoke than women by 62.9%. (42) Research by Lee et al. found that although men have a higher absolute VEP1 value (2.13 ± 0.93 L) than women (1.88 ± 0.53 L), the predicted percentage of VEP1 is lower in men. This indicates that men are more susceptible to a faster decline in lung function.

Previous research by Septiana, et al. regarding the influence of body mass index and gender on VEP1/FKVP showed that gender has a significant relationship to VEP1/FKVP values ($p=0.032$) these results are seen in the dominant male gender towards a faster or more obvious decrease in VEP1 along with the presence of risk factors such as smoking habits. Population studies by Frantz, et al. explained that VEP1 values are higher in men but when adjusted for predicted values based on gender, the relative results of women tend to be more stable with increasing age.

Male gender is often more prevalent in the COPD population, largely due to other factors, such as exposure to cigarettes and industrial pollutants, which can exacerbate COPD. This may underlie the greater decline in lung function in men, as found in this study.

3. Relationship between Occupational History Characteristics of COPD Patients and Spirometry Results (FEV1)

Based on the research results obtained from medical records with a total of 131 samples, it shows that the work history of COPD sufferers in the Waled Regional Hospital treatment room is mostly construction workers with a very severe COPD degree of <30%.

The relationship between work history characteristics and spirometry results (FEV1) is seen from the p-value in the Chi-Square test which has a value of 0.450 ($p>0.05$) which indicates a statistically insignificant relationship. This shows that work history does not affect forced expiratory volume in 1 second statistically. Therefore, the hypothesis cannot be accepted because there is no significant relationship between work history characteristics of COPD sufferers and spirometry results (FEV1) seen at a p-value>0.05. In this study, most suffered by workers in accordance with previous research by Kwok, et al. on workers showed that exposure in the work environment is related to a decrease in FEP1 and the FEP1/FKVP ratio indicates obstructive airways. (45)

The results of this study indicate that there is no significant relationship between work history and spirometry results (FEV1). In theory, the cause of COPD is influenced by several risk factors, one of which is work involving exposure to pollutants. The effect of work history on lung function depends on the duration of exposure, intensity, and the use of personal protective equipment (PPE) when working. Based on research by Patel et al., new COPD patients with a history of work exposure (cigarette smoke or biomass) tend to experience a significant decrease in FEV1 values. Research by Dianova et al. also stated that local studies in Indonesia showed that the length of working time has a significant relationship with the appearance of respiratory symptoms and is related to lung function. A similar study by Alan et al., short-term exposure in the work environment was associated with a decrease in FEV1 of 0.87% per increase of 10 ug/m3. Although the effect is small, this shows that short-term exposure can affect lung function. A similar study by Vinnikov et al. found that production and work in exposed areas have a higher risk of respiratory disorders compared to office workers, and a significantly lower FEV1/FVC ratio was found in the metalworking group compared to the office group, regardless of smoking status and previous medical history. This suggests that exposure in the workplace will influence the occurrence of COPD and other respiratory symptoms.

One possible reason for the insignificant relationship is the presence of other factors that more dominantly influence lung function. This is also similar to the study by Liu et al., who developed a physiological parameter-based FEV1/FVC prediction model that did not include occupational history as a strong predictor in their study. This study showed that the influence of occupational history is not always consistent and can be replaced by more dominant factors such as age, gender, smoking habits, and comorbidities. A study by Nasri et al. in the cement industry found that despite high exposure, smoking habits had a more significant impact than occupational factors. This suggests that lifestyle factors influence spirometry results more than occupational factors themselves. The study by Pandey et al. also stated that exposure to biomass smoke and symptom scores (CAT) were more correlated with decreased FEV1 in non-smokers than occupational factors.

Occupational history is not always significantly related to the type and intensity of exposure to gases, pollutants and smoke, the duration of exposure and the presence of other supporting factors, especially the patient's own lifestyle, are required to influence lung function values.

V. CONCLUSION

This study found that the majority of COPD patients at Waled Regional Hospital (n=131) were elderly (>65 years, 45.04%), male (67.94%), and construction workers (31.30%), with very severe COPD predominating in VEP1 (<30%, 62.60%). Bivariate analysis confirmed a weak positive significant association between age (p=0.040; r=0.180) and gender (p=0.045; r=0.176) with VEP1, while occupational history was not significant (p=0.450), likely due to the lack of actual exposure data. These findings reinforce the role of demographic factors in the progression of pulmonary obstruction, in line with global studies emphasizing aging and risk exposure in manual workers (GOLD, 2024; Susanto et al., 2024).

However, limitations include reliance on secondary data from medical records that are prone to incompleteness, a cross-sectional design without longitudinal causality, and the absence of confounding variables such as smoking history or duration of exposure. Further research is recommended, including prospective direct measurement of occupational exposure and inclusion of comorbid factors using mixed methods for triangulation. Practically, these results recommend routine spirometry screening for at-risk workers in West Java, an elderly prevention program, and the integration of demographic data in primary COPD management to improve prognosis and reduce the burden of hospitalizations (WHO, 2023; Nguyen et al., 2022).

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