



EARLY DETECTION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN LIMESTONE QUARRY COMMUNITIES WITH PUMA SCORE AND PORTABLE SPIROMETRY

Made Agustya Darma Putra Wesnawa*, I Gusti Ngurah Bagus Artana, I Desak Putu Agung Krisdanti, Putu Gita Indraswari, Made Indira Shinta Pratiwi, Maria Carlina

Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Udayana, Jl. P.B. Sudirman, Denpasar, Bali 80232, Indonesia

*putrawesnawa@unud.ac.id

ABSTRACT

Chronic obstructive pulmonary disease (COPD) remains underdiagnosed in primary care, particularly in communities with occupational dust exposure and limited access to spirometry. Objective: This study described COPD risk profiles and examined factors associated with airflow obstruction among adults in a limestone quarry community in Ungasan, Bali. A community-based cross-sectional study design was utilized in this research, with a total of 50 participants selected via a consecutive sampling technique. Data included demographic characteristics, body mass index, smoking history, occupational and biomass exposure, PUMA questionnaire score, and portable spirometry. Airflow obstruction was defined from spirometric interpretation recorded in the screening database. Categorical associations were analysed using two-sided exact tests and odds ratios. Results: Participants had a mean age of 50.0 ± 19.8 years; 56.0% were male and 46.0% were obese. Nine participants (18.0%) were classified as high-risk by PUMA, while airflow obstruction was found in six participants (12.0%). Ever or current smoking was associated with obstruction (31.2% versus 2.9%; OR 15.00; 95% CI 1.58-142.73; $p=0.010$). Brinkman Index ≥ 200 and high-risk PUMA status showed elevated odds but did not reach statistical significance. Targeted community screening using PUMA and portable spirometry can identify undetected airflow obstruction in dusty occupational settings, with smoking history remaining the clearest risk marker.

Keywords: chronic obstructive pulmonary disease; limestone quarry; portable spirometry; puma questionnaire; smoking

How to cite (in APA style)

Wesnawa, M. A. D. P., Artana, I. G. N. B., Krisdanti, I. D. P. A., Indraswari, P. G., Pratiwi, M. I. S., & Carlina, M. (2026). Early Detection of Chronic Obstructive Pulmonary Disease in Limestone Quarry Communities with Puma Score and Portable Spirometry. *Indonesian Journal of Global Health Research*, 8(5), 1451–1460. <https://doi.org/10.37287/ijghr.v8i5.2805>.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major non-communicable respiratory disease and a persistent contributor to premature mortality, disability, and health-care use worldwide. The Global Burden of Disease Study has shown that chronic respiratory diseases remain an important component of the global disease burden, while contemporary reviews emphasise that COPD is still frequently recognised only after substantial physiological impairment has occurred (Cazzola et al., 2024; Vos et al., 2020). This diagnostic delay is clinically important because early disease may be mild, intermittent, or attributed to ageing and physical work, even though early detection creates an opportunity to reduce exposure, promote smoking cessation, and direct patients with abnormal lung function toward longitudinal care.

The burden of undetected COPD is particularly relevant in primary care and community settings. International screening debates caution against indiscriminate population screening of asymptomatic adults, because evidence of outcome benefit remains insufficient (Ghosh et al., 2022). However, the same literature also recognises a need for more precise case-finding among high-risk groups, including individuals with tobacco exposure, respiratory symptoms, occupational dust exposure, or other inhaled hazards (Celli, 2023). In these populations, a practical pathway that

combines a simple questionnaire with spirometric confirmation may be more realistic than relying on clinic-based diagnosis alone.

A targeted approach is also consistent with the modern understanding that COPD is heterogeneous. Although cigarette smoke remains the dominant historical risk factor, COPD can arise through different exposure pathways, including biomass smoke, environmental particulate matter, and occupational dusts. Practical reviews on early COPD emphasise that the earliest clinically relevant stage may not yet resemble advanced symptomatic COPD, and that health systems need simple ways to recognise risk before severe airflow limitation develops (Cazzola et al., 2024). In communities where physically demanding work is common, chronic cough, sputum production, or exertional breathlessness may be normalised as a consequence of labour, thereby delaying health-care seeking and diagnostic testing.

Limestone quarry communities represent a biologically plausible high-risk setting. Quarrying, cutting, crushing, and grinding processes generate respirable mineral dust that may contain calcium carbonate, silica, and other inorganic particles. Indonesian studies among limestone workers have reported a high frequency of impaired lung function and pneumoconiosis, and international studies around quarry and cement environments have associated dust exposure with respiratory symptoms and lower spirometric indices (Nemer et al., 2020; Rajanayagam et al., 2023; Sudrajat et al., n.d.; Yudistira Nalapraya et al., 2021).

The local context is important because quarry-related respiratory hazards do not occur in isolation. Workers and nearby residents may experience overlapping exposure to mineral dust, tobacco smoke, household fuel combustion, and outdoor particulate pollution. In such settings, even modest reductions in lung function can be clinically meaningful when they occur in people with limited access to specialist pulmonary services. Behavioral barriers, including limited knowledge of latent respiratory harm and inconsistent use of adequate respiratory protection make community-based detection more than a diagnostic activity. It becomes an entry point for risk communication, smoking cessation counselling, and referral pathways.

The PUMA questionnaire as a predictive model for COPD in primary care was developed as a pragmatic prescreening instrument to identify individuals who should proceed to spirometric confirmation. Indonesian primary-care data reported that a PUMA cut-off score of at least five had high sensitivity for identifying suspected COPD, while Asian primary care validation also showed that PUMA is feasible for use by trained health workers (Au-Doung et al., 2022; Yunus et al., 2024). A community health-centre study in Malang further found that most individuals classified as high risk by PUMA had an abnormal FEV₁/FVC ratio, supporting its role as a triage tool rather than a diagnostic substitute (Djajalaksana et al., 2025). Nevertheless, evidence from high-risk occupational communities in Bali remains limited.

Another gap concerns the relationship between PUMA results and spirometric obstruction in real-world community programs. Validation studies typically recruit patients from primary-care facilities and may apply eligibility criteria such as age, smoking history, or symptoms. A village-based screening program may have a broader risk profile, including never-smokers with occupational or biomass exposure. It is therefore possible for some participants with obstruction to fall below the usual PUMA threshold, especially when the sample includes younger adults, women, or those without a heavy smoking history. Evaluating this pattern is important for deciding whether community programs should test all attendees or use PUMA only as a triage step.

The present work is therefore positioned at the intersection of occupational health, primary-care case finding, and community engagement. It does not attempt to estimate the true COPD prevalence of Badung Regency or Bali Province. Instead, it examines whether a practical screening package

can describe risk profiles and detect airflow obstruction in a community where exposure concerns had already been identified. This distinction is important because the value of a community screening event is not limited to prevalence estimation. Such a program can also reveal data-quality needs, identify candidates for referral, and help local stakeholders decide how to organise periodic respiratory surveillance (Wibawa et al., 2025).

A small screening program cannot replace population surveillance, but it can generate locally actionable evidence. In Ungasan, the relevant question is whether a simple case-finding workflow can make otherwise invisible respiratory risk visible to clinicians, local leaders, and workers. Therefore, this study aimed to describe the demographic, risk-factor, PUMA, and spirometric profile of adults in a limestone quarry community and to examine the association between selected risk factors and airflow obstruction.

METHOD

This study used a community-based cross-sectional design. Screening was conducted in August 2026 in Ungasan Village, Kuta Selatan District, Badung Regency, Bali, Indonesia, as part of a community lung health program. The target population comprised adults living or working in a limestone quarry environment. Participants were recruited consecutively during the screening activity. Eligible subjects were adults aged 18 years or older who were willing to complete the questionnaire and undergo lung function testing. Individuals with conditions that could make spirometry unsafe were not included. The screening database contained 50 completed records selected via a consecutive sampling technique. Patient names, examination dates, and main occupation were excluded from the analysis dataset used for manuscript preparation. Variables included age, sex, education, body weight, height, body mass index (BMI), oxygen saturation, smoking status, Brinkman Index, occupational exposure, biomass exposure, kitchen ventilation, PUMA item scores, total PUMA score, PUMA interpretation, and spirometric parameters. PUMA scores below five were categorised as low risk and scores of five or more as high risk requiring spirometry, consistent with the database codebook. Airflow obstruction was defined according to the obstruction status recorded in the spirometry section of the database.

Numerical variables were summarised as mean $\pm$ standard deviation and median with interquartile range. Categorical variables were reported as frequency and percentage. Because the number of obstruction cases was small, associations between risk factors and airflow obstruction were analysed using two-sided exact tests. Odds ratios with 95% confidence intervals were calculated for two-by-two comparisons. FEV₁/FVC values were normalised to percentages for descriptive reporting because the source database used decimal notation in some rows and percentage notation in others. Statistical results were interpreted at a two-sided p-value threshold of 0.05.

The PUMA instrument assigns points for sex, age, smoking history, dyspnoea, phlegm, cough, and previous spirometric testing. In the present analysis, PUMA was treated as a prescreening score rather than as a diagnostic endpoint. The primary clinical outcome was airflow obstruction in the spirometry section of the database. BMI categories followed the original database classification. Smoking exposure was analysed in several ways: never smoking versus former or current smoking, current smoking alone, and Brinkman Index of 200 or higher. These categories were chosen because a small sample with only six obstruction events would not support a stable multivariable model.

RESULT

A total of 50 subjects were included. The mean age was 50.0 ± 19.8 years and the median age was 54.5 (30.0–68.0) years. Men accounted for 28 subjects (56.0%) and women for 22 subjects (44.0%). The mean BMI was 24.9 ± 5.2 kg/m². Obesity was the most frequent BMI category (23 subjects, 46.0%), followed by normal BMI (14 subjects, 28.0%). Most subjects had never smoked (34

subjects, 68.0%), while 16 subjects (32.0%) were former or current smokers. The median Brinkman Index among ever or current smokers was 100.0 (48.0-194.0). Occupational exposure was recorded in 10 subjects (20.0%) and biomass exposure in 17 subjects (34.0%). All subjects had good kitchen ventilation recorded in the database.

The mean PUMA score was 2.5 ± 2.1 , with a median of 2.0 (1.0-4.0). Nine subjects (18.0%) were classified as high-risk by PUMA and 41 subjects (82.0%) as low-risk. Spirometric obstruction was found in 6 subjects (12.0%). Among obstructed subjects, the mean FEV₁ percent predicted was 71.0 ± 11.1 , and the mean normalised FEV₁/FVC ratio was $63.5 \pm 3.1\%$. Obstruction was not confined to the high-risk PUMA group. Three obstruction cases occurred among subjects classified as high-risk by PUMA and three occurred among subjects classified as low-risk. This distribution is relevant for program planning because it indicates that using the PUMA threshold as the only gateway to spirometry could miss some abnormal spirometric results in a mixed community sample. Conversely, high-risk PUMA status still showed higher obstruction prevalence than low-risk status, supporting its usefulness as a pragmatic risk marker.

The spirometry profile further indicated that subjects with obstruction had a lower mean FEV₁ percent predicted and a lower FEV₁/FVC ratio than the overall sample. This pattern is internally coherent with the obstruction classification and supports the use of portable spirometry as an objective confirmation tool in the field. Because this screening was conducted in a community setting, the results should be viewed as an early detection signal that requires clinical follow-up rather than as a final specialist diagnosis. The overall oxygen saturation profile was relatively preserved, with a mean SpO₂ of $97.4 \pm 1.2\%$. This finding is clinically plausible in early detection, because resting oxygen saturation may remain normal even when airflow obstruction or small-airway impairment is present. It also supports the argument that symptom enquiry and pulse oximetry alone are insufficient as screening strategies in high-risk communities. Objective lung function testing remains necessary when the goal is to detect airflow limitation before advanced clinical deterioration.

Table 1.
Respondent characteristics (n= 50)

Characteristic	f	%
Male	28	56
Female	22	44
Underweight	5	10
Normal BMI	14	28
Overweight	8	16
Obesity	23	46
Never smoker	34	68
Former smoker	13	26
Current smoker	3	6
Occupational exposure	10	20
Biomass exposure	17	34
High-risk PUMA score	9	18
Airflow obstruction	6	12

Table 2.
Spirometric parameters

Parameter	Mean $\pm$ SD	Median (IQR)
FVC % predicted	88.2 ± 17.7	89.6 (81.4-97.6)
FEV ₁ % predicted	86.7 ± 18.6	89.5 (77.1-98.2)
FEV ₁ /FVC, %	83.3 ± 10.2	85.2 (80.4-89.2)
FEF ₂₅₋₇₅ % predicted	90.9 ± 33.2	88.9 (72.4-106.9)

Table 3.
Association between selected factors and airflow obstruction

Factor	Obstruction in exposed n/N (%)	Obstruction in comparator n/N (%)	OR (95% CI)	p
Male sex	5/28 (17.9)	1/22 (4.5)	4.57 (0.49-42.33)	0.211
Age 40 years or older	5/31 (16.1)	1/19 (5.3)	3.46 (0.37-32.18)	0.387
Obesity	2/23 (8.7)	4/27 (14.8)	0.55 (0.09-3.30)	0.674
Former or current smoking	5/16 (31.2)	1/34 (2.9)	15.00 (1.58-142.73)	0.010
Current smoking	1/3 (33.3)	5/47 (10.6)	4.20 (0.32-55.06)	0.324
Brinkman Index 200 or higher	2/4 (50.0)	4/46 (8.7)	10.50 (1.15-95.92)	0.066
Occupational exposure	2/10 (20.0)	4/40 (10.0)	2.25 (0.35-14.49)	0.586
Biomass exposure	2/17 (11.8)	4/33 (12.1)	0.97 (0.16-5.90)	1.000
High-risk PUMA score	3/9 (33.3)	3/41 (7.3)	6.33 (1.03-38.98)	0.063

Former or current smoking was significantly associated with airflow obstruction (31.2% versus 2.9%; OR 15.00; 95% CI 1.58-142.73; $p=0.010$). Brinkman Index 200 or higher and high-risk PUMA status showed increased odds of obstruction, but these associations did not reach conventional statistical significance in this small sample. Occupational exposure and biomass exposure were not statistically associated with obstruction in the present analysis.

DISCUSSION

The present community screening identified a measurable burden of airflow obstruction in a limestone quarry setting of Ungasan. Among 50 adults, spirometry recorded airflow obstruction in 12% of subjects, while 18% were classified as high risk by the PUMA questionnaire. This proportion is clinically relevant for a community outreach program because the screening was not conducted in a pulmonary clinic, but in a population where respiratory risk may be normalised as part of daily work and ageing. The finding suggests that targeted case-finding can reveal previously unrecognised abnormal lung function even when most participants are not selected because of an established COPD diagnosis (Yunus et al., 2024) .

The demographic profile provides useful context for interpreting the screening results. The mean age was 50 years, more than half of the participants were male, and nearly half were categorised as obese. These characteristics indicate a mixed adult community sample rather than a group composed only of older male smokers. Such a profile is important because COPD case-finding in real community settings must account for overlapping causes of respiratory symptoms, including tobacco exposure, occupational dust, body habitus, and reduced exercise tolerance. In this setting, portable spirometry contributed objective physiological information that could not be obtained from risk history alone (Ghosh et al., 2022).

The spirometry profile supports the value of objective lung function testing during community screening. The overall mean FEV₁ percent predicted and FEV₁/FVC ratio were within relatively preserved ranges, yet six subjects were still classified as having obstruction. Among obstructed subjects, the mean FEV₁ percent predicted was lower and the mean FEV₁/FVC ratio was clearly reduced. This pattern is consistent with an early detection context: most participants may have acceptable average lung function at group level, while a clinically important subgroup already shows airflow limitation that deserves confirmatory assessment and follow-up (Kanj et al., 2024). The preserved oxygen saturation profile also helps explain why simple symptom enquiry or pulse oximetry should not be used as the sole screening approach. The mean resting SpO₂ was high, which is clinically plausible in early or mild airflow limitation because gas exchange may remain adequate at rest. In this context, normal oxygen saturation should be interpreted as reassuring but not exclusionary. Community programs that rely only on visible dyspnoea, cough, or oximetry may miss people with early airflow obstruction, especially when symptoms are underreported or attributed to ageing, smoking, or manual work (Keane & Brennan, 2025) .

The smoking profile further shows why community screening must balance individual and environmental risk. Most participants had never smoked, yet one third were former or current smokers and smoking history was the clearest factor associated with obstruction. This pattern supports smoking cessation as a central intervention, while also reminding practitioners that a quarry community is not defined by smoking alone. A prevention program that focuses only on smokers may overlook never-smokers with dust or biomass exposure, whereas a program that focuses only on occupational dust may miss the dominant individual risk marker identified in this dataset (Djajalaksana et al., 2025).

The association between former or current smoking and airflow obstruction is consistent with the established pathobiology of COPD and with Indonesian evidence linking smoking intensity to PUMA-based early detection risk. Khasanah et al., (2024) reported a significant relationship between Brinkman Index and PUMA score, while the present study found that ever or current smokers had markedly higher odds of obstruction. The wide confidence interval reflects the small number of obstruction cases, but the direction and magnitude of the association underline why smoking history remains a practical first triage marker in community case-finding.

The Brinkman Index analysis points in the same direction, although the estimate was statistically unstable. Subjects with a Brinkman Index of at least 200 had a higher observed prevalence of obstruction than those with a lower or absent smoking exposure, but the p-value did not cross the conventional significance threshold. The wide confidence interval is expected in a dataset with only four participants in the high Brinkman category and six total obstruction events. Rather than disproving a dose-response relationship, this result shows that smoking intensity should be measured more precisely in future screening programs, including pack-years, age at smoking initiation, cessation duration, and exposure to second-hand smoke.

The lack of a statistically significant association for occupational exposure should not be interpreted as evidence that limestone dust is harmless. The source database contained a simple exposure category, not quantitative dust measurement, cumulative duration, respirator quality, or task-level intensity. Previous Indonesian studies reported impaired lung function among limestone milling workers and a 15.1% proportion of pneumoconiosis among limestone miners, while quarry studies from other countries reported lower FVC and FEV₁ among exposed communities and workers (Nemer et al., 2020; Rajanayagam et al., 2023; Sudrajad et al., n.d.; Yudistira Nalapraya et al., n.d.). The absence of significance in this sample is therefore more plausibly explained by limited statistical power and exposure misclassification than by absence of biological risk.

This interpretation has practical implications for occupational health messaging. The local data show that occupational exposure was present in one fifth of subjects, and the broader literature indicates that quarry and limestone-related dust exposure can affect respiratory function. Therefore, prevention should not depend solely on achieving statistical significance in a small community sample. Dust control, adequate respirators, wet methods, ventilation, periodic symptom screening, and periodic lung function testing remain reasonable preventive strategies for quarry communities. A screening database can help prioritise individuals for referral, but environmental and occupational risk management must also address the exposure source.

Biomass exposure was also not associated with obstruction in this dataset, although biomass combustion is a recognised COPD-relevant exposure in many low- and middle-income settings. Mbelambela et al., (2020), for example, found that biomass use and neighbourhood cement-plant exposure had additive effects on airflow obstruction. In Ungasan, all subjects were recorded as having good kitchen ventilation, which may have attenuated the observable association. More detailed information on fuel type, cooking duration, indoor ventilation quality, and lifetime exposure would be needed before drawing firmer conclusions.

The obesity profile also deserves attention in interpreting community respiratory screening. Obesity was the most frequent BMI category and was not associated with obstruction in the two-by-two analysis. However, obesity can influence dyspnoea, exercise tolerance, chest mechanics, and perceived respiratory limitation. In a community where both obesity and inhalational exposures are present, symptom-based screening alone may be insufficient to distinguish obstructive disease from other causes of breathlessness. Integrated assessment that includes BMI, oxygen saturation, smoking exposure, respiratory symptoms, and spirometry is therefore better suited for practical decision-making (Wesnawa et al., 2025).

The PUMA results require a nuanced interpretation. Indonesian and Asian validation studies support PUMA as a high-sensitivity prescreening instrument that helps identify candidates for spirometry (Au-Doung et al., 2022; Yunus et al., 2024). The present screening found elevated odds of obstruction among high-risk PUMA subjects, but the p-value was 0.063 and half of the obstruction cases were classified as low risk by PUMA. This does not negate the value of PUMA; instead, it reinforces that a questionnaire is a triage tool, not a diagnostic replacement. In dusty occupational communities, a lower threshold for spirometric testing may be justified when smoking history, symptoms, or clinical judgement suggest risk.

The distribution of obstruction across PUMA categories is particularly informative. Three obstruction cases occurred among subjects classified as high risk by PUMA and three occurred among those classified as low risk. This finding should not be overread because of the small sample, but it suggests that a questionnaire threshold should not be the only gateway to spirometry in dusty occupational communities. PUMA gives weight to smoking and symptoms; therefore, a never-smoker or a person with fewer reported symptoms can receive a low score even if lung function is already abnormal (Djajalaksana et al., 2025). Community programs may therefore offer spirometry broadly during periodic outreach while using PUMA to prioritise counselling, education, and follow-up intensity. These findings fit the broader screening debate. Universal screening of asymptomatic adults remains controversial, but targeted case-finding in higher-risk groups is a different clinical question (Celli, 2023; Ghosh et al., 2022). The Ungasan model is best understood as targeted community case-finding: the program was delivered in a community with mineral dust exposure, smoking history, and limited routine access to spirometry. In such a setting, combining PUMA with portable spirometry can bridge the gap between symptom recognition and confirmatory testing.

The screening model is feasible from a public health perspective. PUMA requires no equipment, can be delivered by trained staff, and creates a structured conversation about risk. Portable spirometry then provides objective physiological evidence that can motivate referral and behaviour change. This combination is particularly useful in settings where specialist respiratory services are concentrated in hospitals and where residents may not seek care until symptoms interfere with work. For Ungasan, the immediate value of the program lies not only in detecting obstruction but also in building a repeatable pathway for periodic screening by local health cadres and primary-care partners.

For primary-care systems, the operational implication is to separate screening, confirmation, and follow-up into clear steps. First, community staff can identify risk using short questionnaires and exposure histories. Second, trained personnel can perform portable spirometry during scheduled outreach sessions. Third, participants with obstruction, low FEV₁ percent predicted, persistent symptoms, or high exposure burden can be referred for post-bronchodilator spirometry and clinical assessment. This tiered pathway avoids overburdening referral centres while reducing the likelihood that early airflow obstruction remains undetected.

The descriptive results also support a balanced public health message for Ungasan. The data do not imply that most residents or workers have COPD, but they do show that a detectable subgroup has abnormal lung function and that modifiable exposures are present. This framing supports prevention without unnecessary alarm. Former and current smokers should be offered cessation support, while quarry-related respiratory protection should remain a collective responsibility involving workers, employers, local leaders, and health services. A balanced program would combine individual counselling with environmental control, mask availability, symptom surveillance, and clear referral criteria.

The study has several limitations. The sample size was small, only six subjects had obstruction, and the cross-sectional design cannot establish causal relationships. Spirometry interpretation was based on the screening database, and the dataset did not provide post-bronchodilator quality grades or detailed acceptability and repeatability indicators. Occupational and biomass exposure variables were not measured quantitatively. The database also contained mixed decimal and percentage notation for FEV₁/FVC, requiring normalisation for reporting. Despite these limitations, the present analysis provides a more accurate evidence base for local COPD case-finding and should be interpreted as a hypothesis-generating community screening dataset rather than a definitive prevalence study.

Future research should use a larger sample, include post-bronchodilator spirometry with formal quality grading, measure personal or area dust exposure, and follow participants longitudinally. A larger design would allow multivariable modelling to disentangle smoking, age, occupational dust, biomass exposure, BMI, and symptom burden. It would also allow evaluation of whether a lower PUMA cut-off or a combined PUMA-smoking-exposure algorithm improves sensitivity in occupational communities. Repeated screening could determine whether community-based case-finding increases clinical follow-up, smoking cessation, respirator use, or earlier treatment initiation.

A future implementation study should also examine acceptability and feasibility outcomes. These could include the time required to administer PUMA, the proportion of eligible residents willing to undergo spirometry, reasons for refusal, referral completion, and changes in protective behaviour after counselling. Such outcomes would complement physiological endpoints and help determine whether the model can be scaled through community health posts, occupational health units, or primary-care centres serving dusty work environments. For local decision makers, the practical next step is to institutionalise a proportionate surveillance pathway. Repeated annual screening, standardised recording of smoking and dust exposure, and clear referral criteria would make the current community activity more comparable over time and more useful for health-service planning. Such continuity would also improve research quality. Standardised repeated measurements would allow the same community to monitor trends in symptoms, spirometric indices, and exposure behaviour, transforming a single outreach activity into a longitudinal prevention platform for evaluation.

CONCLUSION

Community screening in a limestone quarry area of Ungasan Village identified airflow obstruction in 12% of subjects and high-risk PUMA status in 18%. Former or current smoking was the only factor significantly associated with obstruction, while Brinkman Index 200 or higher and high-risk PUMA status showed non-significant but clinically relevant trends. PUMA and portable spirometry are feasible for targeted case-finding in dusty occupational communities, but questionnaire results should be interpreted alongside smoking history, symptoms, exposure context, and spirometric confirmation.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge Udayana University for supporting this research through the 2026 PNPB grant.

REFERENCES

- Au-Doung, P. L. W., Wong, C. K. M., Chan, D. C. C., Chung, J. W. H., Wong, S. Y. S., & Leung, M. K. W. (2022). PUMA screening tool to detect COPD in high-risk patients in Chinese primary care- A validation study. *PLoS ONE*, 17(9 September). <https://doi.org/10.1371/journal.pone.0274106>
- Cazzola, M., Ora, J., Calzetta, L., & Rogliani, P. (2024). Practical Approaches to Identifying Early Chronic Obstructive Pulmonary Disease. *TouchREVIEWS in Respiratory & Pulmonary Diseases*, 9(1). <https://doi.org/10.17925/usprd.2024.9.1.1>
- Celli, B. (2023). Screening for COPD: Challenging the United States Preventive Services Task Force Recommendation. In *Chest* (Vol. 163, Number 3, pp. 481–483). Elsevier Inc. <https://doi.org/10.1016/j.chest.2022.09.018>
- Djajalaksana, S., Yudi, A., Wardoyo, P., Muarif, H., Sari, F. I., Listyoko, A. S., Lyono, A., Pratiwi, E., Fahmi, K., Muhammad, I., Falyani, S. A., Prasetyo, K. W., & Christanto, A. (n.d.). Profile of Patients at Risk for Chronic Obstructive Pulmonary Disease (COPD) Based on PUMA Score in Six Community Health Centers in Malang City. *Journal of Community Health and Preventive Medicine*, 5(1), 2025.
- Ghosh, R. K., Saha, D., Sarma, M., Bhattacharyya, P., Majumdar, S., Chowdhury, A., & Bhattacharyya, P. (2022). Prevalence and health status of COPD in rural West Bengal. *Lung India*, 39(3), 242–246. https://doi.org/10.4103/lungindia.lungindia_439_21
- Kanj, A. N., Scanlon, P. D., Yadav, H., Smith, W. T., Herzog, T. L., Bungum, A., Poliszuk, D., Fick, E., Lee, A. S., & Niven, A. S. (2024). Application of Global Lung Function Initiative Global Spirometry Reference Equations across a Large, Multicenter Pulmonary Function Lab Population. *American Journal of Respiratory and Critical Care Medicine*, 209(1), 83–90. <https://doi.org/10.1164/rccm.202303-0613OC>
- Keane, R., & Brennan, V. (2025). Assessment of breathlessness: a pulmonologist's perspective – short of breath, but not short of answers. In *Breathe* (Vol. 21, Number 1). European Respiratory Society. <https://doi.org/10.1183/20734735.0096-2024>
- Khasanah, S. K., Prihatin, S., Basuki, H., Fakultas, R. S., Kesehatan, I., Purwokerto, U. M., & Dahlan, J. K. A. (2024). Hubungan Derajat Merokok (Indeks Brinkman) dengan Deteksi Dini Penyakit Paru Obstruktif Kronis (PUMA). Retrieved <http://jurnal.globalhealthsciencegroup.com/index.php/JPPP>
- Mbelambela, E. P., Muchanga, S. M. J., Villanueva, A. F., Eitoku, M., Yasumitsu-Lovell, K., Hirota, R., Shimotake, Y., Sokolo, G. J., Mori, A., & Suganuma, N. (2020). Biomass energy, particulate matter (PM_{2.5}), and the prevalence of chronic obstructive pulmonary disease (COPD) among Congolese women living near of a cement plant, in Kongo Central Province. *Environmental Science and Pollution Research*, 27(32), 40706–40714. <https://doi.org/10.1007/s11356-020-10099-2>
- Nemer, M., Giacaman, R., & Hussein, A. (2020). Lung function and respiratory health of populations living close to quarry sites in Palestine: A cross-sectional study. *International Journal of Environmental Research and Public Health*, 17(17), 1–13. <https://doi.org/10.3390/ijerph17176068>
- Nugraha Surya Wibawa, N., Gusti Ngurah Bagus Ngurah Artana, I., Made Muliarta, I., Ayu Jasminarti Dwi Kusumawardani, I., Wayan Candrawati, N., & Agustya Darma Putra Wesnawa, M. (2025). Hubungan pajanan debu kapas dengan gangguan fungsi paru pada pelaku usaha tekstil di Klungkung, Bali, Indonesia. *Intisari Sains Medis | Intisari Sains Medis*, 16(3), 1335–1344. <https://doi.org/10.15562/ism.v16i3.2544>
- Rajanayagam, B., Sundaramahalingam, M., & Anand, N. (2023). Cumulative Effect of Quarry Dust on Respiratory Health of Stone Quarry Workers. *Universal Journal of Public Health*, 11(3), 305–313. <https://doi.org/10.13189/ujph.2023.110304>
- Sudrajat, M., Azizah, D. R., Kesehatan, D., Fakultas, L., & Masyarakat, K. (n.d.). The Description of Lung Function Status Among Limestone Milling Industry Workers in Tuban Regency.
- Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abolhassani, H., Aboyans, V., Abrams, E. M., Abreu, L. G., Abrigo, M. R. M., Abu-Raddad, L. J., Abushouk, A. I., ... Murray, C. J. L. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, 396(10258), 1204–1222. [https://doi.org/10.1016/S0140-6736\(20\)30925-9](https://doi.org/10.1016/S0140-6736(20)30925-9)

- Wesnawa, M. A. D. P., Subagiarta, I. M., & Nathania, E. (2025). Lung Aging and Lung Function Assessment in Elderly. *Jurnal Respirasi*, 11(1), 93–100. <https://doi.org/10.20473/jr.v11-i.1.2025.93-100>
- Yudistira Nalapraya, W., Susanto, A. D., Mansyur, M., & Marlina, C. (2021). Proportion of Pneumoconiosis In Limestone Mining Workers In Citatah Village, West Bandung District. In *Respir Sci 2021* (Vol. 1, Number 2).
- Yunus, F., Damayanti, T., Nurwidya, F., & Purwono, A. (2024). Tackling the burden of underdiagnosed COPD with PUMA: Screening questionnaire approach in Indonesia's primary healthcare facilities. *Pneumologia*, 73(1), 19–25. <https://doi.org/10.2478/pneum-2025-0004>