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IN THIS ISSUE

About PJCD

The **Philippine Journal of Chest Diseases (PJCD)** [Print ISSN: 2094-1463**,** Electronic ISSN: 3028-1199] is an open-access, English language, online, medical science journal published by the **Philippine College of Chest Physicians (PCCP).**

Its editorial policies are based on the standards for scholarly publication set forth by the **International Committee of Medical Journal Editors (ICMJE) "Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals,"** as well as best practices and guidelines of the **Committee on Publication Ethics (COPE).**

The **PJCD** seeks to be a high-quality, peer-reviewed publication oriented to the practice of pulmonary medicine. The journal publishes scientific papers in the form of original clinical and laboratory investigations, systematic reviews, case reports and series, grand rounds, guidelines and consensus statements, feature articles, opinion articles, editorials, and correspondences/letters to the editor considered to be of relevance to the art and science of pulmonary care.

The journal's target audience are local and international practitioners, clinicians, allied healthcare professionals, scientists and researchers working on pulmonary medicine. It shall accept manuscript submissions from consultants, fellows, residents, and other allied medical professions and specialties in the Philippines. Non-members of the PCCP may submit scientific manuscripts to the journal.

The **PJCD** is published by the PCCP two times a year (June and December). Individual articles accepted and finalized ahead of the publication of an issue are uploaded first as Early Access content. These are subsequently compiled to form the upcoming full issue. Volume, issue, and page numbers are provided once the issue is released. Early Access articles are fully citable since they are provided Digital Object Identifiers once uploaded in the journal site.

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MESSAGE FROM THE PCCP PRESIDENT

It is my pleasure to welcome you to this latest issue of the Philippine Journal of Chest Diseases (PJCD).

Every new issue of the Journal is a reminder of the dedication and passion of our researchers, clinicians, educators, and trainees who continue to ask important questions and seek better ways to care for our patients. Through their work, we strengthen not only our knowledge but also the practice of pulmonary medicine in the Philippines.

In this issue, readers will find studies that address topics highly relevant to our daily practice—from understanding how quality of life and social factors influence tuberculosis treatment outcomes, to improving inhaler technique education among healthcare workers, validating tools that help predict drug-resistant pathogens in pneumonia, and evaluating pulmonary function and exercise capacity among patients with suspected tuberculosis. These articles highlight the breadth of respiratory research being conducted across the country and the commitment of our colleagues to evidence-based patient care.

The PCCP is proud to support the Philippine Journal of Chest Diseases as an important platform for sharing local research and generating knowledge that can guide clinical practice. As a College, we remain committed to upholding high standards in scientific publication and fostering a culture of research, collaboration, and lifelong learning among our members.

I would like to thank our authors, reviewers, editors, and the entire PJCD team for their hard work and dedication. Your efforts ensure that the Journal continues to serve as a valuable resource for our members and for the broader medical community.

I hope you find this issue both informative and inspiring, and that it encourages even more meaningful research in the years ahead.

Virginia S. Delos Reyes, MD, FPCCP, MHPEd, MBA
President, Philippine College of Chest Physicians

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Only submissions that are in scope and have passed preliminary screening for completeness and documentary requirements shall be considered by the Editor-in-Chief if these may proceed to review.

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Original Article

Impact of a structured workshop on the inhaler technique knowledge and skills of healthcare workers in a tertiary government hospital

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ABSTRACT

Background: Poor inhaler technique is associated with poor disease control. With the advent of newer inhaler devices, this study aimed to evaluate the effectiveness of a structured workshop on the knowledge and skills in inhaler technique of healthcare workers (HCWs) in the Department of Medicine of the Philippine General Hospital.

Methodology: This was a quasi-experimental study which compared the knowledge and skills of HCWs on inhaler technique before and immediately after a structured inhaler workshop. A follow-up evaluation was conducted to measure the effect after a one-month period.

Results: A total of 101 participants comprised of interns, nurses, and residents were included in the final analysis. Participants had low baseline knowledge scores; only 41 participants (40.6%) passed the pre-workshop knowledge assessment. The knowledge scores significantly increased immediately post-workshop ($p < .001$ across HCW groups) which persisted until one month after for the residents but not for the nurses and interns. For all groups, the skill scores in using dry powder inhaler (DPI) significantly improved immediately after the workshop ($p < .001$). After one month, there was a decline in skill scores for all, but scores remained significantly higher than pre-workshop values. The metered-dose inhaler (MDI) skill scores of participants immediately post-workshop showed an improvement from baseline that was sustained on follow-up. For all HCW groups, the single-dose DPI (SDPI) skill scores also improved immediately after the workshop and persisted after one month. At baseline, none of the interns possessed any skill in using soft mist inhaler (SMI) while both nurses and residents had low skill scores. Immediately post-workshop and on one-month follow-up, SMI skill scores improved across all HCW groups.

Conclusions: A structured inhaler workshop improves the knowledge and skills of HCWs on inhaler technique on a short-term basis and at one-month follow-up. Further studies are needed to determine the longevity of the effect.

Keywords: inhaler technique, structured workshop, bronchial asthma, chronic obstructive pulmonary disease, healthcare workers

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INTRODUCTION

Bronchial asthma and chronic obstructive pulmonary disease (COPD) remain global health problems. COPD has a global prevalence of 10.3% and is the fourth leading cause of death worldwide, causing 3.5 million deaths in 2021.[1,2] Bronchial asthma is another major noncommunicable disease afflicting an estimated 262 million people in 2019 and causing 455,000 deaths.[3] Since inhaler therapy is the mainstay of treatment for either disease, poor inhaler technique is associated with poor disease control with increased risk of hospitalizations, emergency room consultations, and the need for oral steroids and antibiotics.[4] All types of inhaler devices are equally efficacious.[5] However, with the advent of newer inhaler devices, healthcare providers and patients may not understand the key features of inhalers and how to operate them.[6,7] An educational program may improve this gap.[8]

Patient education on proper inhaler technique is the responsibility not only of the attending physician, but also of the entire healthcare team. The adequacy of the knowledge and skills of healthcare workers (HCWs) at all levels of patient care in inhaler-related patient education is crucial to impart the full benefit of inhaler therapy. In this study, we determined the impact of an inhaler workshop on the inhaler-related knowledge, skills, and teaching practices of HCWs for different inhaler devices to assess its value as part of healthcare delivery improvement measures.

The study aimed to evaluate the effectiveness of a structured workshop on the knowledge and skills on inhaler technique among residents, medical interns, and nurses in the Department of Medicine of the Philippine General Hospital. Specifically, it aimed to describe their baseline knowledge, skills, and patient teaching practices on inhaler technique; and compare their knowledge and skills at three time points, namely: at baseline, immediately post-workshop, and one month after.

METHODOLOGY

Study design

This was a quasi-experimental study which compared the knowledge, skills, and teaching practices of residents, medical interns, and nurses on inhaler technique, before and after a structured inhaler workshop.

Study setting

The study was conducted at the Department of Medicine of the University of the Philippines—Philippine General Hospital which has a high case burden of patients with airway diseases.

Study population

The study population consisted of HCWs at the Department of

Medicine: residents in all levels of training, nurses assigned to the medical wards regardless of length of appointment to the area, and medical intern rotators during the conduct of the study. Participants were included if they were able to attend a face-to-face inhaler workshop.

Participants who did not consent to join the study were excluded. Participants who chose to withdraw from the study at any time were withdrawn.

Sampling and sample size calculation

This study used a convenience sampling method. The average prevalence of incorrect inhaler technique among HCWs in previous studies was 60%.[9-11] Using Fisher's formula, with a confidence interval of 90% and a margin of error of 10%, the minimum sample size was 35 residents-in-training, 37 nurses, and 24 medical interns, with a total of 96 study participants.

During protocol development (basis for sample computation), the Department of Medicine had 70 residents-in-training, 80 nurses, and 36 interns. At the time of the study, the department had 70 residents-in-training, 54 nurses, and 46 rotating medical interns.

Study procedure

This study adapted the procedures done in a local study with an additional follow-up evaluation of the knowledge and skills after a month of the workshop.[12] The evaluators/facilitators of the study were fellows from the Division of Pulmonary Medicine who received training in inhaler technique from the Philippine College of Chest Physicians.

After consent was secured, participants accomplished a self-administered questionnaire on their demographic characteristics, baseline knowledge of inhaler devices, and their reported practices on inhaler education. To assess their baseline skills in inhaler technique, participants were first asked if they knew how to use each of the four commonly prescribed inhaler devices. A score of 0 was given if the participant answered "no" and no demonstration was requested to avoid the participant figuring out the device pre-workshop. For those who knew how to use the devices, participants were asked to demonstrate their use while reciting the steps, and skills were checked by a trained facilitator against a checklist. For each step of the process, a score of 1 was given for the correct step and 0 for missed or incorrect steps. The facilitators did not give feedback on the skills pre-workshop.

A one-hour structured lecture, developed by one of the investigators who serves as a consultant of the Division of Pulmonary Medicine, was then delivered. It covered the following topics: appropriateness of inhaler device type, recommended frequency of assessment of patients' inhaler technique, steps in the proper use of different inhaler types (metered-dose inhaler [MDI], dry power inhaler [DPI], and soft mist inhaler [SMI]), and the indication for the use of spacers. After the lecture, the plenary was divided into small groups with a maximum of 10 participants with a corresponding facilitator. The facilitators conducted demonstrations of inhaler technique using the different inhaler devices in each small group. The participants were given time to practice and have a return demonstration.

After the workshop, participants answered the same self-administered questionnaire. Each participant then demonstrated the use of MDI, DPI (both single-dose and multi-dose), and SMI. The same facilitator from the pre-workshop skills assessment graded the participant's inhaler technique against the same checklist. The same manner of grading was done. For incorrect steps, facilitators gave verbal feedback and corrected the technique after the post-workshop assessment was completed. Only the first attempt of the post-workshop evaluation of skills was graded. The whole duration of the workshop, including the pre- and post-workshop assessments, was approximately 4 hours.

To evaluate the impact after a one-month period, a follow-up evaluation using the same self-administered questionnaire and skills demonstration was done. The same facilitators evaluated the participants. The average duration of the follow-up assessment was approximately 10 minutes.

Data collection

The self-administered questionnaire consisted of the HCWs' demographics and practices. Questions 1 to 7 reported practices, and questions 8 to 19 were about knowledge on proper inhaler technique. These knowledge questions were adopted from a local study which underwent item analysis (Supplementary Material 1).[12] All questions were in English. The questionnaire was administered at baseline, immediately after the workshop, and one month after. The estimated time to answer the questionnaire was 10 minutes.

Device-specific inhaler checklists provided by the manufacturer of each inhaler type were used to grade the skills of the participants (Supplementary Material 2).

Data analysis

Descriptive statistics was used to summarize the demographic data and practices on inhaler technique patient education. Frequency and proportion were used for categorical variables, median and interquartile range for non-normally distributed continuous variables, and mean and standard deviation for normally-distributed continuous variables. Shapiro-Wilk test was used to test the normality of the continuous variables. Wilcoxon signed-rank test was used to compare pre-workshop and immediately post-workshop scores, and pre-workshop and one-month follow-up scores. The null hypothesis was rejected at 0.05 α level of significance. JASP version 0.17.1.2 was used for data analysis.

Ethical consideration

This study was approved by the University of the Philippines Manila Research Ethics Board (UPM-REB 2023-0689-EX) and was conducted in accordance with the Declaration of Helsinki and the Data Privacy Act of 2012. The proper procedures for obtaining informed consent were duly followed.

RESULTS

A total of 170 healthcare workers from the Department of Medicine were deemed eligible and invited to participate, of whom 115 attended the inhaler workshop (Figure 1). Some participants were unable to complete the inhaler workshop (residents, n = 6; nurses, n = 1, interns n = 5) due to emergency calls and two participants who were lost to follow-up, one was on leave and the other one was not available due to conflict of rotation schedule. A total of 101 participants (residents, n = 47; nurses, n = 29; interns n = 25) were included in the final analysis.

As seen in Table 1, nurses were older compared to residents

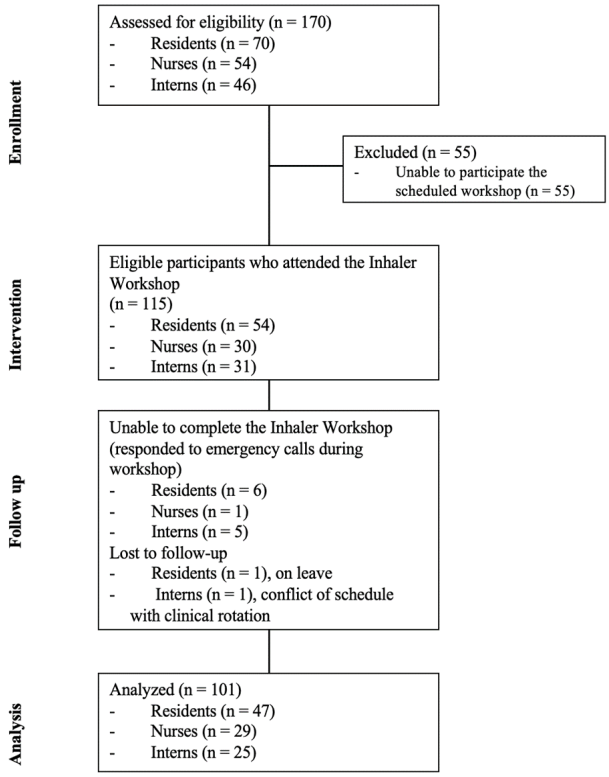

Figure 1. Flow diagram of study participants

and interns (mean age 39.2 ± 10.3 vs 28.1 ± 2.18 and 25.0 ± 1.0 years), and had more years of practice compared to residents (mean 10.2 ± 6.41 vs 2.0 ± 2.0 years). Nurses saw more asthma/COPD patients per week than either interns or residents (median 3.0 [IQR 2.5]). Nurses had a higher proportion of female participants compared to residents and interns (72.4% vs 46.8 and 44%). The majority of residents (55.4%) received hands-on inhaler education, while only one nurse and one intern reported receiving formal instruction on inhaler technique. Among residents who received inhaler education, most (38.5%) obtained it during medical school.

The majority of nurses (89.7%) and residents (93.6%)—but less than half of interns (48%) checked the inhaler technique of patients. Out of those who checked, some assessed the technique at first consult only or if patients had uncontrolled symptoms but there were some who assessed on multiple occasions or every consult regardless of symptoms. The manner of assessing the technique and teaching the proper one to patients varied; most of the assessments were conducted through demonstration, while most of the patient teaching was done via a combination of verbal instruction and video/live demonstration. A higher proportion of nurses compared to residents and interns taught patients on correct inhaler cleaning and proper storage and how to determine if the device was empty.

Results showed that participants had low baseline knowledge scores; there were only 41 participants (40.6%) who passed the pre-workshop knowledge assessment, i.e., having a score of at least 75%. Interns had higher baseline knowledge, with 60% of interns scoring at least 75% compared to only 41.4% for nurses and 29.8% for residents.

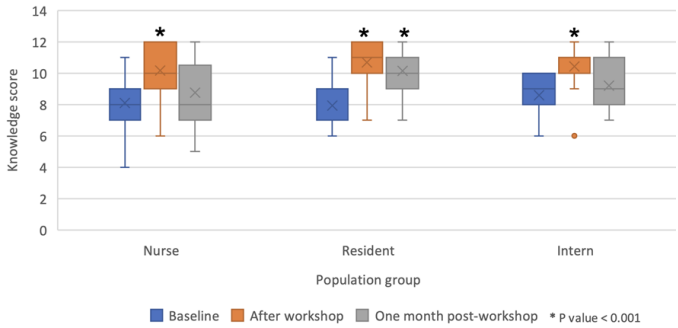

Figure 2. Knowledge scores of the participants at baseline, immediately after workshop, and at one-month follow-up (maximum score of 12)

Baseline inhaler technique scores were also low across all device types. Interns had lower skill scores across all types of inhalers (DPI 1.16 ± 2.81; MDI 5.80 ± 3.63; SDPI 0.52 ± 2.60; SMI 0) compared to either nurses or residents. Residents had higher baseline scores compared to nurses for all inhaler types except SDPI (DPI 4.49 ± 4.49 vs 1.21 ± 2.56; MDI 7.89 ± 3.86 vs 7.38 ± 2.96; SMI 4.21 ± 5.47 vs 0.79 ± 2.14). All groups had more or less similar skills score for MDI (interns 5.80 ± 3.63; nurses 7.38 ± 2.96; residents 7.89 ± 3.86).

The knowledge scores of the residents improved from baseline and persisted until one-month follow-up (p <.001) while the knowledge scores of both interns and nurses improved immediately post-workshop but were no longer statistically significant compared to pre-workshop values at one month (Figure 2).

For all groups, the skill scores in using DPI significantly improved immediately after the workshop (p <.001). After one month, there was a decline in skill scores for all, but scores remained significantly higher than pre-workshop values (Figure 3).

Compared to other inhalers, the mean MDI skill score at baseline was higher for all HCW groups (Table 1). Post-workshop scores improved and were sustained at one-month follow-up (Figure 4).

Interns had a lower baseline mean SDPI skill score compared to nurses and residents with a statistically significant increase

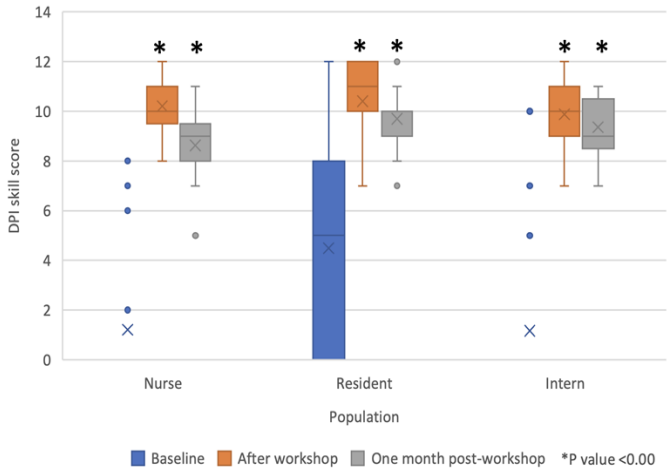

Figure 3. DPI skill scores of the participants at baseline, immediately after workshop, and at one-month follow-up (maximum score of 12). DPI, dry powder inhaler

Table 1. Characteristics of study participants

	Interns (n=25)	Nurses (n=29)	Residents (n=47)	p-value
Age in years, mean (SD)	25.0 (1.0)	39.2 (10.3)	28.1 (2.18)	<0.001
Years of practice, mean (SD)	NA	10.2 (6.41)	2.0 (2.0)	<0.001
Number of asthma/COPD patients/week, median (IQR)	1.0 (0.25)	3.0 (2.5)	2.0 (IQR 1.75)	0.006
Sex				
Female	11 (44.0)	21 (72.4)	22 (46.8)	0.052
Male	14 (56.0)	8 (27.6)	25 (53.2)	
Had hands-on inhaler education	1 (4.0)	1 (3.4)	26 (55.3)	<0.001
Timing of hands-on inhaler education,[1]				
Medical school	1/1 (100.0)	0	10/26 (38.5)	
Unspecified time	0	1/1 (100.0)	8/26 (30.8)	
Residency	0	0	4/26 (15.4)	
Workshop	0	0	2/26 (7.7)	
Pharmacy school	0	0	2/26 (7.7)	
Checked inhaler technique	12 (48)	26 (89.7)	44 (93.6)	<0.001
Frequency of checking inhaler technique[1]				
First consult				
Every consult	7/12 (58.3)	17/26 (65.4)	31/44 (70.5)	
If uncontrolled	5/12 (41.7)	8/26 (30.8)	12/44 (27.3)	
Other	2/12 (16.7)	0	27/44 (61.4)	
Manner of checking inhaler technique[1]				
Verbal	1/12 (8.3)	9/26 (34.6)	9/44 (20.5)	0.097
Demonstration	6/12 (50.0)	13/26 (50.0)	29/44 (65.9)	
Both	5/12 (41.7)	4/26 (15.4)	6/44 (13.6)	
Taught patients correct inhaler technique	14 (56.0)	27 (93.1)	44 (93.6)	<0.001
Manner of teaching inhaler technique				
Verbal				
Video demonstration	1/14 (7.1)	7/27 (25.9)	10/44 (22.7)	0.077
Live demonstration	3/14 (21.4)	0	7/44 (15.9)	
Combination	2/14 (14.3)	8/27 (29.6)	6/44 (13.6)	
Taught patients correct inhaler cleaning and storage	2 (8.0)	19 (65.5)	2 (4.3)	<0.001
Taught patients to determine if device is empty	7 (28.0)	18 (62.1)	1 (2.1)	<0.001
Baseline knowledge score (max: 12), mean (SD)	8.60 (1.29)	8.10 (1.52)	7.94 (1.55)	0.197
Baseline knowledge score at least 75%, mean (SD)	15 (60.0)	12 (41.4)	14 (29.8)	0.045
Baseline skill score, mean (SD)				
DPI (max: 12)				
MDI (max: 13)	1.16 (2.81)	1.21 (2.56)	4.49 (4.49)	<0.001
SDPI (max: 14)	5.80 (3.63)	7.38 (2.96)	7.89 (3.86)	0.063
SMI (max: 14)	0.52 (2.60)	7.07 (4.78)	6.36 (5.95)	<0.001

Data presented as n (%) unless otherwise stated. Denominators are the column totals (interns, n = 25; nurses, n = 29; residents, n = 47) unless otherwise stated.
[1]Participants could select more than one option.
COPD: chronic obstructive pulmonary disease; DPI: dry power inhaler; MDI: metered-dose inhaler; SDPI: single-dose DPI; SMI: soft mist inhaler

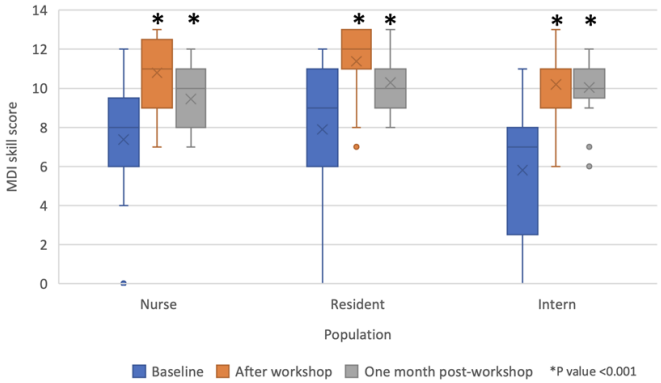

Figure 4. MDI skill scores of the participants at baseline, immediately after workshop, and at one-month follow-up (maximum score of 13). MDI, metered-dose inhaler

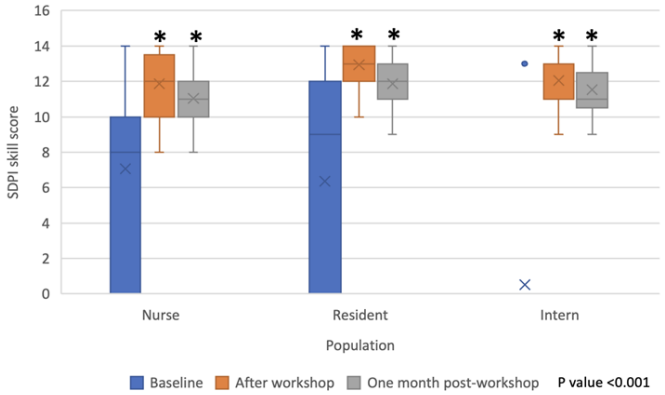

Figure 5. SDPI skill scores of the participants at baseline, immediately after workshop, and at one-month follow-up (maximum score of 14). SDPI, single-dose DPI

immediately after the workshop and on one-month follow-up (Figure 5). The SDPI scores of both nurses and residents improved immediately after the workshop as well and persisted on one-month follow-up.

At baseline, none of the interns possessed any skill in using soft mist inhaler (SMI) while both nurses and residents had low skill scores. Immediately post-workshop and on one-month follow-up, SMI skill scores improved across all HCW groups (Figure 6).

DISCUSSION

Inhaled delivery of bronchodilators and corticosteroids is the cornerstone of management of obstructive airway diseases, such as bronchial asthma and COPD.[13,14] This mode is preferred over systemic administration because it involves direct deposition of medication to airway receptor sites, has a rapid onset of action, and carries fewer systemic side effects.[15] These medications are delivered via nebulizers and inhalers, including MDIs, DPIs and SMIs.[13,16]

Although randomized controlled studies have demonstrated that there is no significant difference between devices in terms of efficacy, they usually exclude patients with poor inhaler technique, thus, overestimating real-world experience. Up to 90% of patients commit critical errors when using an inhaler, or those errors that likely significantly impair delivery of adequate medication to the lungs.[17] Age, educational status, previous inhaler instruction, comorbidities, and socioeconomic

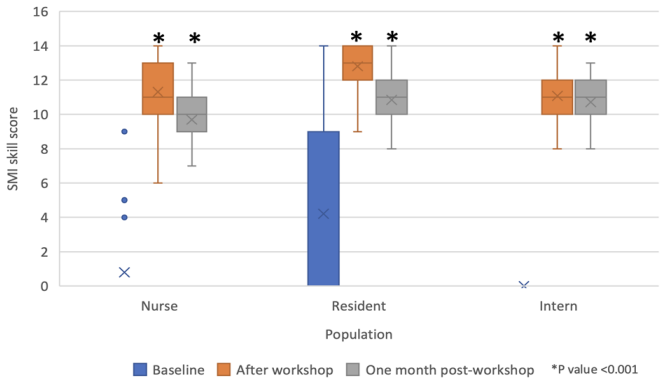

Figure 6. SMI skill scores of the participants at baseline, immediately after workshop, and at one-month follow-up (maximum score of 14). SMI, soft mist inhaler

status are factors associated with high inhaler error frequency.[14]

Healthcare providers play a vital role in ensuring proper inhaler technique among patients. According to a multicenter, cross-sectional, observational study, the provision of patient education instructions by healthcare workers is the only modifiable factor in reducing inhaler misuse.[7] This finding supports the thrust of clinical practice guidelines for both asthma and COPD to train healthcare providers, as they are the ones who instruct and educate patients on proper inhaler therapy.[18-19] Unfortunately, only 15-69% of healthcare professionals can correctly demonstrate correct inhaler use.[13-15] This prevalence is comparable with the findings of this study wherein only 60% of interns, 41.4% of nurses and 29.8% of residents had baseline knowledge scores of at least 75%, suggesting poor knowledge. Of note, despite high baseline knowledge of interns, they were noted to have poor baseline inhaler skills across all types of inhalers used in the study. This could be attributed to a very low prevalence of hands-on inhaler education among interns (4%). This finding is consistent with a cross-sectional survey in the United Kingdom which showed that 88% of medical students perceived that they need further training on inhaler technique.[20]

Educational workshops on inhaler technique have been demonstrated to improve knowledge and skills among healthcare practitioners. A study on residents-in-training showed that a single didactic session and workshop improved knowledge and skills during a short-term assessment.[21] The same result was observed in a small study among emergency department personnel which showed that a short educational session on proper MDI technique improved their ability in using the device.[22] An improvement in inhaler skills after a workshop was also noted in a study among several healthcare practitioners—specialists, general practitioners, pharmacists, pharmacist assistants, nurses, and respiratory therapists, not only during the immediate assessment but even after a four-month period.[23] These findings are consistent with the results of this study, which noted significant improvement in the knowledge scores and inhaler skills scores of not only the residents but also the interns and nurses, immediately after the workshop and at one-month follow-up.

As a limitation, this study demonstrated the knowledge and skills of healthcare workers as evaluated based on the questionnaire and against a checklist. The actual health education of patients and real-world outcomes were not

examined. Thus, it is recommended to evaluate these healthcare workers in their actual clinical practice. A longer follow-up period is also recommended to document the long-term effect of such interventions in the local setting. Lastly, it is recommended to conduct studies that evaluate whether the proper inhaler technique taught by healthcare workers translates to better clinical outcomes.

CONCLUSION

A structured inhaler workshop improves the knowledge and skills of healthcare workers on inhaler technique on a short-term basis and at one-month follow-up. Further studies are needed to determine the longevity of the effect.

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Statement of Authorship

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Authors' Disclosure

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Original Article

Health-related quality of life and sociodemographic factors as predictors of treatment outcomes in pulmonary tuberculosis patients in a tertiary hospital in Cebu City

John Hemingway H. Chang, MD,[1] Laureen Claire Y. Ong, MD[1]

ABSTRACT

Background: Pulmonary tuberculosis (PTB) remains a global health concern affecting millions of lives despite intensified screening and treatment efforts. PTB affects physical health and emotional, environmental, and psychological well-being—collectively influencing a patient's quality of life. This study examined the relationship between pre-treatment health-related quality of life (HRQOL) and sociodemographic data, and their impact on treatment outcomes, whether completed or not, in PTB patients.

Methodology: This prospective cohort study was conducted at the TB DOTS Center of Chong Hua Hospital. It included patients aged 18 years or older without multidrug-resistant or extrapulmonary PTB and without significant comorbidities affecting HRQOL. Sociodemographic data were collected, and HRQOL was assessed using the World Health Organization QOL—Brief Version (WHOQOL-BREF) questionnaire before the start of treatment.

Results: The mean age of our population was 37.18 ± 15.99; 56% were female, 62.5% were single, and 80% completed tertiary education. Fifty-five percent of the participants had comorbidities, the most common of which were hypertension and diabetes mellitus. Before treatment, participants reported a generally acceptable quality of life across all domains (physical, psychological, social, and environmental). Seventy-six patients completed treatment (i.e., treatment success), while four were lost to follow-up. There were no treatment failures. Those who completed treatment showed higher physical and psychological health scores at baseline, albeit the correlation was weak. Sociodemographic factors had minimal association with HRQOL, except for the absence of formal education which was associated with lower psychological scores. None of the analyzed sociodemographic factors were associated with lost to follow-up status.

Conclusions: While PTB treatment is highly effective in achieving clinical success, this study highlights that other factors like QOL are crucial for optimal outcomes. Pre-treatment physical and psychological health are strongly associated with an increased likelihood of treatment completion. The sociodemographic profile had no significant association with HRQOL and treatment outcome.

Keywords: pulmonary tuberculosis (PTB), health-related quality of life (HRQOL), treatment outcomes, World Health Organization Quality of Life—Brief Version (WHOQOL-BREF)

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INTRODUCTION

Pulmonary tuberculosis (PTB) remains a significant global health concern, affecting millions annually. In the Philippines, there has been an increasing trend of TB incidence rate from 554 per 100,000 in 2020 to 650 per 100,000 in 2021. The incidence is predicted to increase by 130 percent and PTB deaths by 170 percent by the year 2025.[1]

PTB is transmitted by respiratory droplets. A third-world country like the Philippines, where poverty and overcrowding are widespread, creates a good medium for the spread of tuberculosis. Most third-world countries lack awareness about the signs and symptoms of PTB disease, often resulting in delayed treatment and further transmission of the bacterium. Another factor that can promotes the spread of PTB is social stigma, which leads to avoidance of medical care and limited access to health care, especially in rural areas.[2] The increase in PTB incidence can be attributed to different factors. The study of Macatangay et al. examined multiple sociodemographic factors that could affect the treatment outcomes among PTB patients. Unlike the results of most studies that showed age is a factor associated with treatment outcome, this study did not find any association between age and treatment outcome. In the studies where age was a factor, it was pointed out that the older population is more likely to have comorbid conditions, immunosuppression, and an increased likelihood of adverse drug reactions, which increase the probability of discontinuation or unsuccessful treatment. In this study, the younger population may not seek appropriate medical treatment because of concerns about their work or school. As to gender, women exhibit better health-seeking behavior than men. The use of tobacco and alcohol also affect treatment outcomes. There is a positive correlation between occupations and education and completion of treatment; craft workers and those with higher levels of education have higher completion rates. The risk of treatment failure is higher in lower-class municipalities than higher-class municipalities for many reasons.[3]

Treatment of PTB does not always lead to success; occasionally, some fail in their treatment. A study conducted by Namukwaya et al. at the Tuberculosis Clinic at Mulago Hospital in Kampala showed that a positive sputum smear test after two months of anti-TB treatment and poor adherence to the regimen were predictors of treatment failure. Distance to the treatment clinic was also associated with treatment failure however, in this study, no such associations were seen, likely because of the presence of more urban tuberculosis treatment clinics. Several

factors that were associated with treatment failure in several studies, like alcohol abuse, low education, and significant comorbidities like diabetes mellitus and HIV seropositivity, were not found to be significant predictors of treatment failure in this study.[4]

Quality of life can also be significantly affected by PTB. The World Health Organization (WHO) defines the quality of life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns.[5] In the study by Dhuria et al., the health-related quality of life (HRQOL) scores of PTB patients were significantly lower compared to the control group, with the physical and psychological domains being the most affected.[6] In a study conducted by Matsumoto et al. in the Philippines, similar results were shown. Contributing factors were socioeconomic status, lack of social support, lower educational level, number of symptoms, and the presence of adverse effects.[7] These two studies demonstrate that PTB patients undergoing TB treatment have poor HRQOL; however, these studies did not explore the relationship between HRQOL and treatment outcomes.

This research aimed to address this gap in knowledge by assessing the association between pre-treatment HRQOL and treatment outcomes among patients with PTB. Specifically, it aimed to 1) measure the HRQOL of patients before undergoing PTB treatment, 2) relate this with treatment outcomes, as well as 3) determine the association between sociodemographic factors and HRQOL and between sociodemographic factors and treatment outcomes. While physicians often focus primarily on physical health, emotional and psychological factors may also affect treatment outcomes. By examining these associations, the study sought to contribute to a more holistic and patient-centered approach to PTB care.

METHODOLOGY

Study design

The study had a prospective cohort design conducted in a TB DOTS center of a 660-bed capacity tertiary hospital in Cebu City.

Study participants

Patients enrolled in the TB DOTS program who were 18 years old and above, and diagnosed with PTB, either bacteriologically or clinically, were included. Patients who were unwilling to participate or who possessed any of the following features were excluded: multidrug-resistant tuberculosis; extrapulmonary tuberculosis; and/or severe comorbidities (e.g., end-stage cancer, severe chronic obstructive pulmonary diseases, decompensated congestive heart failure, end-stage liver cirrhosis, severe mental health conditions, severe neurologic diseases, advanced infection with human immunodeficiency virus or acquired immunodeficiency syndrome.

Ethical consideration

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The protocol was submitted to the Chong Hua Hospital (CHH) Institutional Review Board (IRB) for approval (IRB reference code 2023-086), and informed consent was incorporated in the online survey, allowing participants to voluntarily engage in the study. Measures were taken to ensure that all data collected, stored, and analyzed were protected to maintain privacy and confidentiality.

WHOQOL-BREF questionnaire

The study measured HRQOL using the WHO Quality of Life—Brief version (WHOQOL-BREF). The WHOQOL-BREF questionnaire is a standardized and open-access tool developed by the WHO. The self-administered instrument has 26 items, each rated on a 5-point Likert scale, which assesses the four primary domains of physical, psychological, social, and environmental health.[9] It is reliable, easy to use, and has been tested in different cultural settings and diseases, including PTB. Domain scores are calculated by averaging the scores of items within each domain and then multiplying by four to align with the score used in the original WHOQOL-100 assessment. We adopted the cut-off value of 60 from the study conducted by Silva et al. A score above 60 indicates a higher QOL, which implies that they are generally satisfied, while a score below 60 suggests that intervention may be needed to improve QOL.[10]

Study procedures

Consented participants were enrolled before the start of PTB treatment. Baseline data were collected, including sociodemographic data as part of the WHOQOL-BREF questionnaire. Sociodemographic and clinical variables were collected as follows: birth date (for age computation), recorded in years as a continuous variable; sex, categorized as male or female; marital status, categorized as single, married, widowed, or live-in; education level, classified as none, primary, secondary, or tertiary; and comorbidities, identified based on history. Participants answered the WHOQOL-BREF and, while the questionnaire was self-administered, the researchers were present to provide clarification or answer questions from the participants.

Follow-up procedures were carried out by TB DOTS staff per the National Tuberculosis Control Program's Manual of Procedures (NTP MOP), 6th edition.[8] The researchers had no role in patient follow-up. Treatment outcomes were obtained from the facility. Based on the definitions used in the NTP MOP, the outcomes recorded were: successful treatment, referring to a patient who completed PTB treatment for 6 months; treatment failure, referring to a patient who had no sputum conversion after 5 months or later, acquired resistance, or did not show any clinical improvement during treatment; and lost to follow-up, referring to a patient who had treatment interruption for two months or more.[8]

Sample size

The sample size was determined using Cochran's formula for finite populations. During a specific timeframe, the hospital documented 100 patients diagnosed with PTB. With the assumption of maximum variability ($p = 0.5$), a 95% confidence level, a 5% margin of error, and a population size of 100, the minimum required sample size was calculated to be 80.

Statistical analysis

Data were consolidated and cleaned through data coding and imputation of missing values, then analyzed using JASP version 0.19. WHOQOL-BREF raw domain scores were transformed to a 0-100 scale following the WHOQOL-BREF: Introduction, Administration, Scoring and Generic Version of the Assessment manual (World Health Organization, 1996), with higher scores indicating better quality of life. This was done for the purpose of standardizing the scores and to ease interpretation.[9,10]

Continuous variables were summarized as mean ± standard deviation, while nominal variables were presented as frequency counts and percentages. Confidence intervals (CI) were calculated to estimate population parameters. Multiple and binary logistic regression models were used to assess associations, while point-biserial correlation was used to examine relationships between variables. For analysis of treatment outcome, categorical variables were coded numerically: in correlation analysis, "Completed" treatment was coded as 1, while "Lost to follow-up" was 0; in logistic regression predicting lost to follow-up, the coding was reversed. All patients were included, including those lost to follow-up. Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 shows the baseline characteristics of 80 patients diagnosed with pulmonary tuberculosis (PTB). The mean age of the patients was 37.18 years ± 15.99 years. There was a slight predominance of females (56.25%) compared to males (43.75%). Most patients were single (62.5%) and had completed tertiary education (80%). Nearly half reported comorbidities, the most common being hypertension and diabetes mellitus.

Table 2 presents the HRQOL scores, assessed using the WHOQOL-BREF questionnaire.[9] In the physical health domain, the mean raw score (RS) was 24.31 ± 4.08, corresponding to a transformed score (TS) of 61.88 ± 14.53, with 95% confidence interval (CI) ranging from 58.64 to 65.11. In the psychological health domain, the mean RS was 21.96 ± 3.65 which translates to a TS of 66.34 ± 15.32, with 95% CI ranging from 62.93 to 69.75. For social relationships domain, the mean RS was 10.98 ± 2.21, with a corresponding TS of 66.66 ± 18.57 and a 95% CI ranging from 62.53 to 70.80. In the environmental health domain, patients have a mean RS of 28.31 ± 5.09, resulting in a TS of 65.33 ± 15.95, with 95% CI ranging from 61.78 and 68.87. All scores were above the cut-off of 60 established by Silva et al.[10]

Table 1. Baseline characteristics of patients diagnosed with PTB

	n = 80
Age (years), mean ± SD	37.18 ± 15.99
Sex	
Male	35 (43.75)
Female	45 (56.25)
Marital status	
Single	50 (62.50)
Married	23 (28.75)
Widow	6 (7.50)
Live in	1 (1.25)
Education	
None	1 (1.25)
Primary	2 (2.50)
Secondary	13 (16.25)
Tertiary	64 (80.00)
Comorbidities	
Yes	36 (45.00)
No	44 (55.00)

Values are presented in frequency (percentage) unless otherwise stated

Table 2. Pre-treatment QOL of patients diagnosed with PTB, n = 80

QOL domain	Raw score (RS)	Transformed score (TS)	95% CI for TS
Physical health	24.31 ± 4.08	61.88 ± 14.53	58.64 to 65.11
Psychological health	21.96 ± 3.65	66.34 ± 15.32	62.93 to 69.75
Social relationships	10.98 ± 2.21	66.66 ± 18.57	62.53 to 70.80
Environmental health	28.31 ± 5.09	65.33 ± 15.95	61.78 to 68.87

RS and TS are presented in mean ± SD
The instrument used to measure the Quality of Life is the WHOQOL-BREF questionnaire.[9] The ≥60 cut-off for interpretation follows Silva et al.[10]

Table 3. Treatment outcomes of patients diagnosed with PTB

Treatment outcome	n (%)[a]
Success	76 (95.00)
Failure	0 (0.00)

aFour patients were lost to follow-up during treatment

Table 4. Correlation between QOL and treatment outcome

	Correlation coefficient	p-value
Physical health	0.232*	0.038
Psychological health	0.269*	0.016
Social relationships	-0.007	0.949
Environmental health	0.106	0.349

*Significant at 0.05; Completed (i.e., treatment success) is coded as 1, Lost to Follow-up is coded as 0.

Table 3 shows that PTB treatment had a 95% success rate. There were no cases of treatment failure; however, four patients were lost to follow-up.

Table 4 shows that both physical and psychological health were significantly associated with treatment outcomes, albeit the correlations were weak ($r = 0.232$; $p = 0.038$ and $r = 0.269$; $p = 0.016$, respectively). On the other hand, social relationships and environmental health showed no significant correlation with treatment outcomes.

Table 5 shows that none of the analyzed sociodemographic factors were significantly associated with the physical health component of QOL. The model explains about 24.8% of the variance in physical health QOL.

Table 6 shows that most of the analyzed sociodemographic factors did not have a significant association with the psychological health component of QOL. The only significant association was the lack of formal education; patients who had no formal education experienced notably lower psychological health QOL scores ($p = 0.045$). The model explains only 16.2% of the variance in psychological health QOL.

Table 7 shows that none of the patient characteristics have an association with the social relationships component of QOL, with the model explaining only 13.5% of the variance in social relationships QOL.

Table 8 shows that none of the patient characteristics have an association with the environmental health aspect of QOL, with education at the secondary level ($p = 0.056$) and married status ($p = 0.087$) having p-values close to significance. The model

Table 5. Regression analysis to assess the relationship between pre-treatment QOL (physical health) and sociodemographic characteristics of patients diagnosed with PTB, n = 80

	Coefficient	SE	t	p-value	95% CI	
					Lower	Upper
Gender						
Male	0.833	3.127	0.266	0.791	-5.405	7.070
Education						
Secondary	-7.986	4.369	-1.828	0.072	-16.699	0.727
Primary	-1.986	10.362	-0.192	0.849	-22.652	18.680
None	-21.735	14.811	-1.467	0.147	-51.275	7.806
Marital status						
Married	3.628	4.406	0.824	0.413	-5.159	12.415
Widow	-1.793	7.571	-0.237	0.813	-16.894	13.307
Live in	0.160	13.377	0.012	0.990	-26.519	26.839
Presence of illness	-5.842	3.099	-1.885	0.064	-12.024	0.339
Age	-0.240	0.157	-1.530	0.131	-0.554	0.073

*Significant at 0.05 using multiple regression; Dependent variable: Pre-treatment QOL (physical health); R = 0.498, R^2 = 0.248, adjusted R^2 = 0.151, and RMSE = 13.133

Table 6. Regression analysis to assess the relationship between pre-treatment QOL (psychological health) and sociodemographic characteristics of patients diagnosed with PTB, n = 80

	Coefficient	SE	t	p-value	95% CI	
					Lower	Upper
Gender						
Male	-0.221	3.296	-0.067	0.947	-6.794	6.353
Education						
Secondary	-3.157	4.604	-0.686	0.495	-12.339	6.026
Primary	-11.700	10.921	-1.071	0.288	-33.480	10.081
None	-31.807	15.610	-2.038 *	0.045	-62.940	-0.673
Marital Status						
Married	-0.071	4.643	-0.015	0.988	-9.331	9.190
Widow	-3.290	7.980	-0.412	0.681	-19.205	12.625
Live in	11.764	14.098	0.834	0.407	-16.354	39.881
Presence of illness	1.049	3.266	0.321	0.749	-5.466	7.563
Age	-0.120	0.166	-0.725	0.471	-0.450	0.210

*Significant at 0.05 using multiple regression; Dependent variable: Pre-treatment QOL (psychological health; R = 0.403, R^2 = 0.162, adjusted R^2 = 0.054, and RMSE = 13.842

Table 7. Regression analysis to assess the relationship between pre-treatment QOL (social relationships) and sociodemographic characteristics of patients diagnosed with PTB, n = 80

	Coefficient	SE	t	p - value	95% CI	
					Lower	Upper
Gender						
Male	-2.103	4.264	-0.493	0.623	-10.608	6.401
Education						
Secondary	-4.968	5.957	-0.834	0.407	-16.848	6.912
Primary	-18.101	14.128	-1.281	0.204	-46.279	10.077
None	-28.288	20.195	-1.401	0.166	-68.566	11.989
Marital status						
Married	7.085	6.007	1.180	0.242	-4.895	19.066
Widow	-5.263	10.323	-0.510	0.612	-25.852	15.326
Live in	6.680	18.239	0.366	0.715	-29.695	43.056
Presence of illness	-3.161	4.226	-0.748	0.457	-11.589	5.267
Age	-0.059	0.214	-0.275	0.784	-0.486	0.368

*Significant at 0.05 using multiple regression; Dependent variable: Pre-treatment QOL (social relationships); R = 0.368, R^2 = 0.135, adjusted R^2 = 0.024, and RMSE = 17.907

Table 8. Regression analysis to assess the relationship between pre-treatment QOL (environmental health) and sociodemographic characteristics of patients diagnosed with PTB, n = 80

	Coefficient	SE	t	p - value	95% CI	
					Lower	Upper
Gender						
Male	2.080	3.070	0.678	0.500	-4.043	8.204
Education						
Secondary	-8.321	4.289	-1.940	0.056	-16.875	0.233
Primary	-4.418	10.173	-0.434	0.665	-24.707	15.871
None	-9.767	14.541	-0.672	0.504	-38.769	19.234
Marital status						
Married	7.500	4.325	1.734	0.087	-1.126	16.127
Widow	4.301	7.433	0.579	0.565	-10.524	19.126
Live in	9.495	13.132	0.723	0.472	-16.697	35.687
Presence of illness	-4.584	3.043	-1.507	0.136	-10.652	1.485
Age	-0.137	0.154	-0.886	0.379	-0.444	0.171

*Significant at 0.05 using multiple regression; Dependent variable: Pre-treatment QOL (environmental health); R = 0.388, R^2 = 0.150, adjusted R^2 = 0.041, and RMSE = 12.894

Table 9. Binary logistic regression analysis to assess the relationship between lost to follow-up and sociodemographic characteristics of patients diagnosed with PTB, n = 80

Characteristics	Estimate	Standard Error	z	p-value
Age	0.012	0.057	0.216	0.829
Gender				
Male	-0.727	1.319	-0.551	0.582
Education				
Secondary	0.734	1.470	0.500	0.617
Primary	3.009	2.177	1.382	0.167
None	-14.371	3956.181	-0.004	0.997
Marital status				
Married	-0.172	1.818	-0.094	0.925
Widow	0.273	2.021	0.135	0.893
Live in	-13.888	3956.180	-0.004	0.997
Presence of illness	0.876	1.288	0.680	0.496

*Significant at 0.05, Lost to Follow-up is coded as 1

accounts for only 15.0% of the variance in environmental health QOL.

Table 9 presents the results of binary logistic regression analysis examining the association between patient characteristics and the likelihood of being lost to follow-up. None of the analyzed characteristics were found to have a statistically significant effect on the likelihood of follow-up loss.

DISCUSSION

This study assessed the association between pre-treatment HRQOL and treatment outcomes. Different factors may affect a patient's treatment outcome, and this study aimed to identify some of those factors.

The majority of the patients were young (37.18 ± 15.99 years), female (56.25%), single (62.5%), and completed tertiary education (80%). Nearly half of the population (45%) reported the presence of comorbid illnesses, the most common of which were hypertension and diabetes mellitus.

HRQOL and treatment outcomes

The pre-treatment HRQOL scores were generally satisfactory across all domains, with psychological health and social relationships scoring slightly higher than physical health and environmental health. In comparison, a study conducted in Malaysia in 2014 found that the HRQOL of the population was poor at the start of treatment. A significant finding in this study was that 67.1% of the study participants were at risk for depression at the start of treatment. After the completion of treatment, there was a significant improvement in the HRQOL. However, the overall HRQOL was still low compared to the general population.[11] A similar study conducted in Bangladesh showed that patients who completed PTB treatment had significant improvement in their HRQOL, which was now equal to healthy individuals.[12] These contradicting results underscore the imperfect association between the impact of PTB treatment on the overall HRQOL outcome, suggesting that factors beyond medical treatment may influence HRQOL in PTB patients. The findings of our study showed an association between successful treatment outcomes and good physical and psychological well-being before treatment, suggesting that there may be a role in enhancing both to improve treatment outcomes. Moreover, HRQOL can be used to identify high-risk individuals who should be followed up more closely so that additional interventions can be implemented to improve their overall QOL and treatment outcomes. Lastly, baseline QOL scores are valuable for tracking changes over time and understanding the impact of PTB and its treatment on various aspects of life.

Sociodemographic data and HRQOL

Sociodemographic data had limited association with HRQOL across the four domains. The lack of formal education was the only variable associated with lower psychological HRQOL scores. Similar findings were observed in studies conducted in several Asian countries which demonstrated poor HRQOL before the start of PTB treatment.[12-16] In our study, the majority of the participants had received tertiary education (80%), which could correlate with the higher baseline HRQOL.

Sociodemographic data and treatment outcomes

The treatment success rate was notably high (95%). However,

four patients (5%) were lost to follow-up, emphasizing the need for robust follow-up strategies during treatment. Sociodemographic data did not have any effect on treatment outcomes. When compared to a study conducted in Bangladesh from 2015 to 2017, prolonged disease duration, increased number of symptoms, low socioeconomic status, and low educational attainment were found to be factors that negatively affected treatment outcomes.[12]

Limitations

This study has the following limitations: First, it has a relatively small sample size and a single-center design, which may reduce the generalizability of the findings. In addition, several important variables were not included like lifestyle factors (e.g., tobacco, alcohol use, and occupation), clinical factors (e.g., sputum positivity). Second, the self-reported HRQOL measures introduce a potential response bias. Lastly, the observational design limits the ability to establish a causal relationship between HRQOL and treatment outcomes.

Recommendations

This study recommends that future research be conducted with larger sample sizes and a multicenter approach to better represent the diverse populations affected by PTB. Additional data can also be collected to further characterize patients with PTB. A randomized controlled trial is suggested to more definitively establish a causal relationship between HRQOL and treatment outcomes. Additionally, conducting a pre- and post-treatment HRQOL analysis can help evaluate the impact of successful PTB treatment on patients' HRQOL.

Given the observed association between the physical and psychological dimensions of HRQOL and treatment outcomes, we advocate the integration of additional support services aimed at improving these aspects during TB treatment. Such interventions would be particularly beneficial for patients with low baseline HRQOL.

Furthermore, since a low level of education was found to significantly impact psychological well-being, we recommend implementing targeted health education campaigns and community programs to enhance health literacy and reduce stigma related to PTB. Lastly, we propose long-term follow-up assessments of HRQOL even after treatment completion, to identify ongoing challenges and to inform the development of sustained support strategies for PTB survivors.

CONCLUSIONS

This study highlights that better physical and psychological well-being are associated with favorable treatment outcomes. Improving HRQOL, particularly these domains, may contribute to more successful treatment outcomes for PTB patients. The analyzed sociodemographic characteristics have a limited association with HRQOL, underscoring the multifaceted nature of HRQOL and the importance of addressing not only clinical but also non-clinical factors, such as psychological support, socioeconomic conditions, education, and social support, to achieve comprehensive improvements in the well-being of patients undergoing treatment for PTB.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authors' Disclosure

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Original Article

Comparison of baseline pulmonary function, dyspnea severity, and exercise capacity among active TB and TB-negative cases seen in a TB referral clinic

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ABSTRACT

Background: Tuberculosis (TB) remains a major health concern in high-burden countries like the Philippines. While post-TB lung disease is well documented, baseline pulmonary function and exercise capacity at the time of TB diagnosis are less studied.

Objective: To compare baseline pulmonary function, dyspnea severity, and exercise capacity between active TB and TB-negative individuals, and to identify clinical factors associated with impairment.

Methodology: A cross-sectional study among 290 adults with presumptive pulmonary TB was conducted. After initiating treatment and confirming sputum negativity, participants underwent spirometry, mMRC dyspnea grading, and the six-minute walk test (6MWT). Patients were categorized as active TB (bacteriologically-confirmed or clinically-diagnosed) or TB-negative. Group comparisons and multivariable regression analyses were performed.

Results: Of 290 participants, 139 had active TB and 151 were TB-negative. Active TB patients were younger and had fewer comorbidities. Nearly one-third of active TB patients had abnormal spirometry at baseline. Compared to TB-negative controls, active TB patients had higher mean forced expiratory volume in 1 second (FEV_1) (2.26 ± 0.74 L vs 1.80 ± 0.75 L), forced vital capacity (FVC) (2.97 ± 1.11 L vs. 2.31 ± 0.86 L), and 6MWT distance (539.3 ± 120.5 m vs 488.6 ± 157.3 m) (all p <0.01). Chronic lung diseases were more prevalent among TB-negative individuals. After adjustment, previous TB treatment was the clinical factor most strongly associated with impaired spirometry (aOR 5.02, 95% CI 2.42 to 10.40), moderate-to-severe dyspnea at presentation (aOR 2.06, 95% CI 1.26 to 3.35), and reduced 6MWT distance (β -48.5 m, 95% CI -71.2 to -25.8).

Conclusions: Many patients with active TB exhibit lung impairment even at diagnosis. Nevertheless, active TB patients had surprisingly better lung function in this study which may be attributed to the higher prevalence of asthma and chronic obstructive pulmonary disease in the TB-negative group. Prior TB treatment is independently associated with spirometric and functional decline. Early pulmonary assessment should be integrated into TB care to inform rehabilitation strategies.

Keywords: tuberculosis, spirometry, six-minute walk test, mMRC

INTRODUCTION

Tuberculosis (TB) continues to have a high disease burden globally, affecting an estimated 10.6 million people worldwide in 2022. The Philippines is among the countries with the highest TB burden, ranking fourth, with approximately 7% of global cases.[1] Beyond its mortality and microbiological aspects, TB can cause long-term pulmonary sequelae even after successful treatment. Post-TB chronic lung disease—including airway obstruction, restrictive deficits, and destroyed lung parenchyma–contribute to significant morbidity and reduced quality of life, yet is often under-assessed in clinical practice. Studies report that roughly 20% to more than 80% of TB survivors sustain some permanent lung impairment, indicating a wide spectrum of post-TB lung damage.[2] Pulmonary function tests (PFTs) such as spirometry, along with functional measures like the six-minute walk test (6MWT) and the modified Medical Research Council (mMRC) dyspnea scale, are critical tools to objectively assess respiratory function and its impact on daily life. TB-related lung injury often manifests as irreversible airflow limitation and loss of lung volume (sometimes a mixed obstructive–restrictive pattern),[3] which can lead to exercise intolerance and chronic respiratory symptoms. Early detection and management are important for better outcomes in patients with chronic respiratory diseases.

Therefore, we aimed to compare the baseline pulmonary function, dyspnea severity, and exercise capacity in individuals with active TB disease with TB-negative controls, and to evaluate clinical factors of impairment in terms of lung function, dyspnea during daily activities, and exercise capacity.

METHODOLOGY

Study design and setting

We conducted a cross-sectional study at a TB referral clinic in the Philippines in 2024.

Study participants

All adult presumptive pulmonary TB patients seen in the TB referral clinic in Quezon City for diagnostic evaluation and who underwent testing with smear microscopy, TB LAMP, and/or Xpert MTB/RIF following the National Tuberculosis Control Program Manual of Procedures[4] from August 2024 to February 2025 were included.

Ethical considerations

All participants provided informed consent which was discussed prior to the conduct of the study and once the patient was deemed eligible to be included. The study was done in adherence to the Declaration of Helsinki and was approved by

the East Avenue Medical Center Institutional Ethics Review Board (EAMC IERB 2024-44). Safety of participants was ensured prior to, during, and at the end of the procedures.

Study procedures

Based on the diagnostic workup, patients were classified into two groups: active TB (patients diagnosed with pulmonary TB, either bacteriologically-confirmed through positive sputum tests or clinically-diagnosed by a physician based on clinical and radiographic findings despite negative microbiologic results) and TB-negative (those in whom TB was ruled out and for whom an alternative diagnosis was made).

Baseline demographic and clinical data (including smoking status, symptoms, comorbidities, and previous TB treatment [i.e., retreatment case]) were recorded.

Pulmonary function was assessed using a calibrated portable spirometer. For infection control, spirometry in active TB patients was performed one month after initiating treatment and only after a repeat negative sputum microscopy confirmed reduced infectivity. The technician conducting the test utilized proper personal protective equipment, and institutional infection control protocols were strictly followed. While there was a delay in the timing of the performance of pulmonary function test with respect to diagnosis, we believe that pulmonary function is unlikely to change within one month of initiating treatment. All testing followed American Thoracic Society/European Respiratory Society 2019 standards.[5] Key spirometric measures were: forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC) expressed in liters (L) and as percentages of predicted normal values (FEV_1 %predicted, FVC %predicted); and the FEV_1/FVC ratio. We defined impaired lung function based on standard criteria: FEV_1 <80% predicted, FVC <80% predicted, or FEV_1/FVC <70%. Fixed cut-off values were used for consistency with commonly applied clinical definitions and prior studies, allowing easier interpretation and comparison of results, and with reference standard derived from Global Lung Initiative. If any of these values fell below the threshold, the patient was considered to have an abnormal PFT (suggesting an obstructive or restrictive defect). Other spirometric parameters that were measured were: peak expiratory flow (PEF; in liters per second), forced expiratory time (FET; in seconds); and maximal voluntary ventilation (MVV; in liters per minute).

Dyspnea was assessed using the modified Medical Research Council (mMRC) scale; we considered mMRC grade ≥ 2 as having moderate-to-severe baseline dyspnea.

Exercise capacity was evaluated using the six-minute walk test (6MWT), following a standard ATS protocol to measure the distance walked in six minutes on a flat course.[6] Additionally, overall fatigue or breathlessness was graded using the modified Borg rating of perceived exertion, from 0 (none) to 10 (maximum).

Sample size and sampling

Sample size was calculated based on 2023 clinic records of approximately 924 TB patients. Using a 95% confidence level and 5% margin of error, at least 272 participants were required. Consecutive sampling was done.

Statistical analysis

For analysis, continuous variables were reported as mean ± standard deviation (SD) or median (interquartile range [IQR]) as appropriate, and categorical variables as number (percentage). Group comparisons between active TB and TB-negative groups were performed using independent Student's t -tests for approximately normally distributed continuous variables (or Mann–Whitney U tests if the distributions were non-normal), and chi-square tests (or Fisher's exact tests) for categorical variables. Key results were summarized in tables. Within the active TB cohort, subgroup comparisons between bacteriologically-confirmed versus clinically-diagnosed groups were done. For each comparison, we calculated absolute differences in means or odds ratios (ORs) for proportions, with 95% confidence intervals (CIs), to quantify effect sizes. To identify independent factors of impairment, we performed multivariable regression analyses. A logistic regression model was constructed for the binary outcome of impaired lung function (as defined above), including TB status (active vs negative), age, sex, body mass index, smoking status, and—for TB patients—retreatment status and bacteriologic confirmation as covariates. Adjusted ORs with 95% CIs and p-values were reported for each factor. A second logistic model was ran for moderate-to-severe dyspnea (mMRC ≥2 vs <2) using the same independent variables. Lastly, a linear regression model was applied to the 6MWT distance (in meters) using the same factors; β coefficients (mean differences) with 95% CIs and p-values were obtained. A two-tailed $p < 0.05$ was considered statistically significant for all analyses. Data were analyzed using SPSS version 25.0 (IBM Corp) and R 4.0 software. The study was reported in accordance with the STROBE guidelines for observational studies.

RESULTS

A total of 290 participants met the inclusion criteria, with 139 classified as having active pulmonary TB and 151 as TB-negative. As seen in Table 1, the active TB group was significantly younger than the TB-negative group (mean age 42.0 ± 17.7 vs 48.5 ± 15.6 years, $p = 0.001$). Sex distribution and marital status were similar between groups (both $p > 0.1$). Educational attainment differed markedly: active TB patients were more likely to have attended or completed college (50.4% vs 16.6%) whereas TB-negative individuals more commonly had only elementary or high school education (both $p \leq 0.001$). Full-time employment was more frequent in the active TB group (65.5% vs 39.7%, $p < 0.001$) while unemployment was higher in the TB-negative group (54.3% vs 30.2%, $p < 0.001$).

Regarding presenting symptoms, classical constitutional symptoms were more common in active TB (some data not shown in table). In particular, unintentional weight loss was reported in 13.7% of active TB patients versus 4.0% of TB-negative patients ($p = 0.006$), and the combination of cough, fever, weight loss, and night sweats was also more frequent in the active TB group. Conversely, dyspnea (either alone or with cough) was more often reported by TB-negative individuals: for example, 13.2% of TB-negative patients had both dyspnea and cough at presentation, compared to none of the active TB patients ($p < 0.001$). The TB-negative group also had significantly higher rates of chronic respiratory comorbidities, notably asthma (6.6% vs 0%, $p = 0.002$) and chronic obstructive pulmonary disease (COPD, 13.2% vs 0%, $p < 0.001$), and hypertension (13.2% vs 4.3%, $p = 0.014$). In contrast, diabetes mellitus was more frequent among those with active TB (7.9% vs 0%, $p < 0.001$). Overall, two-thirds of active TB patients had no comorbid conditions, significantly more than the TB-negative group (66.9% vs 35.1%, $p < 0.001$).

Baseline functional assessments showed better mean pulmonary function and exercise capacity in the active TB group. Active TB patients walked farther on the 6MWT (mean 539.3 ± 120.5 m vs 488.6 ± 157.3 m, p = 0.002), and had higher mean FEV_1 (2.26 ± 0.74 L vs 1.80 ± 0.75 L, p <0.001) and FVC (2.97 ± 1.11 L vs 2.31 ± 0.86 L, p <0.001) than TB-negative individuals. There were no significant differences between groups in the FEV_1/FVC ratio, mMRC dyspnea scores, Borg exertional score, smoking history, or alcohol use (all p >0.1). Nevertheless, nearly one-third of active TB patients had abnormal spirometry at baseline.

In Table 2, we performed a subgroup analysis of the 139 active TB cases to explore differences by diagnostic classification.

Table 1. Baseline characteristics of study participants according to TB status (N = 290)

	Active TB (n = 139)	TB-negative (n = 151)	p-value
Age, years (mean ± SD)	42.00 ± 17.73	48.52 ± 15.57	0.001
Sex			
Female	61 (43.9)	81 (53.6)	0.123
Male	78 (56.1)	70 (46.4)	0.123
Marital status			
Married	87 (62.6)	106 (70.2)	0.212
Single	52 (37.4)	45 (29.8)	0.212
Educational attainment			
College	70 (50.4)	25 (16.6)	<0.001
Elementary	8 (5.8)	32 (21.2)	<0.001
High School	53 (38.1)	87 (57.6)	0.001
Vocational	8 (5.8)	7 (4.6)	0.869
Employment status			
Full-time	91 (65.5)	60 (39.7)	<0.001
Not working	42 (30.2)	82 (54.3)	<0.001
Part-time	6 (4.3)	9 (6.0)	0.714
Symptoms			
Asymptomatic	38 (27.3)	49 (32.5)	0.412
Cough	33 (23.7)	42 (27.8)	0.511
Dyspnea	8 (5.8)	25 (16.6)	0.005
Fever	13 (9.4)	6 (4.0)	0.094
Weight loss	19 (13.7)	6 (4.0)	0.006
Night sweats	7 (5.0)	0 (0)	0.005
Comorbidity			
Asthma	0 (0)	10 (6.6)	0.002
COPD	0 (0)	20 (13.2)	<0.001
Hypertension	6 (4.3)	20 (13.2)	0.014
Diabetes	11 (7.9)	0 (0)	<0.001
Cancer	3 (2.2)	2 (1.3)	0.667
6MWT distance, m (mean ± SD)	540 ± 120	489 ± 157	0.002
FEV_1, L (mean ± SD)	2.26 ± 0.74	1.80 ± 0.75	<0.001
FEV_1, %predicted (mean ± SD)	73.0 ± 22.5	59.7 ± 21.7	<0.001
FVC, L	2.97 ± 1.11	2.31 ± 0.86	<0.001
FVC, %predicted (mean ± SD)	68.6 ± 21.0	60.5 ± 18.6	<0.001
FEV_1/FVC, ratio (mean ± SD)	80.7 ± 12.5	78.4 ± 13.2	0.113
PEF, L/s (mean ± SD)	5.0 ± 3.5	4.5 ± 3.8	0.130
FET, s (mean ± SD)	4.0 ± 3.0	4.8 ± 3.5	0.020
MVV, L/min (mean ± SD)	90 ± 50	80 ± 45	0.050
6MWT Borg score ≥1	20 (14.4)	23 (15.2)	0.852
6MWT Borg score ≥4	4 (2.9)	0 (0)	0.049

Data presented as n (%) unless otherwise stated.
TB: tuberculosis; COPD: chronic obstructive pulmonary disease; 6MWT: six-minute walk test; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; PEF: peak expiratory flow; FET: forced expiratory time; MVV : maximal voluntary ventilation

Among active TB patients, those who were bacteriologically-confirmed (n = 72) were significantly younger than those who were clinically diagnosed (n = 67) (median age 28 years vs 53 years, p = 0.002). The bacteriologically-confirmed group also had a higher proportion of males, although the sex difference was not significant (58% vs 54% male, p = 0.585). Educational attainment differed: none of the bacteriologically-confirmed cases had only elementary education, compared to 12% of the clinically-diagnosed group (p <0.001). Conversely, the clinically-diagnosed group had no individuals with vocational education compared to the bacteriologically-confirmed group (0% vs 11%). Employment status was slightly different, with full-time employment more common in bacteriologically-confirmed patients (68.1% vs 62.7%, p = 0.019).

Clinically, there was heterogeneity in symptom profiles (some data not shown in table). Bacteriologically-confirmed TB patients were more likely to have classic TB symptoms: more than half in the bacteriologically-confirmed group reported significant weight loss at diagnosis (56.9% vs 26.9% in the clinically-diagnosed group, p <0.001), and night sweats were reported by 9.7% of bacteriologically-confirmed cases compared to none of the clinically-diagnosed cases (p = 0.009). In contrast, clinically-diagnosed TB patients tended to have fewer typical symptoms but a higher burden of certain comorbidities. Notably, 17.9% of clinically-diagnosed patients had a history of cancer (vs 0% of the bacteriologically-confirmed, p <0.001). While none in the clinically-diagnosed group had hypertension or diabetes, these conditions were present in 19.4% and 5.6% of the bacteriologically-confirmed group, respectively (for hypertension, p <0.001; for diabetes, p = 0.043). Prior TB was much more prevalent in the clinically-diagnosed group: 50.8% of clinically-diagnosed patients were retreatment cases (having had prior TB treatment) compared to only 15.3% of the bacteriologically-confirmed group (p <0.001).

In terms of lung function, patients with clinically-diagnosed TB achieved a significantly greater distance on the 6MWT (median 611 m vs 485 m, p <0.001), and had higher baseline FEV_1 and FVC values. Specifically, mean FEV_1 %predicted was 76% in the clinically-diagnosed group versus 63% in the bacteriologically-confirmed group (p = 0.001), and mean FVC %predicted was 71% vs 65.5% (p = 0.047). Clinically-diagnosed patients also had higher maximal voluntary ventilation (MVV) and longer forced expiratory time (FET) on spirometry than bacteriologically-confirmed patients (median MVV 107 L/min vs 77 L/min, p = 0.009; median FET 4.82 s vs 3.51 s, p = 0.004). Patients in the clinically-diagnosed group reported lower exertional symptoms during the 6MWT–only 9.0% had significant post-walk dyspnea versus 29.2% in the bacteriologically-confirmed group (p = 0.003)—and none experienced angina after the walk (no difference between groups). However, ratings on the Borg scale of perceived exertion were higher in the bacteriologically-confirmed group. Specifically, 18.1% of bacteriologically-confirmed patients reported a Borg score of 4 (severe breathlessness) after the 6MWT, compared to 0% in the clinically-diagnosed group (overall p <0.001).

In multivariable analyses (Table 3), a history of prior TB treatment (retreatment case) emerged as the strongest independent factor associated with baseline pulmonary impairment. After adjusting for age, sex, BMI, smoking status, and TB confirmation status, patients with previous TB treatment had significantly higher odds of having abnormal

Table 2. Subgroup analysis of active TB patients according to diagnostic classification (n = 139)

	Bacteriologically confirmed (n = 72)	Clinically diagnosed (n = 67)	p-value
Age, years (median [IQR])	28 [23]	53 [23]	0.002
Sex			
Female	30 (41.7)	31 (46.3)	0.585
Male	42 (58.3)	36 (53.7)	0.585
Marital status			
Married	41 (56.9)	46 (68.7)	0.154
Single	31 (43.1)	21 (31.3)	0.154
Educational attainment			
Elementary	0 (0)	8 (11.9)	<0.001
High School	31 (43.1)	22 (32.8)	…
College	33 (45.8)	37 (55.2)	…
Vocational	8 (11.1)	0 (0)	...
Employment status			
Full-time	49 (68.1)	42 (62.7)	0.019
Not working	20 (27.8)	20 (29.9)	0.781
Part-time	3 (4.2)	5 (7.5)	0.480
Weight loss at diagnosis	41 (56.9)	18 (26.9)	<0.001
Night sweats	7 (9.7)	0 (0)	0.009
Any classic TB symptoms[1]	65 (90.3)	43 (64.2)	<0.001
Comorbidity			
Cancer	0 (0)	12 (17.9)	<0.001
Hypertension	14 (19.4)	0 (0)	<0.001
Diabetes	4 (5.6)	0 (0)	0.043
Prior TB (retreatment)	11 (15.3)	34 (50.8)	<0.001
6MWT distance, m (median [IQR])	485 [100]	611 [125]	<0.001
FEV_1 %predicted (mean ± SD)	63.0 ± 19.2	76.0 ± 18.7	0.001
FVC %predicted (mean ± SD)	65.5 ± 17.5	71.0 ± 16.3	0.047
MVV, L/min (median [IQR])	77 [34]	107 [59.5]	0.009
FET, s (median [IQR])	3.51 [4.64]	4.82 [1.11]	0.004
Borg score = 1 after 6MWT	7 (9.7)	12 (17.9)	0.157
Borg score = 4 after 6MWT	13 (18.1)	0 (0)	<0.001

Data presented as n (%) unless otherwise stated.
[1]Any of the following symptoms at presentation: cough, fever, weight loss, or night sweats.
TB: tuberculosis; 6MWT: six-minute walk test; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; MVV: maximal voluntary ventilation; FET: forced expiratory time

spirometry at diagnosis (adjusted OR 5.02, 95% CI 2.42 to 10.40; p <0.001). Previous TB treatment was also associated with greater odds of moderate-to-severe dyspnea (mMRC ≥2) at presentation (adjusted OR ~3, p <0.01) and with a shorter 6MWT distance (adjusted β -48.5 m, 95% CI -71.2 to -25.8; p <0.001) in the regression models. By contrast, factors such as patient sex, age, and whether TB case was bacteriologically-confirmed or not did not independently identify impaired lung function in the adjusted model once TB history was accounted for.

In the multivariable model incorporating continuous pulmonary function and exercise capacity measures (Table 4), only a history of previous TB treatment remained significantly associated with moderate-to-severe dyspnea or mMRC ≥2 (aOR 2.06, 95% CI 1.26 to 3.35; p = 0.004). None of the spirometric or functional parameters were independently associated with dyspnea severity after adjustment.

Table 3. Multivariable regression analysis of factors associated with impaired spirometry and 6MWT

	aOR for impaired spirometry (95% CI)	p-value	β for 6MWT distance (95% CI)	p-value (β)
Previous TB treatment	5.02 (2.42 to 10.40)	<0.001	-48.5 (-71.2 to -25.8)	<0.001
Bacteriologically confirmed	1.32 (0.65 to 2.70)	0.430	-12.3 (-33.8 to 9.2)	0.260
Age (per year)	1.01 (0.99 to 1.04)	0.250	-0.60 (-1.52 to 0.32)	0.200
Sex (male)	0.98 (0.60 to 1.61)	0.920	2.10 (-5.7 to 9.9)	0.590
BMI (per kg/m²)	1.03 (0.98 to 1.08)	0.140	1.20 (-0.4 to 2.8)	0.120
Smoking (current/ former)	1.10 (0.85 to 1.41)	0.450	-5.80 (-20.1 to 8.5)	0.420

TB: tuberculosis; BMI: body mass index; aOR: adjusted odds ratio; 6MWT: six-minute walk test

Table 4. Multivariate regression analysis of factors associated with moderate-to-severe dyspnea (mMRC ≥2)

	aOR (95% CI)	p-value
Intercept	1.72 (0.2 to 15.12)	0.625
Age (per year)	0.99 (0.98 to 1.01)	0.499
Male (vs Female)	1.36 (0.83 to 2.21)	0.223
BMI (per kg/m²)	0.97 (0.93 to 1.01)	0.146
Ever smoker (pack-years >0)	1.16 (0.71 to 1.88)	0.560
Active TB (vs TB-negative)	0.98 (0.56 to 1.71)	0.939
Previous TB treatment	2.06 (1.26 to 3.35)	0.004
Bacteriologically-confirmed (vs others)	1.48 (0.7 to 3.11)	0.304
FEV_1 (%predicted)	1.0 (0.99 to 1.01)	0.392
FVC (%predicted)	1.0 (0.99 to 1.01)	0.890
FEV_1/FVC ratio	1.0 (0.98 to 1.01)	0.619
6MWT distance (per meter)	1.0 (1.0 to 1.0)	0.405

BMI: body mass index; TB: tuberculosis; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; 6MWT: six-minute walk test; aOR: adjusted odds ratio

DISCUSSION

While it may appear paradoxical that TB-negative individuals in this study demonstrated lower mean FEV_1 and FVC values compared to patients with active TB disease, this counterintuitive finding may be explained by differences between the populations. The TB-negative group in our study had a higher prevalence of chronic respiratory disorders (asthma, COPD) and other comorbidities that likely contributed to diminished lung function. Our multivariable analysis confirmed that these underlying factors (especially prior TB) outweighed the effect of active TB itself on baseline impairment. Essentially, many "TB-negative" participants had chronic lung disease unrelated to TB, leading to worse pulmonary metrics at diagnosis, whereas active TB patients, despite having an active infection, often lacked significant chronic lung injury at baseline.

This study provides novel insights into the functional respiratory status of patients newly diagnosed with active pulmonary TB. Surprisingly, individuals with active TB had, on average, better spirometric values and 6MWT performance relative to TB-negative controls. This does not imply that TB infection improves lung function; rather, it may reflect a selection phenomenon. Those who were ultimately confirmed to have TB tended to be younger and without chronic lung conditions, whereas many TB suspects who turned out to be TB -negative had pre-existing lung problems that likely prompted

their initial evaluation. Nevertheless, a substantial proportion of patients with active TB did show evidence of early functional compromise. Approximately 30% of the active TB cohort already met criteria for abnormal spirometry at the time of diagnosis, underscoring that early lung impairment is present in a significant subset of cases even at baseline.

Our subgroup analysis revealed considerable heterogeneity within the active TB population. Patients with bacteriologically-confirmed TB were younger and had fewer comorbidities specifically cancer than those with clinically-diagnosed TB, yet paradoxically showed worse lung function on average. This aligns with the idea that patients in the clinically-diagnosed group (often retreatment cases) may have adapted to chronic lung changes over time or had milder acute disease, whereas new TB cases with heavy bacterial burden experienced more acute loss of lung capacity. Additionally, clinically-diagnosed patients—by virtue of previous TB episodes—have already undergone interventions that preserved their functional status. Prior TB was notably more common in the clinically-diagnosed group, and our regression results identified it as a key independent associated factor for impairment. These findings reinforce the notion that cumulative lung damage from past TB can significantly impair present lung function—a conclusion supported by a recent systematic review that found that a history of TB is associated with significantly decreased lung function compared to no history.[3]

In the Philippine context, our study adds to the limited literature on pulmonary function during active TB disease. A local study by Masumoto et al found that Filipino TB patients in Manila experienced significantly impaired health-related quality of life, especially those with low education, positive sputum smears, and multiple symptoms.[7] Our findings complement this by focusing on physiologic function: even when lung volumes are relatively preserved on average, many patients have underlying impairment that might later manifest as reduced quality of life.

Another key finding is the impact of prior TB on current function. Patients with a history of prior TB (retreatment cases) consistently showed worse lung metrics at baseline, underscoring the cumulative damage from repeated episodes on respiratory health despite treatment. This suggests that clinicians should be particularly vigilant in evaluating lung function in retreatment TB cases, as they are at higher risk of baseline pulmonary impairment.

The finding that previous TB treatment was associated with moderate-to-severe dyspnea highlights the lasting functional impact of post-TB lung disease. Studies have shown that breathlessness and exercise limitation may persist despite normalized lung volumes and treatment completion, reflecting residual airway and parenchymal damage or deconditioning not captured by routine pulmonary function tests.[8-9]

Early initiation of pulmonary rehabilitation and breathing exercises during TB treatment may help improve outcomes for such high-risk patients. Supervised exercise programs lead to improvements in exercise capacity, lung function, and quality of life, supported by findings from a recent review on pulmonary rehabilitation in TB survivors. This is supported by emerging evidence: a recent review documented that pulmonary rehabilitation in TB survivors can significantly improve exercise capacity, lung function, and quality of life.[10] These considerations highlight the need to integrate functional assessment and rehabilitation into TB care, not only after cure but even during treatment, to mitigate long-term disability.

To our knowledge, this study is among the first studies in the Philippines to rigorously characterize baseline lung function in active TB patients and compare it with appropriate controls. Strengths include the relatively large sample size and comprehensive data collection including spirometry, exercise testing, and symptom scores for all participants at diagnosis. We adhered to international standards for pulmonary function testing and conducted subgroup and multivariate analyses to explore underlying factors.[5] However, several limitations should be noted. The study's cross-sectional design precludes assessment of causality or long-term outcomes—we cannot determine how pulmonary function trajectories evolve after TB treatment completion based on this baseline-only analysis. Another limitation is the inability to adjust for baseline imbalances in COPD and asthma prevalence between groups, which may have confounded the observed associations with the outcomes studied. We also did not incorporate chest imaging findings in our analysis; the extent of radiographic disease (e.g., cavitation or fibrosis) may explain some of the functional differences and would strengthen interpretations if included. Misclassification is another concern; the "clinically-diagnosed" TB group might have included some patients who in fact had non-TB disease (given the lack of microbiological confirmation), although all were treated as TB by experienced physicians. We attempted to minimize this by only including clinically-diagnosed cases with consistent clinical and radiologic evidence and having an alternative diagnosis for the TB-negative group. Additionally, we did not formally assess adherence to or the quality of pulmonary function maneuvers beyond adhering to ATS criteria; however, all patients were well coached, and poor effort tests were repeated to ensure valid results. Finally, our study was conducted at a single tertiary referral center which may limit generalizability. Patients seen at specialized clinics could differ from those managed in primary care–for example, more severe or complex cases might be overrepresented. Nonetheless, the referral-center context also enhanced the internal validity of measurements. Lastly, the study may be underpowered for the subgroup comparisons of bacteriologically-confirmed and clinically-diagnosed TB.

CONCLUSIONS

Our findings indicate that a substantial proportion of patients with active tuberculosis already exhibit lung impairment at the time of diagnosis. While active TB disease was associated with generally better lung function compared to TB-negative individuals, this paradox is likely attributable to a higher burden of chronic respiratory comorbidities (such as asthma and COPD) in the TB-negative group. Patients with history of previous TB treatment demonstrate worse functional outcomes, underscoring the cumulative impact of repeated disease episodes on respiratory health.

These findings emphasize the importance of comprehensive respiratory assessment including spirometry and 6MWT in at-risk patients. Routine evaluation of lung function may aid in identifying patients at risk for long-term pulmonary sequelae and enable early referral to pulmonary rehabilitation. Future studies should incorporate more detailed phenotyping and longitudinal follow-up to better understand the trajectory of TB -related lung impairment and to disentangle the overlapping effects of infectious and chronic pulmonary diseases.

Data Availability Statement
Datasets are not publicly available because participants in the study did not give written consent for their data to be shared.

Statement of Authorship
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Original Article

Validation study of the modified Drug Resistance in Pneumonia (mDRIP) score in identifying infections with drug-resistant pathogens among hospitalized patients with community-acquired pneumonia at the Chinese General Hospital and Medical Center

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ABSTRACT

Background: Community-acquired pneumonia (CAP) continues to be the leading cause of infection-related deaths globally and is the fourth leading cause of both morbidity and mortality in the Philippines. Despite the development of novel vaccines, antibiotics, and rapid diagnostic tests, managing CAP remains challenging, especially with the emergence of drug-resistant pathogens (DRP). The modified Drug Resistance in Pneumonia (mDRIP) score is a scoring system which was derived from locally-relevant clinical risk factors that can predict infections with DRP. The performance of mDRIP score in identifying infections with DRP among patients with CAP was evaluated in this cross-sectional study.

Methodology: A total of 127 participants with CAP were included. The mDRIP score was calculated upon admission. Antimicrobial culture results were later obtained and clinical outcomes were ascertained. The mDRIP score performance was assessed by determining the relevant performance metrics using area under the receiver operating characteristic curve (AUC-ROC). Clinical outcomes were compared between patients with DRP and those without.

Results: The prevalence of drug-resistant pathogens in the study was 40.16%. The most common organism isolated was *Klebsiella pneumoniae*. Among the major and minor risk factors for drug resistance included in the mDRIP score, the most common were recent antibiotic use (46.46%) and poor functional status (47.24%), respectively. The discrimination performance of the mDRIP score was good, with an AUC-ROC value of 0.868 (95% CI 0.801 to 0.935). There was no statistically significant difference in the length of hospital stay and hospital outcome between those with and without DRP.

Conclusions: The mDRIP score demonstrates good performance in identifying infections due to DRP in CAP. It is an accessible and effective risk stratification tool that can be utilized by clinicians for appropriate selection of antibiotics in CAP, especially in resource-limited settings.

Keywords: mDRIP score, community-acquired pneumonia, drug resistance, validation study

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INTRODUCTION

Community-acquired pneumonia (CAP) remains the leading cause of infection-related mortality globally.[1] The high incidence, hospitalization, and mortality rates impose a huge burden—including physical, psychological, and especially economic—to patients and their families. This problem is especially magnified in developing countries.[2]

CAP is a significant public health concern in the Philippines, ranking 4th in the leading cause of mortality as of 2024.[3] It places a heavy burden on healthcare resources, with PhilHealth data showing an economic impact of PhP 8.48 billion for moderate-risk cases and PhP 643.76 million for high-risk cases, and this is increasing up to the present time.[4]

CAP has recently been linked to the emergence of drug-resistant pathogens (DRP).[5] DRP is defined based on the results of sputum cultures and antibiotic susceptibility tests showing resistance to non-pseudomonal beta-lactam antibiotics (ceftriaxone, cefotaxime, ampicillin-sulbactam) as well as to respiratory fluoroquinolones (levofloxacin, moxifloxacin). DRPs require different antibiotics compared to the initial empiric antibiotics recommended in the guidelines for community-acquired pneumonia.[6] It has been found that the prevalence of DRP in community-acquired pneumonia differs across regions—20.0 to 45.2% in America, 5.9 to 33.0% in Europe, and 7.2 to 36.0% in the Asia Pacific region.[7] For Southeast Asia, data from Indonesia is 40.6%.[8]

The DRIP (Drug Resistance In Pneumonia) score published by Webb et al in 2016 is a model that predicts the risk of acquiring pneumonia due to drug-resistant pathogens. At a threshold of 4 points, the DRIP score demonstrated sensitivity of 0.82, specificity of 0.81, positive predictive value (PPV) of 0.68, and negative predictive value (NPV) of 0.90.[9] In comparison with other prediction models such as the Schreiber, Schorr, Niedermann, Shindo, Aliberti, Park, PES (*P. aeruginosa*, extended-spectrum β-lactamase-positive *Enterobacteriaceae*, and methicillin-resistant *Staphylococcus aureus* [MRSA]), and HCAP (healthcare-associated pneumonia) scores, the DRIP score performed significantly better in detecting the risk of pneumonia due to drug-resistant pathogens.[9] Further, it has been validated to be effective in guiding the appropriate use of broad-spectrum antibiotics in community-acquired pneumonia. A study done by Farkas et al concluded that the application of the DRIP score in patients suffering from CAP succeeded in reducing the use of broad-spectrum antibiotics.[10] The DRIP score consists of 10 risk factors associated with DRP. Major risk factors are: history of antibiotic use (prior 60 days), residence in a long-term care facility, enteral nutrition, and history of infection with a drug-resistant pathogen (prior 12 months). Minor risk factors are:

history of hospitalization (an inpatient hospital stay for more than 48 hours within the prior 60 days), chronic lung disease (defined as chronic obstructive, interstitial, or other structural disease, including bronchiectasis), poor functional status (defined as a Karnofsky score of less than 70 or non-ambulatory status), gastric acid suppression, wound care, and history of MRSA colonization (prior 12 months). A score of less than 4 is classified as low risk and a score of 4 and above is classified as high risk.[9]

In the Philippines, a study by Villalobos et al validated the DRIP score in a tertiary hospital, with results showing high specificity, thus, making it an efficient tool for antibiotic selection in clinical practice. This was comparable to the specificity of 81% observed in the study of Webb et al. Sensitivity, however, was only 62.1% compared to the 82% by Webb et al which was attributed by the investigators to the unavailability of prior infection records for patients who were admitted in other (i.e., outside) hospitals.[9,11] One noteworthy drawback identified by the investigators was the inapplicability of one of the major risk factors in the DRIP score, namely, residence in a long-term care facility as such is not a common practice in the country. This may affect the applicability of the DRIP score in our setting as previous studies had derived the cut-off point of 4 and computed the accuracy of the DRIP score with this component factored in. Thus, a modified DRIP (mDRIP) score eliminating residence in a long-term care facility as one of the major risk factors was evaluated by Villalobos et al. At the same cut-off value, results showed similar sensitivity and specificity with the original DRIP score.[11]

As the microbiology of CAP continues to evolve, predicting the risk of drug-resistant infections remains challenging, highlighting the need for better prediction methods. Generally, the DRIP score may help clinicians avoid unnecessary use of broad-spectrum antibiotics in patients with "low-risk" pneumonia. Moreover, it can help in selecting patients who can benefit from initiating broad-spectrum antibiotics in those with "high-risk" pneumonia. The mDRIP score is most relevant as it reflects the risk factors that are applicable in the local setting. Villalobos et al recommended further studies tailoring the risk factors of the DRIP score based on the local situation. Lastly, Webb et al and Villalobos et al recommended doing prospective implementation studies to determine the role of this prediction tool using patient outcomes as the measured endpoint.[9,11]

Hence, this study aimed to determine the validity of the mDRIP score in identifying infections due to drug-resistant pathogens among hospitalized adult patients with CAP at the Chinese General Hospital and Medical Center (CGHMC). Specifically, the study aimed to 1) determine the demographic and clinical profile of patients; 2) determine the prevalence of pneumonia due to DRP; 3) compare mDRIP scores and its individual components between those with and without DRP; 4) determine the accuracy, sensitivity, specificity, predictive values, and likelihood ratios of the mDRIP score in identifying infections with DRP; and 5) compare length of hospital stay and hospital outcome between those with and without DRP.

METHODOLOGY

Study design

This was a single-center cross-sectional study.

Study setting

The study was conducted at the Chinese General Hospital and Medical Center, a level IV tertiary healthcare institution in the Philippines with over 700-bed capacity.

Study population

Participants were adult patients (aged 18 years and above) with moderate- to high-risk CAP admitted from June 2024 to December 2024.

Excluded patients were those with incomplete data, inadequate quality of culture samples, cultures taken more than 48 hours post-admission, or those that reported no growth or yielded positive results for fungal growth. Cultures with sputum as specimen source were also excluded if a second, alternative pathogen was concomitantly recovered from a specimen collected by invasive means (blood or bronchoalveolar fluid). Cultures from blood were also excluded if bacteremia was from a more likely alternate source, such as the urinary tract.

Ethical considerations

The study was conducted in compliance with the ethical principles set forth in the Declaration of Helsinki and the National Ethical Guidelines for Research Involving Human Participants (NEGRIHP) 2022. Review and approval of the study protocol by the Chinese General Hospital and Medical Center Research Ethics Review Board (CGHMC RERB) were sought prior to study initiation (CGHMC RERB 2024-F-15).

Patient information and results of the study were kept strictly confidential by the primary author in compliance with the Data Privacy Act of 2012. Each participant was issued a unique code, hence, their names did not appear in any of the data collection tools. The data was stored in the primary investigator's database which was password-protected.

Study procedure

Eligible participants were patients with community-acquired pneumonia who were admitted or referred from either the ward or the emergency room. Informed consent was obtained from all the participating patients or their consenting party at the site of recruitment.

Pneumonia was defined based on criteria consistent with the Infectious Diseases Society of America/American Thoracic Society (IDSA/ATS) Clinical Pathway for CAP. This pertains to the presence of two or more clinical signs or symptoms—temperature <36.0°C or >38.0°C; respiratory rate >20 breaths per minute; room air oxygen saturation <90%; partial pressure of oxygen in arterial blood <60 mm Hg; cough; sputum production; white blood cell count <4,000/ul or >10,000/ul; or bandemia >10%—plus radiographic evidence of new parenchymal opacity or cavitation.

After obtaining consent, history taking was conducted with the patient, relative, or caregiver to collect demographic and clinical data, including risk factors for drug resistance. Particularly, the following data were collected for the mDRIP score: for the major risk factors—recent antibiotic use (use of any intravenous or oral antibiotics within the preceding 60 days prior to hospital admission); presence of tube feeding (includes nasogastric or jejunal feeding or feeding via a percutaneous gastrostomy tube); and prior drug-resistant pneumonia diagnosis within one year (a documented episode of pneumonia caused by a drug-resistant pathogen occurring within 12 months prior to hospital admission); while for the minor risk factors—prior hospitalization (an inpatient stay of more than 48 hours in the preceding 60 days); chronic

obstructive pulmonary disease (includes both clinically-diagnosed and those diagnosed through pulmonary function testing); functional status (evaluated using Karnofsky performance status); gastric acid suppression (intake of any histamine-2 receptor antagonist or any proton pump inhibitor within 14 days of admission); presence of an active wound (any type of open wound at the time of hospital admission); and methicillin-resistant *Staphylococcus aureus* (MRSA) colonization (either colonization or clinical infection with MRSA documented within the 12-month period preceding hospital admission). The mDRIP score, or the index test, was determined within 48 hours of admission. A score of at least 4 (2 major risk factors; 1 major risk factor plus 2 minor risk factors; or 4 minor risk factors) was classified as having high probability of pneumonia due to DRP, while a score of less than 4 was classified as having low probability. Notably, the mDRIP score does not include long-term care residency seen in the original DRIP score, as a component.

Microbiologic cultures were taken at baseline, with results typically available after 48 to 72 hours' incubation period. Cultures taken from any of the following sites—sputum, endotracheal aspirate, pleural fluid, bronchoalveolar lavage, or blood—were reviewed for the presence of drug-resistant pathogens and served as the reference standard. Chest X-rays were retrieved through the hospital information system, MERX™.

The process flow is seen in Figure 1.

Sample size

Sample size computation for a receiver operating characteristic (ROC) curve was conducted using PASS 2008 version 8.0.15. From the study of Oliver et al,[12] the estimated lower bound of the 95% confidence interval for the area under the receiver operating characteristic curve (AUC-ROC) of the mDRIP score in predicting drug-resistant pathogens was 0.690 (AUC_1). A null AUC (AUC_0) of 0.70 was employed as recommended by

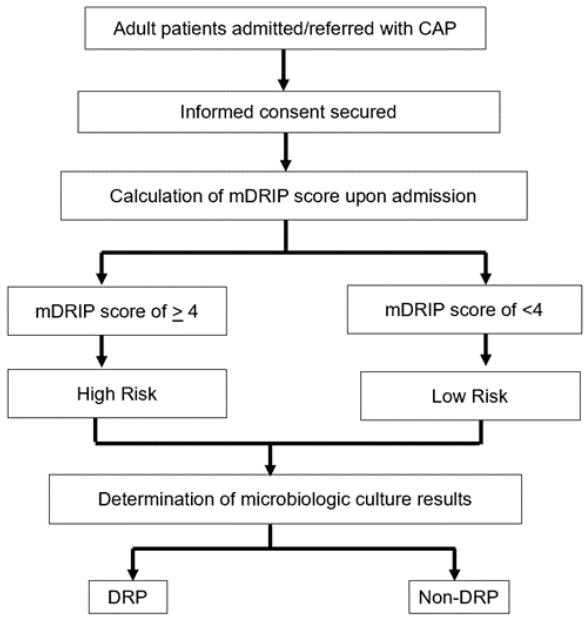

Figure 1. Schematic diagram of the data collection process. CAP: community-acquired pneumonia. mDRIP: modified Drug Resistance in Pneumonia; DRP: drug-resistant pathogen

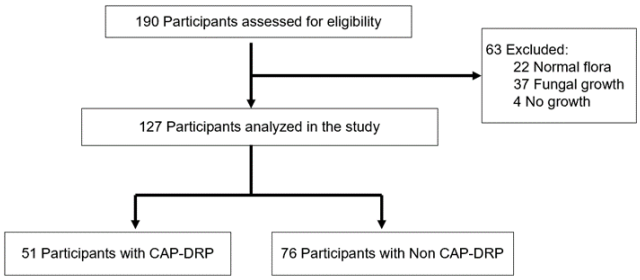

Figure 2. Participant flow chart

Hamilton.[13] With AUC_0 of 0.800, AUC_1 of 0.690, minimum power of 80%, and significance level of 5% (two-tailed), a total of 166 participants was necessary.

Data management and analysis

Statistical analyses were performed using Stata version 18, with significance set at a p-value of ≤0.05. Descriptive statistics summarized the data obtained while comparative analyses assessed differences in the patient characteristics and outcomes examined based on the presence or absence of drug-resistant pathogens using chi-square test of homogeneity or Fisher's exact test, Mann-Whitney U test, and independent t-test. The prevalence of pneumonia with drug-resistant pathogens was estimated alongside its 95% confidence interval (CI) using chi-square test exact binomial.

The AUC-ROC was employed to determine the psychometric properties of the mDRIP score in identifying infections with drug-resistant pathogens. This statistical test determined the discriminative ability of the mDRIP score in identifying the outcome, and was represented using the concordance (c) statistic or the AUC-ROC statistic. The sensitivity, specificity, predictive values, and likelihood ratios of the mDRIP score at a cut-off of 4 were also determined.

RESULTS

Demographic and clinical characteristics

As shown in Figure 2, a total of 190 participants were assessed for eligibility; sixty-three were removed based on the exclusion criteria. A total of 127 participants were deemed eligible and included in the study.

The demographic characteristics of the participants according to microbiologic culture status are presented in Table 1. The prevalence of drug-resistant pathogens in CAP was 40.16%. The median age of the participants was 73.00 years, and the majority were males (57.48%), non-smokers (61.42%), and had hypertension (50.39%) and diabetes mellitus (34.65%) as comorbidities. Comparative analyses showed that the median age of those with DRP was significantly higher than those without (80.00 vs 66.50 years; p = 0.001). Neurologic disease and cognitive impairment were more common in those with DRP (p = 0.007 and 0.038, respectively).

Microbiologic data and antimicrobial use

As seen in Table 2, the most common specimen type was sputum (85.04%). The most prevalent microorganism isolated was *Klebsiella pneumoniae* (29.13%), and the most commonly administered initial antibiotic was piperacillin-tazobactam (58.27%).

Comparison of mDRIP score and its components

As presented in Table 3, the median mDRIP score was 3.00 and

Table 1. Demographic and clinical characteristics of participants (n = 127)

	Total (N = 127)	With DRP (n = 51)	Without DRP (n = 76)	Test statistic[a]	p-value
Age, years (median [IQR])	73.00 [60.00 to 82.00]	80.00 [68.00 to 86.00]	66.50 [56.50 to 79.00]	-3.40*	0.001
Sex				0.06	0.802
Male	73 (57.48)	30 (58.82)	43 (56.58)		
Female	54 (42.52)	21 (41.18)	33 (43.42)		
Smoking history				2.48	0.463
Non-smoker	78 (61.42)	32 (62.75)	46 (60.53)		
Previous smoker	47 (37)	18 (35.29)	29 (38.16)		
Second-hand smoker	2 (1.57)	1 (1.96)	1 (1.32)		
Comorbidities					
Diabetes mellitus	44 (34.65)	17 (33.33)	27 (35.53)	0.06	0.799
Hypertension	64 (50.39)	31 (60.78)	33 (43.42)	3.68	0.055
Atrial fibrillation	4 (3.15)	2 (3.92)	2 (2.63)	0.17	1.000
Heart failure	4 (3.15)	0 (0.00)	4 (5.26)	2.77	0.148
Dyslipidemia	3 (2.36)	1 (1.96)	2 (2.63)	0.06	1.000
Chronic lung disease	39 (30.71)	16 (31.37)	23 (30.26)	0.02	1.000
Chronic kidney disease	11 (8.66)	6 (11.76)	5 (6.58)	1.04	0.347
Pulmonary tuberculosis	24 (18.90)	9 (17.65)	15 (19.74)	0.09	0.768
Neurologic disease	23 (18.1)	15 (29.41)	8 (10.53)	7.34*	0.007
Cognitive impairment	6 (4.72)	5 (9.80)	1 (1.32)	4.89*	0.038
Rheumatic arthritis	1 (0.79)	0 (0.00)	1 (1.32)	0.68	1.000
Malignancy	25 (19.69)	12 (23.53)	13 (17.11)	0.80	0.372

*Data presented as n (%) unless otherwise stated.
[a]Comparative analyses were conducted using chi-square test of homogeneity or Fisher's exact test (for Sex, Smoking status, and Comorbidities); and Mann-Whitney U test (for Age).
*Significant at 0.05
DRP: drug-resistant pathogen

most participants were categorized as low risk (61.42%). Among the major risk factors in the mDRIP, the most commonly seen was recent antibiotic use (46.46%) while among the minor risk factors, poor functional status (47.24%) was the most prevalent.

Comparative analyses showed that the median mDRIP score and the proportion of patients classified as high risk were significantly higher among those with DRP (p = 0.001 for both). Recent antibiotic use, enteral nutrition, recent hospitalization, poor functional status, and gastric acid suppression were also encountered more commonly in the DRP group (p <0.05).

Comparison of clinical outcomes

Table 4 shows that the median length of hospital stay was 8.00 days and most participants were discharged (88.98%). Length of hospital stay and hospital outcome were not significantly different in those with and without DRP (p >0.05).

Table 2. Microbiologic data and antimicrobial use for all participants

	n (%)
Specimen type	
Sputum	108 (85.04)
Throat swab	1 (0.79)
Endotracheal aspirate	9 (7.09)
Tracheal aspirate	8 (6.30)
Bronchoalveolar lavage aspirate	1 (0.79)
Isolated microorganism	
Achromobacter species	1 (0.79)
Acinetobacter baumannii	11 (8.66)
Acinetobacter iwoffii	1 (0.79)
Alcaligenes faecalis	2 (1.57)
Citrobacter koseri	2 (1.57)
Enterobacter cloacae	7 (5.51)
Escherichia coli	8 (6.3)
Klebsiella aerogenes	2 (1.57)
Klebsiella oxytoca	1 (0.79)
Klebsiella pneumoniae	37 (29.13)
Proteus mirabilis	2 (1.57)
Pseudomonas fluorescens	2 (1.57)
Pseudomonas aeruginosa	15 (11.81)
Rothia mucilaginosa	1 (0.79)
Serratia marcescens	6 (4.72)
Staphylococcus aureus	7 (5.51)
Staphylococcus epidermidis	2 (1.57)
Staphylococcus haemolyticus	2 (1.57)
Stenotrophomonas maltophilia	6 (4.72)
Streptococcus mitis	1 (0.79)
Streptococcus oralis	1 (0.79)
ESBL *K. pneumoniae*	2 (1.57)
ESBL *S. haemolyticus*	1 (0.79)
Methicillin-resistant *S. aureus* (MRSA)	1 (0.79)
Methicillin-resistant *S. epidermidis* (MRSE)	3 (2.36)
Multidrug-resistant and carbapenemase-producing *E. coli*	1 (0.79)
Multidrug-resistant and carbapenemase-producing *K. oxytoca*	1 (0.79)
Multidrug-resistant and carbapenemase-producing *P. aeruginosa*	1 (0.79)
Initial antibiotic	
Azithromycin	22 (17.32)
Cefepime	5 (3.94)
Ceftazidime	8 (6.30)
Ceftazidime-avibactam	1 (0.79)
Ceftriaxone	29 (22.83)
Ceftriaxone-sulbactam	1 (0.79)
Ciprofloxacin	2 (1.57)
Clindamycin	9 (7.09)
Ertapenem	1 (0.79)
Levofloxacin	3 (2.36)
Meropenem	4 (3.15)
Piperacillin-tazobactam	74 (58.27)

ESBL: extended spectrum beta-lactamase

Diagnostic accuracy indices of the mDRIP

Based on the AUC-ROC, the mDRIP score was shown to have an

Table 3. Comparison of mDRIP and its components according to microbiologic

	Total (N = 127)	With DRP (n = 51)	Without DRP (n = 76)	Test statistic[a]	p-value
mDRIP score (median [IQR])	3.00 [2.00 to 4.00]	4.00 [4.00 to 5.00]	2.00 [1.00 to 3.00]	-7.13*	0.001
mDRIP risk stratification				62.87*	0.001
Low risk (mDRIP <4)	78 (61.42)	10 (19.61)	68 (89.47)		
High risk (mDRIP ≥4)	49 (38.58)	41 (80.39)	8 (10.53)		
Major risk factors					
Recent antibiotic use	59 (46.46)	33 (64.71)	26 (34.21)	11.41*	0.001
Enteral nutrition	37 (29.13)	24 (47.06)	13 (17.11)	13.26*	0.001
Prior infection with DRP	2 (1.57)	2 (3.92)	0 (0.00)	3.03	0.159
Minor risk factors					
Recent hospitalization	26 (20.47)	17 (33.33)	9 (11.84)	8.66*	0.003
Chronic pulmonary disease	35 (27.56)	18 (35.29)	17 (22.37)	2.55	0.110
Poor functional status	60 (47.24)	36 (70.59)	24 (31.58)	18.63*	0.001
Gastric acid suppression	37 (29.13)	25 (49.02)	12 (15.79)	16.32*	0.001
Wound care	1 (0.79)	0 (0.00)	1 (1.32)	0.068	1.000
MRSA colonization	0 (0.00)	0 (0.00)	0 (0.00)	—	—

Data presented as n (%) unless otherwise stated.
[a]Comparative analyses were conducted using chi-square test of homogeneity or Fisher's exact test (for Major and Minor risk factors, mDRIP risk stratification); and Mann-Whitney U test (for mDRIP score).
*Significant at 0.05
DRP: drug-resistant pathogen; MRSA: methicillin-resistant *S. aureus*

Table 4. Comparison of clinical outcomes according to microbiologic status

	Total (N = 127)	With DRP (n = 51)	Without DRP (n = 76)	Test statistic[a]	p-value
Length of hospital stay, days (median [IQR])	8.00 [7.00 to 14.00]	9.00 [7.00 to 15.00]	8.00 [6.50 to 11.00]	-0.90	0.371
Hospital outcome				0.05	0.827
Discharged	113 (88.98)	45 (88.24)	68 (89.47)		
Expired	14 (11.02)	6 (11.76)	8 (10.53)		

Data presented as n (%) unless otherwise stated.
[a]Comparative analyses were conducted using chi-square test of homogeneity or Fisher's exact test (for Major and Minor risk factors, mDRIP risk stratification); and Mann-Whitney U Test (for mDRIP score).
*Significant at 0.05
DRP: drug-resistant pathogen; MRSA: *methicillin-resistant S. aureus*

accuracy of 0.868 (Figure 3). At a cut-off of 4, risk stratification via mDRIP had a sensitivity and specificity of 80.40% and 89.50%, respectively. The estimated positive predictive value (PPV) was 83.70% and the negative predictive value (NPV) was 87.20%. The positive likelihood ratio (LR+) was 7.64 while the negative likelihood ratio (LR–) was 0.219.

Table 5. Accuracy indices of mDRIP in identifying drug-resistant pathogens in CAP

	Calculation	Value, %	95% CI, %
Accuracy	---	0.868	0.801 to 0.935
Sensitivity	41/51	80.40%	66.90 to 90.20
Specificity	68/76	89.50%	80.30 to 95.30
Positive predictive value	41/49	83.70%	70.30 to 92.70
Negative predictive value	68/78	87.20%	77.70 to 93.70
Positive likelihood ratio	(41/51)/(8/76)	7.64	3.91 to 14.90
Negative likelihood ratio	(10/51)/(68/76)	0.219	0.125 to 0.384
Youden's index	---	0.699	---

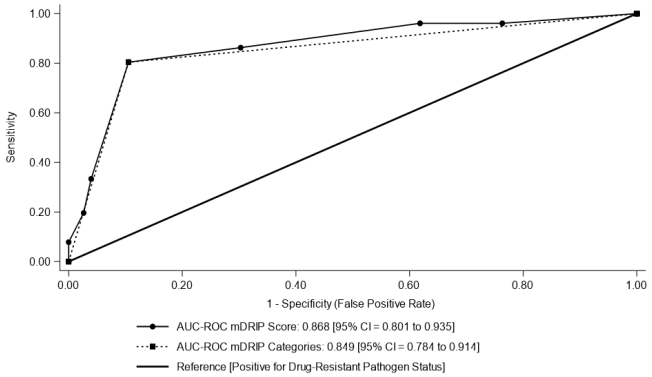

Figure 3. Area under the receiver operating characteristic curve (AUC-ROC) of mDRIP in identifying drug-resistant pathogens in CAP

DISCUSSION

This single-center cross-sectional study validated the utility of the modified DRIP (mDRIP) clinical prediction score for identifying pneumonia due to drug-resistant pathogens. The mDRIP score is a modified version of the original DRIP score which was tailored based on well-established host risk factors in the local setting. At a cut-off of 4, the mDRIP categorized patients as high risk or low risk. With an AUC-ROC of 0.8680 (95% CI 0.801 to 0.935), mDRIP showed good performance in identifying infections due to DRP in community-acquired pneumonia. Further, results of this study showed a higher specificity of 89.50% and higher sensitivity of 80.40% compared to the study done by Villalobos et al which reported a specificity and sensitivity of 81% and 62.1%, respectively. In this study, all participants were either new patients or previous patients in the same institution who were re-admitted, hence, all the risk factors were properly accounted for especially the history of prior DRP infection, probably explaining such results.

The prevalence of drug-resistant pathogens was 40.16%, which is notably increased compared to the prevalence of 29.7% in the study of Villalobos et al. The timing of the study may have had an impact since it was done post-pandemic whereas the study by Villalobos et al was conducted pre-pandemic. Increased public awareness of various health conditions post-pandemic may have led more people to seek appropriate consultation thereby increasing hospital admissions and the likely increased detection of DRP. Another possible explanation is the changes in environmental risk factors, such as worsening pollution.[14] Moreover, the enhanced data collection and

reporting system, particularly the hospital information system MERX™ in CGHMC, may have contributed to the increased prevalence. Another plausible contributor to the high prevalence of DRP is the demographic and clinical profile of the participants; a substantial proportion of the study population has increased susceptibility for high-risk pneumonia due to factors such as advanced age and presence of comorbid conditions specifically, diabetes mellitus.

K. pneumoniae was the most commonly isolated pathogen in this study whereas *P. aeruginosa* was the most frequent in Villalobos et al. Comorbidities among participants were comparable, with hypertension and diabetes mellitus being the most common (50.39% and 34.65%, respectively).

A higher proportion of patients with DRP were males (58.82%) compared with females (41.18%).This may be attributed to differences in immune response brought about by hormonal effects. Sex hormones act as important modulators of the immune response, with the male sex hormone testosterone generally being immunosuppressive while the female sex hormone estrogen tends to be immunoenhancing.[15]

Recent antibiotic use was the most common major risk factor for drug resistance identified (46.46%). In the derivation of the original DRIP score by Webb et al, this association was likewise observed, with the most predictive interval being 60 days prior to admission, which was also consistent with other studies. Costelloe et al concluded that individuals prescribed antibiotics in the primary care setting for either a respiratory or urinary tract infection develop bacterial resistance to that antibiotic, with the effect being greatest in the month immediately after treatment and may persist for up to 12 months.[16] In another study by Goldstein et al, multidrug-resistant organisms were subsequently isolated from moxifloxacin-treated patients and ceftriaxone/azithromycin-treated patients within 90 days after beginning therapy.[17] Among the minor risk factors, poor functional status was the most prevalent (47.24%) which may be partly explained by the clinical profile of participants. The median age was 73 years old, and participants with either neurologic disease or cognitive impairment made up 22.8% of the total. This finding is similar to the study of Shindo et al where non-ambulatory status was shown to be a significant independent risk factor for DRP in community-acquired pneumonia.[18]

Clinical prediction models like the mDRIP score calculate the probability of an outcome for a patient based on their individual characteristics.[19] These models help identify individuals at higher risk for specific conditions or outcomes, thereby allowing targeted interventions and appropriate resource allocation. Prediction tools, however, have been reported in survey data of physicians as time-consuming, difficult to use, and not always providing value.[20] Its implementation can also be difficult due to barriers for adoption and utilization, and its integration in the clinical workflow can be challenging especially when prediction scores include large numbers of risk factors that are difficult to obtain from an electronic health record.[21] The modification in the mDRIP score streamlined the original DRIP score by considering locally-relevant clinical risk factors, making it an easily accessible tool that requires minimal time to provide a quick recommendation, hence, addressing challenges typically associated with clinical prediction tools. Elligsen et al reported a similar heuristic approach, utilizing previous culture results as stewardship intervention to optimize initial empiric antibiotic use which improved prescribing.[22] Additionally, the clinical relevance of the mDRIP is especially valuable in resource-limited settings like the Philippines. Although technological advancements have introduced tests capable of quickly identifying pathogens compared to microbiologic cultures, such as the multiplex polymerase chain reaction assay that offers the advantage of rapidly identifying multiple pathogens in a single sample with a short turnaround time, this test is not widely accessible in many hospitals across the country and its high cost makes it unaffordable for many patients. In this context, mDRIP can serve as a complementary and effective clinical prediction tool.

Limitations

This study has the following limitations: It was conducted in a single urban academic private hospital, limiting its generalizability to other healthcare settings such as public hospitals with different patient populations, resources, and healthcare practices. Additionally, the reliance on microbiologic cultures with non-standardized drug susceptibility testing may affect consistency of detecting drug-resistant pathogens. Moreover, the appropriateness of antibiotic used and its effect on outcomes was not considered. Lastly, the study may be insufficiently powered given that the sample size computation was based on a study using DRIP score, not mDRIP.

Recommendations

In order to enhance the generalizability and clinical applicability of the mDRIP outside the original setting in which it was developed, additional local validation studies, especially in different regions of the country and in different healthcare settings are thus recommended. In addition, further studies to determine the impact of mDRIP on antibiotic utilization while factoring in the effect of antibiotic appropriateness on the outcomes are recommended. Future studies should also consider performing a priori sample size calculations based on parameters specific for the mDRIP to ensure adequate statistical power for detecting meaningful associations or differences. Also, expanding the sample size may enhance validity and enable more precise assessment of the performance of the mDRIP.

CONCLUSIONS

Prediction of the risk of disease due to drug-resistance pathogens remains a challenge for clinicians. This prospective study shows that the modified DRIP, using a cut-off score of ≥4, is a useful clinical tool for predicting the risk of pneumonia due to drug-resistant pathogens. As an easily accessible decision support tool, it has the potential to reduce the irrational use of broad-spectrum antibiotics in community-acquired pneumonia, especially among low-risk patients and in resource -limited settings. Further studies to strengthen the role of mDRIP in optimizing antibiotic prescribing practices are encouraged.

Data Availability Statement

Datasets are not publicly available because participants in the study did not give written consent for their data to be shared.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authors' Disclosure

The authors declared no conflict of interest.

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All authors are required to submit individual declarations of conflicts of interest using the **International Committee of Medical Journal Editors Disclosure of Interest form**. The form should be completely accomplished and included with the submission. Potential conflicts of interest include (but are not limited to) ownership, employment, research support, involvement as speaker, consultant, or any other financial relationship or arrangement with manufacturers, companies, suppliers, or distributors, by any of the authors or his/her immediate family.

INFORMED CONSENT FORM

For case reports/series and grand rounds, the authors shall be required to submit a scanned copy of the written/informed consent for publication from the involved patient/subject. For case series whose patient data are reported in aggregate, informed consent is not required. However, if the case series includes patient details that contain individual information which make them identifiable (e.g., individual case histories, photos, x-rays, etc.), an informed consent form for publication must be submitted.

The **PJCD** encourages the use of its standard **Informed Consent Form**. If the authors prefer to use their institution's Informed Consent Form, the same may be accepted provided there is explicit mention that the patient consents to the publication of information about him/her in a journal article. The Editor-in-Chief may require the use of its standard ICF if the institutional ICF is found to be insufficient. Shall the involved subject/s and/or relative/guardian no longer be available to provide Informed Consent, the Author/s shall state so in the cover letter with a description of the due diligence exerted in order to secure Informed Consent. PJCD will decide whether to accept submissions without informed consent on a case-by-case basis.

ARTICLE CATEGORIES

The **PJCD** publishes articles in the following general categories:

Original Articles (Peer-reviewed)

- Primary research article used to publish data gathered and analyzed by the author/s.
- Original articles shall not exceed 3500 words excluding figures, tables, and references.
- Structured abstracts for original articles shall not exceed 300 words.

Systematic Reviews/Meta-analysis (Peer-reviewed)

- Comprehensive summary of research on a specific topic gathered in a systematic manner and representing the current knowledge base
- Systematic reviews shall not exceed 3500 words, excluding figures, tables, and references.
- Structured abstracts for systematic reviews/meta-analysis shall not exceed 300 words

Case Report/Case Series (Peer-reviewed)*

- Primary research article reporting a rare and interesting clinical case, occurrence of uncommon features of a common condition, emergence of new or previously unknown pathology.
- Case reports shall not exceed 1200 words excluding figures, tables, and references.
- Case series shall not exceed 1500 words excluding figures, tables and references.
- Unstructured abstracts of case reports/case series shall not exceed 200 words.
- In certain cases, PJCD may request for a formal determination from the IRB that a case (or collection of cases) does not constitute research, hence, does not require IRB approval.

Grand Rounds

- Interesting cases presented during the PCCP Interhospital Symposium by the different training institutions to highlight the strengths and uniqueness of their training, services, and patient cases
- The Interhospital Symposium is conducted in a "grand rounds" format and include presenting the medical problems and treatment of a particular patient to colleagues
- Grand Rounds shall not exceed 2000 words excluding figures, tables, and references.
- Further instructions for this article type are available in the website.

Guidelines and Consensus Statements

- Guidelines and consensus statements shall not exceed 4000 words excluding figures, tables, and references.
- Unstructured abstracts of guidelines and consensus statements shall not exceed 300 words.

Feature Articles

- Invited/solicited articles from technical experts or specialists presenting up-to-date evidence-based knowledge on a particular field or topic
- Feature articles shall not exceed 1500 words excluding figures, tables, and references.
- Unstructured abstracts of feature articles shall not exceed 150 words.

Opinion Articles

- Invited/solicited articles from technical experts or specialists expressing the author's opinion or unique viewpoint on a particular field or topic
- Opinion articles shall not exceed 1500 words excluding figures, tables, and references.
- Unstructured abstracts of feature articles shall not exceed 150 words.

INSTRUCTIONS TO AUTHORS

Editorials
- Article representing opinion/s of the Editor/s on specific topics
- Editorials shall not exceed 1000 words excluding references (if any).

Correspondence/Letters to the Editor
- Brief reports of data from original research shared by author/s to the journal
- Correspondences shall not exceed 500 words excluding references (if any).

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MANUSCRIPT
Authors are strongly encouraged to use the EQUATOR Network Reporting Guidelines when writing their manuscripts.

During peer review, the same checklists will be used by external reviewers and may inform their recommendation on the manuscript.

Title
Complete title of the article shall be informative and as brief as possible (no more than 20 words

Author/s
Complete names of each author with highest academic degree(s) and complete address of a maximum of one (1) institutional affiliation per author.

Presentations in Previous Conferences/Conventions/Scientific Meetings
Listing of any meeting(s)/conference(s) where the work has been previously presented as oral report or poster, and/or any awards/distinctions. The title, venue, month, and year of the meeting/conference shall be included.

Corresponding Author
Corresponding author's name and complete contact information which includes official mailing address, telephone, and e-mail address. Personal contact information are discouraged. The corresponding author will be responsible for all questions about the manuscript. *NOTE: Only one author is to be designated as corresponding author and he/she does not need to be the first author on the manuscript.*

Appropriate footnotes for explanatory purposes or additional information may be placed with proper cross-referencing to the main text, in the following order of usage: *, **, ***

Funding Source
Information on financial support received related to the research, authorship, and/or publication of the article, if any, shall be listed, including the funding agency name and grant number. The purpose of the funding shall be described.

Abstract
Original Articles and Review Articles require a structured abstract of not more than 300 words, with the following four headings:

Background: Briefly state the problem being addressed and the purpose/s or aim/s of the study.
Methodology: State the study design (e.g., randomized clinical trial, case-control study, cross-sectional study, systematic review), setting (multi-center, institutional, etc), study population.
Results: Briefly summarize the data obtained. Results shall be accompanied by data with confidence intervals and the exact level of statistical significance.
Conclusions: Provide brief and concise conclusion(s) directly supported by the data.
NOTE: Do not place crosslinks to references in the abstract.

Case Reports/Case Series do not require a structured abstract, with a maximum of 200 words.

Grand Rounds do not have an abstract.

Keywords
At least 3 keywords (maximum of 10) should be provided. These terms are relevant to the article that readers or researchers may use to facilitate online searches in journal databases. *NOTE: Medical Subject Headings database ([MeSH] of the National Center for Biotechnology Information [NCBI] [https://www.ncbi.nlm.nih.gov/mesh/]) may be used to check if keywords provided are likely to yield search results.*

Body of the Text
For **Original Articles and Review Articles**, the manuscript shall be written following the IMRAD format (Introduction, Methodology, Results and Discussion, Conclusion).

Introduction: The Introduction shall provide a brief background for the study, to include the research question, rationale, objectives of the study, and hypothesis to be tested if any. Cite only the most pertinent past publications and shall not be an extensive review of the literature.
Methodology: Methods shall be written with sufficient detail to permit reproducibility.
- Study Design: State the study design using a phrase such as randomized or nonrandomized clinical trial, case-control study, cross-sectional study, cohort study, systematic review, meta-analysis;
- Setting: (e.g. multicenter, institutional, clinical practice);
- Study Population: Number of participants, inclusion/exclusion criteria, selection and randomization procedures undertaken
- Intervention, to include main and secondary outcome measure(s);
- Data and statistical analyses, to include what specific software was used for the computations.
- For Original Articles, statements regarding adherence to the Declaration of Helsinki, approval by the Institutional Review Board (IRB)/Ethics Committee, and description of the informed consent process shall be included.

Results: Results must be concise. This may include demographic data of the study population, outcomes, and measurements. Data shall be accompanied by confidence intervals (usually at the 95% interval) and exact *p-values* or other indicators of statistical significance. Negative results should also be reported.
Discussion: The discussion shall be restricted to the significant findings presented. Results should not be repeated in this section. Limitations should be stated, to include whether additional studies are required, and the implications of the results.
Conclusion/s: The conclusion(s) shall be directly supported by the results and shall state how the study addresses the objectives. Overgeneralization and speculation are discouraged.

For **Case Reports/Series**, the manuscript should contain the following general sections: Introduction, Case Presentation, Discussion, and Conclusion.

Introduction: The Introduction shall provide a brief summary of what is unique about the case and what it adds to the scientific literature.
Case Presentation: The Case Presentation shall include the patient history, physical examination, test results, differential diagnoses, diagnosis, treatment, and, when available, the course on follow-up and outcomes.
Discussion: This section should contain the discussion of the diagnosed condition, including the treatment options and managements, as in other clinical manuscripts. The strengths and limitations of the case should be stated.
Conclusion: The conclusion shall provide readers with the learning points gathered from the case report/series or grand rounds.

For **Grand Rounds,** further instructions for this article type are available in the website.

When not pertinent to the case, manuscripts should refrain from giving away patient details not relevant to the case that, collectively, risk identifying the patient to the public.

Abbreviations
All abbreviations shall be spelled out once (i.e., the first time they are mentioned in the text), followed by the abbreviation enclosed in parentheses.

INSTRUCTIONS TO AUTHORS

Abbreviations shall be restricted to those that are widely used, accepted, and understood.

Measurements
All measurements and weights shall be expressed in SI units.

Mention of Drugs and Medications
Use generic names only in the text body. State the trade name of a particular drug cited in parentheses including the manufacturer's name, city, state and/or country when first mentioned in the text.

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With regard to instruments or equipment utilized in the study, enclose in parentheses the specific model, manufacturer's name, city, state and/or country.

Conflicts of Interest
Potential conflicts of interest where existing, shall be disclosed. This includes but is not limited to: ownership, employment, research support (including provision of equipment or materials), involvement as speaker, consultant, or any other financial relationship or arrangement with manufacturers, companies or suppliers. Such disclosure will indicate whether the person and/or his/her immediate family has any financial relationship with pharmaceutical companies, medical equipment manufacturers, biomedical device manufacturers, or any companies with significant involvement in the field of health care.

Acknowledgments
Contributors to the work who do not fulfill all of the authorship criteria shall be acknowledged in this section following the Contributor Role Taxonomy (CRediT).

Tables, Figures, Illustrations and Photographs
Tables
All tables shall be embedded within the body of the text at the appropriate points.

Only tables cited in the text should be included. All tables should be called out in the text and shall be numbered in ascending order depending on the sequence they were referred to in the text. A different order for tables and figures is to be used. Symbols are * † ‡ § ¶.

Table titles must be placed on top of the table.

Headings within the table must be bold-faced. Columns should be clearly labeled, including units of measure.

Explanatory notes or legends should be written at the bottom of the table or figure. All abbreviations should also be explained.

Footnotes may be placed at the bottom of the table if there is a need to make the table understandable that will not easily fit into the table title or data cells.

Figures (Graphs, Illustrations, and Photographs)
All figures shall be embedded within the body of the text at the appropriate points.

Each figure must be numbered consecutively in Arabic numerals by order of citation in the text. Each shall have a brief explanatory legend as necessary. Legends must identify all symbols or letters that appear on the prints. Any figure that has been published elsewhere or adapted shall have an acknowledgement to the original source. A copy of the release to publish the figure signed by the copyright holder must also be submitted.

Each final figure (graph, illustration, and photograph) shall be submitted as individual Joint Photographic Experts Group (JPEG), Portable Network Graphics (PNG), or Tag Image File Format (TIFF) files with appropriate labels (figure number, title).

Modifications, such as cropping, changes in color, orientation, or placement of arrows or shapes, should be disclosed.

Arrows or other indicators used to identify key structures in illustrations and photographs should be part of the picture and not pasted as a separate object.

Graphs
Graphs may be submitted in "PowerPoint" or "Excel" format. Raw data may be requested by the Editorial Board for verification of computations.

Illustrations
Illustrations must be professionally rendered with appropriate labels.
Photographs
Photographs (clinical photographs, fluorescein angiograms, computed tomography [CT] scans, magnetic resonance imaging [MRI], X-ray, photomicrographs, transmission/scanning electron micrographs [TEM/SEM], graphs, etc.) shall have a resolution of at least 600 dpi. Photographs may be in black and white, or submitted in full color.

Photomicrographs shall include stains used and magnification.

Clinical photographs shall be masked when possible to prevent identification of the patient. Any personally-identifying data or features of the patient/subject under study such as names, case or hospital numbers, identifying tattoos, etc., should be removed when not pertinent to the understanding of the case, diagnostic questions, and interventions being discussed.

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Supporting material that cannot be included in the publication of the manuscript for reasons of space but is complementary and directly relevant to the manuscript content, can be made available online as supplementary material. These may include additional figures or tables, data sets, or detailed methods.

The supplementary material should be referred to in the main manuscript for example as "See Supplementary Table 1" or "See Supplementary Figure 1".

References
Authors are responsible for the accuracy and completeness of their references and for correct text citations. All references should be identified at the appropriate parts of the text using Arabic numerals as superscript, cross-referenced in consecutive order in the list of references.

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Date

The Editor in Chief
Philippine Journal of Chest Diseases
84-A Malakas Street, Pinyahan, Quezon City 1100

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Article Type	Indicate if Original Article, Systematic Review/Meta-Analysis, Case Report/Case Series, Grand Rounds (from PCCP Interhospital Symposium), Guidelines or Consensus Statement, Feature Article, Correspondence/Letter to the Editor

On behalf of all the authors, I shall act as the corresponding author with the journal from hereon.

We are submitting with this letter, the completely accomplished **PJCD Author Form,** individually accomplished **ICMJE Declaration of Conflicts of Interest**, as well as supplementary required files (Informed Consent Form for Case Reports/Case Series/Grand Rounds; Institutional Animal Care and Use Committee approval for animal studies; or Institutional Review Board (IRB) Approval for Original Articles).

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Philippine Journal of CHEST DISEASES
The official publication of the Philippine College of Chest Physicians

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AUTHORSHIP CERTIFICATION

In consideration of our submission to the **Philippine Journal of Chest Diseases**, all of the undersigned author(s) hereby certify, that we have fulfilled the ICMJE Authorship criteria: (1) active and sufficient participation in the conception or design of the work, the acquisition, analysis and interpretation of data for the work; AND (2) drafting the work, revising it critically for important intellectual content; AND (3) responsibility for the final approval of the version to be published; AND (4) accountability for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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The undersigned author(s) of the manuscript hereby declare:

- That the submitted manuscript represents original, exclusive and unpublished material;
- That it is NOT under simultaneous consideration for publication elsewhere until a final editorial decision has been issued by PJCD;
- That the study on which the manuscript is based had conformed to ethical standards and/or had been approved by the appropriate institutional ethics committee;
- That the article had written/informed consent for publication from involved subjects (for case reports/series and grand rounds only) and that in case the involved subject/s can no longer be contacted (i.e., retrospective studies, no contact information, etc), all means have been undertaken by the author(s) to obtain the consent; and
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***The provided ORCID ID of the author(s) will facilitate linking of the published article to their ORCID account. Authors' email addresses will be included in the article's metadata but only the corresponding author's email address will be published with the article.*

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Philippine Journal of CHEST DISEASES
The official publication of the Philippine College of Chest Physicians

INFORMED CONSENT FORM FOR PUBLICATION OF CASE REPORTS/CASE SERIES/GRAND ROUNDS

It is the commitment of the **Philippine Journal of Chest Diseases** to ensure that patient rights to confidentiality and privacy are observed as part of its ethical publication practices. For case reports, case series, and grand rounds to be accepted by the **Philippine Journal of Chest Diseases**, the author/s must document that patients or patients' legal guardian/relative have provided informed consent to publish information about them in the journal. The completely accomplished Informed Consent Form shall be scanned and submitted along with the manuscript. **No manuscript shall be received without the form.**

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Further, we appreciate the thoughtful comments and efforts of the following reviewers of 2025:

Dr. Maria Cecilia Alarilla-Batungbacal (Hi-Precision Diagnostics, East Avenue, Quezon City)
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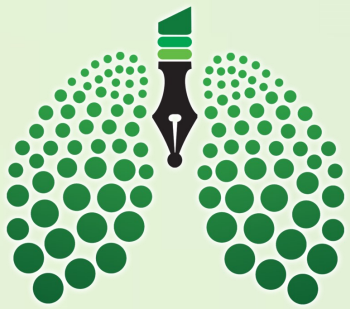
The official logo of the **Philippine Journal of Chest Diseases** consists of a pen surrounded by colored dots forming the shape of the lungs. The gradient represents the process of building the manuscript from research conception to publication, ultimately forming a cohesive and coherent written work represented by the lungs.



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