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Evaluation of Symptom Burden in COPD Patients Following a Home-Based Pulmonary Rehabilitation Program

Evaluación de la carga de síntomas en pacientes con EPOC tras un programa de rehabilitación pulmonar domiciliaria

Irmawan Andri Nugroho[1,2], Fatimah Ahmedy[3*], Zulkhairul Naim bin Sidek Ahmad[4]

SUMMARY

Introduction: *Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by persistent airflow limitation, resulting in significant symptoms, particularly dyspnea, fatigue, and reduced exercise capacity. The symptoms negatively impact patients' quality of life and daily activities. Pulmonary rehabilitation (PR) is an established intervention for reducing symptom burden; however, traditional center-based programs frequently experience underutilization. Home-based pulmonary rehabilitation (HPR) offers a feasible option, particularly in settings with limited resources.* **Objective:** *This study aims to assess the symptom burden in patients with COPD who have undergone a home-based pulmonary rehabilitation program.* **Method:** *This study utilized the COPD Assessment Test (CAT) to assess the symptom burden of patients with COPD following an eight-week home-based pulmonary rehabilitation program. A randomized controlled trial was conducted involving 60 clinically stable patients with COPD. Participants were randomly assigned to an intervention group (n = 30), which received structured HPR, or a control group (n = 30), which received standard care. The HPR program consisted of aerobic and resistance exercises, breathing techniques, educational resources, and weekly phone monitoring. Statistical analyses utilized paired and independent t-tests. Ethical approval was secured from the Health Research Ethics Committee of Universitas Muhammadiyah Gombong.* **Results:** *At baseline, participants in both groups had a moderate to high symptom burden. Post-intervention, the HPR group showed a significant decrease in CAT scores,*

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ORCID: 0000-0001-5494-6174[1]
ORCID: 0000-0002-5811-4188[3]
ORCID: 0000-0002-0608-7528[4]

[1]Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Malaysia. E-mail: irmawan_a@yahoo.co.id
[2]Department of Nursing, Faculty of Health Sciences, Universitas Muhammadiyah Gombong, Indonesia. E-mail: andri@unimugo.ac.id

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[3]Rehabilitation Research & Service Group. Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Malaysia. E-mail: fatimahmedy@ums.edu.my
[4]Department of Medical Education, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah. E-mail: zulkhairul@ums.edu.my

*Corresponding author: Fatimah Ahmedy. E-mail: fatimahmedy@ums.edu.my
Address: Universiti Malaysia Sabah Kota Kinabalu 88400 Sabah Malaysia

with a mean difference of 7.80 ± 4.122, compared to a mean difference of 0.23 ± 0.728 observed in the control group (p < 0.001). Following the intervention, 40 % of the HPR group indicated a low symptom burden, with no participants remaining in the high or very high categories. Conversely, the majority of participants in the control group maintained higher levels of symptom burden. **Conclusion:** *The results indicate that home-based pulmonary rehabilitation significantly reduces symptom burden in patients with COPD, as evidenced by improved CAT scores. The findings support the implementation of HPR as an effective, accessible, and patient-centered approach for managing COPD symptoms and enhancing quality of life. Additional research is necessary to investigate long-term adherence and optimization strategies for diverse populations with COPD.*

Keywords: *COPD, home-based pulmonary rehabilitation, symptom burden.*

RESUMEN

Introducción: *La Enfermedad Pulmonar Obstructiva Crónica (EPOC) es una afección respiratoria progresiva caracterizada por una limitación continua del flujo aéreo, que causa manifestaciones sustanciales, especialmente disnea, fatiga y una capacidad de ejercicio minimizada. Los síntomas afectan negativamente la calidad de vida y las actividades diarias de los pacientes. La rehabilitación pulmonar (RP) es una intervención establecida para reducir la carga de síntomas; sin embargo, los programas tradicionales basados en centros con frecuencia experimentan una subutilización. La rehabilitación pulmonar domiciliaria (RPD) ofrece una viabilidad, especialmente en condiciones con pocos recursos disponibles.* **Objetivo:** *Este estudio busca determinar la evaluación de la carga de síntomas en pacientes con EPOC después de un programa de rehabilitación pulmonar domiciliaria.* **Método:** *Este estudio utilizó la Prueba de Evaluación de la EPOC (CAT) para evaluar la carga de síntomas de los pacientes con EPOC después de un programa de rehabilitación pulmonar domiciliaria de ocho semanas. Se realizó un ensayo controlado aleatorizado que incluyó a 60 pacientes con EPOC clínicamente estables. Los participantes fueron asignados aleatoriamente a un grupo de intervención (n = 30), que recibió RPD estructurada, o a un grupo control (n = 30), que recibió atención estándar. El programa HPR consistió en ejercicios aeróbicos y de resistencia, técnicas de respiración, recursos educativos y monitoreo telefónico semanal. Los análisis estadísticos utilizaron pruebas t pareadas e independientes. Se obtuvo la aprobación del Comité de Ética de Investigación en Salud de la Universitas Muhammadiyah Gombong.* **Resultados:** *Al inicio, los participantes en ambos grupos realizaron una carga de síntomas moderada a alta. Después de la intervención, el grupo HPR presentó una disminución significativa en las puntuaciones CAT, con una diferencia media de 7.80 ± 4.122, en contraste con un 0.23 ± 0.728 observado en el grupo control (p < 0.001). Después de la intervención, el 40 % del grupo HPR indicó una carga de síntomas baja, sin que ningún participante permaneciera en las categorías alta o muy alta. Por el contrario, la mayoría de los participantes del grupo control mantuvieron niveles más altos de carga sintomática.* **Conclusiones:** *Los resultados indican que la rehabilitación pulmonar domiciliaria reduce significativamente la carga sintomática en pacientes con EPOC, como lo demuestran las mejores puntuaciones en la CAT. Los hallazgos promueven la implementación de la RAP como una estrategia eficaz, accesible y centrada en el paciente para el manejo de los síntomas de la EPOC y la mejora de su calidad de vida. Se requieren investigaciones adicionales para analizar la adherencia a largo plazo y las estrategias de optimización para diversas poblaciones con EPOC.*

Palabras clave: *EPOC, rehabilitación pulmonar domiciliaria, carga sintomática.*

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder marked by airflow limitation, persistent inflammation, and symptoms include dyspnea and fatigue. It remains a significant source of illness and mortality globally, resulting in diminished quality of life for individuals impacted (1-3). Notwithstanding advancements in medical treatment, COPD presents a significant symptom burden, encompassing dyspnea, fatigue, and diminished exercise tolerance, which collectively lessen the quality of life and functioning capacity of affected individuals (4,5).

The global frequency of COPD is still increasing, with around 384 million cases documented globally, resulting in 3.23 million fatalities annually. In several countries, it is one of the leading three causes of mortality, with tobacco use and environmental pollution recognized as major risk factors. Early diagnosis and the implementation of appropriate therapy strategies, including pulmonary rehabilitation,

are crucial for enhancing patient outcomes and slowing disease progression (6).

Chronic Obstructive Pulmonary Disease (COPD) imposes a considerable symptom burden on patients, significantly affecting their health-related quality of life (HRQoL), physical functioning, and psychological well-being. The symptom burden frequently encompasses various severe manifestations, including dyspnea, persistent cough, sputum production, and related psychological concerns such as depression and anxiety, which exacerbate the difficulties encountered by these individuals (7-9).

Pulmonary rehabilitation (PR) is a key component of COPD care, offering a multifaceted approach that encompasses exercise training, education, and behavioral modification. It has consistently demonstrated benefits in reducing dyspnea, improving overall health, and enhancing physical capacity. However, traditional center-based PR is underutilized due to several constraints, including transportation challenges, comorbidities, and limited facility availability, particularly in rural or low-resource settings (10-12).

Home-based pulmonary rehabilitation (HPR) has developed as a feasible and efficient alternative to standard PR, allowing patients to receive structured procedures at home. Studies have demonstrated that HPR can offer comparable therapeutic benefits to center-based programs, particularly in enhancing exercise capacity and health-related quality of life, while providing greater flexibility and potentially increasing adherence (13,14).

The measurement of symptom burden often employs tools like the COPD Assessment Test (CAT), which quantifies the impact of symptoms on daily functioning and quality of life. Higher CAT scores, indicative of greater symptom burden, are associated with reduced adherence to medication and greater healthcare utilization (15-17). Understanding and addressing the multifaceted burden of COPD symptoms is essential for developing comprehensive management and supportive care strategies, thereby improving clinical outcomes and HRQoL for patients with this chronic illness.

Despite these advantages, there is a lack of research investigating the specific impact of HPR on symptom burden. This key patient-centered outcome reflects the frequency and severity of COPD symptoms in everyday life. The COPD Assessment Test (CAT) is a validated, easy-to-use, and frequently employed instrument for measuring the impact of COPD symptoms on patients' lives, making it an appropriate tool for evaluating symptom burden in both clinical and research contexts (18,19).

This study aims to investigate changes in symptom burden among patients with COPD following participation in a home-based pulmonary rehabilitation program, using the CAT as the primary outcome measure. The results are expected to contribute to the growing body of evidence supporting the implementation of HPR as a scalable and patient-centered approach to COPD treatment.

METHODS

This study employed a randomized controlled trial design to evaluate the impact of a home-based pulmonary rehabilitation (HPR) program on symptom burden in patients with Chronic Obstructive Pulmonary Disease (COPD). A total of 60 patients with clinically diagnosed COPD were recruited based on the following inclusion criteria: a confirmed COPD diagnosis, clinical stability, and the ability to participate in home-based interventions.

Participants were randomly assigned to two groups: the intervention group (n = 30), who received an eight-week home-based pulmonary rehabilitation program, and the control group (n = 30), who continued to receive standard care without structured rehabilitation. Randomization was conducted using a computer-generated sequence to ensure allocation concealment and minimize selection bias. The home-based pulmonary rehabilitation program consisted of individualized aerobic and strength-training exercises, breathing techniques, and weekly telemonitoring or phone follow-up for adherence and support. Participants were also provided

with written guidelines and an activity logbook to record their daily progress.

The primary outcome of the study was the change in symptom burden, as measured by the COPD Assessment Test (CAT). This validated questionnaire assesses the impact of COPD symptoms on health-related quality of life. CAT scores were collected at baseline (pre-intervention) and the end of the 8-week intervention period. Higher CAT scores indicate a greater symptom burden. SPSS was used to analyze the data, employing paired and independent t-tests to assess both within- and between-group differences. A p-value of less than 0.05 was considered statistically significant.

This research was conducted by ethical standards and received approval from the Health Research Ethics Committee of Universitas Muhammadiyah Gombong. The study received ethical exemption, identified by Exemption Number: 255.6/II.3.AU/F/KEPK/VIII/2023, and was registered under ethical protocol number: 21124000009.

RESULTS

Respondent Characteristics

The study comprised a total of 60 participants. Most of the participants were male, comprising 40 (66.7 %), while females accounted for 20 (33.3 %). The majority of participants were elderly. Two persons (3.3 %) were aged 41-50 years, 19 (31.7 %) were aged 51-60 years, 24 (40.0 %) were aged 61-70 years, and 15 (25.0 %) were aged 71-80 years. This indicates that most of the sample was aged between 61 and 70. Regarding smoking status, 16 participants (26.7 %) were either current or former smokers, whereas 44 participants (73.3 %) indicated they did not smoke (Table 1).

These demographic characteristics are typical of the COPD population, which is primarily composed of older adults and males, with substantial numbers of them having a smoking history.

Table 1. Respondent Characteristics

Characteristics	Intervention		Control	
	n	%	n	%
Gender				
Male	18	60.0	22	73.3
Female	12	40.0	8	26.7
Age (Years)				
41 to 50	2	06,7	0	00.0
51 to 60	13	43,3	6	20.0
61 to 70	5	16,7	19	63.3
71 to 80	10	33,3	5	16.7
Smoking status				
Smoking	16	53.3	0	00.0
Non-Smoking	14	46.7	30	100.0

Symptom Burden among COPD Patients

Measured by the COPD Assessment Test (CAT), the study details the variations in symptom burden levels experienced by patients with COPD in the intervention and control groups (Table 2). Four levels were identified to separate the symptom burden: low, moderate, high, and very high. To evaluate the effectiveness of the home-based pulmonary rehabilitation program, pre- and post-test evaluations were compared (Table 3).

Table 2. Symptom burden of COPD patients before following a home-based pulmonary rehabilitation program

Group	Outcome	Mean	SD	Mean Difference	*P-Value
Intervention	CAT Score	19.87	3.71	0.033	0.972
Control	CAT Score	19.83	3.54		

*P-value obtained from Independent T-Test

Measuring utilizing the COPD Assessment Test (CAT) before and after the intervention period, Table 3 shows the variation of symptom burden levels among COPD patients in both the intervention and control groups. The baseline (pre-test) evaluation for the intervention group (n = 30) revealed 13 individuals (43.3 %) had a high symptom burden and 17 participants (56.7 %) had a moderate symptom burden. At baseline, no subjects fell into either the low or extremely high symptom burden category. Immediately after the 8-week home-based pulmonary rehabilitation program (post-test), 12 participants (40.0 %) were categorized as having a low symptom burden, and 18 participants (60.0 %) were classified as reporting a moderate symptom burden. Notably, no one remained in the high or very high categories after the intervention.

In contrast, the control group (n = 30), which had only standard therapy, exhibited minimal improvement in symptom burden levels. Four (13.3 %) of the pre-test subjects had a moderate symptom burden, while the remaining 26 (86.7 %) had a high symptom burden. Only a slight change was observed in the post-test data: 25 subjects (83.3 %) remained in the high burden category, while five (16.7 %) were classified as having a moderate symptom burden. At any one time, none of the group members attained either low or very high levels.

In contrast, the control group showed only a slight change; our results reveal a notable decrease in symptom burden among participants in the home-based pulmonary rehabilitation program. The results confirm that well-organized home-based rehabilitation helps individuals with COPD reduce the severity of their symptoms.

Table 3. Symptom Level of COPD Patients within Pre and Post-Home-Based Pulmonary Rehabilitation Program.

Group	Outcome	Pre-Intervention (Mean + SD)	Post-Intervention (Mean + SD)	Mean Difference	*P-Value
Intervention	CAT Score	19.87 + 3.71	12.07 + 2.935	7.800	<0.001
Control	CAT Score	22.63 + 2.39	22.40 + 2.358	0.233	0.090

*p-value obtained from Independent T-Test

The comparison of mean symptom levels between the intervention and control groups after the 8-week study period is presented in Table 4. The results show that the intervention group had a significantly greater reduction in symptom burden, with a mean difference of 7.80 ± 4.122, compared to only 0.23 ± 0.728 in the control group.

Table 4. Mean of Symptom Level based on CAT Score

Intervention group	Control group	Mean Difference	P-Value
7.80 + 4.122	0.23 + 0.728	7.567	<0.001

*p-value obtained from Independent T-Test

The mean difference between groups was 7.567, and this difference was statistically significant ($p < 0.001$). These findings indicate that the home-based pulmonary rehabilitation program had a substantial impact on reducing the symptom severity in COPD patients, as measured by the CAT score.

The significant difference between the two groups can be attributed to the structured and comprehensive nature of the home-based pulmonary rehabilitation program, which included components such as breathing exercises, physical activity, education, and self-management support. These interventions are known to enhance lung function, reduce dyspnea, improve physical endurance, and empower patients to manage their symptoms effectively. In contrast, the control group received standard care, which may not have provided the same level of engagement or therapeutic intensity, resulting in minimal improvement in symptom burden.

DISCUSSION

The symptom burden in COPD includes many physical and psychological aspects such as dyspnea, persistent cough, sputum production, fatigue, and anxiety, which progressively diminish functional capacity and quality of life (7-9). The study results indicated that, before the pulmonary rehabilitation program, the intervention group consisted of 8 respondents (53.3 %) in the moderate category and 7 respondents (46.7 %) in the high category. Patients with COPD have persistent cough, chest discomfort, and limitations in activities of daily living. Patients frequently experience fatigue while ambulating and discomfort during sleep due to their dyspnea. Dyspnea occurs due to anatomical changes in the airways, specifically inflammation, fibrosis, goblet cell metaplasia, and smooth muscle hypertrophy, leading to airway obstruction. Shortness of breath in COPD patients may result from hypoxia, hypercapnia, lactic acidosis, and airway obstruction, leading to hyperinflammation and weakening of the respiratory muscles in more severe cases (20,21).

The evaluation of symptom burden after home-based pulmonary rehabilitation (PR) programs indicates significant proof that these interventions effectively reduce several symptoms experienced by individuals with Chronic Obstructive Pulmonary Disease (COPD). This work contributes to the current literature by demonstrating that home-based pulmonary rehabilitation significantly reduces this burden, as evidenced by improvements in patient-reported outcome measures, particularly the COPD Assessment Test (CAT) (22-25).

The CAT, as a validated instrument, was used as an objective assessment to evaluate the symptomatic condition and daily functional impacts caused by COPD. The values range from 0 to 40, with higher scores indicating a more significant symptom burden. Within the framework of home-based pulmonary rehabilitation, improvements in CAT scores indicate a clinically significant decrease in symptom severity, particularly regarding dyspnea during physical activity, chest tightness, and restrictions on home or social activities. Our results confirm those of previous studies, indicating that structured home-based pulmonary rehabilitation provides both immediate and enduring decreases in CAT scores, which signify enhanced symptom management and improved health-related quality of life (26,24). An 8-week home-based rehabilitation program led to significant reductions in CAT scores, indicating that patients experienced reduced dyspnea, less disruption to daily activities, and improved sleep

quality. These enhancements have an impact not only in the immediate context but also establish a basis for long-term disease treatment, especially when supported by continuous engagement in self-care practices (10).

The methods through which home-based pulmonary rehabilitation reduces symptom burden are complex. Home-based pulmonary rehabilitation (HBPR) effectively reduces symptom burden by integrating tailored aerobic and resistance exercises, improving respiratory muscle function, and lessening exertional dyspnea. This individualized approach, often including supervised sessions and educational components, enhances exercise capacity and overall quality of life. Moreover, educational components emphasizing breathing methods, energy conservation, and early symptom identification empower patients to manage their symptoms more proactively. This holistic approach fosters the development of self-efficacy, a crucial element in the ongoing management of COPD symptoms beyond clinical settings (27).

Home-based PR facilitates the incorporation of therapeutic activities into daily activities, thereby improving adherence and mitigating challenges related to mobility and planning, which are prevalent in traditional center-based PR. Conducting rehabilitation in a familiar and comfortable setting enhances psychological well-being and reduces the anxiety and emotional distress often related to the symptom burden of COPD. Research indicates that patients participating in home-based pulmonary rehabilitation experience physical enhancements alongside decreases in psychological symptoms, including anxiety and depression, which intensify the perception of breathlessness and fatigue (28).

Adherence to home-based pulmonary rehabilitation is a critical factor influencing its effectiveness on symptom burden, despite the associated benefits. Patients may encounter challenges including diminished motivation, perceived lack of benefit, or insufficient social support—elements that can reduce the overall effectiveness of the program (29). Ongoing monitoring and motivational reinforcement, utilizing telehealth platforms or community health workers, are crucial for sustaining engagement and achieving sustained symptom control. Sustained improvements in symptom burden are most probable when patients actively engage in their care beyond the initial rehabilitation period (30).

A reduction of at least two points in the CAT score is recognized as the minimal clinically important difference, indicating a significant improvement in a patient's condition. Our study demonstrates that numerous patients surpassed this threshold after engaging in home-based pulmonary rehabilitation, suggesting that these programs yield statistically significant outcomes as well as improvements that are both noticeable and beneficial to the patients. The findings support the idea that well-structured home-based PR programs can provide symptom relief similar to that achieved in traditional settings, even without in-person supervision (31).

Improvements in CAT scores frequently correlate with enhancements in other quality-of-life indicators, such as the St. George's Respiratory Questionnaire (SGRQ), suggesting a broader influence on overall well-being. This association supports the notion that alleviating symptom burden via rehabilitation contributes to a decrease in disease-related disability and an improvement in social and emotional functioning.

CONCLUSION

Home-based pulmonary rehabilitation presents a practical and effective method for addressing the symptom burden in individuals with COPD. This study highlights the significance of assessing symptom burden both as a clinical outcome and as an indicator of intervention success from the patient's perspective. Improvement in CAT scores, as evidenced by this study and others, indicates significant changes in symptom severity, functional limitations, and health-related quality of life. To optimize and maintain these advantages, home-based PR programs should be thorough, individualized, and reinforced by ongoing follow-up strategies.

Future research should focus on enhancing these programs to promote long-term adherence and identify the most effective components that facilitate sustained symptom relief in various COPD populations.

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Conflict of Interests

The authors declare that there are no conflicts of interest regarding the publication of this article. They have no financial or personal relationships with individuals or organizations that could inappropriately influence or bias the research presented in this study. This declaration affirms the authors' commitment to maintaining the integrity, objectivity, and transparency of the research process and its outcomes.

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