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Short Communication

Effectiveness of adequate chicken egg white consumption on dyspnea degree and exacerbation incidence in stable COPD patients practicing strength and endurance exercises

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Abstract

Lack of physical exercise and inadequate nutritional intake in chronic obstructive pulmonary disease (COPD) patients could lead to low muscle mass and function, which causes reduced respiratory function, increased incidence of exacerbations, exercise intolerance, increased visits to health facilities, and low health status. Therefore, physical exercise and good nutritional intake are the main foundations of a comprehensive pulmonary rehabilitation program for COPD patients. The aim of the study was to determine the effect of chicken egg white supplementation on dyspnea degree and the incidence of exacerbations in stable COPD patients who perform physical exercise independently at home. A quasi-experimental study was conducted in 38 stable COPD patients based on the Global Initiative for Chronic Lung Disease (GOLD) 2021 classification criteria. The patients were divided into two groups: the control group who did smartphone application-assisted physical exercises and the intervention group who did the same physical exercises plus chicken egg white supplementation for 12 weeks. Performed physical exercises included both strength and endurance training. The degree of dyspnea was assessed with modified Medical Research Council (mMRC) dyspnea scale and the incidence of exacerbations was assessed by direct interviews at the beginning and at the end of the intervention. A Fisher's exact test was used to assess the association between the intervention with dyspnea degree and exacerbation incidence. In the intervention group, chicken egg white supplementation for 12 weeks lowered the dyspnea degree by 3.16 times than the control (relative risk 3.16 with p=0.001). Furthermore, the incidence of exacerbations was also reduced by 1.8 times compared to the control group (relative risk 1.8, p=0.001). This study highlights a significant improvement in dyspnea degree and exacerbation incidence in COPD patients with the combination of protein supplementation and physical exercise. Therefore, adding chicken egg white intake could be beneficial for stable COPD patients practicing physical exercises.

Keywords: COPD, dyspnea degree, exacerbation, physical exercise, egg white intake

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Introduction

The morbidity and death of chronic obstructive pulmonary disease (COPD) are greatly increased by exacerbations, which also have a dramatic impact on the patient. The relationship between decreased health-related quality of life (HRQOL) and mortality in COPD patients may be influenced by the fact that patients who experience frequent exacerbations have lower HRQOL than those who do not. Utilization of healthcare resources is also significantly impacted by exacerbations. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) [1,2] along with the American Thoracic Society and the European Respiratory Society (ATS/ERS) Standards for the Diagnosis and Management of COPD, both prominently identify the prevention and treatment of exacerbations as essential objectives of the clinical management of COPD [2,3]. As a result of the airway inflammatory reactions that occur during COPD flare-ups, airway edema, bronchospasm, and increased sputum production aggravate airflow limitation and lead to the development of dynamic hyperinflation [4,5].

Dyspnea, the most typical sign of an exacerbation, is primarily caused by this hyperinflation, which also has other effects such as modifying gas exchange and mechanical and cardiovascular effects. The risk that a patient may experience respiratory failure increases with the severity of the underlying disease, as this increases the degree of physiological change at exacerbation that exacerbates airflow limitation [4,5]. Presently one of the top three global causes of death, 90% of deaths from COPD occur in low- and middle-income nations. In 2012, COPD claimed the lives of almost 3 million people or 6% of the total deaths worldwide. One significant public health issue that can be treated and prevented is COPD [6]. The lack of physical exercise and inadequate nutritional intake can lead to low muscle mass and function, which causes reduced respiratory function, increased incidence of exacerbations, health status, exercise intolerance, death, and increased visits to health facilities. COPD patients with symptoms and those that have a high risk of exacerbation are recommended to undergo pulmonary rehabilitation, especially COPD groups B, C and D (based on GOLD classification) [7]. Pulmonary rehabilitation has been recommended as the standard management for COPD patients. The ATS/ERS stated that pulmonary rehabilitation is a multidisciplinary and comprehensive intervention that has been proven effective based on evidence-based medicine for COPD patients who were symptomatic and experienced a decrease in daily activities [7].

Physical exercise, such as endurance and strength training, is a major component of pulmonary rehabilitation and thus the end result is used consistently in assessing and evaluating the efficacy of interventions [8]. Pulmonary rehabilitation programs are given according to the patient's ability. Most pulmonary rehabilitation programs are given 2–3 times a week for 4 to 12 weeks or more. Progressive improvements in each session will be monitored and physical exercise intensity will be increased accordingly [9].

Systemic inflammation has been linked to the pathophysiology of muscle atrophy and weight loss. In people with COPD, activation of nuclear factor kappa B (NF-κB) in the skeletal muscle may be sufficient to cause muscular atrophy. Conversely, NF-κB suppression results in the restoration of muscle mass, suggesting that NF-κB plays a crucial role in this process [10]. Malnutrition that occurs in COPD causes general muscle weakness (especially respiratory muscles), impaired lung ventilation, and impaired immune function. Assessment of the nutritional status of COPD patients is important to determine the risk of malnutrition and provide management of malnutrition in COPD patients [11]. A study demonstrated that providing protein supplementation to geriatric patients, especially with COPD was associated with weight gain, increased muscle function, and reduced the incidence of hospitalization and mortality [12]. Another study reported that providing protein supplementation to geriatric patients significantly increased muscle mass and physical exercise ability [13]. Numerous applications exist for chicken egg whites in the culinary, biological, and pharmaceutical sectors. They are rich in proteins. Ovobumin, ovotransferrin, ovomucoid, lysozyme, ovomucin, ovomacroglobulin, and avidin are a few of the main active proteins found in egg whites [14].

The aim of the study was to determine the effect of chicken egg whites on the degree of dyspnea and the incidence of exacerbations in stable COPD patients who perform physical exercise independently at home using a smartphone.

Methods

Study design, patients and sampling

A quasi-experimental group study design was carried out from January 2021 to December 2022 at Prof. dr. Chairuddin Panusunan Lubis Universitas Sumatera Utara Hospital and Siti Hajar Hospital, Medan, Indonesia on stable COPD patients to determine the reduction of exacerbation incidence and degree of dyspnea before and after the intake of chicken egg-whites and physical excessive. This study included patients diagnosed with stable COPD, aged 40–80 years, received therapy based on the COPD group (i.e., group A, B, C and D COPD based on GOLD classification), undergoing pulmonary rehabilitation program, had no history of allergies to chicken eggs, and can operate a smartphone. Patients who had a history of malignancy, acute coronary syndrome, acute congestive heart failure, neuromuscular and skeletal disorders, cognitive impairment, and receiving long-term oxygen therapy were excluded. Non-probability consecutive sampling method was employed and the minimum sample size required was calculated based on the sample formula for unpaired numerical data hypothesis testing, the G*Power application was used and a minimum sample size of 19 was determined for both the control and intervention group. G*Power is a power analysis application for several statistical tests that are often used in the biological, social, and behavioral sciences [15].

Interventions

Prior to the study, patients were educated earlier on physical exercises and the number of eggs to be consumed. The control group only performed physical exercises, while the intervention group exercised and was given ten cooked chicken egg whites per day for each session, based on the 30 grams of daily protein requirement for patients above 40 years of age [16]. For every 100 grams of egg white, 10.8 grams of protein are contained. The eggs consumed are boiled for 15 minutes. The physical exercise included both upper extremity endurance and strength exercises. Over the course of 12 weeks, physical exercise was done three times a week for at least 30 minutes each day with a smartphone application “PARU SEHAT” independently at home. Patients watched videos of physical exercise on the app, which is available for free download from the Android Play Store. Patients were required to follow a physical activity schedule, consume chicken egg whites, and submit full-length recordings of their exercise in order to monitor the intervention.

Co-variates

In this study, some co-variables were collected such as demographic data, comorbidities, smoking degrees and degree of obstruction of the COPD. Comorbidities were assessed by direct interviewing and assessing the medical records. The smoking degree was classified based on the Brinkman Index (IB) (calculated by multiplying the number of cigarettes per day multiplied by the duration of smoking in years), such as mild IB 1–199, moderate IB 200–599 and severe IB 600. According to GOLD 2021 obstruction severity was classified into: GOLD 1 mild, GOLD 2 moderate, GOLD 3 severe, GOLD 4 very severe.

End points

The end points of the study were the incidence of exacerbation and degrees of dyspnea. The incidence of exacerbations was evaluated by conducting interviews. Reduced incidence of exacerbations indicated that the condition was improved, and vice versa. All the data obtained was used to observe changes in the patients’ condition before and after the intervention. The degree of dyspnea was assessed using the modified Medical Research Council (mMRC) dyspnea scale. A decrease or persistent mMRC score of 0 was considered as an improvement, while an increase in mMRC or a persistent score if >0 indicated a lack of improvement.

Statistical analysis

This study collected data in the form of categorical data on unpaired groups. The hypothesis was tested using the Chi-Square, where a $p<0.05$ indicated a significant difference. Subsequently, the homogeneity of characteristics between groups was analyzed using the Fisher's Exact Test, which was said to be no different if the $p<0.05$. All analysis was conducted using a computerized system with the SPSS program version 25 (IBM SPSS, New York, United States).

Results

Characteristics of the patients

A total of 38 patients were included in this study, with each control and intervention group consisting of 19 patients (**Table 1**). All of the patients were males. Both in the control and intervention group, the majority were aged above 60 years old and hypertension was the most common comorbid. As expected, a history of heavy smoking was seen in both groups. Out of all patients in the control group, 63.2% of patients were classified in the GOLD 2 severity degree. Whilst among the intervention group, 42.1% of the patients were in the GOLD 4 category. No statistical differences in characteristics were found between both groups.

Table 1. Characteristics of the COPD patients (n=38)

Characteristics		Control group		Intervention group		*p*-value
		n	%	n	%	
Age (years)	51–60	3	15.8	2	10.5	0.620
	61–70	8	42.1	13	68.4	
	71–80	8	42.1	4	21.1	
Gender	Male	19	100.0	19	100.0	1.000
	Female	0	0.0	0	0.0	
Comorbidity	No comorbid	3	13.6	5	22.7	0.430
	Hypertension	13	59.1	7	31.8	
	Pulmonary tuberculosis	4	18.2	6	27.3	
	Type 2 diabetes mellitus	1	4.5	2	9.1	
	Hepatitis C	1	4.5	0	0.0	
	Hyperuricemia	0	0.0	1	4.5	
	Congestive heart failure	0	0.0	1	4.5	
Smoking degree	Mild Brinkman Index (IB)	2	10.5	0	0.0	0.100
	Moderate IB	4	21.1	1	5.3	
	Heavy IB	13	68.4	18	94.7	
Degree of obstruction	GOLD 1	0	0.0	0	0.0	
	GOLD 2	12	63.2	5	26.3	0.070
	GOLD 3	4	21.1	6	31.6	
	GOLD 4	3	15.8	8	42.1	

Role of chicken egg white supplementation to reduce the dyspnea degree

A significant improvement in mMRC scores was observed in both intervention and control groups, with a p=0.001 (**Table 3**). The results also showed that the improvements in the intervention group were 1.8 times better compared to the control (**Table 3**).

Table 3. Effect of chicken egg white intake on the degree of dyspnea in stable COPD patients practicing physical exercise (n=38)

Group	Changes in mMRC		Relative risk	*p*-value
	Improved Frequency (%)	Not improved Frequency (%)		
Intervention	18 (94.7)	1 (0.04)	1.8	0.001
Control	10 (52.6)	9 (47.3)		

Role of chicken egg white supplementation to improve exacerbation incidence

All patients among the intervention group experienced no exacerbations, while 13 patients in the control group still found exacerbations. The Fisher's exact test was carried out and a p=0.001 was obtained. A significant decrease in the incidence of exacerbations was seen between both groups. Furthermore, the decrease experienced in the intervention group was 3.16 times lower compared to the control (**Table 2**).

Table 2. Effect of chicken egg white intake on exacerbation changes in stable COPD patients practicing physical exercise (n=38)

Group	Changes in exacerbations		Relative risk	*p*-value
	Improved Frequency (%)	Not improved Frequency (%)		
Intervention	19 (100.0)	0 (0.0)	3.16	0.001
Control	6 (31.5)	13 (68.4)		

Discussion

Pulmonary rehabilitation combined with protein intake has been reported to have clinically relevant effects on peripheral muscle function [17]. Some studies revealed that COPD is a respiratory disease that affects the lungs, and causes non-respiratory manifestations, including skeletal muscle dysfunction with atrophy and weakness [18,19]. It also causes systemic inflammation, lack of nutrition, and malnutrition, which can contribute to limited physical activity, thereby affecting daily life and mobility [9,10]. A study reported that lower limb resistance training for a month can safely and effectively change the scale of dyspnea and lung function in COPD patients [20]. This study revealed the same, where there were significant changes in the symptoms and degree of dyspnea in both control and intervention groups. These physical exercise programs have been demonstrated to improve muscle function, reduce complaints of difficulty in breathing, and enhance the quality of life [21].

Apart from physical exercise, another important component of pulmonary rehabilitation is nutritional health. COPD is often associated with muscle depletion caused by an increase in the rate of protein degradation and a decrease in the synthesis, which worsens with aging [17]. Several studies revealed that providing nutrition, especially protein, causes a significant increase in functional capacity and well-being as well as a decrease in morbidity and mortality for COPD patients [22]. The daily requirement for protein in older patients is within the range of 1.2–1.6 g/kg/day [12]. Eggs are one of the affordable food sources with a high protein content. Previous studies revealed that albumin (ovalbumin) is more abundant in egg whites compared to the yolks. Every 100 grams of chicken egg whites contains an average of 10.5 grams of protein, of which 95% is albumin [23,24].

This study showed very significant results in improving mMRC scores among the intervention group compared to the control group. This finding showed that the provision of physical exercise interventions and egg white intake is beneficial to COPD patients apart from their routine treatment of low protein intake was associated with an increased risk of acute exacerbations leading to hospitalizations and emergency department visits in mild to moderate COPD patients [23]. These findings suggest that encouraging patients to consume adequate protein such as chicken egg whites may be important in their management [23]. Weight loss and wasting of muscle mass can occur in COPD patients and adversely affect the respiratory and peripheral muscle function, exercise capacity, and health status. Loss of weight can also occur due to an unbalanced increase in energy expenditure caused by inadequate food intake [25]. A study showed that nutritional supplementation with comprehensive and intensive pulmonary rehabilitation produced significant improvements in all St George's respiratory questionnaire (SGRQ) parameters and that this improvement was higher than most of the reported improvements in the study [26]. A study in Korea concluded that there was an increased risk of exacerbation in COPD patients who consumed less protein (<42 grams/day) [23].

A study revealed that low protein intake was associated with an increased risk of acute exacerbations leading to hospitalization and emergency room visits in mild to moderate COPD patients. These findings suggest that encouraging patients to consume an adequate amount of protein is very important in the management of COPD [13]. This is consistent with this study, by providing additional protein intake, significant changes were noticed in the incidence of exacerbations when compared from the beginning to the end of the intervention. Based on a study, the administration of protein supplementation to geriatric patients significantly increased muscle mass and exercise ability [13].

This study is subject to some limitations. In addition to the small sample size, the lack of female COPD patients at the study's location made it impossible to conclude with certainty if the therapies were beneficial for female patients. It is necessary to carry out further studies with a larger population, consisting of females because they often become second-hand smokers and this has an impact on lung health problems.

Conclusion

An adequate protein diet is crucial in pulmonary rehabilitation for COPD patients. Significant improvements were seen in the reduction of dyspnea and exacerbation incidence after chicken egg white intake in COPD patients. In the intervention group, the treatment lowered the degree

of shortness of breath by 3.16 times more than the control. Furthermore, the incidence of exacerbations was also reduced by 1.8 times compared to the control. Adding chicken egg white intake is very beneficial for stable COPD patients who do physical exercise.

Ethics approval

This study has received ethical approval from the Health Research Ethics Committee of University Sumatera Utara with the following reference number 501/KEPK/USU/2022.

Competing interests

The authors declare that there is no conflict of interest.

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Underlying data

Derived data supporting the findings of this study are available from the first author on request.

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References

1. Vogelmeier CF, Criner GJ, Martinez FJ, *et al.* Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease 2017 report. Am J Respir Crit Care Med 2017;195(5):557-582.
2. Decramer M, Nici L, Nardini S, *et al.* Targeting the COPD Exacerbation. Respir Med 2008;102 Suppl 1:S3-S15.
3. Summary E. American Thoracic Society/European Respiratory Society statement: Standards for the diagnosis and management of individuals with alpha-1 antitrypsin deficiency. Am J Respir Crit Care Med 2003;168(7):818-900.
4. Ramanathan K, Antognini D, Combes A, *et al.* Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19 research that is available on the COVID-19 resource centre - including this for unrestricted research re-use a 2020(January):19-21.
5. O' Donnell DE, Parker CM. COPD exacerbations · 3: Pathophysiology. Thorax 2006;61(4):354-361.
6. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global initiative for chronic obstructive lung. 1. 2023.
7. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease update. 2021.
8. Agustí A. Systemic effects of chronic obstructive pulmonary disease: What we know and what we don' t know (but should). Proc Am Thorac Soc 2007;4(7):522-525.
9. Lareau SC, Fahy B. Pulmonary rehabilitation. Am J Respir Crit Care Med 2018;198(10):P19-P20.
10. Barnes PJ, Celli BR. Systemic manifestations and comorbidities 2009;33(5):1165-1185.
11. Pichon R, Couturaud F, Mialon P, *et al.* Responsiveness and minimally important difference of the 6-minute stepper test in patients with chronic obstructive pulmonary disease. Respiration 2016;91(5):367-373.
12. Chapman I, Oberoi A, Giezenaar C, *et al.* Rational use of protein supplements in the elderly—Relevance of gastrointestinal mechanisms. Nutrients 2021;13(4).
13. Park Y, Choi JE, Hwang HS. Protein supplementation improves muscle mass and physical performance in undernourished prefrail and frail elderly subjects: A randomized, double-blind, placebo-controlled trial. Am J Clin Nutr 2018;108(5):1026-1033.

14. Li Z, Huang X, Tang Q, *et al.* Functional properties and extraction techniques of chicken egg white proteins. Foods 2022;11(16):2434.
15. Faul F, Erdfelder E, Lang AG, *et al.* G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 2007;39(2):175-191.
16. Chapman I, Oberoi A, Giezenaar C, *et al.* Rational use of protein supplements in the elderly—relevance of gastrointestinal mechanisms. Nutrients 2021;13(4):1227.
17. Vestbo J, Hurd SS, Agustí AG, *et al.* Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med 2013;187(4):347-365.
18. Dourado VS, Tanni SE, Antunes LCO, *et al.* Effect of three exercise programs on patients with chronic obstructive pulmonary disease. Braz J Med Biol Res 2009;42(3):263-271.
19. Agustí A. Systemic effects of chronic obstructive pulmonary disease: What we know and what we don’ t know (but should). Proc Am Thorac Soc 2007;4(7):522-525.
20. Tarigan AP, Pandia P, Mutiara E, *et al.* Impact of lower-limb endurance training on dyspnea and lung functions in patients with COPD. Open Access Maced J Med Sci 2018;6(12):2354-2358.
21. Tarigan AP, Pandia P, Tarigan AH, *et al.* Effectiveness of upper limb exercises and breathing exercises in COPD stable patients during COVID-19 pandemic era. Adv Respir Med 2022;90(1):68-76.
22. Gea J, Barreiro E. Nutritional abnormalities and chronic obstructive pulmonary disease. Int J Tuberc Lung Dis 2019;23(5):531-532.
23. Park S, Kim SW, Rhee CK, *et al.* Effect of low protein intake on acute exacerbations in mild to moderate chronic obstructive pulmonary disease: data from the 2007-2012 KNHANES. J Thorac Dis 2021;13(10):5592-5603.
24. Pereira MM, Cruz RAP, Almeida MR, *et al.* Single-step purification of ovalbumin from egg white using aqueous biphasic systems. Process Biochem 2016;51(6):781-791.
25. Schols AMWJ, Creutzberg EC, Buurman WA, *et al.* Plasma leptin is related to proinflammatory status and dietary intake in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1999;160(4):1220-1226.
26. Korkmaz C, Demirbas S, Vatansev H, *et al.* Effects of comprehensive and intensive pulmonary rehabilitation and nutritional support on quality of life and functional status in patients with chronic obstructive pulmonary disease. J Int Med Res 2020;48(4):300060520919567.