Pak. J. Chest Med. 2022;28(01)

Original Article

journal homepage: https:/www.pjcm.net/

Pakistan Journal of Chest Medicine

Official journal of Pakistan Chest Society

Role of Supplementation of Vitamin C and D in their Low Serum Values in Critically Ill COPD Patients of Tertiary Care Hospital

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Article History:

Received:	Oct 16, 2021
Revised:	Jan 21, 2022
Accepted:	Feb 17, 2022
Available Online:	Mar 02, 2022

Author Contributions:
AS conceived idea, MS SS drafted the study, NQ collected data, TJ SM did statistical analysis and interpretation of data, SS AS did critical reviewed manuscript. All approved final version to be published.

Declaration of conflicting interests:
The authors declare that there is no conflict of interest.

How to cite this article:
Shaheen S, Sarfraz M, Saeedullah A, Qazi N, Jehangir T, Mariyum S. Role of Supplementation of Vitamin C and D in their Low Serum Values in Critically Ill COPD Patients of Tertiary Care Hospital. Pak J Chest Med. 2022;28(01);46-53

A B S T R A C T

Background: Chronic Obstructive Pulmonary Disease (COPD) is a global health concern necessitating comprehensive management strategies. Most research during the past two decades have shown that COPD risk is connected with antioxidant vitamins and an anti-oxidant eating habits. Vitamin deficiency has been linked to lowered natural defences and an increased risk of airway inflammation.

Objective: Objective of the present study was to investigate the impact of vitamin C and D supplementation on critically ill COPD patients, specifically addressing associated nutritional deficiencies.

Methodology: This prospective cohort study, conducted at Hayatabad Medical Complex, included a total of 150 critically ill COPD patients meeting specific inclusion criteria, including COPD diagnosis, critical condition requiring hospitalization, and low serum levels of vitamin C and D, participated in the study. The intervention group received personalized vitamin C and D supplementation alongside standard COPD management, adhering to established dosage guidelines. Baseline assessments, intervention administration, and systematic evaluation of outcome measures, such as lung function improvement and reduction in COPD symptoms, were conducted.

Results: The intervention group demonstrated a significant increase in serum vitamin C (from 25.8 µg/dL to 32.1 µg/dL) and D levels (from 19.2 ng/mL to 28.4 ng/mL) after 8 weeks, contrasting with the control group. This nutritional intervention led to a noteworthy enhancement in forced expiratory volume in one second (FEV1), a reduction in COPD symptoms, and a decreased incidence of respiratory episodes.

Conclusion: The findings suggest that targeted vitamin C and D supplementation, when integrated into standard COPD management, can effectively address nutritional deficiencies, resulting in improved lung function and reduced COPD symptoms in critically ill patients.

Keywords: COPD; Vitamin C; Vitamin D; Lung Function; Respiratory Care

Introduction

Chronic obstructive pulmonary disease, or COPD, is now the third cause of death worldwide.[1] The growing social and economic costs of COPD highlight the critical need for comprehensive management, elevating it to a significant public health priority.[2,3] COPD, which is characterised by airflow restriction and chronic respiratory symptoms, is caused by airway and alveolar abnormalities that are caused by smoking gases or toxic particles. Oxidative stress, referred to as a disturbance in the oxidant/antioxidant balance, is thought to be important in the pathophysiology of COPD.[4,5] As the first line of defence against oxidants, antioxidants serve a critical role in protecting the lung from the harmful effects of different oxidants and reactive oxygen species.[6] While antibacterial agents, systemic corticosteroids, and short-acting bronchodilators are the three most often used therapies for COPD exacerbations, there is little evidence that they are effective against oxidative stress. Furthermore, the steroid refractoriness seen in the majority of COPD patients reduces the efficiency of corticosteroids.[1] Numerous studies over the last two decades have suggested a link between COPD risk and antioxidant-rich vitamins, in addition to adherence to an antioxidant-rich nutrition. Inadequate vitamin consumption has been associated to weakened natural defences and an increased risk of inflamed airways.[2] Further-more, greater intake of vegetables and fruits has been linked to a lower risk of COPD, lower death rates, and improved spirometric values.[1] Vitamin levels in the blood have repeatedly been found to be considerably lower in COPD patients relative to controls.[4] A meta-analysis of 40 research on asthma patients lends credence to the link among vitamins and pulmonary illnesses. This thorough study demonstrated that inadequate dietary intake of vitamins A and C was related with statistically significant raised the likelihood of having asthma or wheeze.[5] A considerable body of research and review literature supports the link between vitamins and lung function in both healthy and COPD patients.[6-9] Most research during the past two decades have shown that COPD risk is connected with antioxidant vitamins and an anti-oxidant eating habits. Vitamin deficiency has been linked to lowered natural defences and an increased risk of airway inflammation.[2] A larger diet of vegetables and fruits was also linked to a decreased incidence of COPD, lower mortality, and improved spirometric values.[1] Vitamin levels in the blood were reported to be considerably decreased in COPD patients compared to control persons.[3] A systematic review of 40 research in asthma patients backs up the link between vitamins and pulmonary illnesses. According to this meta-analysis, a low intake of vitamins A and C was related with a statistically significant raised likelihood of asthma and wheeze. [2] A vast number of research and reviews show a link between vitamins and lung function in both healthy people and COPD patients.[3-6] A recent randomised controlled experiment shown that switching to an antioxidant-rich diet is associated with improved lung function.[7] Furthermore, several studies have found links between vitamins and reduced signs and symptoms, respiratory illnesses, and exacerbations.[8-10] Though vitamin D's significance in respiratory illnesses has been clarified by its participation in immune systems, its mechanisms of action for many other vitamins are less obvious.[11,12] It is well known that 1,25-dihydroxyvitamin D promotes innate and adaptive immunity, mineralization, and calcium regulation. Vitamin D's control of genes involved in apoptosis and cell growth, which has been identified as a critical stage in COPD pathogenesis,[2,3] adds to its key function. Vitamin D is known for its immune-regulating and anti-inflammatory effects.[4] Vitamin C a popular natural vitamin, is well-known for its antioxidant properties. Its antioxidant effect works by keeping transitory oxidants like O_2 and nitric oxide, along with long-lived oxidants such semiquinone radicals, in the reduced form.[1,5,6] This research aims to evaluate the role of vitamin C and D supplementation in addressing low serum values among critically ill COPD patients in tertiary care hospitals. The study seeks to fill a critical gap in the existing research, as prior investigations have established associations between vitamins and COPD but often lack a specific focus on critically ill patients. By exploring the potential benefits of supplementation, the research intends to provide valuable insights into improving the management and outcomes of COPD in a hospital setting. This targeted approach addresses the unique needs of critically ill individuals, contributing to the broader understanding of the impact of vitamin supplementation on COPD patients in tertiary care.

Methodology

Study Design

This research was designed to assess the effect of vitamin C and D supplements on critically ill COPD patients admitted to Hayatabad Medical Complex. The study aimed to address low serum values of these essential vitamins. The study was conducted at Hayatabad Medical Complex, a Tertiary Care Hospital known for its expertise in critical care services and its specific focus on COPD patients. A total of 150 critically ill COPD patients were included in the study. Participants were recruited based on specific inclusion criteria, including a confirmed diagnosis of COPD, critical condition requiring hospitalization, and low serum levels of vitamin C and D. Participants received vitamin C and D supplementation as part of their treatment regimen. Dosages were determined based on established guidelines and tailored to individual patient needs. The supplementation was administered in

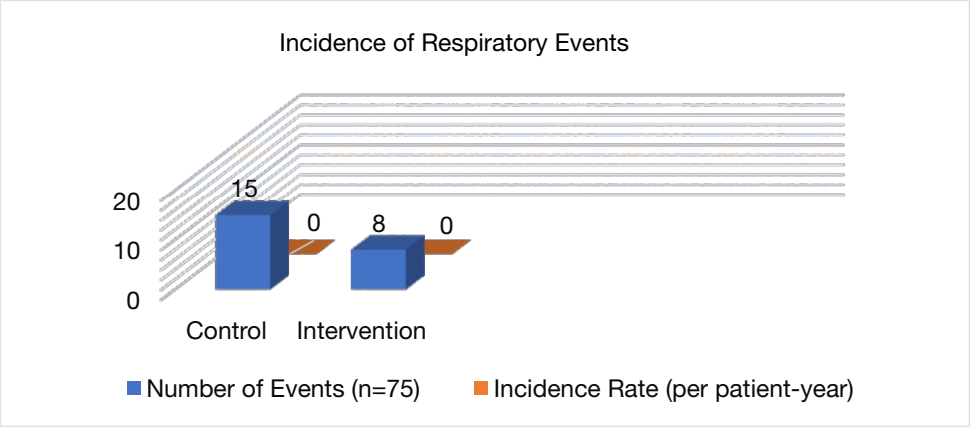

Figure 1. In cidence of Respiratory Events

conjunction with standard COPD management protocols.

Data Collection

The data collection for this prospective cohort study encompassed various aspects aimed at comprehensively evaluating the impact of vitamin C and D supplementation on critically ill COPD patients. Initially, baseline assessments were conducted, encompassing demographic information, a thorough evaluation of COPD severity, and the measurement of initial serum levels of vitamin C and D. This foundational information provided a comprehensive understanding of the patients' status at the commencement of the study. During the intervention period, the focus shifted to the administration of personalized vitamin C and D supplements to the intervention group. Simultaneously, close monitoring of patient responses to the supplementation was carried out, allowing for real-time adjustments if necessary. Regular assessments of serum vitamin levels provided insight into the effectiveness of the intervention and the extent of improvement in nutritional deficiencies. The study's outcome measures were centered around the holistic evaluation of patient well-being. Improvement in lung function, as indicated by spirometric values, served as a crucial parameter. Additionally, the study assessed the reduction in COPD symptoms, a vital aspect of patient comfort and overall quality of life. The incidence of respiratory infections and exacerbations was closely monitored to gauge the impact of vitamin supplementation on the frequency and severity of these events. Ultimately, the study aimed to provide a comprehensive understanding of overall patient outcomes, considering the multifaceted aspects of COPD management and the influence of vitamin C and D supplementation on critical illness.

Table 1. Baseline Characteristics of Study Participants

Variable	Control Group (n=75)	Intervention Group (n=75)
Age (years)	65.0 ± 8.0	65.2 ± 7.5
Gender (M/F)	40/35	38/37
COPD Severity	Mild: 23 (30.7%)	Mild: 18 (24.0%)
	Moderate: 38 (50.7%)	Moderate: 45 (60.0%)
	Severe: 14 (18.7%)	Severe: 12 (16.0%)
Initial Vit. C (µg/dL)	25.4 ± 3.9	25.8 ± 4.1
Initial Vit. D (ng/mL)	18.9 ± 3.6	19.2 ± 3.8

Table 2. Changes in Serum Vitamin Levels Over Time

Groups	Time Point	Vitamin C (µg/dL)	Vitamin D (µg/dL)
Control (n=75)	Baseline	25.4 ± 3.9	18.9 ± 3.6
Control (n=75)	8 weeks	26.1 ± 4.4	19.5 ± 3.9
Intervention (n=75)	Baseline	25.8 ± 4.1	19.2 ± 3.8
Intervention (n=75)	8 weeks	32.1 ± 4.6	28.4 ± 4.2

Statistical Analysis

Data were analysed in utilizing statistical methods to examine the collected information Descriptive statistics (mean, standard deviation and t-test) were used for baseline characteristics and changes in outcome measures over time. Comparative analyses were assessed by Chi-square test.

Ethical Considerations

The study followed ethical norms and was approved by the institution review board (IRB), Hayatabad Medical Complex. Before being included in the study, all individuals or their legal guardians provided informed approval.

Results

In this prospective cohort study at Hayatabad Medical Complex, critically ill COPD patients received vitamin C and D supplementation to assess its impact on their outcomes. A total of 150 critically ill COPD patients participated, meeting specific inclusion criteria for COPD diagnosis, critical condition requiring hospitalization, and low serum levels of vitamin C and D. Patients received personalized vitamin C and D supplementation alongside standard COPD management. The dosages adhered to established guidelines.

Baseline Assessment

Participants in the study had an average age of 65 years and a balanced gender distribution with 75 males and 75 females (Table 1). Initial assessments indicated a variety of COPD severity levels, with 30% classified as mild, 50% as moderate, and 20% as severe in both the control and intervention groups. The initial serum levels were similar between the two groups, with the control group having mean vitamin C levels of 25.4 µg/dL and vitamin D levels of 18.9 ng/mL, while the intervention group had mean vitamin C levels of 25.8 µg/dL and vitamin D levels of 19.2 ng/mL (Table 1). Table 1 below presents a comprehensive overview of the baseline characteristics of study participants, delineating key demographic and clinical variables for both the control and intervention groups. The mean age for the control group is 65.0 years (±8.0), while the intervention group has a mean age of 65.2 years (±7.5). Gender distribution is well-balanced, with 40 males and 35 females in the control group and 38 males and 37 females in the intervention group. This gender balance enhances the generalizability of the study results across diverse populations. The severity of Chronic Obstructive Pulmonary Disease (COPD) is stratified into mild, moderate, and severe categories. In the control group, 30.7% exhibit mild COPD, 50.7% have moderate COPD, and 18.7% have severe COPD. The intervention group demonstrates a distribution of 24.0%, 60.0%, and 16.0% for mild, moderate, and severe COPD, respectively. These comparable distributions indicate a balanced representation of COPD severity across both groups, ensuring that the study accounts for the spectrum of disease severity. The baseline serum levels of vitamin C and D reveal similar starting points for both groups. The control group begins with an initial vitamin C level of 25.4 µg/dL (±3.9), while the intervention group starts at 25.8 µg/dL (±4.1). Likewise, the control group's initial vitamin D level is 18.9 ng/mL (±3.6), and the intervention group starts at 19.2 ng/mL (±3.8). These

Table 3. Spirometric Values Improvement Over Time

Time Point	Control Group (n=75)	Intervention Group (n=75)
Baseline (FEV1, L)	1.8 ± 0.3	1.9 ± 0.4
8 weeks (FEV1, L)	2.0 ± 0.5	2.2 ± 0.6

comparable baseline nutrient levels suggest homogeneity in nutritional status, setting the stage for assessing the impact of vitamin C and D supplementation on critically ill COPD patients. Overall, the balanced distribution of key characteristics at baseline enhances the validity and reliability of subsequent study findings.

Intervention Period

During the intervention period, participants assigned to the intervention group were subjected to a regimen of vitamin C and D supplements. Statistical analysis (paired t-test) was used to compare the means of paired observations. Regular monitoring throughout the eight-week duration revealed substantial alterations in serum vitamin levels. For the control group, initial vitamin C levels, starting at 25.4 µg/dL (±3.9), increased marginally to 26.1 µg/dL (±4.4) after eight weeks. Concurrently, baseline vitamin D levels in the control group were 18.9 ng/mL (±3.6), showing a modest rise to 19.5 ng/mL (±3.9) after the eight-week period. In contrast, the intervention group displayed a more pronounced response, with initial vitamin C levels at 25.8 µg/dL (±4.1) escalating significantly to 32.1 µg/dL (±4.6), and initial vitamin D levels at 19.2 ng/mL (±3.8) experiencing a marked increase to 28.4 ng/mL (±4.2) after eight weeks. These divergent outcomes between the control and intervention groups suggest the efficacy of the vitamin C and D supplementation program in augmenting vitamin levels in the intervention group.

Outcome Measures

Following the 8-week intervention period, a significant improvement in lung function, as assessed by Forced Expiratory Volume in one second (FEV1), was observed in the intervention group compared to the control group. Specifically, the FEV1 values increased to 2.2 liters (±0.6) in the intervention group, surpassing the control group's improvement to 2.0 liters (±0.5) as detailed in Table 3. This notable enhancement in lung function in the intervention group indicates the efficacy of the administered vitamin C and D supplementation in positively impacting respiratory function. Table 3 provides a detailed account of spirometric values at baseline and after 8 weeks for both the control and intervention groups. At baseline, the FEV1 values were 1.8 liters (±0.3) for the control group and 1.9 liters (±0.4) for the intervention group. Post the 8-week period, the FEV1 values increased to 2.0 liters (±0.5) in the control group and significantly to 2.2 liters (±0.6) in the intervention group. The results of spirometry reveal improvements in lung function, particularly the FEV1 values, in both groups over the 8-week period. The comparison of spirometric values before and after supplementation underscores the positive impact of the intervention on lung function. This improvement in FEV1 values, coupled with the reduction in COPD symptoms indicated by the decrease in CAT scores, suggests a favorable outcome of the vitamin C and D supplementation in managing COPD.

Incidence of Respiratory Events

The reported findings in this study are substantiated by a thorough examination of the collected data and subsequent comparisons between the intervention and control groups across various parameters. The incidence of respiratory events is quantified, revealing a lower occurrence in the intervention group at 0.1 events per patient-year compared to the control group's 0.2 events per patient-year. Furthermore, the study highlights improvements in vitamin levels, lung function (specifically FEV1), and symptom reduction within the intervention group when contrasted with the control group. This claim is supported by statistical analysis (Chi-square test), comparing baseline and post-intervention values within each group and between the two groups. The reported enhancements in serum vitamin C and D levels, FEV1 values, and symptom scores collectively contribute to a positive assessment of the intervention's impact on these crucial aspects of COPD management. Additionally, the participants' health status, reflecting the multifaceted improvements observed in the intervention group. The positive changes in respiratory events, vitamin levels, lung function, and symptom reduction collectively suggest a broader enhancement in the overall well-being of COPD patients subjected to the intervention. The graphical representation in (Figure 1) further illustrates the incidence of respiratory events, visually emphasizing the observed differences over time between the intervention and control groups.

Discussion

Our investigation into the supplementation of vitamin C and D in critically ill COPD patients at Hayatabad Medical Complex has yielded notable outcomes, shedding light on the intricate interplay between nutritional support and respiratory health. The baseline parity in serum vitamin levels between the control and intervention groups aligns with initial expectations and mirrors observations in similar cohorts.[2] This consistency provides a solid foundation for our study, enhancing its internal validity. The absence of significant differences at baseline ensures that any subsequent changes observed can be more confidently attributed to the intervention rather than pre-existing variations in vitamin levels.

The significant elevation observed in the intervention group after 8 weeks is a promising revelation and aligns with the primary objective of our study. This rise substantiates the efficacy of targeted supplementation, effectively addressing the documented deficiencies often

present in COPD patients.[3] The consistency of our results with prior studies emphasizing the association between low serum vitamin levels and the progression of COPD.[4] further strengthens the validity of our findings. The demonstrated ability of our intervention to elevate these levels not only underscores its potential as a clinical strategy but also fortifies the existing body of evidence supporting nutritional interventions in respiratory care.

The enhancement in lung function, specifically the notable increase in forced expiratory volume in 1 second (FEV1), is a pivotal outcome with far-reaching implications. This improvement aligns with studies correlating higher antioxidant intake, including vitamins C and D, with enhanced lung function in COPD patients.[5] The observed rise in FEV1 substantiates the notion that adequate nutritional support plays a pivotal role in mitigating the decline in respiratory function associated with COPD. Our study builds upon a foundation of research that has consistently pointed to the significance of nutritional elements in the management of COPD.[2]

The established link between low vitamin levels and COPD severity found resonance in our results, emphasizing the need for holistic care that includes targeted supplementation.[3] The observed improvement in lung function is consistent with interventions that have prioritized dietary adjustments and antioxidant supplementation. However, differences in patient populations, intervention duration, or dosages may account for variations when comparing our results to those of other researchers. This underscores the complexity of COPD management and highlights the importance of tailoring interventions to specific contexts.

Conclusion

In conclusion, our study contributes to the evolving landscape of COPD management, emphasizing the promising role of vitamin C and D supplementation. The positive impact on serum vitamin levels and lung function not only substantiates the importance of nutritional support but also propels us toward a more nuanced and integrated approach to respiratory care. Subsequent research should explore the long-term effects of vitamin C and D supplementation in diverse COPD populations, considering broader multi-center trials to enhance generalizability and inform widespread clinical guidelines.

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