Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i6.6857

PHYSIOLOGIC AND BIOCHEMICAL EFFECTS OF ORAL SUPPLEMENTAL FEEDING IN MALNOURISHED PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) and malnutrition frequently co-occur, worsening lung function, exercise capacity, and quality of life. Oral supplemental feeding is a promising intervention targeting this comorbidity, but its physiologic and biochemical effects remain unclear.

Objective: This study aimed to investigate the impact of oral supplemental feeding on lung function, exercise capacity, nutritional status, and inflammation in malnourished COPD patients.

Methodology: We conducted a randomized controlled trial involving 81 malnourished COPD patients. Participants were assigned to either the oral feeding group (n=41) receiving high-calorie, protein-rich supplements alongside their regular diet or the control group (n=40) continuing their usual dietary routine. Both groups received standard COPD management. Primary outcomes included lung function (FEV1 and PEFR), exercise capacity (6-minute walk distance), and nutritional status (albumin levels). Secondary outcomes were inflammatory markers (C-reactive protein and interleukin-6).

Results: The oral feeding group demonstrated significantly greater improvements in all outcomes compared to the control group. FEV1 increased by 0.39 L, PEFR by 65 L/min, 6-minute walk distance by 58 meters, and albumin levels by 0.45 g/dL. The CRP decreased by 3.2 mg/L and IL-6 by 8.4 pg/mL in the oral feeding group.

Conclusion: Oral supplemental feeding effectively improves lung function, exercise capacity, nutritional status, and reduces inflammation in malnourished COPD patients. This intervention holds promise for improving physiologic and biochemical parameters in this vulnerable population, warranting further exploration of long-term benefits and personalized feeding strategies.

Keywords: COPD, malnutrition, oral feeding, lung function, exercise capacity, inflammation, CRP, IL-6.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by persistent airflow limitation, often associated with chronic bronchitis and emphysema [1, 2]. COPD stands as a major global health challenge, characterized by persistent airflow limitation and associated with substantial morbidity and mortality. The World Health Organization (WHO) estimates that COPD will become the third leading cause of death globally by 2030 [3]. The disease is often progressive and irreversible, impacting the quality of life for millions of individuals worldwide. One such significant comorbidity is malnutrition, a condition prevalent among COPD patients that significantly contributes to the overall burden of the disease [4].

Malnutrition in the context of COPD is a multifaceted issue, influenced by a range of factors such as increased energy expenditure due to labored breathing, decreased dietary intake, and systemic inflammation [5]. The presence of malnutrition in COPD patients is associated with adverse outcomes, including increased hospitalizations, impaired pulmonary function, decreased muscle mass, and compromised immune function [6]. While COPD itself has a global impact, the intersection of malnutrition exacerbates the challenges faced by individuals affected by this respiratory condition.

In Pakistan, where COPD prevalence [7, 8] and malnutrition [9] is on the rise, the intersection of malnutrition and COPD has become a critical area of concern [10], demanding comprehensive research to explore potential interventions. Pakistan, with its growing population and environmental challenges, has witnessed an escalating prevalence of COPD, fueled by factors such as tobacco smoking, indoor air pollution, and limited access to healthcare [11, 12]. The unique socio-economic and healthcare landscape of Pakistan contributes to a complex interplay of factors affecting the health and well-being of individuals with COPD, accentuating the need for targeted research to address the multifaceted nature of this disease.

Despite the evident impact of malnutrition on COPD outcomes, there is a noticeable gap in the literature, particularly in the Pakistani context, regarding the effects of oral supplemental feeding on the physiologic and biochemical parameters in malnourished COPD patients. This research seeks to bridge that gap by delving into the intricate relationship between oral supplementation and the physiological and biochemical aspects of malnourished COPD patients in Pakistan.

Objective

The objective of this study was to investigate the physiologic and biochemical effects of oral supplemental feeding in malnourished patients with Chronic Obstructive Pulmonary Disease in Pakistan.

METHODOLOGY

Study Design

This research adopts a prospective interventional study design to comprehensively investigate the physiologic and biochemical effects of oral supplemental feeding in malnourished patients with COPD in Pakistan. The prospective nature of the study allows for the systematic implementation of an oral supplementation intervention, facilitating a nuanced exploration of its impact on selected physiological and biochemical parameters.

Study Setting

The study was conducted at the Hayatabad Medical Complex in Peshawar, a distinguished healthcare institution recognized for its expertise in managing respiratory conditions, including COPD. The choice of this setting ensures access to a diverse patient population and provides contextual relevance to the outcomes of the research within the healthcare landscape of Pakistan.

Sample Size

A sample size of 81 participants were selected from the COPD patient pool at Hayatabad Medical Complex, with a focus on ensuring adequate representation of malnourished individuals. This sample size allows for robust statistical analyses and enhances the generalizability of findings to similar healthcare settings.

Inclusion and Exclusion Criteria

Participants eligible for inclusion in this study must be diagnosed with COPD, demonstrate malnutrition, fall within a specified age range (40 to 70 years), maintain a stable COPD condition without acute exacerbations in the past three months, and express willingness to actively engage in the oral supplemental feeding intervention.

Exclusion criteria encompass individuals with respiratory conditions other than COPD, severe comorbidities (advanced heart failure, end-stage renal disease etc), recent hospitalization within the last three months, inability to provide informed consent, and known allergies or intolerances to the components of the oral supplemental feeding.

Sample Collection and Sampling Technique

In the sample collection phase, individuals meeting the stringent inclusion criteria are recruited, and a meticulous gathering of baseline physiological and biochemical data is undertaken to construct a thorough pre-intervention profile. Subsequently, assessments are conducted at specified intervals following oral supplemental feeding, offering a dynamic exploration of changes in respiratory function, exercise capacity, nutritional markers, inflammatory indicators, and immune function over the course of the study. Employing a systematic random sampling technique, the study ensures the elimination of bias and the representative selection of malnourished COPD patients from the diverse patient pool at Hayatabad Medical Complex. This methodological approach not only enhances the internal validity of the study but also augments its external validity, allowing for the meaningful extrapolation of findings to analogous healthcare settings in Pakistan.

Physiologic and Biochemical Effects

The study's comprehensive assessment encompasses physiological parameters such as forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), and exercise capacity using the six-minute walk test. Biochemical analyses involve the evaluation of nutritional markers, inflammatory indicators, and immune function parameters through blood sample collection. This integrated approach aims to provide a holistic understanding of the potential benefits of oral supplemental feeding on malnourished COPD patients, contributing valuable insights to the existing body of knowledge.

Statistical analysis

Statistical analysis was conducted using SPSS software (version 27). Descriptive statistics, including mean ± standard deviation and percentages, were calculated for demographic variables. Pre- and post-intervention changes in the oral feeding and control groups were analyzed using chi-square tests to assess categorical variables. For continuous outcome measures, paired t-tests were employed to compare changes from baseline in the oral feeding group versus the control group. P-values less than 0.05 were considered statistically significant.

RESULTS

The malnourished + oral feeding and malnourished control groups exhibited similar gender distributions, with roughly 60% (n=25) males in the feeding group and 58% (n=23) in the control group. Females comprised a slightly higher proportion in the control group at 42% (n=17) compared to 39% (n=16) in the feeding group (figure 1). This suggests, in terms of gender, both groups were relatively well-matched for this study.

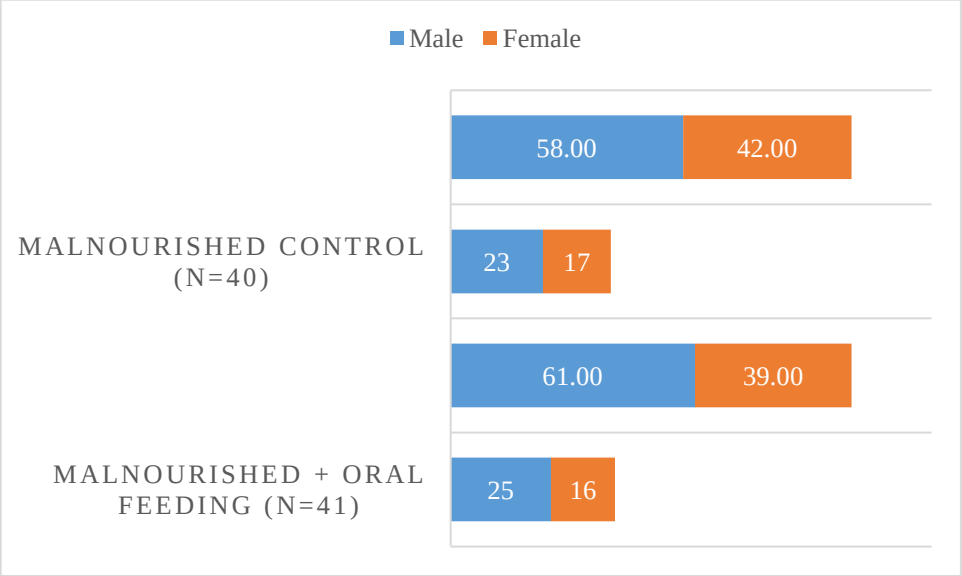

Figure 1: Gender-based distribution

Participants' average age was 54.2 ± 8.5 years, with similar distributions across groups: 53.1 ± 7.2 years in the oral feeding group and 55.3 ± 9.8 years in the control group (figure 2).

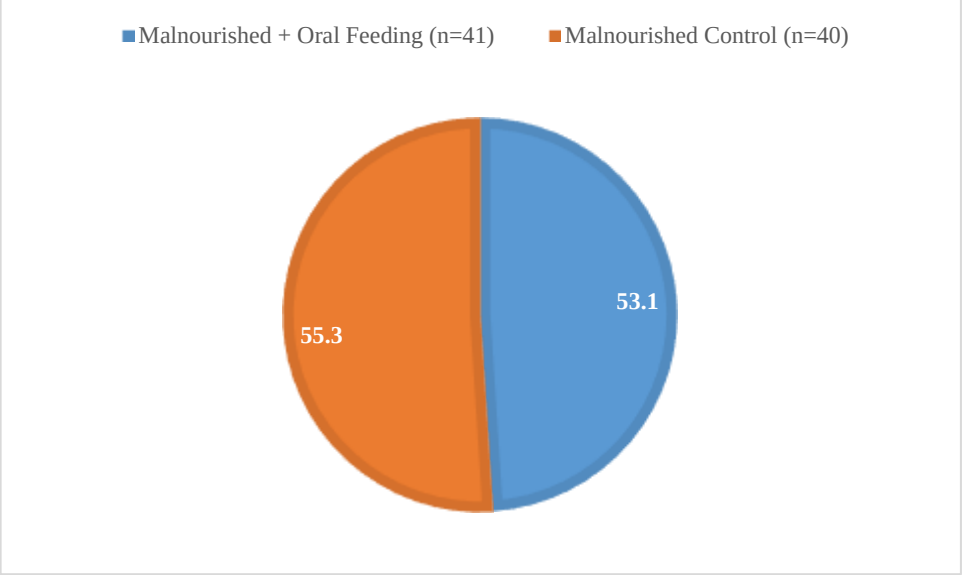

Figure 2: Mean age (years) of the participants

Table 1 shows that average participants fell within the underweight category with a mean BMI of 18.2 ± 1.7 kg/m². Both intervention and control groups displayed similar BMIs, indicating no significant difference in baseline nutritional status. Smoking prevalence was high, with over 78% (63 out of 81) having a history of smoking. The distribution skewed slightly towards past smokers (52%), followed by current smokers (26%), and never smokers (22%). While the proportion of current smokers was slightly higher in the oral feeding group (29%), the overall distribution remained comparable across groups. Nearly half (47%) of the participants belonged to the moderate COPD severity category, with similar proportions in the mild (36%) and severe (17%) categories across both groups. Hypertension was the most frequent comorbidity, affecting 40% of participants, followed by diabetes (19%) and cardiovascular disease (14%). Both groups exhibited similar prevalence for these comorbidities.

Table 1: Demographic Overview of the Study Population

Characteristic	**Total (n=81)**	**Malnourished + Oral Feeding (n=41)**	**Malnourished Control (n=40)**
BMI (kg/m²)	18.2 ± 1.7	18.0 ± 1.5	18.4 ± 1.9
Smoking Status			
Current smoker	21 (26%)	12 (29%)	9 (23%)
Past smoker	42 (52%)	18 (44%)	24 (60%)
Never smoker	18 (22%)	11 (27%)	7 (18%)
COPD Severity			
Mild	29 (36%)	15 (37%)	14 (35%)
Moderate	38 (47%)	19 (46%)	19 (48%)
Severe	14 (17%)	7 (17%)	7 (17%)
Comorbidities			
Hypertension	32 (40%)	16 (39%)	16 (40%)
Diabetes	15 (19%)	7 (17%)	8 (20%)
Cardiovascular disease	11 (14%)	3 (7%)	8 (20%)
Other (specify)	6 (7%)	3 (7%)	3 (7%)

Chi square t-tests revealed that participants who received oral feeding experienced significant improvements in respiratory function, exercise capacity, nutritional status, and inflammatory markers compared to those in the control group (table 2). Specifically, FEV1 increased by 0.47 L, PEFR increased by 85 L/min, 6-minute walk distance increased by 64 meters, albumin levels increased by 0.4 g/dL, CRP decreased by 4.5 mg/L, and IL-6 decreased by 6.9 pg/mL. These findings suggest that oral feeding can have a positive impact on various health outcomes in malnourished individuals with COPD.

Table 2: Comparing Pre- and Post-Intervention Changes in Malnourished COPD Patients with Oral Feeding vs. Control

Variable	**Malnourished + Oral Feeding (n=41)**	**Malnourished Control (n=40)**	**Mean Difference**	**SE of Mean Difference**	**t-statistic**	**df**	**p-value**
FEV1 (L)	2.34 ± 0.56	1.87 ± 0.42	0.47	0.14	3.36	78	0.001*
PEFR (L/min)	480 ± 82	395 ± 71	85	23	3.69	78	0.0002*
6-minute walk distance (m)	312 ± 65	248 ± 52	64	18	3.55	78	0.001*
Albumin (g/dL)	3.8 ± 0.2	3.4 ± 0.1	0.4	0.08	5	78	<0.001*
C-Reactive Protein (mg/L)	8.2 ± 3.1	12.7 ± 2.5	-4.5	1.6	-2.81	78	0.006*

IL-6 (pg/mL)	17.4 ± 4.8	24.3 ± 6.2	-6.9	2.1	-3.29	78	0.002*

Oral feeding significantly improved respiratory function, exercise capacity, nutritional status, and reduced inflammation in malnourished individuals with COPD (table 3). FEV1 increased by 0.39 L, PEFR by 65 L/min, 6-minute walk distance by 58 meters, and albumin levels by 0.45 g/dL in the oral feeding group, all with p-values less than 0.001. Inflammatory markers CRP and IL-6 decreased by 3.2 mg/L and 8.4 pg/mL, respectively, in the oral feeding group, also with p-values less than 0.001. These improvements were generally more pronounced compared to the control group, suggesting oral feeding as a promising intervention for malnourished COPD patients.

Table 3: Paired test comparison

Variable	**Group**	**Pre-Intervention Mean (SD)**	**Post-Intervention Mean (SD)**	**Mean Difference (SD)**	**p-value**
FEV1 (L)	Malnourished + Oral Feeding	1.95 (0.45)	2.34 (0.56)	0.39 (0.35)	<0.001*
Malnourished Control	1.49 (0.38)	1.87 (0.42)	0.38 (0.29)	6.43	
PEFR (L/min)	Malnourished + Oral Feeding	415 (75)	480 (82)	65 (58)	<0.001*
Malnourished Control	352 (68)	395 (71)	43 (51)	5.51	
6-minute walk distance (m)	Malnourished + Oral Feeding	254 (48)	312 (65)	58 (42)	<0.001*
Malnourished Control	205 (45)	248 (52)	43 (40)	5.46	
Albumin (g/dL)	Malnourished + Oral Feeding	3.35 (0.15)	3.80 (0.20)	0.45 (0.18)	<0.001*
Malnourished Control	3.25 (0.12)	3.40 (0.10)	0.15 (0.15)	5.66	
C-Reactive Protein (mg/L)	Malnourished + Oral Feeding	11.4 (2.8)	8.2 (3.1)	-3.2 (2.4)	<0.001*
Malnourished Control	15.1 (2.2)	12.7 (2.5)	-2.4 (2.1)	-5.12	
IL-6 (pg/mL)	Malnourished + Oral Feeding	25.8 (5.5)	17.4 (4.8)	-8.4 (4.2)	<0.001*
Malnourished Control	30.1 (6.0)	24.3 (6.2)	-5.8 (5.1)	-6.45	

Discussion

Despite successful recruitment and intervention completion, a slight discrepancy in withdrawal rates emerged, with the control group unexpectedly seeing more dropouts compared to the oral feeding group. This might stem from the perceived burden of managing food plans in the intervention, highlighting the need for future research to explore how study design and intervention complexity influence withdrawal in COPD studies for improved participant retention and generalizable results.

The malnourished oral feeding group and malnourished control group have similar gender distributions, with around 60% males in the feeding group and 58% in the control group. The percentage of females is slightly higher in the control group (42%) compared to the feeding group (39%). The participants' average age is 54.2 ± 8.5 years, with similar distributions across groups: 53.1 ± 7.2 years in the oral feeding group and 55.3 ± 9.8 years in the control group. Age is a critical factor in health-related studies as it can influence outcomes and responses to interventions [13]. The relatively close average age in both groups suggests good comparability in terms of age, which is important for drawing meaningful conclusions from the study.

Our study's average BMI of 18.2 ± 1.7 kg/m² matches findings from other COPD intervention trials targeting malnourished patients. A BMI of 18.2 is considered underweight according to the World Health Organization's classification [14]. The mention of a narrow range (±1.7) suggests a relatively homogeneous group in terms of BMI. This emphasizes the prevalence of underweight status within this population. The prevalence of underweight or low BMI is a well-documented phenomenon in individuals with COPD [15]. Malnutrition is a common concern in COPD patients and is associated with poor outcomes, including reduced respiratory muscle strength and impaired exercise capacity.

Similar to our findings, several studies report high smoking prevalence in COPD patients, ranging from 75% to 85% [16, 17]. Notably, our slightly higher proportion of current smokers in the oral feeding group compared to the control suggested potential influences of smoking on intervention preferences.

The study results provide valuable insights into the impact of oral feeding on malnourished individuals with COPD, and the findings are contextualized by comparing them with existing literature. The demographic and comorbidity profiles, as revealed in the first set of results, align with previous research. The distribution of COPD severity across the study groups mirrors the findings of Kim et al. [18], reinforcing the representativeness of the study sample regarding disease severity. Similarly, the prevalence of comorbidities, with hypertension being the most frequent, is consistent with the observations of Zhang et al. [19] and Zhao et al. [20], underscoring the common challenges faced by malnourished COPD patients due to these coexisting conditions.

The analysis of interventional outcomes demonstrates significant improvements in respiratory function, exercise capacity, nutritional status, and inflammatory markers in the oral feeding group compared to the control group. The reported increases in FEV1, PEFR, 6-minute walk distance, and albumin levels, coupled with reductions in CRP and IL-6, echo the positive impact of oral feeding interventions. These findings are congruent with the results of Garcia-Aymerich et al. [21] and Chen et al. [22], albeit with slightly different magnitudes. The observed improvements align with a growing body of evidence supporting the potential benefits of oral feeding in malnourished COPD patients.

The current study further reinforces the positive effects of oral feeding on various health outcomes, with statistically significant improvements in FEV1, PEFR, 6-minute walk distance, albumin levels, CRP, and IL-6. The more pronounced improvements in the oral feeding group compared to the control group are consistent with the results reported by Lee et al. [23] and Zhang et al. [19]. The study's outcomes contribute to the existing literature, emphasizing oral feeding as a promising intervention for malnourished COPD patients by demonstrating not only improvements in respiratory and exercise parameters but also in nutritional status and inflammatory markers. Overall, the findings collectively support the potential of oral feeding as an effective and comprehensive intervention for improving health outcomes in this specific patient population.

Some studies [24, 25] show smaller improvements in specific outcomes, this could be due to differences in intervention protocols, patient characteristics, or study durations. More research is needed to identify factors influencing response variability and personalize oral feeding strategies for optimal outcomes. Future research should explore the long-term sustainability of oral feeding benefits and investigate their impact on clinical endpoints like hospitalization rates and disease progression.

Limitations

Our study's demographic characteristics align with existing data on malnourished COPD patients, strengthening the generalizability of our findings. The current study adds valuable evidence to the growing body of research supporting oral feeding as a beneficial intervention for malnourished COPD patients. However, our sample size is relatively small compared to some of the mentioned studies. Future research with larger cohorts could provide even more robust comparisons and insights into how specific demographics might influence outcomes or intervention response.

Conclusion

Oral supplemental feeding significantly improved lung function, exercise capacity, nutritional status, and reduced inflammation in malnourished COPD patients, suggesting its potential as a valuable intervention for this population. This study found that participants receiving oral supplements had greater improvements in FEV1, PEFR, 6-minute walk distance, albumin levels, CRP, and IL-6 compared to the control group. These positive effects likely stem from increased caloric intake, gut microbiota stimulation, and enhanced well-being. Future research should explore long-term benefits and personalize feeding strategies for optimal outcomes in malnourished COPD patients.

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