RESEARCH PAPER

Dietary Intake, Nutritional Status and Functional Status in Stable COPD: A Cross-Sectional Study from a Tertiary Care Centre in Puducherry, India

Dheepiga PK, Vimal Raj R, Raman KV*, Kalaiyarasan K

Department of Pulmonary Medicine, Sri Venkateshwaraa Medical College Hospital and Research centre, Ariyur, Puducherry

***Corresponding author:** dr.kv.raman2011@gmail.com*

Received: 25th June 2026; **Revised:** 28th July 2026; **Accepted:** 10th October 2026; **Available Online:** 15th October 2026

Abstract

Background: Nutritional status is a modifiable determinant of outcome in chronic obstructive pulmonary disease (COPD), yet Indian data linking what patients actually eat to how well they function are limited. We examined how energy and protein intake, body composition and dietary patterns relate to exercise capacity and health-related quality of life in stable COPD.

Methods: We conducted a single-centre cross-sectional study of 100 stable COPD patients aged 40–65 years (GOLD-defined), recruited by convenience sampling. Intake was estimated from a 24-hour recall and a food frequency questionnaire (FFQ). Anthropometry (BMI, waist and mid-arm circumference, skinfold thickness), six-minute walk distance (6MWD) and SGRQ-C scores were recorded. Associations were tested with Pearson correlation, t-tests and one-way ANOVA; dietary patterns were derived by principal component analysis (PCA) with varimax rotation.

Results: Mean age was 58.3 ± 6.3 years; 70% were men and 72% smokers. Mean energy intake was 1385.7 ± 253.9 kcal/day, protein intake 45.2 ± 15.5 g/day and energy adequacy 63.5 ± 12.1%. By BMI, 18% were underweight and 33% obese, while 43% had a low mid-arm circumference. Protein intake ($r = 0.51$), energy adequacy ($r = 0.47$) and calorie intake ($r = 0.42$) correlated positively with 6MWD. Protein intake correlated with BMI ($r = 0.406$), skinfold thickness ($r = 0.415$) and mid-arm circumference ($r = 0.233$) but not waist circumference. Higher BMI was accompanied by longer walking distance ($F = 4.62$, $p = 0.005$) and higher SGRQ-C scores ($F = 4.26$, $p = 0.007$). Walking distance fell as SGRQ-C category worsened ($F = 5.67$, $p = 0.001$). Seven dietary components explained about 66% of variance in food frequency.

Conclusion: In this cohort, intake was well below requirement, and higher protein and energy intake went together with better exercise capacity and better anthropometric indices. Because the design is cross-sectional these findings describe association only, but they support routine dietary assessment in COPD clinics and justify trials of protein-focused nutritional support in Indian patients.

Keywords: COPD; dietary intake; protein; six-minute walk test; SGRQ-C; anthropometry; dietary patterns; India

How to cite this article: Dheepiga PK, Vimal Raj R, Raman KV, Kalaiyarasan K., Dietary Intake, Nutritional Status and Functional Status in Stable COPD: A Cross-Sectional Study from a Tertiary Care Centre in Puducherry, India. Int J Drug Deliv Technol. 2026;16(89s): 213-217; DOI: 10.25258/ijddt.16.89s.25

Source of support: XX

Conflict of interest: XX

Introduction

COPD is a progressive condition in which persistent airflow limitation accompanies chronic inflammation of the airways and lung parenchyma, usually after prolonged exposure to tobacco smoke or other inhaled irritants [1]. It remains one of the leading causes of death and disability worldwide, with a disproportionate share of the burden in low- and middle-income countries [2]. The disease is no longer viewed as purely pulmonary: systemic inflammation, oxidative stress and skeletal-muscle atrophy contribute to breathlessness, reduced exercise tolerance and a poorer quality of life [1,3].

Nutrition sits at the centre of this systemic picture. Low energy and protein intake, together with raised metabolic demand, favour loss of fat-free mass, weaken respiratory and peripheral muscles and limit exercise tolerance [3,4]. Reviews of nutritional support suggest it can improve

nutritional status and aspects of function in selected patients [5], and observational work has tied dietary intake and nutritional status to health-related quality of life in outpatients with COPD [6]. Beyond single nutrients, habitual dietary patterns have been linked to the risk of developing COPD [7,8].

Most of this evidence comes from Western and East Asian populations. India has a different dietary structure, largely cereal- and pulse-based with variable animal-protein intake, and undernutrition and excess adiposity coexist. Whether intake of specific nutrients tracks with functional capacity among Indian COPD outpatients is not well documented. We therefore set out to relate energy and protein intake to six-minute walk distance (primary objective), and to describe nutritional status, quality of life, the link between protein intake and body measurements, and the dietary patterns of patients with stable COPD attending a tertiary centre in Puducherry.

Methods

Design, setting and participants

This cross-sectional study was carried out in a tertiary care centre at Puducherry, over 18 months following ethics approval. Consecutive attenders who met the criteria were enrolled by convenience sampling. Adults aged 40–65 years with COPD diagnosed according to GOLD criteria [9] and in a stable phase were eligible. We excluded those with contraindications to spirometry or the six-minute walk test, known chronic cardiac, renal or hepatic disease, and those who declined consent.

The sample size was based on a reported 80% prevalence of malnutrition in stable COPD, using $n = 4pq/d^2$ with 8% absolute precision, which gives 100 participants.

Data collection

Trained investigators interviewed each participant face to face using a pretested semi-structured proforma. It recorded demographics, symptoms, smoking history (smoking index and pack-years), comorbidities, exacerbation and treatment history, and dyspnoea grade on the modified Medical Research Council (mMRC) scale [10]. Spirometry (FEV_1, FVC, FEV_1/FVC) followed GOLD recommendations.

Dietary assessment. Usual intake was estimated with a 24-hour recall together with a food frequency questionnaire covering common food groups. Energy and protein were calculated from the Nutritive Value of Indian Foods tables [11]. Energy adequacy was expressed as the percentage of the estimated requirement met.

Anthropometry. Height (stadiometer) and weight (light clothing, barefoot) gave BMI, classified using Asian cut-offs [12]. Waist circumference was measured midway between the lowest rib and iliac crest; mid-arm circumference (MAC) on the non-dominant arm midway between acromion and olecranon; skinfold thickness with a caliper.

Functional measures. After 10 minutes of rest, participants walked at their own pace on a flat course for six minutes breathing room air, with standardised encouragement [13]; distance, heart rate and oxygen saturation were recorded. Health-related quality of life was measured with the SGRQ-C (score 0–100; higher means worse), grouped as normal (<25), mild (25–49), moderate (50–74) and severe (≥75).

Statistical analysis

Data were entered in Microsoft Excel and analysed in SPSS (IBM). Continuous variables are given as mean ± SD (and median/IQR where skewed), categorical variables as counts and percentages. Pearson correlation was used for intake against 6MWD and for protein intake against anthropometry; independent-samples t-tests and one-way ANOVA compared intake, 6MWD and SGRQ-C across BMI, MAC, waist and skinfold categories and SGRQ-C bands. Effect sizes (η^2, partial η^2, Cohen's f^2) were reported for ANOVA on 6MWD. Dietary patterns were extracted from FFQ data by PCA with varimax rotation, after checking sampling adequacy (Kaiser–Meyer–Olkin) and Bartlett's test; components with eigenvalue >1 were retained. Significance was set at $p < 0.05$.

Ethics

The Institutional Ethics Committee approved the study. All participants gave written informed consent, data were de-identified with codes, and the study followed the Declaration of Helsinki (2013).

Results

Participant characteristics

The 100 participants had a mean age of 58.27 ± 6.33 years (median 60, IQR 8). Forty-five percent were aged 51–60 years, 41% were over 60 and 14% were under 50. Seventy were men and 72 were smokers. Mean BMI was 23.18 ± 4.46 kg/m²: 18% were underweight, 26% normal, 23% overweight and 33% obese. Waist circumference placed 65% in the high-risk band and skinfold thickness was high in 69%, yet 43% had a MAC in the malnourished range (Table 1). Mean SGRQ-C was 32.86 ± 11.73, with 31% scoring normal, 24% mild, 36% moderate and 9% severe.

Table 1. Baseline nutritional, dietary and functional characteristics (N = 100)

Variable	Value
Age, years (mean ± SD)	58.27 ± 6.33
Men / women, n	70 / 30
Smokers, n (%)	72 (72)

Variable	Value
BMI, kg/m² (mean ± SD)	23.18 ± 4.46
Waist circumference, cm: men / women	91.2 ± 5.9 / 88.32 ± 6.45
Mid-arm circumference, cm: men / women	25.7 ± 1.85 / 25.16 ± 2.1
Skinfold thickness, mm	15.92 ± 1.30
Energy intake, kcal/day	1385.7 ± 253.9
Protein intake, g/day	45.2 ± 15.5
Energy adequacy, %	63.5 ± 12.1
6MWD, m	87.68 ± 9.61
SGRQ-C score	32.86 ± 11.73

Intake and exercise capacity

Average intake was low: energy adequacy was about 64% and mean protein intake 45 g/day. All three intake measures correlated positively with 6MWD, protein most strongly (Table 2).

Table 2. Correlation of dietary intake with six-minute walk distance

Intake measure	r	p
Energy (kcal/day)	0.42	0.02
Protein (g/day)	0.51	0.01
Energy adequacy (%)	0.47	0.01

Protein intake and body measurements

Protein intake correlated with BMI ($r = 0.406$, $p < 0.001$), skinfold thickness ($r = 0.415$, $p < 0.001$) and MAC ($r = 0.233$, $p = 0.020$), but not with waist circumference ($r = 0.147$, $p = 0.145$).

Intake across nutritional categories

Energy and protein intake both rose across BMI categories (Table 3). Underweight participants consumed the least (1185 kcal and 34.5 g protein daily), obese participants the most (1479 kcal and 51.6 g). Those with a normal MAC ate more energy (1448 vs 1303 kcal, $p = 0.005$) and protein (48.8 vs 40.4 g, $p = 0.004$) than those with a low MAC. Energy intake was also higher in the high-skinfold group ($p = 0.045$), whereas protein showed only a borderline difference ($p = 0.051$). Neither nutrient differed by waist-circumference risk category.

Table 3. Intake by BMI category (mean ± SD)

BMI category	n	Energy, kcal/day	Protein, g/day
Underweight (<18.5)	18	1185.08 ± 157.64	34.50 ± 6.38
Normal (18.5–24.9)	26	1390.60 ± 251.91	45.52 ± 13.91
Overweight (25.0–29.9)	23	1403.63 ± 231.15	44.10 ± 14.56
Obese (≥30.0)	33	1478.91 ± 260.78	51.62 ± 17.75
ANOVA		$F = 6.08$, $p = 0.001$	$F = 5.45$, $p = 0.002$

BMI, exercise capacity and quality of life

Walking distance increased stepwise with BMI, from 82.15 ± 9.54 m in underweight to 93.47 ± 8.77 m in obese participants ($F = 4.62$, $p = 0.005$; $\eta^2 = 0.13$, a moderate effect). SGRQ-C scores also differed by BMI ($F = 4.26$, $p = 0.007$), being highest in the obese group (35.28 ± 9.41) and similar (31.4–32.1) in the other three. Thus the heavier patients walked further but reported worse quality of life.

Quality of life, exercise capacity and diet

Mean 6MWD was 91.45 ± 9.29 m in the normal SGRQ-C band, 90.29 ± 9.50 m in the mild band, 83.14 ± 8.33 m in the moderate band and 85.89 ± 9.18 m in the severe band ($F = 5.67$, $p = 0.001$). Energy intake did not differ across SGRQ-C bands ($p = 0.44$). Protein intake did ($F = 3.21$, $p = 0.027$), but unexpectedly it was highest in the severe group (53.19 ± 16.78 g/day, $n = 9$) and lowest in the mild group (41.79 ± 10.75 g/day).

Dietary patterns

The data were suitable for factor analysis (KMO = 0.657; Bartlett $\chi^2 = 692.085$, $df = 210$, $p < 0.001$). PCA with varimax rotation extracted seven components with eigenvalue >1, together explaining about 65.6% of the variance (Table 4). The largest was a starchy–dessert pattern (rice, pudding, milk; 14.2%), followed by a legume–vegetable–sugar pattern (10.8%) and an animal-protein pattern (meat, fish, shellfish, eggs; 9.7%).

Table 4. Dietary patterns identified by PCA of the FFQ (n = 100)

Component	Main foods	Variance, %
1. Starchy/dessert	Rice, pudding, milk, potatoes	14.2
2. Legume–vegetable/sweet	White beans, chickpeas, vegetables, sugar	10.8
3. Animal protein	Meat, fish, shellfish, eggs	9.7
4. Bakery/snack	Bread, yoghurt, cookies	8.7
5. Plant protein/carbohydrate	Lentils, green peas, fruits	8.1
6. Confectionery	Chocolate	7.1
7. Fat–fruit–dairy	Butter, fruits, yoghurt	7.0

Discussion

Main findings. In this sample of stable COPD outpatients, energy and protein intake fell well short of requirement, and intake—protein in particular—was positively associated with six-minute walk distance. Protein and energy intake were also higher in patients with better anthropometric indices. Heavier patients walked further but had worse SGRQ-C scores, and walking distance declined as SGRQ-C category worsened.

Intake and exercise capacity. The association between protein intake and walking distance is biologically plausible. Inadequate protein and energy promote loss of muscle mass and strength [3,4], and low energy intake has been associated with reduced skeletal muscle mass and physical performance in stable COPD [14]. Observational data likewise link intake and nutritional status to outcomes [6,15], and supplementation trials and meta-analyses report gains in nutritional status and functional capacity, although effects vary [5,16]. Combined nutrition and exercise programmes appear promising [17]. Our correlations are moderate and cross-sectional, so we cannot say whether better eating supports walking capacity or whether patients who walk better simply eat more; fatigue and breathlessness may themselves depress appetite and intake.

Body composition. Protein intake tracked with BMI, skinfold thickness and MAC but not waist circumference, suggesting that it relates to overall tissue mass rather than central fat distribution. Notably, 43% of patients had a low MAC even though more than half were overweight or obese by BMI. This discordance hints at reduced muscle reserve hidden behind a normal or high BMI, a pattern described in COPD [3]; however, we did not measure muscle mass directly, so sarcopenia cannot be inferred from our data.

BMI, walking distance and quality of life. The positive gradient between BMI and 6MWD is in keeping with the so-called obesity paradox, whereby modest excess weight appears protective in COPD [18]. Greater body mass may reflect larger energy and muscle reserves. At the same time, obese participants reported the poorest SGRQ-C scores, which fits the idea that excess adiposity worsens respiratory mechanics and symptom burden. These two observations are not contradictory—a patient can walk further yet feel more limited—but they argue against reading higher BMI as uniformly beneficial.

Unexpected protein finding. Protein intake was highest in the small severe-SGRQ-C group. With only nine participants, chance is a likely explanation, but reverse causation (symptomatic patients being advised to eat more) or the heavier body mass of this group may also contribute. We would not interpret it as evidence that protein harms quality of life.

Dietary patterns. PCA yielded seven patterns dominated by cereals, sweets, legumes and animal-source foods. Such data-driven patterns are context-specific, and ours reflect local food habits; the number of components relative to 21 food items and 100 participants calls for cautious interpretation and replication. Wider evidence links healthier patterns, and fruit and vegetable intake, with lower COPD risk and better outcomes [7,8,19].

Clinical implications. Intake in this cohort was far below requirement irrespective of BMI, and many overweight patients showed signs of low muscle reserve. Routine dietary history and a measure of muscle mass or MAC, rather than BMI alone, would help clinics identify those who may benefit from dietitian-led, protein-focused advice within a multidisciplinary programme [5,20].

Limitations

This study combined dietary, anthropometric, functional and quality-of-life measures in the same patients, used standard instruments, and studied an under-represented Indian population. Limitations include a single centre and modest sample, convenience sampling, and a cross-sectional design that precludes causal inference. Dietary intake was self-reported and subject to recall error. Confounders such as socioeconomic status, physical activity, comorbidity and airflow-limitation severity were not adjusted for in the analyses reported here. Skinfold and waist-circumference cut-offs were applied to the whole group, and no direct measure of lean mass was available. Finally, no long-term follow-up was possible.

Conclusion

Among stable COPD outpatients in Puducherry, habitual energy and protein intake were low, and higher protein and energy intake were associated with longer six-minute walk distance and better anthropometric indices. Higher BMI was linked to better walking distance but poorer quality of life, and a substantial share of patients had low mid-arm circumference despite normal or high BMI. These

associations, though not causal, support systematic nutritional assessment in COPD care and warrant prospective and interventional studies of protein-focused nutrition in Indian patients.

References

1. Barnes PJ. Inflammatory mechanisms in patients with chronic obstructive pulmonary disease. J Allergy Clin Immunol. 2016;138(1):16–27.
2. Safiri S, Carson-Chahhoud K, Noori M, et al. Burden of chronic obstructive pulmonary disease and its attributable risk factors in 204 countries and territories, 1990–2019. BMJ. 2022;378:e069679.
3. Barreiro E, Jaitovich A. Muscle atrophy in chronic obstructive pulmonary disease: molecular basis and potential therapeutic targets. J Thorac Dis. 2018;10(Suppl 12):S1415–S1424.
4. Tramontano A, Palange P. Nutritional state and COPD: effects on dyspnoea and exercise tolerance. Nutrients. 2023;15(7):1786.
5. Collins PF, Yang IA, Chang YC, Vaughan A. Nutritional support in chronic obstructive pulmonary disease (COPD): an evidence update. J Thorac Dis. 2019;11(Suppl 17):S2230–S2237.
6. Nguyen HQ, Collins PF, Pavey TG, et al. Nutritional status, dietary intake, and health-related quality of life in outpatients with COPD. Int J Chron Obstruct Pulmon Dis. 2019;14:215–226.
7. Yu D, Lv J, Man J, et al. Dietary patterns and risk of chronic obstructive pulmonary disease: a prospective cohort study of Chinese adults. Eur Respir J. 2021;57(2):2001627.
8. Ghosn B, Onvani S, Ardestani ME, et al. Association between diet quality and chronic obstructive pulmonary disease: a case-control study. BMC Public Health. 2023;23:2071.
9. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of COPD: 2024 report. https://goldcopd.org/2024-gold-report/
10. Yorke J, Khan N, Garrow A, et al. Evaluation of the individual activity descriptors of the mMRC breathlessness scale: a mixed method study. Int J Chron Obstruct Pulmon Dis. 2022;17:2289–2299.
11. Gopalan C, Sastri BVR, Balasubramanian SC. Nutritive Value of Indian Foods. Hyderabad: National Institute of Nutrition, ICMR; 2021.
12. World Health Organization. WHO Asian BMI classification. [Replace with the primary WHO Expert Consultation citation: Lancet. 2004;363:157–163.]
13. Agarwala P, Salzman SH. Six-minute walk test: clinical role, technique, coding and reimbursement. Chest. 2020;157(3):603–611.
14. Tomita M, Uchida M, Imaizumi Y, et al. Relationship of energy malnutrition with skeletal muscle mass and physical functional performance in patients with stable COPD. Nutrients. 2022;14(13):2596.
15. Kim V, Zhao H, Regan EA, et al. Impact of dietary intake and nutritional status on chronic obstructive pulmonary disease outcomes: a cross-sectional analysis. Int J Chron Obstruct Pulmon Dis. 2019;14:2599–2608.
16. Lattanzi G, Lelli D, Incalzi RA, Pedone C. Effect of macronutrient or micronutrient supplementation on nutritional status, physical functional capacity and quality of life in patients with COPD: a systematic review and meta-analysis. J Am Nutr Assoc. 2024;73(1):1–15.
17. Beck AM, Damkjær K, Sørensen LL, et al. Nutritional support combined with exercise training in patients with chronic obstructive pulmonary disease: a single-arm intervention study. Clin Nutr ESPEN. 2021;42:213–220.
18. Jo YS. Long-term outcome of chronic obstructive pulmonary disease: a review. Tuberc Respir Dis (Seoul). 2022;85(4):289–301.
19. Stent R, Dowling L, Scott H, Wood L. Influence of fruit and vegetable intake on COPD risk and outcomes: a systematic review and meta-analysis. Proc Nutr Soc. 2025;84:e66.
20. Beijers RJHCG, Steiner MC, Schols AMWJ. The role of diet and nutrition in the management of COPD. Eur Respir Rev. 2023;32(167):220003.