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Aging and COPD affect different domains of nutritional status - The ECCE study

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ABSTRACT:

BACKGROUND: COPD and ageing may contribute to malnutrition. AIM: we aimed at exploring whether COPD and aging determine malnutrition in different manners. METHODS: stable COPD outpatients (n=460; M/F: 376/84) from the Extrapulmonary Consequences of COPD in the Elderly (ECCE) study database were investigated (age 75.0(5.9) years; FEV_1%pred 54.7(18.3)%). Nutritional status was evaluated by Mini Nutritional Assessment (MNA) questionnaire. From the MNA, three scores exploring the domains of the nutritional status were calculated: body composition, energy intake and body functionality scores. RESULTS: GOLD stages were negatively correlated with five MNA items exploring mobility, patient's perception of own nutrition and health status, arm and calf circumferences (lowest r_s=-0.013; highest p=0.039). GOLD stages were independently correlated with body composition and body functionality scores (model R^2=0.075). Age was negatively correlated with four MNA items exploring loss of appetite, fluids intake, mobility and autonomy in daily life (lowest r_s=-0.013; highest p=0.030). Age was independently correlated with body functionality score (model R^2=0.037). CONCLUSION: Severe COPD and aging are independent and probably concurrent conditions leading to malnutrition. MNA questionnaire allows a valuable insight into complexity of components of nutritional status and may provide useful clues for treatment strategies.

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KEY WORDS:

Malnutrition, Geriatric medicine; chronic obstructive pulmonary disease, aging.

BACKGROUND

Chronic obstructive pulmonary disease (COPD) is a common condition characterized by a poorly reversible limitation in airflow resulting from inflammation and remodeling of the airways (1), and many systemic effects have been recognized (2). Amongst these malnutrition is very common and its prevalence increases along with the severity of the disease (3, 4) and it has been recognized as a risk factor for mortality (5). The relation between malnutrition and mortality has been also confirmed in elderly COPD patients (6). Regardless of disease status, the prevalence of malnutrition increases with age (7); consistent with this concept, subjects aged 80 years or older have a five times higher prevalence of malnutrition than subjects younger than 50 years (8). Thus, it is conceivable that COPD and ageing may contribute, in at least an additional manner, to malnutrition. Nutritional status is the result of the interaction of food intake, absorption and utilization of nutrients and it is possible to define it through three variables: body composition, energy intake and body functionality (9). Malnutrition is an overall term including: undernutrition, overnutrition, specific nutrient deficiencies and imbalance because of disproportionate intake (9). However, in the elderly it is often referred to undernutrition (9) and with this intent it is used in the present paper.
In the assessment of nutritional status, the World Health Organization (WHO) has adopted the body mass index (BMI: weight/height^2) as the reference method to classify adults as: underweight (BMI <18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), or obese (>30 kg/m^2) (10). However, it has been demonstrated that BMI is inadequate to assess malnutrition in COPD (11, 12), where reduction in the fat-free mass, especially in patients with overrepresented fat mass, may not be detected by the BMI alone. Since a single variable may be inadequate to fully describe the nutritional status, questionnaires and composite indexes have been developed (9, 13, 14). Among these diagnostic tools, the Mini Nutritional Assessment (MNA) questionnaire has been designed and validated to provide a rapid assessment of malnutrition in elderly patients (15). Moreover, MNA identifies people at risk for malnutrition before severe changes in weight or albumin levels occur and is predictive of mortality and hospital costs (15).
The characteristics and correlates of malnutrition in elderly COPD patients are still debated and the role of aging has not been fully elucidated. Therefore, we aimed at exploring whether COPD and aging determine malnutrition in different manners. For this purpose we investigated the characteristics of nutritional status by BMI and MNA questionnaire and assessed its correlates in elderly COPD patients.

METHODS

Design overview and patients

We analyzed data from the Extrapulmonary Consequences of COPD in the Elderly (ECCE) study, a multicenter (see list on the Appendix 1) population-based observational study of Caucasian stable COPD outpatients aged ≥65 years (16). Protocol details were reported elsewhere (16).

Patients

Participants were recruited among those attending the pulmonary medicine outpatient clinics of 15 participating Italian centers (see list on the Appendix 1). Among the 516 screened patients, 56 were excluded from the analysis (20 because of age <65 years, 27 for unconfirmed diagnosis, 5 for low quality spirometry, 4 for incomplete data on MNA). The final sample was composed of 460 patients (M/F: 376/84).
The diagnosis and staging of COPD was made according to ATS/ERS and GOLD guidelines (1, 17). To be included in the study, patients had to be in stable conditions and not to report acute symptoms or therapy modifications in the 30 days before enrolment. People with a diagnosis of cancer were excluded, regardless of disease activity.

Nutritional assessment

The nutritional status was evaluated by BMI and by MNA questionnaire (see appendix 2) (15, 18). MNA questionnaire explores the three domains of the nutritional status: body composition, energy intake and body functionality (9). It consists of 18 items: 4 explore the body composition (BMI, arm and calf circumferences, weight loss in the last 3 months), 6 explore the energy intake (n° of total, proteic, and vegetables and fruit-based daily meals, reduction of appetite, hydration, feeding autonomy) and 8 explore the body functionality (number of drugs, acute events, autonomy in daily life and in transfers, pressure ulcers, cognitive status, patient's perception of his/her own nutritional status and own health status compared to the other elderly persons) (9). A score for each of the three nutritional domains was calculated.

The MNA questionnaire was completed accordingly to developers' instruction (available at www.mna-elderly.com). MNA is divided into a two-step procedure: the screening step and the global assessment step. According to the total score achieved (screening+global), patients are classified as "malnourished", "at risk of malnutrition", and "well nourished". According to the conventional procedure, the "global assessment step" of the MNA should only be done in patients not reaching the screening threshold. However, we also extended the global assessment step to patients with a score over the screening threshold. This extension was decided as an amendment to the original protocol after the study was started. As a consequence, the calculation of the scores for each of the three nutritional domains (body composition, energy intake and body functionality) was obtained on 286 patients only. The patients with a score over the screening threshold were 288; amongst these, 114 completed the "global assessment step" of the MNA and 174 did not: these two groups did not differ for age, BMI, MRC dyspnea score, oxyhemoglobin saturation, distance walked at the six-minutes walking test, FEV_1% of predicted and FEV1/FVC ratio.

Statistical analysis

Statistical analysis was performed using SPSS statistical software package V 13.0 (SPSS Inc, Chicago, IL, USA). In descriptive analysis, data are presented as mean and standard deviation (SD) or median + range depending on their distribution, whereas, when groups are compared, data are presented as mean and standard error of mean (SEM). Differences between groups were evaluated by one-way ANOVA with appropriate post-hoc analysis. Correlations were assessed using Pearson's coefficient (r) or Spearman rho (r_s).

Multiple ordinal regression models were performed including GOLD stages as dependent variable and as independent variables: i) the 18 items of the MNA questionnaire; ii) the

three MNA domains. The models were corrected for age. Same approach was adopted with linear regression models with age as dependent variable. These models were corrected for GOLD stages.

Probability values of $p<0.05$ were considered to be statistically significant.

Results

Anthropometric and functional characteristic of the sample are summarized in table 1. The mean age of enrolled patients was 75.0 (5.9) years and the mean FEV_1% was 54.7 (18.3)%. Distribution of the sample by stage was as follows: 41 (8.9%) stage I, 202 (43.9%) stage II, 133 (28.9%) stage III, and 61 (13.3%). stage IV; GOLD stage was undetermined in 23 patients (5%), due to lack of acceptable spirometry.

Description of the nutritional status

The average BMI was 27.1 (5.3) Kg/m^2 (range 14.4 to 51.4 Kg/m^2). The distribution of patients according to the BMI-based WHO classification of nutritional status (10) was as follows: 14 patients (3.0%) were underweight (BMI <18.5 kg/m^2), 157 patients (34.1%) had normal weight (18.5–24.9 kg/m^2), 168 patients (36.5%) were overweight (25–29.9 kg/m^2), and 121 patients (26.3%) were obese (>30 kg/m^2).
When patients were categorized according to the MNA score, 288 patients (62.6%) passed the screening step of the MNA questionnaire and were immediately classified as "well nourished". After the completion of the test, 31 additional patients (6.7%) were classified as "well nourished", leading the total number of "well nourished" patients to 319 (69.3%), 124 (27.0%) were classified as "at risk of malnutrition" and 17 patients (3.7%) were classified as "malnourished".
Although the BMI decreases along with MNA groups ["well nourished" (n=319): mean BMI=28.3(4.8) Kg/m^2; "at risk of malnutrition" (n=124): mean BMI= 24.9(5.2) Kg/m^2; "malnourished" (n=17): mean BMI= 20.5(4.0) Kg/m^2; ANOVA p <0.001], there were 75 (47.7%) normal, 35 (20.8%) overweight and 17 (14%) obese subjects classified as malnourished or at risk of malnutrition according to MNA. These data are displayed in table 2.
Mean age did not differ among the GOLD stages (table 3).

Nutritional characteristics of COPD

BMI was higher in GOLD stages I and II compared to stages III and IV (ANOVA p<0.001), and the MNA total score was higher (i.e. better) in GOLD stage I compared to the other three (ANOVA p=0.020) (table 3).

When the 18 items of the MNA questionnaire were separately analyzed, five of them qualified as negative correlates of GOLD stages: question "C – mobility" (r_s = -0.11, p = 0.017), question "O – self view of nutritional status" (r_s = -0.13, p = 0.039), question "P – how does the patient consider his/her health status?" (r_s = -0.20, p = 0.001), question "Q –

mid-arm circumference (r_s = -0.20, p = 0.001)" and question "R – calf circumference (r_s = -0.23, p < 0.001)" (see appendix 2). Multiple ordinal regression analysis demonstrated that only questions "R" and "P" of the MNA questionnaire where independently correlated to GOLD stages (Model: R^2 = 0.136; coefficients: -0.379 and -1.058; p values: 0.036 and 0.004, respectively).

In 286 patients we analyzed the three domains of the MNA questionnaire. The 114 patients with a score over the screening threshold, who completed the "global assessment step" of the MNA, were representative of the whole sample of 288 patients with a score over the screening threshold, as described in the methods section. While the energy intake score was the same in different GOLD stages, the body composition score was lower (i.e. worse) in GOLD stage IV and the body functionality score was lower (i.e. worse) in GOLD stages III and IV (see table 4). Multiple ordinal regression analysis confirmed that body composition and body functionality scores where independently correlated with GOLD stages (for the model see table 5).

Nutritional characteristics of aging

Age did not differ among BMI groups based on WHO classification (ANOVA p=0.063).

The age of "malnourished" patients was significantly higher [mean age (SEM) = 78.0 (1.6) yrs] compared to the other two groups: "at risk" 75.6(05) yrs and "well nourished" 74.6(0.3); (ANOVA: p < 0.031).

When the 18 items of the MNA questionnaire were separately analyzed, four of them qualified as negative correlates of age: question "A – loss of appetite, digestive problems, chewing or swallowing difficulties" question (r_s = -0.17, p < 0.001), "C – mobility" (r_s = -0.24, p < 0.001), question "G – lives independently" (r_s = -0.27, p < 0.001), and question "M – how much fluid is consumed per day" (r_s = -0.13, p = 0.03) (see appendix 2). Multiple regression analysis demonstrated that only questions "C" and "G" of the MNA

questionnaire were independently correlated with age (Model: R^2 = 0.108; beta: -0.198 and -0.172; p values: 0.004 and 0.013, respectively).

Energy intake and body functionality scores were significantly and negatively correlated with age (r = -0.16, p = 0.008; r = -0.15, p = 0.009; respectively), whereas body composition was not. Multiple regression analysis demonstrated that body functionality only was independently correlated to age (for the model see table 6).

Finally, body composition, energy intake and body functionality scores did not differ between genders (data not shown).

Discussion

The main finding of this study is that COPD severity and aging are significantly, though weakly, correlated with different aspects of the nutritional status: disease severity correlated with body composition and body functionality, whereas aging did so mainly with decreased body functionality. While BMI remains a primary index of malnutrition and disease severity, MNA questionnaire allows a valuable insight into complexity of components of nutritional status and may provide useful clues for treatment strategies. In fact, our results suggest that prevention and treatment of body functionality deterioration might be the main objective of nutritional interventions, whichever are their effects on body composition.

Our findings confirm and extend previous observations by other authors. Firstly, it has been demonstrated that the prevalence of underweight increases with severity of COPD (12) and that fat-free mass decreases in advanced GOLD stages (19). Furthermore, both gold standard and surrogate parameters of body composition, such as low fat-free mass (4), mid-thigh muscle cross-sectional area (11) and mid-arm muscle area (20) are better predictors of mortality than BMI. Secondly, our study demonstrates that energy intake is not correlated with disease severity. This is consistent with data from a systematic review, which indicated that nutritional support has no significant effect on anthropometric measures, lung function or exercise capacity in patients with stable COPD (21). Furthermore, recent data (22) demonstrated that moderate-to-severe COPD patients report an adequate intake of main foods and macro- and micro-nutrients. However, other authors found that dietary counseling and higher caloric intake resulted in weight gain and improvement in outcome in COPD outpatients at risk of malnutrition (23).

Body composition score did not correlate with age. However, the sample of the present study only included patients aged 65 years and over. This narrowed range may explain this lack of expected correlation. Indeed, muscle mass loss is a progressive component of aging, exacerbated by limited physical activity and not linked to age-associated diseases (24). Bioelectrical impedance analysis demonstrates a clear trend toward a reduction of lean mass with age (25). In addition, a longitudinal study, confirmed a significant decrease in FFM and body water in both sexes from age 75 to 80 years, even in the absence of significant body weight changes (26).

Sparse data are present in literature about “body functionality” in COPD patients.The most considered body functionality indexes are autonomy in activities of daily life and the number and type of current pathologies that may influence malnutrition (9). The present study demonstrated that this component of the nutritional status was correlated with both disease severity and aging. Data on elderly COPD showed that the following factors were more frequent among the malnourished patients compared with those identified as at risk for malnutrition: living alone, not living in one’s own home, requiring daily community service and meals-on-wheels (27). This is consistent with our observation of negative correlation between age and question “G – lives independently” of the MNA.

A potential weakness of the present study could be the age range (65-92 yrs) that precludes comparisons with younger patients. The present study was designed to focus on elderly patients with COPD. This represents an homogeneous setting, with patients sharing similar characteristics, and likely allows to perform observations and analysis targeted to this population, taking also into account the fact that a reasonably wide age range, including almost 3 decades (65-92 years), was studied. While it must be recognized that a comparison with younger subjects may have added valuable information, it must be underlined that COPD at a younger age is relatively uncommon or at earlier stage and so it

would have been hard to enrol significant numbers of much younger patients with similar clinical phenotype.
The choice of any assessment instrument (including MNA) could be questionable, because many variables and (consequently tools) may be used to assess malnutrition. It has to be taken into account that no single measurement has emerged as gold standard in defining malnutrition in the elderly (9, 14). The use of MNA questionnaire seems a suitable choice since it explores all the three determinants of the nutritional status (9) and the European Society of Parenteral and Enteral Nutrition (ESPEN) endorsed it as recommended screening tool in the elderly (14).
Another potential limitation of the study concerns the submission of the full MNA questionnaire to all patients, regardless of screening score. It should be considered that originally the MNA was developed in its full version (18 items) and only subsequently the short form (that is the screening; six items) was developed (18). The authors who developed the MNA pointed out that the MNA short form can be used with confidence, however administering the full MNA might be more efficient in some settings (18). The screening is only a way to saving time in some clinical situations, while the full MNA is appropriate in all kind of elderly patients. In addition the statistical analysis shows the absence of difference between subjects who did or did not complete the full MNA (see methods).
MNA was originally designed as a composite tool in which various domains contribute to the final score (18). As such, the individual validity of each domain may be questioned. However, previous studies on malnutrition in elderly have shown that lower dietary score distinguishes between malnourished and at-risk populations better than body composition and body function domains of the MNA (29).
Several mechanisms may explain the finding that aging and COPD determine malnutrition by acting on different aspects of the nutritional status. In COPD patients, both physical inactivity due to exercise intolerance (30) and the systemic inflammation (3) may explain the prevalent loss of free fat mass. In addition, the expansion of extracellular and intracellular water volumes, driven by hypoxemia, may explain why malnutrition may occur despite normal weight (31). On the other hand, in elderly subjects, weight loss and malnutrition are highly prevalent (7) and variously depend upon physical, social and medical factors (7). The observed negative correlation between aging and energy intake might be due to nutritional (e. g. loss of taste, poor dentition, dysphagia, poor chewing and swallowing ability, poor appetite, food aversion) and social (e. g. living or eating alone, poverty) problems, and to decreased energy and inability to self feed. Furthermore, many age-related medical factors (comorbidity, polypharmacy, infections, fractures, dementia, physical disability) can contribute to link aging and body functionality, as found in this study. Body functionality includes several variables that can be causes or effects of malnutrition, at the same time. Nevertheless, as stated by Chen et al. (28) “malnutrition in the elderly is a multidimensional concept encompassing physical and psychosocial elements. It is precipitated by loss, dependency, loneliness and chronic illness”. In this perspective, the management of malnutrition in the elderly COPD cannot only include “nutrients”. In line with this and taking together the present results on correlations with GOLD stages and age, “motility” (item C) and subjective perception of health status (item P) appear as susceptible to specific intervention, such as rehabilitation or treatment of depression. As a consequence, a pure nutritional intervention is highly unlikely to improve nutritional status and physical performance in COPD (32), while only an integrated multidimensional intervention centered on rehabilitation is likely to succeed. The favorable findings in both very old and frail patients (33) and in selected COPD populations (34, 35) support this conclusion. Within this frame particular attention is deserved by depression as

a factor susceptible of intervention: in fact an association between malnutrition, as assessed by MNA, and depressive symptoms has been demonstrated (36).

In conclusion, the results of the present study suggest that severe COPD and aging are independent and probably concurrent conditions leading to malnutrition. COPD influences aspects related to body composition, whereas both, COPD and aging, contribute to poor body functionality. Present findings should be considered preliminary in nature due to the cross-sectional design and the small size of the correlation coefficients. Nevertheless they likely contribute to our understanding of the complex relationship among COPD severity, aging and nutritional status.

Appendix 1: ECCE participating centers and study investigators:

1. Di.Bi.M.I.S., Università di Palermo (Resp: Prof. Bellia V.; Refer.: Dott. Battaglia S, Dott. Paglino G, dott.ssa Catania R., Dott. Spatafora M, Dott. Scichilone N.);
2. Università Campus Biomedico, Roma (Resp: Prof. Antonelli Incalzi R.; Refer: Dott. Scarlata S., Dott.ssa Conte E.);
3. Università Cattolica, Roma (Resp: Prof. Pistelli R.; Refer: Dott.ssa Andreani M., Dott.ssa Baldari F.);
4. Medicina Respiratoria, Spedali Civili, Brescia (Resp: Prof. Grassi V.; Refer: Prof. Tantucci, Dott.ssa Ghibelli S., Dott.ssa Casella)
5. Università degli Studi Federico II, Napoli (Resp: Prof. Rengo F.; Refer: Dott.ssa Visconti C.);
6. Azienda ULSS13, Mirano (VE) (Resp: dott. Cester A.; Refer: Dott. Vitale E.);
7. Policlinico Ospedale D'Avanzo, Foggia (Resp: Prof.ssa Foschino M.P.; Refer: Dott.ssa Ventura I., Dott.ssa Cagnazzo M.G.);
8. Università S.Cuore-CEMI, Roma (Resp: Prof. Bernabei R.; Refer: Dott. Cerullo F., Dott.ssa Palmacci C.);
9. Pio Albergo Trivulzio, Milano (Resp: Dott. Berardinelli P.; Refer: Dott. Carotenuto E.);
10. Policlinico di Bari (Resp: Prof. Onofrio Resta; Refer: Dott. Di Gioia G., Dott.ssa Scoditti C.);
11. Università di Perugia, (Resp: Prof. Lucio Casali; Refer: dott. Gradoli C.)
12. Fondazione San Raffaele, Cittadella della Carità, Taranto (Resp: Dott. Guadalupi G.);
13. Università degli Studi di Firenze (Resp: Prof. Masotti G.; Refer: Prof. Di Bari M.);
14. I.N.R.C.A. Istituto di Ricovero e Cura a Carattere Scientifico, Cosenza (Resp: Dott. Mazzei B.; Refer: Dott. Zottola C.);
15. Ospedale San Giuseppe Moscati, Taranto (Resp: Dott. Giusti A.; Refer: Dott. Spada C.).

Appendix 2: Mini Nutritional Assessment (MNA) Questionnaire

Nestlé Nutrition INSTITUTE

Mini Nutritional Assessment MNA®

Last name: First name: Sex: Date:

Age: Weight, kg: Height, cm: I.D. Number:

Complete the screen by filling in the boxes with the appropriate numbers.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe loss of appetite
1 = moderate loss of appetite
2 = no loss of appetite ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed/chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F Body Mass Index (BMI) (weight in kg) / (height in m²)
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

Screening score (subtotal max. 14 points) ☐☐
12 points or greater Normal – not at risk – no need to complete assessment
11 points or below Possible malnutrition – continue assessment

Assessment

G Lives independently (not in a nursing home or hospital)
0 = no 1 = yes ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
• At least one serving of dairy products (milk, cheese, yogurt) per day yes ☐ no ☐
• Two or more servings of legumes or eggs per week yes ☐ no ☐
• Meat, fish or poultry every day yes ☐ no ☐
0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐.☐

L Consumes two or more servings of fruits or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk…) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐.☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his/her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐.☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC 22 or greater ☐.☐

R Calf circumference (CC) in cm
0 = CC less than 31 1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐.☐
Screening score ☐☐
Total Assessment (max. 30 points) ☐☐.☐

Malnutrition Indicator Score
17 to 23.5 points at risk of malnutrition ☐
Less than 17 points malnourished ☐

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For more information : www.mna-elderly.com

Tables

Table 1: Anthropometric and functional characteristic of the whole sample.	
Number	460
Sex (m/f)	376/84
Age [and age range] (yrs)	75.0 (5.9) ; [65 - 92]
FEV_1 (% Pred)	54.7 (18.3)
FEV_1/FVC	0.52 (0.11)
Smoke (pack/y)	49.4 (41.3)
SaO_2 (%)	94.4 (2.8)
6m-WT (m)	311.0 (129.2)
BMI (kg/m^2)	27.1 (5.3)
GOLD stages: **I** **II** **III** **IV**	 41 (8.9%) 202 (43.9%) 133 (28.9%) 61 (13.3%)

Data are presented as mean(SD) or absolute number(%) as appropriate.
Abbreviations: 6m-WT = six minutes walking test; SaO_2 = oxyhemoglobin saturation.

Table 2: cross table of BMI *versus* MNA groups				
	Malnourished	**At risk**	**Well nourished**	**Total**
BMI <18.5 kg/m^2	7	7	0	**14**
BMI 18.5-24.99 kg/m^2	9	66	82	**157**
BMI 25-29.99 kg/m^2	1	34	133	**168**
BMI >30 kg/m^2	0	17	104	**121**
Total	**17**	**124**	**319**	**460**
BMI, Mean (SD)	20.5 (4.0)	24.9 (5.2)	28.3 (4.8)	**ANOVA** P<0.001
Values are expressed as absolute number of observations.				

Table 3: Differences of BMI and MNA total score in the GOLD stages					
	GOLD I	**GOLD II**	**GOLD III**	**GOLD IV**	**p value (ANOVA)**
BMI (kg/m^2)	27.8(0.7)*	28.1(0.4)*	26.4(0.4)	24.9(0.6)	<0.001
MNA total score	25.1(0.7)*	23.7(0.3)	23.0(0.5)	22.3(0.6)	0.020
Mean age (yrs)	75.9(6.8)	74.8(6.1)	75.4(5.5)	73.8(5.1)	0.231
Data are mean (standard error of mean). * = significant difference at the post hoc test.					

Table 4: differences in body composition, energy intake and body functionality scores

between GOLD stages.					
	GOLD I	**GOLD II**	**GOLD III**	**GOLD IV**	**p value**
Body score	6.8 (0.3)	6.6 (0.2)	6.3 (0.3)	5.5 (0.3)*	0.009
Energy score	8.0 (0.2)	7.4 (0.1)	7.6 (0.2)	7.6 (0.2)	0.229
Functionality score	10.3 (0.3)	9.7 (0.2)	9.1 (0.2)*	9.1 (0.3)*	0.011
Data are mean (standard error of mean). * = significant difference at the post hoc test.					

Table 5: Multiple ordinal regression analysis. Dependent variable: GOLD stages; independent variables: body composition, energy intake and body functionality scores. Model corrected for age.		
$R^2 = 0.073$		
	Beta standardized Coefficient	**P value**
Body score	-0.186	0.005
Energy score	0.154	0.073
Functionality score	-0.163	0.006

Table 6: Multiple regression analysis. Dependent variable: age; independent variables: body composition, energy intake and body functionality scores. Model corrected for GOLD stages.		
$R^2 = 0.037$		
	Beta standardized Coefficient	**P value**
Body score	0.011	0.868
Energy score	-0.103	0.122
Functionality score	-0.131	0.047

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