Original Article

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TANAFFOS

Mini-Nutritional Assessment Test and Fat-Free-Mass Depletion in Tunisian Chronic Obstructive Pulmonary Disease Patients

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Background: Fat-Free Mass (FFM) depletion is one of the systemic manifestations of COPD, causing functional impairment. We aimed to evaluate the relevance of the Mini-Nutritional Assessment (MNA) test in predicting FFM depletion in Tunisian COPD patients and to determine the relationship between nutritional status and disease severity.
Materials and Methods: This was a cross-sectional study of patients with stable COPD. Respiratory function was assessed. The MNA test and the COPD Assessment Test (CAT) questionnaire were also completed. FFM was measured by bioelectrical impedance analysis. Fat-Free Mass Index (FFMI) was calculated according to the following formula: FFM (kg)/height $(m)^2$. FFM depletion was defined as a FFMI < 16 kg/m^2.
Results: The study population consisted of 160 patients with COPD. FFM depletion was higher in patients with more severe COPD. Patients with FFM depletion had a lower MNA score than patients without FFM depletion. The independent predictors of FFM depletion in COPD were MNA ($p<0.0001$; OR=0.333; CI: 0.2-0.552) and BMI ($p<0.0001$; OR=0.547; CI: 0.408-0.733). The MNA score was significantly correlated with FFMI, CAT score, and lung function. ROC curve analysis defined a value of 19.25 as the optimal cut-off value of the MNA score to discriminate COPD patients with FFM depletion from those without FFM depletion. By using this value, the sensitivity and specificity of the MNA test for detecting FFM depletion were 90% and 74%, respectively.
Conclusion: Our results suggest that the MNA test, a simple and universally available tool, can predict FFM depletion in COPD.

Keywords: Bioelectrical impedance analysis; COPD; Nutritional status; Respiratory function; Quality of life

INTRODUCTION

COPD is a chronic respiratory disease characterized by airflow limitation secondary to chronic, progressive, and not completely reversible bronchial obstruction (1,2) which causes systemic effects with multiple manifestations (3). It leads to a high mortality rate, with approximately three million deaths per year (4). It is expected to become one of the world's top three causes of death in the coming decades (5).

Undernutrition is one of the systemic manifestations of the disease (6,7), which can be associated with worse impaired respiratory function and a poor prognosis (8).

Therefore, an evaluation of nutritional status among COPD patients is necessary and should be systematic in clinical practice, leading to better management, lower public health costs, and improved quality of life.

Several tools have been developed to assess nutritional status among COPD patients (BMI classification, weight changes, body composition, and several measurement scales (9,10).

BMI remains the principal measurement tool, but it does not take into account changes in body composition (10). Bioelectrical impedance analysis (BIA) is a method that determines body composition and evaluates Fat-Free-Mass (FFM) depletion with a high sensitivity to prognosis accuracy if compared with BMI (11). However, not all departments are equipped with BIA. The use of a measurement scale for nutritional evaluation could, in this case, represent an easier alternative. The Mini-Nutritional Assessment (MNA) test is an easy, inexpensive, and rapid tool that works well in the elderly (9). To the best of our knowledge, only a few studies have been conducted to evaluate the nutritional status of COPD patients using the MNA test, but none have investigated the relationship between the MNA test and undernutrition in Tunisian patients with COPD.

This study aimed to evaluate the relevance of the MNA test for the prediction of FFM depletion in a group of COPD patients and to determine the relationship between the nutritional status and the severity of the disease.

MATERIALS AND METHODS

Design and subjects

This was a cross-sectional study (2018-2020) involving patients with COPD referred to the Department of Functional Explorations at Habib Bourguiba Hospital, Sfax, Tunisia, and the Department of Respiratory Functional Explorations at Abderrahmen Mami Hospital, Ariana, Tunisia. The study approval (N°15/2024) was obtained from the Ethical Committee of the Abderrahmen Mami Hospital (Ariana, Tunisia).

COPD diagnosis and disease severity grading were based on the 2020 version of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines (12). Only Stable COPD patients at least one month away from an exacerbation episode were included in the study.

Sample size

The primary objective of this cross-sectional study was to determine the correlation between two quantitative variables of interest: the MNA score and the FFM. The sample size was calculated according to this formula (13): $N= [((Z_{\alpha/2} + Z_{1-\beta})^2) / (1/4 (\log_e((1+r) / (1-r))] + 3$; where "$Z_{\alpha/2}$" is the normal deviation for a risk of error α (=1.96 for 5% significance level); "$Z_{1-\beta}$" is the study power (=1.64 for 95% power), and "r" is the correlation coefficient, determined from a previous study (9) including 83 COPD patients, in which the r between MNA score and FFM was 0.423. The estimated sample size for the two-tailed alternative test was accordingly calculated to be 60 patients.

Patients' characteristics and anthropometric measurements

Each patient answered a structured questionnaire for eliciting demographic characteristics, patient history of chronic disease, and smoking status. Body Mass Index (BMI) and body composition were also measured.

Foot-to-foot BIA (TANITA, Model TBF-410) was performed to determine fat body mass and FFM. This equipment had two stainless-steel foot-pad electrodes mounted on a platform scale on which the subject stands barefoot. No specific instructions were given to participants before testing. Weight is recorded automatically. Gender, age, and height were entered manually into the keypad interface. The body composition of all subjects was estimated using standard prediction equations rather than those intended for athletes, based on the exercise habits of the participants.

Fat-free mass index (FFMI) was calculated according to FMM (kg)/height (m^2). FFM depletion was defined as FFMI < 16 kg/m^2(14).

Pulmonary function tests

All patients underwent body plethysmography (Bodybox550, Medisoft). Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC), the FEV1/FVC ratio, Residual Volume (RV), Functional

Residual Capacity (FRC), and Total Lung Capacity (TLC) were measured. The values obtained were expressed as a percentage of the predicted values.

Patients having a history compatible with COPD and post-bronchodilator (BD) FEV1/FVC < 0,7 were diagnosed with COPD.

Patients were grouped into four COPD severity groups based on the post BD FEV1 (%): Stage 1 (Post BD FEV1 ≥ 80), Stage 2 (Post BD FEV150-79), Stage 3 (Post BD FEV1 30-49), and Stage 4 (Post BD FEV1 < 30).

Used scales

Mini-Nutritional Assessment (MNA) Test

It includes questions about general health status, nutrition, anthropometric assessment, and the patient's self-assessment. The patient's total score can range from 0 to 30 points. It contains 18 items evaluating four different aspects: anthropometric evaluation (BMI, weight, arm, and calf circumferences); general evaluation (lifestyle, drug, mobility, depression, and dementia); short nutritional evaluation (number of meals, food and fluid intake, and nutritional autonomy); and finally subjective assessment (self-perception of health and nutrition) (15,16).

Modified Medical Research Council (MMRC)

MMRC was used to evaluate patients' dyspnea perception. MMRC is a simple self-administered 5-point scale that quantifies the effect of breathlessness on daily activities (17).

The COPD Assessment Test (CAT)

It was used to evaluate quality of life (QoL) CAT consists of eight items scored from 0 (best) to 5 (worst) related to cough, mucus production, chest tightness, capacity for exercise and activities, confidence, sleep quality, and energy levels. The scaling ranges from 0 to 40 (18).

Statistical Analysis

Statistical analyses were performed with SPSS version 20.0 software (SPSS Inc., Chicago, Illinois, USA).

The quantitative data were determined to be distributed normally by the Kolmogorov-Smirnov test and were expressed by their mean ± SD. The categorical data were expressed in absolute (n) and relative (%) frequencies.

The chi-squared test, the one-way ANOVA test, and the Tukey test were used to analyze differences between COPD groups' characteristics. Pearson's correlation analysis was performed to determine the strength of the relations of quantitative variables. Receiver operating characteristic (ROC) curves were generated for the MNA score using the FFM depletion as a reference. $P<0.05$ was considered significant.

RESULTS

A total of 160 patients were included in the study. All of the patients were male. The mean age of the study group was 64.54 ± 7.75 years. Twenty-three patients (14.4%) had COPD stage 1, 62 (38.8%) had COPD stage 2, 53 (33.1%) had COPD stage 3, and 22 (13.8%) had COPD stage 4. There was no difference in terms of age among all groups. MNA score and FFMI were significantly different among the groups ($p < 0.0001$). Demographic data, clinical characteristics, and nutritional status were stratified by post BD FEV1 (%) as shown in Table 1.

Functional testing findings are illustrated in Table 2. FFM depletion was higher in patients with more severe COPD. Indeed, the FFMI in the COPD stage 4 group was significantly lower than in the COPD stage 2 ($p<0.001$) and COPD stage 1 group ($p=0.001$). However, no significant difference was found between the COPD stage 4 and the COPD stage 3 group. Moreover, the MNA score was significantly higher in patients with normal FFMI ($p<0.0001$) (Figure 1). Pearson correlation showed that MNA score was significantly correlated with FFMI ($r=0.392$; $p<0.0001$) (Figure 2), FEV1 (%) ($r=0.5$; $p<0.0001$), CAT ($r=-0.539$; $p<0.0001$), and MMRC ($r=-0.44$; $p<0.0001$). Additionally, BMI was found to be significantly correlated with FFMI ($r= 0.870$; $p<0.0001$).

Furthermore, all factors that can determine FFM depletion were evaluated by univariate analysis. Parameters associated with FFM depletion were therefore introduced in a multiple regression analysis that included age, BMI, post BD FEV1(%), MNA score, CAT score, and MMRC. The independent predictors of FFM depletion in COPD were MNA ($p<0.0001$; OR=0.333; CI:0.2-0.552) and BMI ($p<0.0001$; OR=0.547; CI:0.408-0.733).

Table 1. Demographic, clinical characteristics, and nutritional status of 160 Tunisian COPD patients stratified using the post-bronchodilator FEV1 (%)

	COPD stage 1 (n=23)	COPD stage 2 (n=62)	COPD stage 3 (n=53)	COPD stage 4 (n=23)	p-value
Age (years)[a]	63.91 ± 7.59	65 ± 8.030	65.28 ± 7.22	62.13 ± 8.32	0.399
Tobacco consumption (PY)[a]	45.78 ± 26.47	48.29 ± 24.18	46.89 ± 24.12	72.59 ± 31.84	**0.001***
Arterial hypertension	8 (23.52)	13 (38.23)	11 (32.35)	2 (5.88)	0.750
Diabetes mellitus[b]	3 (23.07)	5 (38.46)	3 (23.07)	2 (15.38)	0.200
Dyslipidemia[b]	4 (30.76)	5 (38.46)	4 (30.76)	-	0.210
Coronary heart disease[b]	4 (19)	9 (42.85)	6 (28.57)	2 (9.5)	0.810
BMI (kg/m²)[a]	25.56 ± 4.58	25.26 ± 5.19	23.54 ± 5.21	22.09 ± 3.76	**0.027***
FFMI (kg/m²)[a]	19.54 ± 2.49	18.63 ± 2.80	17.04 ± 3.02	16.8 ± 2.47	**<0.001***
FFM depletion[b]	2 (8.69)	13 (20.96)	22 (41.5)	10 (45.45)	**0.004***
MNA score[a]	23.85 ± 2.52	22.04 ± 2.29	20.49 ± 2.97	19.27 ± 2.24	**<0.001***
MMRC[a]	1.17 ± 0.57	1.64 ± 0.81	2.35 ± 0.73	2.81 ± 0.39	**<0.001***
CAT[a]	13.26 ± 4.91	19.85 ± 4.53	25.52 ± 4.20	29.72 ± 3.64	**<0.001***

Note. PY. Pack-Years; BMI. Body Mass Index; FEV1. Forced Expiratory Volume in One Second; FFMI. Fat-Free Mass Index; FFM. Fat-Free Mass; MNA. Mini-Nutritional Assessment; MMRC. Modified Medical Research Council; CAT. COPD Assessment Test. *p<0.05: analysis of variance between the 4 groups (ANOVA test).
Data were [a]mean ± *SD*; [b]number (%).

Table 2. Functional findings of 160 Tunisian COPD patients stratified by using the post-bronchodilator FEV1 (%)

	COPD stage 1 (n=23)	COPD stage 2 (n=62)	COPD stage 3 (n=53)	COPD stage 4 (n=23)	p-value
Post BD FEV1(%)	89.32 ± 7.90	60.77 ± 8.29	41.54 ± 7.51	24.70 ± 4.29	**<0.001***
Post BD FEV1/FVC	0.63 ± 0.05	0.56 ± 0.08	0.46 ± 0.09	0.36 ± 0.09	**<0.001***
RV (%)	149.00± 31.22	180.18 ± 46.00	208.12 ± 69.59	267.61 ± 63.88	**<0.001***
FRC (%)	145.18 ± 22.80	157.36 ± 34.15	169.17 ± 41.39	206.3 ± 38.91	**<0.001***
TLC (%)	115.77 ± 16.24	117.62 ± 17.02	128.59 ± 43.75	132.19 ± 25.99	0.3180

Note. FEV1. Maximum Expiratory Volume during the First second; FVC. Forced Vital Capacity; RV. Residual Volume; FRC. Functional Residual Capacity; TLC. Total Lung Capacity; BD. Bronchodilatator; *p<0.05: analysis of variance between the 4 groups (ANOVA test); Data were mean ± *SD*

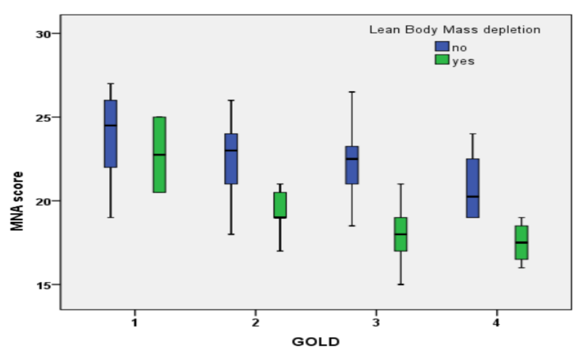

Figure 1. Mini-Nutritional Assessment (MNA) score in subjects with and without lean body mass depletion in stage 1, stage 2, stage 3, and stage 4 COPD patients (n=160)

Using the receiver operator curve analysis, the best MNA score to find patients with FFM depletion in COPD was calculated. The area under the curve (AUC) was 0.924 (95% confidence interval 0.879-0.97, $p < 0.001$). The cut-off level for MNA score with optimal sensitivity and specificity was calculated as 19.25 with a sensitivity of 90% and specificity of 74.5% (Figure 3).

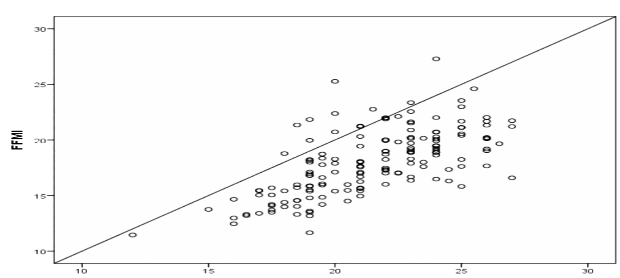

Figure 2. Correlation between Fat-Free Mass Index (FFMI) and Mini-Nutritional Assessment (MNA) score in 160 COPD patients (Relationship was analyzed by Spearman's correlation test. A correlation coefficient (r) and p value are indicated)

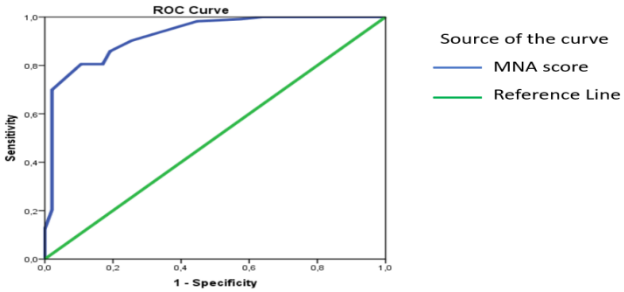

Figure 3. Receiver-operating characteristic (ROC) analysis for the Mini-Nutritional Assessment (MNA) score against Fat-Free mass depletion in 160 COPD patients.
The area under curve (AUC) was 0.924 (95% confidence interval 0.879-0.97, $p < 0.001$). The cut-off level for MNA score with optimal sensitivity and specificity was calculated as 19.25 with sensitivity of 90% and specificity of 74.5%.

DISCUSSION

COPD is a major cause of chronic morbidity and a real burden on public health (19). Moreover, malnutrition is common in patients with COPD, associated with both social impact and quality of life deterioration (8). FFM depletion was shown to be able to predict disease severity (20) and mortality in COPD (21). But, nutritional assessment is still limited in routine practice (9). Lately, the GOLD report of 2023 has recommended the nutritional management for COPD patients (22).

The present study demonstrated that MNA predicted well FFM depletion among patients with COPD since a significant association was found between low MNA score and FFM depletion in COPD in all stages ($p < 0.05$). The association remained significant even after allowing for multiple potential confounding factors. Importantly, this study also showed that the MNA score correlates with FEV1 (%). FFM depletion was higher in patients with more severe COPD. Thus, an estimation of the MNA cut-off in patients with COPD was made to categorize subjects with and without FFM depletion, which was found to be 19.25. A significant correlation ($r=-0.539$; $p<0.0001$) was also found between MNA and CAT scores. Patients with an MNA score inferior to 19.25 might be trapped in a vicious cycle of deconditioning with disability and altered quality of life.

In the literature, a poor nutritional status in COPD patients could be due to a combination of poor dietary intake, systemic inflammation, and lack of physical activity (8) .

Only a few studies have been conducted to evaluate the nutritional status of COPD patients using MNA. Hsu et al. (9) evaluated the value of MNA in 83 COPD patients to predict the FFM depletion and found a significant correlation between FFMI and pulmonary functional indicators. Mete et al. (15) used the MNA to investigate the prevalence of malnutrition in 105 patients with COPD, which was found to be equal to 17%. They also demonstrated that spirometric parameters were significantly lower in patients with malnutrition.

In another study conducted by Benedik et al. (23), associations between the MNA test, body composition, and rehospitalizations in COPD patients were studied. The prevalence of malnutrition was found as 14%, and a positive correlation between MNA score and FFM was observed.

The predictive value of the MNA score equal to 19.25 for FFM depletion in patients with COPD should be taken into consideration in daily practice in medical structures. COPD patients who develop a FFM depletion should be provided with nutritional support, appropriate treatments, and pulmonary rehabilitation.

Regarding the impact of poor nutritional status on QoL, a recent study conducted by Nguyen et al. (24), aimed to examine the nutritional status and dietary intake among COPD patients and its possible associations with QoL. The latter was low for all levels of malnutrition or disease severity. While Well-nourished patients and those with less disease severity had better QoL (24). Therefore, managing FFM depletion leads to the amelioration of the Qol of COPD patients.

Strengths of the study

To the best of our knowledge, this was the first study that investigated the relationship between the MNA test and undernutrition in Tunisian patients with COPD. Due to its importance as an indicator, FFMI was employed as the major reference for assessing the relevance of the MNA. It was a bicenter study with a larger group of COPD patients than a related study conducted by Hsu et al. (9)

with only 83 COPD patients. It brought an important contribution by setting the predictive value of the MNA score equal to 19.25 for FFM depletion in patients with COPD.

Limitations of the study

This was a cross-sectional study; weight loss in the weeks prior to the study was not known. It would have been useful to assess the loss of weight or FFM over a few weeks. Most of the subjects were older adults, and some may have had difficulty recalling some of the information on the MNA questionnaire correctly. The other difficulty encountered was related to the low level of education of the patients, some of whom had difficulties in understanding the questions asked.

CONCLUSION

The results of the present study suggest that the MNA test, a simple and universally available tool, can predict FFM depletion in COPD.

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