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Nutritional Evaluation in Chronic Obstructive Pulmonary Disease Patients

[1]Afsane Ahmadi, [2]Neda Haghighat, [3]Maryam Hakimrabet and [4]Hamidreza Tolide-ie
[1]Department of Nutrition, School of Health and Nutrition,
Shiraz University of Medical Sciences, Shiraz, Iran
[2,3]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
[4]Faculty of Health, Gonabad University of Medical Sciences, Gonabad, Iran

Abstract: Malnutrition is a common problem in moderate or severe Chronic Obstructive Pulmonary Disease (COPD) patients which affects body composition and food intake of these patients. In this study, the relationship of the stage of COPD with nutritional intake and body mass index in COPD patients were investigated and compared with healthy people and Dietary Reference Intake tables. A total of 93 COPD patients were referred by pulmonary physicians in Motahari and Faghihi medical centers. Pulmonary Function Test (PFT) was used in order to confirm the diagnosis of COPD and also categorize the patients into three categories (mild, moderate and sever). The control group consisted of 108 adults matched to the cases by age and gender. Anthropometric indices and physical activity and a 24 h dietary recall were recorded. All analyses were performed using the SPSS 14. All data presented as means (±SD). The mean intake of energy ($p = 0.002$), protein ($p<0.001$), fat ($p = 0.007$), vitamin C ($p = 0.003$), vitamin E ($p<0.001$), magnesium ($p<0.001$) and omega-3 ($p<0.001$) was significantly lower in COPD patients compared with controls. The mean BMI of the severe group was significantly lower than the controls ($p = 0.016$). The mean intake of energy, carbohydrate, fat, vitamin E, magnesium and omega-3 was significantly lower in both case and control groups compared to the RDA ($p<0.001$) for all of the mentioned nutrients). Vitamin C intake was lower than RDA in the case ($p<0.001$) and also in the control males ($p<0.001$). In COPD patients, there is a significant relationship between the stage of COPD and nutrients intake and their BMI.

Key words: Pulmonary disease, nutritional intake, body mass index, anthropometric indices

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is characterized by obstruction of the airways which is progressive and is associated with an anomalous inflammatory response of the lungs to harmful gases or particles, primarily tobacco smoke (Agusti *et al*., 2003). COPD is a leading cause of morbidity and mortality worldwide (Asia Pacific COPD Roundtable Group, 2005) and the fourth leading cause of mortality in the United States and in Europe (Murray and Lopez, 1997). COPD will be the third leading cause of death worldwide by 2020 (Murray and Lopez, 1997). Exacerbations in COPD patients lead to an increase in the need for medical care and hospitalization, thereby causing increases in health-care costs (Siafakas *et al*., 1995). Attention to nutritional status in patients with respiratory diseases is important because of malnutrition has direct effect on the lung's function, respiratory muscles and the lung parenchyma, consequently contributing to worsening of the disease (Batres *et al*., 2007). There is Malnutrition in at least one third of moderate or severe cases of COPD. Malnutrition affect functional performance and quality of life of these patients and independent of other aspects of the disease it is indicator of both morbidity and mortality (Foley and ZuWallack, 2001). Imbalance in dietary intake and energy expenditure contributed to weight loss. In contrast to an adaptive decreased energy metabolism during starvation, total daily energy expenditure has been increased in COPD patients (Slinde *et al*., 2003). The low intake in these patients can be explained by a cytokine leptin link leading to increased levels of leptin. These increased leptin levels lead to reduced food intake and higher energy demand and therefore, poor response to nutritional support (Saudny-Unterberger *et al*., 1997). It seems that patients with COPD are at high risk for malnutrition, making it essential that these patients undergo careful assessment and screening to identify those who require dietary treatment. So in this study, we evaluated the nutritional status in COPD patients and compared it with healthy control groups.

Corresponding Author: Neda Haghighat, Student Research Committee, Shiraz University of Medical, Sciences, Shiraz, Iran
Tel: +98-711-6247594, +98-9177050021

MATERIALS AND METHODS

Participants: The study was conducted in two therapeutic centers, Motahari and Faghihi, in Shiraz during 1 year. A total of 93 COPD patients were diagnosed and referred by pulmonary physicians. In order to confirm the diagnosis of COPD and categorize the patients into three categories (mild, moderate and sever) pulmonary function test (PFT: was used to measure the intensity and reversibility of obstruction of airways in COPD patients) and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages (Asia Pacific COPD Roundtable Group, 2005) were used. The control group consisted of 108 adults from the same domain as the cases. The controls were matched to the cases by age (within 5 years) and gender and their health was confirmed by physicians.

Inclusion criteria were as follow: age between 55-75 years and having COPD diagnosis as the primary limiting illness within the past four years. Exclusion criteria were diabetes, renal failure, liver diseases, dementia, Parkinson disease, cancer and other cachexic conditions, current dental problem, parenteral or enteral feeding and multivitamin-multimineral supplement consumption.

The objective and protocol of the study were explain to the participants and written informed consent provided from them. The study was approved by the ethics committee of the School of Public Health and Nutrition of Shiraz University of Medical Sciences.

Instruments: A face-to-face interview with each participant was conducted by using a structured questionnaire. The first part of the questionnaire included demographic information on age, gender, educational level, occupation, cigarette smoking (never smoker; ex-smoker; current smoker) and duration of smoking (data not shown). In the second part of the questionnaire, dental status, nausea, vomiting and anorexia during the period of disease and medication use were recorded. In the third part, anthropometrical measures; height (m), weight (kg) and weight reduction in previous months were assessed. Body weight was assessed with a beam scale to the nearest 0.1 kg while they were worn light clothing. Height was measured by a clinical stadimeter in standing position. BMI, defined as weight (kg) divided by the square of height (m), was calculated. The forth part was about physical activity, history of supplement consumption and a 24 h dietary recall. Dietary intake was measured by dietary recall that is a validated measure to assess habitual food consumption. In the 24 h dietary recall, some questions about food preparation were also asked. Dietary intakes were monitored by 3 day 24 h food recall, including 2 week day and 1 weekend day. To analyze the dietary data we used DFP (Dorosty food processor: which is a software to calculate the amount of calorie and nutrient intake in the diet). The last part was the result of their spirometry test.

Statistical analysis: For statistical analysis, SPSS program version 11.5 (SPSS Inc., Chicago, IL, USA) was used and for comparison of continuous variables in the two groups, we used independent samples t-test for normally distributed data and non-parametric Mann-Whitney U test for variables showing non-normal distribution. One-sample t-test was used to compare the mean of continuous variables with standard numbers. For qualitative variables the Chi-square test was used for each contingency table. A two-tailed $p<0.05$ was considered statistically significant.

RESULTS

Table 1 presents the anthropometric status of the cases and controls. The mean BMI of the severe group was significantly lower than the controls ($p = 0.016$). About weight loss, more subjects in the case group (mild, moderate and sever) had weight loss in previous months than the controls ($p<0.001$).

Table 2 presents the comparison of nutrient intake in the case and control groups. The mean intake of energy ($p = 0.027$), carbohydrate ($p<0.001$), vitamin E ($p<0.001$)

Table 1: Mean intake of energy, macro and micro-nutrients in COPD patient and control group

	COPD					p-value			
Variables	Mild (n = 26)	Moderate (n = 32)	Severe (n = 35)	Total (n = 93)	Control (n = 108)	P1	P2	P3	P4
Energy (kcal)	500±2285	612.0±2014	473.0±1033	759.6±1721	544.00±2022.9	0.027	ns	<0.001	0.002
Fat (g)	60.8±307.6	80.1±283.6	63.5±160.7	94.7±244	80.40±235.8	<0.001	0.004	<0.001	ns
Carbohydrate (g)	13.36±68.5	18.4±58.09	18.9±34.6	22.3±52.1	15.09±63.6	ns	ns	<0.001	<0.001
Protein (g)	31.4±86.19	39.8±76.78	28.3±33.1	40.7±62.9	29.12±76.8	ns	ns	<0.001	0.007
Vitamin C (mg)	44.1±38.67	34.2±28.6	30.9±28.5	34.3±33.3	43.03±48.4	ns	ns	0.003	0.003
Vitamin E (mg)	30.15±12.1	5.73±5.48	3.3±2.41	16.6±6.2	7.10±12.2	<0.001	<0.001	<0.001	<0.001
Magnesium (mg)	29.20±28.93	22.81±26.36	16.68±11.1	23.9±21.3	21.70±28.3	ns	ns	<0.001	<0.001
Omega_3 (g)	0.075±0.017	0.063±0.026	0.045±0.024	0.059±0.026	0.525±0.363	<0.001	<0.001	<0.001	<0.001

P1: Mild vs. control, P2: Moderate vs. control, P3: Severe vs. control, P4: Total group vs. control group, Values are Mean±SD

Table 2: Body mass index (BMI) and weight loss with COPD exacerbation in COPD patients and healthy people

	COPD				p-value				
Variables	Mild (n = 26)	Moderate (n = 35)	Severe (n = 35)	Total (n = 97)	Control	P1	P2	P3	P4
BMI (kg m^{-2})	4.5±21.5	4.2±22.3	20.5±5	4.6±21.4	3.9±22.5	ns	ns	0.016	ns
Weight loss number	17	19	28	64	24	<0.001	<0.001	<0.001	<0.001
Weight loss (%)	65.4	61	80	69.6	25	<0.001	<0.001	<0.001	<0.001

P1: Mild vs. control, P2: Moderate vs. control, P3: Severe vs. control, P4: Total group vs. control group, Values are Mean±SD

Table 3: Comparing the Mean intake of energy, macro and micro-nutrients in COPD patient and control group with DRI tables

	COPD		Control SD±Mean		RDA		p-value			
Variables	Male (n = 66)	Female (n = 27)	Male (n = 74)	Female (n = 34)	Male	Female	P1	P2	P3	P4
Energy (kcal)	796.42±1753.72	668.66±1641.81	488.07±2195.90	469.77±1646.47	3067	2403	0.000	0.000	0.000	0.000
Fat (g)	42.70±65.79	35.23±56.07	30.66±83.13	19.65±63.11	102	80	0.000	0.002	0.000	0.000
Carbohydrate (g)	244.07±94.76	244.07±94.76	235.79±80.44	235.79±80.44	130	130	0.000	0.000	0.000	0.000
Protein (g)	52.51±22.57	51.33±19.52	65.77±15.62	58.82±12.84	56	46	0.234	0.160	0.000	0.000
Vitamin C (mg)	37.30±37.04	23.60±24.39	44.11±35.11	57.92±56.05	90	75	0.000	0.000	0.000	0.085
Vitamin E (mg)	6.19±16.66	6.19±16.66	12.25±7.10	12.25±7.10	15	15	0.000	0.000	0.000	0.000
Magnesium (mg)	20.08±24.70	24.37±22.24	29.48±22.85	25.83±19.12	420	320	0.000	0.000	0.000	0.000
Omega_3 (g)	0.06±.02	0.57±.03	0.55±.35	0.46±.38	1.6	1.1	0.000	0.000	0.000	0.000

P1: Male COPD vs. DRI, P2: Female COPD vs. DRI, P3: Male healthy vs. DRI, P4: Female healthy vs. DRI, Values are Mean±SD

and omega-3 ($p<0.001$) in the mild group was significantly lower than the controls. In the moderate group, the mean intake of carbohydrate ($p = 0.004$) and vitamin E ($p<0.001$) was lower than the control group. But there were not any significant difference in the intake of other nutrients. And the severe group had a lower mean intake of energy and all other nutrients that were analyzed in this study. Finally, in the overall comparison of the case and controls, the mean intake of energy ($p = 0.002$), protein ($p<0.001$), fat ($p = 0.007$), vitamin C ($p = 0.003$), vitamin E ($p<0.001$), magnesium ($p<0.001$) and omega-3 ($p<0.001$) were significantly lower in the case group.

Table 3 shows the mean intake of energy and some nutrients in the case and control groups by gender differentiation and also comparison of their intake with Recommended Dietary Allowance (RDA). The mean intake of energy, carbohydrate, fat, vitamin E, magnesium and omega-3 were significantly lower in both the case and control groups compared to the RDA ($p<0.001$) for all of the mentioned nutrients). Vitamin C intake was lower than RDA in the case ($p<0.001$) and also in the control males ($p<0.001$).

DISCUSSION

In this case-control study, the intake of energy and nutrients that effect COPD patients, was measured and compared with the control group and DRI tables. Eating difficulties, higher metabolic rate and cost of ventilation, together with oxidative stress causing systemic inflammation are important factors for weight loss in these patients (Hallin *et al*., 2006). One of the strengths of this study was spirometric measurements of the lung function that were taken to ensure correct classification (mild, moderate, severe). Another strength of the study was the comparison of dietary intake in both case and control groups with DRI tables.

Body Mass Index (BMI) in the mild and moderate COPD patients have no significant relationship with the control group but severe COPD patients have lower BMI in comparison with the control group.

Furthermore, patients group have weight loss more than the control group. These results indicate that with the exacerbation of the condition of COPD patients, the basic metabolic rate increases and the energy intake decrease, causing the lower BMI and higher weight loss in severe COPD patient as compared with the control group. Hallin *et al*. (2006) also have reported in agreement with our results. Because of reduced dietary intake and increased in resting energy expenditure, severe patients have impaired energy balance, consequently they have more weight loss (Vermeeren *et al*., 1997). Systemic inflammation is another possible cause of weight loss in severe patients (Schols *et al*., 1996) and is more pronounced (Soler-Cataluna *et al*., 2005). In a cohort study, they concluded that low BMI was an independent risk factor for mortality in subjects with COPD and that the association was strongest in the subjects with severe COPD (Landbo *et al*., 1999). It is still difficult to know whether weight loss and low weight is a cause or a consequence of exacerbations.

In normal-weight or overweight patients, it is more appropriate to measure the Mid-arm muscle area because of the Muscle Mass Depletion (MD) is a better predictor of mortality than BMI in patients with COPD (Agusti *et al*., 2003).

All of the patients had lower intake of energy and protein than the healthy control group. The epidemiological evidence also indicated lower food consumption in these patients (Saudny-Unterberger *et al*., 1997; Foley and ZuWallack, 2001; Slinde *et al*., 2003; Batres *et al*., 2007). In a recent study, found seven out of ten patients had insufficient food intake which cause negative energy balance (Tang *et al*., 2002). In one study, patients hospitalised for an exacerbation have been found to be in negative nitrogen balance but some little gains were observed with increased energy intake (Saudny-Unterberger *et al*., 1997). Thus interventions for boosting energy intake may improve Health of these patients.

The lower intake of proteins as compared with the control group was the same as the result of Donna and Artemis (Palmer *et al*., 2004). COPD patients also had lower intake of all macronutrient than DRI tables except proteins. However, the energy intake of patients decreased but the protein consumption has no significant relationship with DRI tables. It seems it's due to the vulgar belief "more protein intake, more disease recovery", so, they consumed more high protein foods.

There was no significant different between the intake of carbohydrate in COPD patients and healthy group. The observed normal intake of carbohydrate by COPD patients was not a consequence of eating well. Because of dysphagia and eating difficulties, these patients prefer sugar drink rather than solid food.

The lower intake of fat than control group and DRI tables was seen in our study; however, due to lower Respiratory Quotient (RQ), the increase of fat consumption in these patients is more appropriable. It has to be noticed that the intake of fat has to be from vegetable oil such as olive or canola oil to decrease the risk of cardiovascular disease. In one study, Grigorakos and co-workers reported, giving combination nutrition (including enteral and parenteral nutrition) assisted with high amounts of fat cause positive nitrogen balance and prevent development of malnutrition (Grigorakos *et al*., 2009).

Inflammation is associated with COPD Pathogenesis. Omega-3 PUFAs acts as an anti-inflammatory agent in the lung (Matsuyama *et al*., 2005). We observed the lower intake of omega-3 PUFA in the diet of the whole patients (mild, moderate, severe) than the control group and DRI tables. Matsuyama concluded that nutritional support with the omega-3 could reduce inflammation and improve exercise tolerance in COPD patients (Matsuyama *et al*., 2005).

Normally, the lung exists in an oxygen-rich environment balanced between the toxicity of oxidants (generated through normal cellular function or exposure to prooxidants) and the protective activities of several intracellular and extracellular antioxidant defense systems (Matsuyama *et al*., 2005). Increase in oxidant stress or a impairment of antioxidant resources can initiate a series of pathophysiologic events in the lung concluding cellular death and dysfunction. Researchers have hypothesized that a diet low in antioxidants such as |3-carotene and vitamins C and E may reduce natural defenses and increase susceptibility to oxidant attack and airway inflammation. Higher intake of such foods rich in antioxidants has been associated with a better lung function (Heffner and Repine, 1989). Vitamin C and vitamin E are as important antioxidants in people diet. A previous study by Schwartz and Weiss (1994) suggested the significant statistical relationship between vitamin C and pulmonary functional status. Walda and his co-workers have shown the results against of Schwartz and our study (Walda *et al*., 2002). This study have been shown that severe group of patients have lower intake of vitamin C than the control group and standards.

Some minerals such as magnesium have the potential to promote bronchodilatation and improve lung function in obstructive diseases. It is indicated that with exacerbations in COPD patients, the intake of magnesium decreases. In the study conducted by Do Amaral *et al*. (2008) magnesium causes improvement in lung hyperinflation and respiratory muscle strength in stable COPD patients.

CONCLUSION

This study indicated the importance of assessment of nutritional status and monitoring weight changes in COPD patients. Lower BMI and higher weight loss have been seen with exacerbations in COPD patients and have been shown that COPD patients have low nutrient intake in compare with control group and DRI tables. So, in patients with COPD nutritional intervention appears to be an approach to obtaining anthropometric parameters improvement.

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