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Correlation between handgrip strength and nutritional indicators and its influencing factors in patients with stable COPD: a cross-sectional study

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Abstract: This study aimed to explore the Correlation between handgrip strength and nutritional indicators and its influencing factors in patients with stable chronic obstructive pulmonary disease (COPD) to provide evidence for early nutritional intervention. Stable COPD patients who visited the respiratory department clinic of a Tertiary Grade A hospital in Guangxi from January 2021 to March 2022 were chosen using a convenient sampling method. The general information questionnaire and mini nutritional assessment short-form (MNA-SF) were used for investigation, and the HGS, anthropometric, and laboratory indicators were collected. Correlation analysis was used to analyze the relationship between HGS and nutritional indicators in patients with stable COPD. Multiple linear regression analysis was used to examine the factors influencing HGS in patients with stable COPD. A total of 232 patients with stable COPD were included, and the HGS was (25.18±7.95)kg. Correlation analysis showed that height, body weight, body mass index (BMI), calf circumference, hemoglobin concentration, total protein concentration, albumin concentration, prealbumin concentration were positively correlated with HGS in stable COPD patients (P <0.05), whereas age was negatively correlated with HGS in stable COPD patients (P <0.05). Multiple linear regression analysis showed that gender, age, number of concomitant diseases, and nutritional status were the influencing factors of HGS in patients with stable COPD (P <0.05), explaining 31.3% of the total variation of HGS in patients with stable COPD. Patients with stage COPD need to improve their HGS, which correlates with nutrition-related indicators. HGS levels are low in female COPD patients who are older, have multiple comorbidities, and are malnourished. Outpatient medical workers should pay attention to the HGS level of stable COPD patients, quickly screen the nutritional status of COPD patients, implement early nutritional intervention, and improve the overall health level of patients.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is the third leading cause of death in China [1]. Malnutrition, as one of the common complications of COPD patients, has a prevalence of about 70% [2], which is prone to increase the risk of cognitive impairment and frailty, and reduce the quality of life of patients [3]. The incidence of malnutrition in COPD patients in China is about 20-60% [4]. Therefore, it is necessary to carry out early nutrition monitoring in the outpatient setting and provide relevant nutrition management strategies and exercise rehabilitation programs in time. However, few studies on COPD nutrition management have been conducted in China, and there is no consensus on how to evaluate the nutritional status of COPD patients in China [5]. Handgrip strength (HGS), as an important indicator of whole-body muscle strength, has been included as an important tool for evaluating the physical health of the elderly and plays an important role in chronic disease prevention [6]. Handgrip strength (HGS) has been shown to have a suggestive effect on daily activity ability and the risk of acute exacerbation in COPD patients [7, 8]. Thus, HGS has gradually become a preliminary screening tool for nutritional risks and plays an important role in nutritional assessment [9, 10]. However, few studies on HGS of COPD patients have been conducted in China, and the relationship between HGS and the nutritional status of COPD patients is still unclear. This study aims to explore the present situation of HGS in stable COPD patients, analyze its relationship with nutrition-related indicators and influencing factors, and provide a foundation for outpatient medical staff to early identify the nutritional status of COPD patients and carry out an effective nutritional intervention.

2. Materials and methods

2.1 Study Population

From January 2021 to March 2022, 232 stable COPD patients treated in the respiratory outpatient department of a tertiary grade A hospital in Guangxi were selected by convenience sampling method. Inclusion criteria: (1) Patients who met the 2020 GOLD guideline diagnostic criteria for stable COPD [11]; (2) patients with clear consciousness and have no communication barriers; (3) Age of parients ≥40 years. Exclusion criteria: (1) Patients suffering from mental or cognitive disorders; (2) Patients with malignant tumors or other end-stage diseases; (3) Patients with severe edema, arthritis, nerve damage, or other conditions that impair upper limb strength testing. The hospital ethics committee approved this study, and all subjects provided informed consent.

2.2 Research methods

2.2.1 Research tools

(1) General information questionnaire. The researchers themselves designed, which included ① demographic data: gender, nationality, education background, residence, smoking status, and working status. ② Disease data: course of the disease, number of comorbidities, percentage of forced expiratory volume in the first and second to predicted value (FEV_1% pred), ratio of forced expiratory volume in the first second to vital capacity (FEV_1/FVC), pulmonary function grading. ③ Nutritional indicators: age, height, body weight, body mass index (BMI), upper arm circumference, calf circumference, hemoglobin concentration (HGB), total protein concentration (TP), albumin concentration (ALB), and prealbumin concentration (PA) are all factors to consider.

(2) Physical test. Two trained medical personnel measured the patients' height and weight, and based on the data; they calculated their BMI, upper arm circumference, and calf circumference. The measurement was repeated three times, the maximum value was taken, and the result was accurate to

0.1 cm.

(3) HGS test. An electronic grip dynamometer was used to measure HGS. Before measurement, the grip dynamometer was calibrated to zero, and the patient was instructed to sit up straight, with the arm to the side, the elbow of the dominant hand bent to 90 °, and the forearm lying in the middle position with the wrist in a neutral position. The grip dynamometer was firmly grasped, and the measurement was repeated three times at 30 s intervals. The researcher read the maximum value for data analysis.

(4) Nutritional assessment. Mini nutritional assessment short form (MNA-SF) was used to assess the nutritional status of patients, which included six aspects: BMI, activity ability, weight loss in recent three months, loss of appetite, psychological pressure or acute disease, and neuropsychological problems. The total score of 14 points where MAN-SF ≤11 points was considered malnutrition, and 12 points ≤MAN-SF≤14 points was considered normal nutrition.

2.2.2 Data collection methods

The researchers selected patients who met the inclusion criteria and explained the purpose and requirements of the study to the patients. The general information and nutritional score were collected on the spot, and the HGS was tested. The patients' pulmonary function and laboratory test results were recorded during the visit. Electronic medical records were used to obtain disease courses, comorbidities, and other disease-related data. Following the evaluation, the researcher checked the information for missing or unclear items.

2.2.3 Statistical methods

For statistical analysis, SPSS version 26.0 statistical software was used. The measurement data were tested for normality using the Kolmogorov-Smirnov method. Measurement data that conformed to normal distribution were expressed as mean ± standard deviation, whereas those that did not conform to the normal distribution were expressed as median (interquartile range). Counting data were expressed as frequency (percentage). The comparison of measurement data between groups was by normal distribution and homogeneity of variance. Two-sample independent t-test and one-way analysis of variance were used. Pearson correlation analysis or Spearman correlation analysis was used to explore the correlation between HGS and nutritional indicators in stable COPD patients. The HGS of stable COPD patients was analyzed by multiple linear regression. $P < 0.05$ was considered statistically significant.

3. Results

3.1 General information

There were 203 males and 29 females among the 232 patients. The average age was (64.65±9.22) years old; the height was (161.09±6.88) cm; the body weight was (58.28±12.08) kg; BMI was (22.41±4.19). Lung function: FEV_1% pred was [56.60(42.14,64.16)]%, FEV_1/FVC was (52.30±13.32)%. The upper arm circumference was (29.21±4.81)cm, and the calf circumference was (32.04±5.36)cm. There were 58 cases (25.00)% of normal nutrition and 174 cases (75.00)% of malnutrition measured by MNA-SF. The HGS level was (25.18±7.95)kg.

3.2 Univariate analysis of HGS in stable COPD

There was no significant difference in HGS among COPD patients with different nationalities, smoking status, course of the disease, and pulmonary function grade (P >0.05). There were significant differences in HGS among COPD patients with different gender, educational backgrounds, residence, working status, number of combined diseases, and nutritional statuses (P <0.05), as shown in Table 1.

Table 1: Univariate analysis results of general data and HGS of stable COPD patients(n=232).

Item	Group	Number of cases (Percentage, %)	HGS (kgf, $\bar{x}\pm s$)	Statistical value	P-value
Gender	Male	203(87.5)	26.11±7.67	4.997[1)]	<0.001
	Female	29(12.5)	18.60±6.79		
ethnic group	Han	189(81.47)	25.42±8.10	0.990[1)]	0.323
	Others	43(18.53)	24.09±7.29		
Education background	Primary school education and below	83(35.78)	23.36±7.84	4.622[2)]	0.004
	Junior high school	82(35.34)	25.00±7.53		
	Senior high school/Technical secondary school	42(18.10)	28.80±7.84		
	College degree or above	25(10.78)	25.71±8.23		
Residence	Rural	65(28.02)	22.62±7.30	3.105[1)]	0.002
	Nonrural	167(71.98)	26.17±8.00		
Smoking status	Current smokers	78(33.62)	25.94±8.20	0.843[2)]	0.432
	Former smokers	102(43.97)	25.14±7.71		
	No smoking	52(22.41)	24.09±8.08		
Working state	Unemployed	94(40.52)	22.80±7.65	7.569[2)]	0.001
	Retirement	99(42.67)	26.59±7.50		
	In service	39(16.81)	27.32±8.49		
Number of combined diseases	≤3	190(87.93)	26.07±7.73	3.747[1)]	<0.001
	>3	42(12.07)	21.13±7.78		
The course of disease (Year)	≤1	45(19.40)	26.12±7.85	1.409[2)]	0.187
	2~	92(39.66)	26.12±7.80		
	6~	30(12.93)	24.19±8.00		
	>10	65(28.02)	23.64±8.11		
Pulmonary function grade	Grade I	39(16.81)	25.22±8.76	0.180[2)]	0.956
	Grade II	108(46.55)	24.99±8.39		
	Grade III	63(27.61)	25.17±6.53		
	Grade IV	22(9.48)	26.05±8.49		
Nutritional status	Malnutrition	174(75.00)	24.06±7.56	-3.799[1)]	<0.001
	Normal nutrition	58(25.00)	28.52±8.23		

Note: FEV_1% pred >80% is considered as grade I of pulmonary function, 50% ≤FEV_1% pred <80% is considered as grade II, 30% ≤FEV_1% pred <50% is considered as grade III, and FEV_1% pred <30% is considered as grade IV; MNA-SF score ≤11 points is considered as malnutrition, 12 points≤ MAN-SF ≤14 points are considered as normal nutrition; 1) t-value; 2) F-value.

3.3 Correlation analysis between HGS and nutritional indicators in stable COPD patients

According to correlation analysis, Table 2 presents that height, body mass, BMI, calf circumference, HGB concentration, TP concentration, and PA concentration were positively correlated with the HGS of stable COPD patients (P <0.05), whereas age was negatively correlated with the HGS of stable COPD patients (P <0.05).

Table 2: Correlation between HGS and nutritional indicators in stable COPD patients(n=232).

Item	*r*-value	*P*-value
Age [1)]	-0.254	<0.001
Height [1)]	0.211	0.001
Body mass [1)]	0.242	<0.001
BMI[1)]	0.173	0.008
Upper arm circumference [1)]	0.076	0.248
Calf circumference [1)]	0.165	0.012
HGB concentration [1)]	0.186	0.004
TP concentration [1)]	0.237	<0.001
ALB concentration [2)]	0.165	0.012
PA concentration [2)]	0.200	0.002

Note: 1) Pearson correlation analysis, 2) Spearman correlation analysis

3.4 Multivariate analysis results of HGS in stable COPD patients

The HGS level of stable COPD patients was used as the dependent variable, and statistically significant variables in univariate analysis were used as independent variables (see Table 3 for the assignment of the independent variable). Multiple linear regression analysis was performed according to the standard of α_{in} = 0.05 and α_{out} =0.10. Table 4 presents that gender, age, number of comorbidities, and nutritional status are the influencing factors of HGS in stable COPD patients (P <0.05).

Table 3: Assignment of independent variables.

Independent variable	Assignment method
Gender	Male=0,Female=1
Age	<60=0,60~ =1,70~ =2
Number of comorbidities	≤3=0,>3=1
Nutrition status	MNA-SF score≤11=1,12≤MAN-SF≤14=2

Table 4: Multiple linear regression analysis results of influencing factors of HGS in stable COPD patients(n=232).

Variable	Regression coefficient	Standard error	Standardized regression coefficient	*t*-value	*P*-value
Constants	32.576	52.196	-	0.624	0.533
Gender	-6.420	1.503	-0.267	-4.272	<0.001
Age	-0.197	0.051	-0.228	-3.899	<0.001
Number of comorbidities	-3.263	1.197	-0.158	-2.726	0.007
Nutrition status	2.794	1.154	0.152	2.421	0.016

Note: R =0.598, R^2=0.357, adjusted R^2=0.313, F=8.009, P <0.001.

4. Discussion

4.1 HGS of stable COPD patients needs to be improved

In addition to the progressive decline of lung function, COPD mostly has adverse non-pulmonary manifestations such as muscle weakness, atrophy, and nutritional abnormalities [13]. According to Bui et al. [14], 70% of COPD patients have muscle weakness. The HGS level of stable COPD patients in this study was (25.18±7.95)kg, which was lower than the findings by Wu et al. [15], and may be related to the inconsistency of the regions and demographic characteristics of the included study subjects. As an important measurement tool for COPD management [16], HGS plays an important role in patients' respiratory muscle mass, cardiac function, and disease prognosis [17]. HGS has gradually become an important indicator for clinical nutritional risk prediction due to its simple, economical, and effective characteristics. However, there are few studies on applying HGS in the nutritional assessment of COPD patients. Therefore, medical personnel in China should pay attention to the HGS level of COPD patients to provide a foundation for rapid nutritional assessment and subsequent development of nutritional interventions.

4.2 Influencing factors of HGS in stable COPD patients

4.2.1 HGS is lower in women and elderly COPD patients

The present findings showed that gender and age influence HGS in COPD patients, which is consistent with the results of other studies conducted at home and abroad [18, 19]. HGS is an important marker that reflects strength and function of the muscles throughout the body. Numerous studies [20, 21] have confirmed that the HGS of females is generally smaller than that of males, and the HGS gradually decreases with age. It may be related to the higher concentration of major anabolic hormones (testosterone, growth hormone, etc.) in male plasma and strong muscle strength, whereas the change rate of female body composition is faster than that of male. Muscle strength deteriorates as estrogen and progesterone levels decline, increasing the risk of sarcopenia [22]. With the growth of age, the body declines, neuromuscular and endocrine systems age, and the HGS decreases faster [23]. A previous report [19] showed that female COPD patients are more likely to suffer from anxiety, depression, and osteoporosis, while elderly COPD patients have reduced bone mineral density and reduced muscle and fat reserves [24], all of which are risk factors for HGS decline. Therefore, medical staff should pay attention to female, middle-aged and elderly patients with COPD, assisting them in developing a good lifestyle, providing targeted muscle strength training, and improving their functional status.

4.2.2 COPD patients with more than three comorbidities have lower HGS

This study found that the number of comorbidities has an impact on HGS in COPD patients. The more the number of comorbidities, the lower the HGS, which is consistent with the findings by Montes et al. [25]. Multiple diseases can increase the risk of body dysfunction and cause significant damage to body function. Researchers [26] showed that comorbidities are common in COPD, with an average of about 3.9. Presently, the mechanism by which comorbidities influence HGS is unclear, and only a few relevant studies were conducted in China [27]. Medical staff should pay special attention to COPD patients who have comorbidities, investigate the impact of comorbidities on HGS, and provide a foundation for developing scientific health management plans.

4.2.3 Malnourished COPD patients have low HGS

In this study, the MAN-SF score was used to evaluate the nutritional status of COPD patients [28]. The incidence of malnutrition in stable COPD patients was found to be 75%, which was similar to the findings by Sun et al. [29]. Multiple linear regression analysis showed that nutritional status was the influencing factor of HGS in patients with COPD, and the HGS of patients with malnutrition was smaller, similar to Deutz et al. [30]. Due to systemic inflammatory reactions, increased resting energy consumption, and other reasons, COPD patients are prone to poor appetite, anorexia, and other adverse manifestations [31]. Furthermore, increased protein loss in patients can easily lead to muscle strength loss, muscle function impairment, and decreased HGS. Moreover, this study also found that HGS was correlated with traditional nutritional indicators such as anthropometric indicators (such as BMI and calf circumference) and laboratory indicators (such as HGB and TP) in COPD patients, which was consistent with the findings of Qaisar et al. [32]. Currently, the nutritional evaluation indicators of COPD have not been unified [5], and the examination of biochemical indicators is an invasive procedure that requires a certain cost, increasing the financial burden of patients [33]. However, BMI and other physical examination indicators have many unstable factors and low sensitivity, which should not be used as a sole nutritional assessment tool [34]. HGS has gradually become an important marker for nutritional assessment in recent years [35], but it is still rare in the field of COPD. Therefore, medical personnel should actively combine the HGS test with other assessment tools and analyze its correlation with more nutrition indicators. This will further explore the application value of HGS in the nutrition assessment of COPD patients to provide a foundation for rapid screening of the nutritional status of outpatients with COPD, implementing early nutrition intervention and health education, and improving the health outcomes of patients.

5. Conclusions

The HGS of stable COPD patients in Guangxi , related to nutritional indicators, needs to be improved. The HGS of stable COPD patients who were female, older, had more than three comorbidities, and malnutrition was lower. The results of this study suggest that medical staff can initially assess the nutritional status of COPD patients based on their HGS level, allowing for the early nutritional management of COPD.

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