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Analysis of the relationship between frailty index and 25(OH) vitamin D in elderly inpatients

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Abstract: To analyze the relationship between frailty index and 25(OH) vitamin D in elderly inpatients. Totally 300 elderly patients in the geriatric department of Yuncheng Central Hospital from December 2019 to November 2020 were enrolled. There were 100 cases of non-frailty, pre-frailty, and frailty, respectively. The incidence of frailty was higher in patients with low household income, more diseases, less education, more medication, poor health self-assessment, and older age. There were statistical differences in vitamin D levels in weight loss, slower walking pace, reduced grip strength, decreased physical performance, and fatigue. There were significant differences in hypertension, diabetes mellitus, cerebral apoplexy, osteoporosis, and multiple chronic diseases among the three groups. The correlation analysis of senile frailty with age, weight, education level, income, BMI, combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, and vitamin D level was statistically significant. Factors, included age, weight, education level, income, BMI, combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, vitamin D level had a significant effect on frailty. Logistic regression analysis showed that vitamin D and age were independent influencing factors for frailty.

Keywords: Elderly inpatients; Frailty index; 25(OH) vitamin D.

INTRODUCTION

With the increasing aging of the population, the health of the elderly has gradually become a focus of attention in all areas of society (Adams *et al.*, 2013; Alfawaz *et al.*, 2014). In 2019, China has 253.88 million elderly people over the age of 60, accounting for 18.1% of the total population (in China, those aged 60 or above are classified as elderly people).

(Kang *et al.*, 2017). With aging, various health problems emerge in the elderly, such as frailty and vitamin D deficiency, which drastically compromise the quality of life and health of the elderly, and intensify the financial burden of medical care (Bayon-Calatayud and Benavente-Valdepeñas, 2018). Vitamin D plays an important role in calcium and phosphorus metabolism, immunity, endocrine, nervous system and muscle function (McCollough and Leng, 2020). Although vitamin D is readily available through food, vitamin D deficiency is still pervasive in people of all ages, especially the elderly, due to factors such as reduced skin exposure, diet, and geographical location (Duval *et al.*, 2017; van Deudekom *et al.*, 2016). A number of foreign studies have shown a strong relationship between vitamin D and frailty, but relevant data are still lacking in China (Marra *et al.*, 2014). The purpose of this study was to investigate the relationship between frailty and 25(OH) vitamin D in elderly inpatients in China.

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MATERIALS AND METHODS

General information

According to Modern Medical Statistics, the number of samples that could be selected is about 5-20 times the number of variables; therefore, 17 research variables were used in this study, namely: gender, age, height, weight, education level, income, BMI, combined chronic diseases, smoking history, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, vitamin D level, and debilitating state. A total of 300 patients were included in the study after screening and eliminating cases with invalid questionnaires and withdrawal from the examination midway. This study was approved by the Medical Ethics Committee of our hospital, the patients and their family members were fully informed of the content of this study and signed the informed consent.

Inclusion criteria: (1) Patients and their family members were informed of the study and voluntarily participated in the study; (2) Patients aged ≥ 60 years old; (2) Patients who could walk freely or independently with the assistance of auxiliary tools; (3) The patients or their caregiver could clearly complete the actions required by the research team and answer the questions raised by the research team; (4) Patients who voluntarily filled in the questionnaire and received frailty assessment and other related tests.

Exclusion criteria: (1) Patients who previously received

vitamin D preparation, calcium supplement preparation, and other treatments that would affect serum vitamin D level; (2) Patients with abnormal liver and kidney function; (3) Patients with hyperthyroidism or hypothyroidism; (4) Patients in the acute or terminal stage of the disease; (5) Patients who were unable to walk with the assistance of assistive tools; (6) Patients with severe dementia and disability; (7) Patients with communication disorders.

Methods

Study variables of patients were collected, including gender, age, height, weight, education level, income, BMI, combined chronic diseases, smoking history, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, vitamin D level and debilitating state.

Observational index

(1) *General information*: the general information of patients included gender, age, height, weight, education level, income, BMI, complicated chronic disease, smoking history, and waist-hip ratio. The collection of general information was conducted through standardized measurement, or the patient's self-report.

(2) *Weight loss*: The subjects' previous medical history (including weight and height) within 1 year were inquired to obtain the weight loss. A BMI of less than 18.5 kg/m2 was considered to meet the criteria for weight loss.

(3) *Slower walking pace*: The walking time at a brisk pace of about 4.6m (15 ft) was measured and the required time unit (s) with a stopwatch timer was recorded.

(4) *Reduced grip strength*: The patient's dominant hand strength, known as grip strength, was measured three times using a handheld electronic grip meter and then averaged (Hubbard *et al*., 2011).

(5) *Decreased physical performance*: The activity amount and time of the patient in the past 1 week were obtained and the total energy consumed by the patient was calculated.

(6) *Fatigue*: The evaluation of fatigue was conducted through questions and answers ① Do you feel that everything you have done in the past week has gone through a lot of effort? ② Have you felt unable to walk independently in the past week? A score of 2 points or more from any of the above two questions is considered to meet the criteria of exhaustion (fatigue).

(7) *Vitamin D levels*: 3ml fasting venous blood of the patients in the morning was collected and centrifuged to obtain the serum which was then stored in a refrigerator at -80℃. The determination of the levels of vitamin D was in strict accordance with the kit instructions.

(8) *Frailty state*: Frailty is defined by adopting the frailty phenotype proposed by Fried et al (Byrne *et al.*, 2019), which included five indicators: weight loss, slower walking speed, reduced grip strength, decreased physical performance and fatigue.

STATISTICAL ANALYSIS

SPSS20.0 software was used to analyze the data obtained in this study. Measurement data conforming to normal distribution were represented by ($\bar{x}\pm s$), and count data were represented by percentage or rate. Independent sample t-test and One-way ANOVA were used for the normal distribution, and contingency table analysis was used for the comparison of multiple groups of samples of classified variables. Multivariate analysis was performed by Logistic regression.

RESULTS

Results of general information

There were 100 cases of non-frailty, pre-frailty and frailty, respectively. The incidence of frailty was higher in patients with low household income, more diseases, less education, more medication, poor health self-assessment, and older age. Results of general information are shown in table 1

Vitamin D distribution

The serum vitamin D levels of the 300 included subjects showed that there were statistical differences in vitamin D levels in weight loss, slower walking pace, reduced grip strength, decreased physical performance, and fatigue ($P<0.05$). Vitamin D distribution is shown in fig. 1.

Different frailty states combined with chronic diseases

Among the 300 included subjects, by comparing the frailty, pre-frailty and frailty groups with different frailty states combined with chronic diseases, there was no significant difference between hyperlipidemia and coronary heart disease ($P>0.05$). There were significant differences in hypertension, diabetes mellitus, cerebral apoplexy, osteoporosis and multiple chronic diseases among the frailty, pre-frailty and frailty groups of patients ($P<0.05$). Different frailty states combined with chronic diseases are shown in table 2.

Spearman rank correlation test of senile frailty and vitamin D

Spearman rank correlation test between senile frailty and vitamin D showed that there was no significant correlation between senile frailty and gender, height, and smoking history ($P>0.05$). The correlation analysis of senile frailty with age, weight, education level, income, BMI, combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, vitamin D level was

statistically significant (P<0.05). Spearman rank correlation test of senile frailty and vitamin D is shown in table 3.

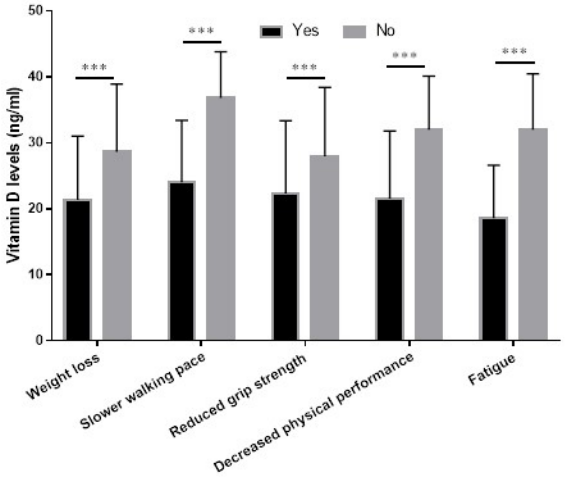

Fig. 1: Vitamin D distribution

Logistic regression analysis of aging frailty and vitamin D

Factors that have a significant effect on frailty included age, weight, education level, income, BMI, combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, and vitamin D level. These influencing factors were taken as independent variables for Logistic regression analysis of senile frailty. The results showed that vitamin D and age were independent influencing factors for frailty (P<0.05). Logistic regression analysis of aging frailty and vitamin D is shown in table 4

DISCUSSION

As the elderly population increases, the number of people aged 65 and older worldwide is now estimated to increase from 461 million in 2004 to 2 billion in 2050 (Wang *et al.*, 2020). A study focused on the prevalence of frailty syndrome in 638 community-dwelling elders between the ages of 64 and 74), and found that frailty occurred in 4.1 percent of men and 8.5 percent of women (Bieniek *et al.*, 2016). Another health study also used Fried's frailty phenotype for investigation and found a prevalence of 6.9% for frailty syndrome. The incidence of frailty syndrome increased with age and the prevalence of frailty syndrome was 3.2%, 9.5% and 25.7% in the age group of 65-70 years, 75-79 years and 85-89 years, respectively (Payne *et al.*, 2012). Results of a meta-analysis showed that the prevalence of frailty syndrome among the elderly in the community was 12.7%, higher than the reported global level (10.7%) and the incidence of pre-frailty was 47.3%, which was also higher than the reported global level (41.6%), with higher prevalence of frailty in women than that in men (Gradel *et al.*, 2016).

Frailty syndrome can be used as a common indicator to assess the health status and nursing needs of the elderly. Its main manifestation is decreased physiological reserve and increased vulnerability, which can lead to serious adverse consequences, such as adverse events, disease, disability and death (Eeles *et al.*, 2012). Vitamin D deficiency is a global problem. Serum vitamin D deficiency is more common in the elderly. Vitamin D deficiency compromises the health and quality of life of patients, results in intensive medical burden and considerable pressure on the social economy (Stamp *et al.*,

Table 1: Results of general information

Projects		Non-frailty (n=100)	Pre-frailty (n=100)	Frailty (n=100)	H	P
Gender	Male	54	47	49	0.371	>0.05
	Female	46	53	51		
Age	60-69	52	32	40	19.504	>0.05
	70-80	48	68	60		
Height (cm)(Average)		156.10±6.54	162.04±5.01	154.72±6.03	20.041	>0.05
Weight (kg)(Average)		55.72±9.04	58.84±2.10	54.68±8.78	16.201	>0.05
Education level	Primary school or below	48	54	50	8.545	>0.05
	Middle school	47	39	42		
	College degree or above	5	7	8		
Income (month)	<2000	28	32	31	8.152	>0.05
	2000-5000	45	47	52		
	>5000	27	21	17		
BMI(kg/m^2)		22.17±3.51	23.01±3.64	22.58±3.41	17.201	>0.05
Complicated chronic disease	Yes	65	68	64	8.901	>0.05
	No	35	32	36		
Smoking history	Yes	44	41	47	11.027	>0.05
	No	56	59	53		
Waist-to-hip ratio	<0.80	47	40	43	9.531	>0.05
	0.80-0.90	45	42	48		
	>0.90	8	18	9		

Table 2: Different frailty states combined with chronic diseases

Chronic diseases		Non-frailty	Pre-frailty	Frailty	Kruskal Wallis H(K)	P
Hypertension	Yes	9	12	9	10.655	<0.05
	No	91	88	91		
Diabetes mellitus	Yes	5	8	13	6.384	<0.05
	No	95	92	87		
Hyperlipidemia	Yes	3	5	4	2.847	>0.05
	No	97	95	96		
Coronary heart disease	Yes	8	5	5	1.905	>0.05
	No	92	95	95		
Cerebral apoplexy	Yes	11	16	3	9.254	<0.05
	No	89	84	97		
Osteoporosis	Yes	19	15	19	6.654	<0.05
	No	81	85	81		
Multiple chronic diseases	Yes	10	7	11	1.071	<0.05
	No	90	93	89		

Table 3: Spearman rank correlation test of senile frailty and vitamin D

Parameter index	Frailty	
	r	P
Gender	0.054	>0.05
Age	0.682	<0.05
Height	-0.112	>0.05
Weight	-0.235	<0.05
Education level	0.142	<0.05
Income	0.324	<0.05
BMI	-0.218	<0.05
Combined chronic diseases	0.364	<0.05
Smoking history	-0.086	>0.05
Waist-to-hip ratio	0.532	<0.05
Weight loss	0.331	<0.05
Slower pace	0.672	<0.05
Decreased grip strength	0.684	<0.05
Decreased physical fitness	0.317	<0.05
Fatigue	0.612	<0.05
Vitamin D level	-0.754	<0.05

Table 4: Logistic regression analysis of aging frailty and vitamin D

Influence factor	SE	B	Wald	OR	Upper 95% confidence interval for OR	Lower limit of 95% confidence interval for OR	P
Age	0.026	-0.094	6.312	0.904	0.845	29.106	<0.05
Weight	0.084	0.040	0.024	1.053	0.841	1.758	>0.05
Education level	0.304	-0.134	2.314	1.851	0.706	1.254	>0.05
Income	0.315	-0.201	7.152	4.462	0.841	1.684	>0.05
BMI	0.234	0.125	7.250	3.818	0.360	2.354	>0.05
Combined chronic diseases	0.957	1.504	2.345	3.084	0.172	2.065	>0.05
Waist-to-hip ratio	0.514	1.502	4.866	3.407	0.135	0.997	>0.05
Weight loss	0.051	2.152	4.128	0.851	0.804	35.710	>0.05
Slower pace	0.035	1.301	10.584	9.545	2.501	8.514	>0.05
Decreased grip strength	0.047	-0.135	5.310	0.842	0.814	0.947	>0.05
Decreased physical fitness	0.319	0.254	7.821	3.074	1.085	1.814	>0.05
Fatigue	0.034	0.047	4.550	0.845	0.766	0.905	>0.05
Vitamin D level	0.05	0.415	36.348	1.513	1.302	15.310	<0.05

2018).

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were statistical differences in vitamin D levels in weight loss, slower walking pace, reduced grip strength, decreased physical performance, and fatigue (P<0.05). Among the 300 included subjects, by comparing the frailty, pre-frailty and frailty groups with different frailty states combined with chronic diseases, there was no significant difference between hyperlipidemia and coronary heart disease (P>0.05); There were significant differences in hypertension, diabetes mellitus, cerebral apoplexy, osteoporosis and multiple chronic diseases among the frailty, pre-frailty, and frailty groups of patients (P<0.05). Spearman rank correlation test between vitamin D and vitamin D showed that gender, height, smoking history there was no significant correlation between senile frailty and gender, height and smoking history (P>0.05). The correlation analysis of senile frailty with age, weight, education level, income, BMI, combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue, vitamin D level was statistically significant (P<0.05). Factors that have a significant effect on frailty included age, weight, education level, income, BMI,

Combined chronic diseases, waist-to-hip ratio, weight loss, slower pace, decreased grip strength, decreased physical fitness, fatigue and vitamin D level. These influencing factors were taken as independent variables for Logistic regression analysis of senile frailty. The results showed that vitamin D and age were independent influencing factors for frailty (P<0.05).

CONCLUSION

In conclusion, the degree and phenotype of frailty in elderly inpatients is closely related to vitamin D, as vitamin D deficiency increases the risk of frailty. Vitamin D supplementation can improve muscle function and physical activity.

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