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# Prevalence and the factors associated with malnutrition risk in elderly Chinese inpatients

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## Abstract

**Background:** Malnutrition is an under recognized, but common issue in elderly patients. This study aimed to investigate the prevalence of poor nutritional status and identify comprehensive geriatric assessment-based clinical factors associated with increased malnutrition risk to assessing malnutrition risk in hospitalized elderly patients in China.

**Methods:** A total of 365 elderly hospitalized patients (178 women, 76.37 ± 7.74 years) undertook a comprehensive geriatric assessment (CGA), and have their nutritional status assessed using the short-form mini-nutritional assessment.

**Results:** Among 365 patients, 32 (8.77%) were malnourished and 112 (30.68%) were at risk of malnutrition. A logistic regression analysis showed that age (odds ratio [OR], 1.59; 95% confidence interval [CI], 1.13-2.23), alcohol consumption (OR, 2.04; 95% CI, 1.19-3.48), presence or history of cancer or heart failure (OR, 3.48 and 2.86; 95% CI, 1.49-8.13 and 1.12-7.27), depression (OR, 2.86; 95% CI, 1.97-4.17), body mass index (OR, 5.62; 95% CI, 3.62-8.71), being dependent in activity of daily living (OR, 3.81; 95% CI, 2.61-5.57), a lower score in instrumental activities of daily living (OR, 3.01; 95% CI, 2.09-4.33), recent fall(s) (OR, 2.22; 95% CI, 1.37-2.91), cognitive impairment (OR, 1.81; 95% CI, 1.30-2.53), insomnia (OR, 1.49; 95% CI, 1.07-2.06), hemoglobin and albumin level (OR, 1.72 and 2.86; 95% CI, 1.17-2.50 and 1.53-5.36) were independent correlates of malnutrition in older patients.

**Conclusion:** Our study demonstrated that age, alcohol consumption, chronic diseases (cancer and heart failure), depression, body mass index, function status, recent fall(s), cognitive impairment, insomnia, and low hemoglobin and albumin levels were independently associated with malnutrition in these patients. Comprehensive geriatric assessment can provide detailed information of older patients and can be a useful tool for assessing malnutrition risk-associated factors.

KEYWORDS

comprehensive geriatric assessment, elderly, geriatric, hospitalized, malnutrition

## 1 | INTRODUCTION

The global population is rapidly aging as we are currently faced with an unprecedented rise in the number of older adults.[1] Shrinking fertility rates and longer lifespans are changing the global demographic landscape, resulting in declining human population growth rates.[2] Individuals of ≥ 65 years of age or more is increasing in numbers globally, and by 2050, the global population aged ≥ 65 years is predicted to reach over 1 billion.[3] China, the most populated country in the world, will confront challenges related to its aging population over the coming decades.[4] According to the China Aging Development Report (2013), the country had, by 2012, 194 million individuals aged ≥ 60 years, representing 14.3% of its total population, and one-fifth of the world's population aged ≥ 65 years. By 2030, China's elderly population will be expected to approximate at 400 million, becoming the country that has the highest population of elderlies in the world.[5]

The elderly population is a vulnerable group at risk of developing nutritional deficiencies. Aging is associated with declined physical and physiological functioning, and psychosocial and financial difficulties; if inadequately treated, these can lead to nutritional inadequacy.[6] Malnutrition is an under recognized but common issue in elderly patients; and, if overlooked, it can lead to deteriorated quality of life.[7] To date, in China, the adverse effects of geriatric malnutrition are well-documented and remain a major public health issue; although the true incidence of geriatric malnutrition may be significantly higher, placing a portion of undetected malnourished elderlies at risk for functional problems. Despite some geriatric malnourished cases that remain indolent, nutritional assessment is not routinely conducted as part of the clinical evaluation of elderly patients at most Chinese hospitals.[8]

Comprehensive geriatric assessment (CGA) is typically used to assess the physical, mental, psychosocial, and functional capabilities in elderly persons. Nutritional assessment is an important nutritional screening component of CGA.[8] The primary objective of our study was to estimate the prevalence of poor nutrition status among elderly inpatients, by conducting Mini-Nutritional Assessment Short-Form (MNA-SF) on elderly patients being admitted to the First Hospital of Lanzhou University, China. The secondary objective was to further our understanding of the relationship between malnutrition and factors, such as psychological well-being, lifestyle, cognitive function, and functional capacity. All patients have provided informed consent to conduct the CGA.

## 2 | MATERIALS AND METHODS

### 2.1 | Participants

A retrospective study was conducted at the First Hospital of Lanzhou University in China, a 2408-bed teaching hospital with specialized geriatric wards and outpatient clinics. A total of 365 Chinese inpatients aged ≥ 60 years were randomly selected from the hospital's geriatric wards to be recruited to this study between January 2014 and September 2016. Ethics approval for all protocols used in this study was obtained through the First Hospital of Lanzhou University who approved all protocols used in this study. Patients receiving end-of-life care were excluded from the study, to eliminate bias in the analysis of the prognostic factors. All participating eligible patients gave signed informed consent.

### 2.2 | CGA and clinical data

All 365 patients had their CGA evaluated by trained geriatricians and nurses. The participants' baseline demographic data were collected using a questionnaire, surveying their age, gender, educational history, smoking and alcohol history, marital status (yes or no [single / divorced / widowed]), living arrangements (alone or with others), occupational income, and history of chronic illness (hypertension, diabetes, cerebrovascular disease, chronic obstructive pulmonary disease, coronary heart disease, cancer, and heart failure). Other questionnaire data recorded were: body pain over the past 4 weeks (ranging from 0-10, where 0 is no pain and 10 the most severe pain imaginable); the number of falls over the past year; insomnia; and polypharmacy, which included the number of medications, polypharmacy appropriateness, and drug-drug interactions. A monthly income of 2000 RMB or less was defined as a low income. Charlson complication index score was also assessed to grade the severity of the patients' medical condition(s).

CGA consists of several domains. Current and previous functional status was measured as activity of daily living (ADL) dependency on the Barthel Index scale (ranging from 0-100, with 100 being the best score), and as instrumental activities of daily living (IADL) dependency described by Lawton et al.[10] Cognitive status was measured by conducting mini-mental state examination (MMSE) (ranging from 0-30, with 30 being the best score). Educational history entails no standard cutoffs for the MMSE. In this study, MMSE cutoff values were therefore adjusted for the patients' educational level to improve clinical evaluation of impaired cognitive function. Specifically, significant cognitive impairment was defined as an MMSE score of less than 20 in illiterate subjects or in subjects being primary school graduates; and as an MMSE cutoff score of 24 or below in highly educated participants who have at least 16 years of schooling. The Geriatric Depression Scale (GDS) short-form 15 was used to indicate depression (ranging from 0-15, with 0-5 as normal and > 5 depressed).

### 2.3 | Mini-Nutritional Assessment Short-Form

The nutritional status of a patient was evaluated using the MNA-SF, a revised and rapid screening form of the mini-nutritional assessment being developed to maximize diagnostic accuracy in patients aged 60 years or above.[10] The patients were interviewed to report their appetite, weight loss, mobility, recent illness / stress, dementia / depression, and body mass index (BMI), with each reported history being scored using a subjective scale from zero to three. Patients who are adequately or well-nourished at

the time of MNSA-SF, had a subjective MNA-SF score of 12 and higher,[10] with the maximum reported score being 14; patients at risk of malnutrition scored between 8 and 11; and malnourished patients scored 7 or less. Some patients who are unable to stand independently, had their calf circumferences measured as an alternative scoring for their BMI, as proposed by Kaiser et al.[11] BMI was calculated by dividing the patient's weight in kilogram by the patient's height squared in centimeter squared. In addition, the patients' hemoglobin and albumin levels and lymphocyte counts were assessed when determining their nutritional status.

### 2.4 | Statistical analysis

Normally distributed variables were expressed as means ± their standard deviation. Categorical variables were expressed as a number and a percentage. Demographic and clinical characteristics of malnourished patients and patients at risk of malnourishment, and adequately or well-nourished patients, were compared. A chi-square test of association was conducted to examine the significance of the variable. Odds ratios were calculated to evaluate the magnitude of the impact of the significant variables. A binary logistic regression analysis was performed to identify factors indicative of malnourishment; from the chi-square test, significant factors were introduced as the first step in the model, and nonsignificant factors were subsequently pruned; and to explore potential associations between significant indicators of malnourishment and nutritional statuses. SPSS version 22 software was used to analysis all data where the level of statistical significance was defined as $P$ value < 0.05.

## 3 | RESULTS

### 3.1 | Patient characteristics

The average age of the 365 randomly selected elderly inpatients (178 women and 187 men) was 76.37 ± 7.74 years, and their ages ranged from 60 to 93 years. Table 1 shows the participants' demographic and baseline characteristics. Most patients were either married (58.63%) or widowed (40.55%) and the majority lived with others (family or relatives, 84.93%) in urban areas (97.53%). Only 17.81% of the participants smoked and 7.67% consumed alcohol or had a history of alcohol or smoking addiction. Almost half of the patients (45.48%) reported that they were previously diagnosed with more than five chronic diseases. Moreover, 237 patients (64.93%) were hypertensive, 121 patients (33.15%) were diabetic, 94 patients (25.75%) had chronic obstructive pulmonary disease(s), and 10 patients (0.03%) had cancer or heart failure.

### 3.2 | Patient characteristics by nutritional risk

Based on the MNA-SF score, only 32 patients (8.77%) were clearly malnourished (0-7 points), whereas one-third of the patients (112% or 30.68%) were at risk of being malnourished (8-11 points). Statistically significant differences were observed between the nutritional status and factors including: age ($P$ = 0.003), marital status ($P$ = 0.030), alcohol consumption ($P$ = 0.034), presence or history of cancer ($P$ = 0.000), and of heart failure ($P$ = 0.001). Malnourished patients or those at risk of malnutrition were significantly older than the subjects with a normal nutritional status. Furthermore, married patients had a better nutritional status than unmarried patients. Among patients who had an alcohol history, 13% of them were malnourished or were at risk of malnourishment, compared to 5% of patients who had an alcohol history of being well nourished. Similarly, patients who were previously treated for cancer or heart failure often also were malnourished or were at risk of malnourishment. Additionally, Table 2 shows that compared to well-nourished patients, significantly more malnourished patients and significantly more patients at risk of malnourishment also suffered from depression ($P$ = 0.000), insomnia ($P$ = 0.044), or recent fall(s) ($P$ = 0.001). Likewise, malnourished patients and those at risk also had significantly ($P$ = 0.000) lower median BMI values, ADL or IADL, and MMSE scores, and hemoglobin and albumin levels.

Table 3 illustrates that 88% of malnourished patients and 62% of patients being at risk of malnutrition saw declined food intake over the past 3 months, compared to 16% of the seemingly well-nourished patients reporting declined food intake ($P$ = 0.000). Accordingly, a significantly higher percentage of malnourished patients (94%) and patients at risk of malnutrition (73%) noted weight loss over the past 3 months ($P$ = 0.000). In addition, the percentage of patients who are able to walk without assistance was significantly lower among the malnourished (53%) and patients at risk of malnutrition (84%), as compared to well-nourished patients (94%; $P$ = 0.000). The percentages of patients having a history of or suffering from psychological trauma or mental illness were also significantly higher among the malnourished patients (53% and 44%, respectively) and among those at the risk of malnutrition (19% and 14%, respectively; $P$ = 0.000).

### 3.3 | Univariate logistic regression analysis

Table 4 shows the factors that were significantly associated with malnutrition or with a risk of malnutrition, including: advanced age (odds ratio [OR], 1.59; 95% confidence interval [CI], 1.13-2.23), alcohol consumption (OR, 2.04; 95% CI, 1.19-3.48), presence or history of cancer

or heart failure (OR, 3.48 and 2.86; 95% CI, 1.49-8.13 and 1.12-7.27, respectively), depression (OR, 2.86; 95% CI, 1.97-4.17), a lower BMI value (OR, 5.62; 95% CI, 3.62-8.71), being dependent in ADL (OR, 3.81; 95% CI, 2.61-5.57), a lower score in IADL (OR, 3.01; 95% CI, 2.09-4.33), a recent fall (OR, 2.22; 95% CI, 1.37-2.91), a lower score in MMES (OR, 1.81; 95% CI, 1.30-2.53), insomnia (OR, 1.49; 95% CI, 1.07-2.06), lower hemoglobin levels (OR, 1.72; 95% CI, 1.17-2.50), and lower albumin levels (OR, 2.86; 95% CI, 1.53-5.36).

**TABLE 1** Demographic characteristics of the study population according to nutritional status

| Demographic characteristics % or mean ± SD | Nutritional status | | | Total n = 365 | *P*-value |
|---|---|---|---|---|---|
| | Malnourished n = 32, 8.77% | At risk of malnutrition n = 112, 30.68% | Well nourished n = 221, 60.55% | | |
| Gender | | | | | |
| Male | 15 (0.47) | 56 (0.5) | 116 (0.52) | 187 (0.51) | 0.798 |
| Female | 17 (0.53) | 56 (0.5) | 105 (0.48) | 178 (0.49) | |
| Age | 78.84 ± 6.34 | 77.78 ± 7.67 | 75.27 ± 7.77 | 76.37 ± 7.74 | 0.003* |
| 60-74 | 8 (0.25) | 40 (0.36) | 96 (0.43) | 144 (0.39) | 0.085 |
| 75-84 | 18 (0.56) | 51 (0.46) | 100 (0.45) | 170 (0.47) | 0.497 |
| > 85 | 6 (0.19) | 21 (0.18) | 25 (0.11) | 51 (0.14) | 0.139 |
| Living arrangement | | | | | |
| Living with others | 25 (0.78) | 92 (0.82) | 193 (0.87) | 310 (0.85) | 0.24 |
| Living alone | 7 (0.22) | 20 (0.18) | 28 (0.13) | 55 (0.15) | |
| Marital status | | | | | |
| Married | 12 (0.38) | 69 (0.62) | 133 (0.60) | 214 (0.59) | 0.030* |
| Single | 0 (0) | 0 (0) | 3 (0.02) | 3 (0.01) | 0.373 |
| Widow | 20 (0.62) | 43 (0.38) | 85 (0.38) | 148 (0.40) | 0.030* |
| Monthly income | | | | | |
| < 2000 RMB | 5 (0.16) | 11 (0.10) | 20 (0.09) | 36 (0.10) | 0.507 |
| 2000 RMB+ | 27 (0.84) | 101 (0.90) | 201 (0.91) | 329 (0.90) | |
| No health insurance | 5 (0.16) | 11 (0.10) | 20 (0.09) | 36 (0.10) | 0.507 |
| Place of residence | | | | | |
| Rural areas | 2 (0.06) | 3 (0.03) | 4 (0.02) | 9 (0.02) | 0.313 |
| Urban areas | 30 (0.94) | 109 (0.97) | 217 (0.98) | 356 (0.98) | |
| Education | | | | | |
| Illiterate | 5 (0.16) | 16 (0.14) | 23 (0.10) | 44 (0.12) | 0.478 |
| Primary or high school | 22 (0.69) | 67 (0.60) | 140 (0.63) | 229 (0.63) | 0.626 |
| College or university | 5 (0.16) | 29 (0.26) | 58 (0.26) | 92 (0.25) | 0.425 |
| Smoking | 5 (0.16) | 25 (0.22) | 35 (0.16) | 65 (0.18) | 0.384 |
| Alcohol | 4 (0.13) | 14 (0.13) | 10 (0.05) | 28 (0.08) | 0.034* |
| Hypertension | 17 (0.53) | 70 (0.63) | 150 (0.68) | 237 (0.65) | 0.168 |
| Diabetes | 9 (0.28) | 35 (0.31) | 77 (0.35) | 121 (0.33) | 0.599 |
| Coronary disease | 11 (0.34) | 24 (0.21) | 59 (0.27) | 94 (0.26) | 0.248 |
| Hyperlipidemia | 3 (0.09) | 15 (0.13) | 36 (0.16) | 54 (0.15) | 0.491 |
| COPD | 5 (0.16) | 14 (0.12) | 21 (0.10) | 40 (0.11) | 0.503 |
| Cancer | 5 (0.16) | 3 (0.03) | 2 (0.01) | 10 (0.03) | 0.000* |
| Heart failure | 4 (0.13) | 4 (0.04) | 2 (0.01) | 10 (0.03) | 0.001* |

Abbreviation: COPD, chronic obstructive pulmonary disease.

*$P$ value < 0.05.

## 4 | DISCUSSION

Malnutrition is a common problem among hospitalized elderly patients. Even in well-developed countries, such as the United States, the prevalence of malnutrition is increasing.[12] Published prevalence of malnutrition varies depending on patients' diagnoses, nutritional parameters, and assessment tools used. Therefore, care has to be taken when comparing different studies. A previous report on the Asian population elucidated the prevalence of malnutrition, ranging from 16% to 78% among hospitalized seniors.[12] In our study, 30.68% of elderly inpatients were at risk of malnutrition and 8.77% were classified as being malnourished. Our study revealed that age, the presence or history of cancer or of heart failure, depression, low BMI, being dependent in ADL, low IADL, a recent fall (within the year), cognitive impairment, insomnia, and lower hemoglobin and albumin levels, were independently

**TABLE 2** Comprehensive geriatric assessment (CGA) scores and clinical characteristics among elderly inpatients by nutritional status

| Demographic characteristics % or mean ± SD | Malnourished n = 32 | At risk of malnutrition n = 112 | Well nourished n = 221 | *P* value |
|---|---|---|---|---|
| GDS mean score | 5.44 ± 3.55 | 4.43 ± 3.22 | 2.72 ± 2.53 | 0.000** |
| Number of patients with GDS ≥ 5 | 16 (0.50) | 50 (0.45) | 39 (0.18) | 0.000** |
| BMI, kg/m$^2$ | 19.96 ± 3.78 | 21.53 ± 3.16 | 25.08 ± 2.88 | 0.000** |
| Chronic illnesses, > 5 | 17 (0.53) | 48 (0.43) | 101 (0.46) | 0.499 |
| Polypharmacy, > 5 prescribed drugs | 24 (0.75) | 67 (0.60) | 134 (0.61) | 0.222 |
| ADL | 76.41 ± 27.48 | 88.66 ± 17.79 | 96.72 ± 9.22 | 0.000** |
| IADL | 3.65 ± 2.80 | 5.14 ± 2.62 | 6.43 ± 2.14 | 0.000** |
| Constipation | 12 (0.38) | 43 (0.38) | 62 (0.28) | 0.168 |
| Fall | 13 (0.41) | 28 (0.25) | 32 (0.14) | 0.001** |
| Pain | 23 (0.72) | 62 (0.55) | 120 (0.54) | 0.156 |
| MMSE mean score | 20.97 ± 6.07 | 22.28 ± 6.51 | 24.45 ± 5.02 | 0.000** |
| Insomnia | 21 (0.66) | 60 (0.54) | 97 (0.44) | 0.044** |
| Charlson comorbidity index | 3.21 ± 2.18 | 2.27 ± 1.51 | 2.52 ± 2.01 | 0.059 |
| Hemoglobin, g/dL | 123.76 ± 25.57 | 130.07 ± 23.65 | 139.89 ± 23.02 | 0.000** |
| Normal, ≥ 12 | 20 (0.63) | 89 (0.79) | 184 (0.83) | 0.019** |
| Abnormal, < 12 | 12 (0.38) | 26 (0.23) | 37 (0.17) | |
| Albumin | 123.76 ± 25.57 | 130.07 ± 23.65 | 139.20 ± 24.66 | 0.000** |
| Lymphocytes mean | 1.54 ± 0.84 | 1.52 ± 0.64 | 1.64 ± 0.92 | 0.416 |
| MNA | 5.78 ± 1.41 | 9.66 ± 1.11 | 13.24 ± 0.84 | 0.000** |
| Chronic pain | 3.50 ± 3.23 | 3.09 ± 8.32 | 2.63 ± 2.99 | 0.566 |

Abbreviations: ADL, activity of daily living; BMI, body mass index; GDS, Geriatric Depression Scale; IADL, instrumental activities of daily living; MMSE, mini-mental state examination; MNA, mini-nutritional assessment.

*$P$ value < 0.05.

associated with malnutrition. In a recent cohort study, Krzyminska-Siemaszko et al[13] reported that as many as 44.2% of the Polish elderly population had poor nutritional status; of which 6.2% were malnourished, and 38.0% were at risk of malnutrition. In agreement with some of our results, these authors also highlighted that an advanced age, symptoms of depression, cognitive impairment, multimorbidity, and anemia were independently correlated to a poor nutritional status.[13] Likewise, they assessed the nutritional status by conducting MNA-SF and CGA.[13]

Several factors that can be associated with malnutrition in elderly patients were elucidated. In the present study, we found a significant correlation between malnutrition and advanced age. Previously published studies highlighted that aging and age-related medical conditions can result in decreased food intake,[14] an exaggerated decline in taste perception and/or in olfactory perception with a consequent reduction in appetite,[15] and cognitive changes.[16] Our study also demonstrated the relationship between poor nutritional status and reduced functional capacity. This was congruent with the results reported by Chevalier et al.[17] Indeed, functional impairment increases vulnerability and may adversely decrease appetite and food intake.[18] A common symptom of aging is changes in bone density, which can increase the risk for osteoporosis.[19] Aging is also characterized by the loss of lean muscle mass (sarcopenia) and the concomitant strength loss, functional decline, and poor endurance.[20] If left inadequately treated, all of these can limit the mobility of elderly individuals and make eating more difficult.

Although alcohol contains calories and provides energy, it has little nutritional value. Many patients who have current or a history of alcohol use are malnourished, either because they ingest inadequate amounts of essential nutrients, such as carbohydrates, proteins, and vitamins, or because alcohol and alcohol metabolites hamper the body's ability to properly absorb, digest, and metabolize those nutrients.[21] Elderly people who depend on alcohol are also at increased risks of falling and consequent hip fracture, thereby increasing their risk of morbidity and mortality.[22]

Chronic disease affects the nutritional status of the patient, and malnutrition can impact its course.[23] Appetite is known to be reduced by chronic diseases that are characterized by systemic inflammation, such as cancer and heart failure.[24] Several studies have shown a high prevalence of nutritional risk in elderly patients

**TABLE 3** Nutritional status of the geriatric patients according to food intake, mobility, weight loss, psychological trauma and mental disease

| Demographic characteristics % or mean ± SD | Malnourished n = 32 | At risk of malnutrition n = 112 | Well nourished n = 221 | *P*-value |
|---|---|---|---|---|
| Food intake | | | | |
| Decrease in food intake | 28 (0.88) | 69 (0.62) | 36 (0.16) | 0.000* |
| No decrease in food intake | 4 (0.13) | 43 (0.38) | 185 (0.84) | |
| Mobility and walking ability | | | | |
| Walk without assistance | 17 (0.53) | 94 (0.84) | 208 (0.94) | 0.000* |
| Walk with assistance | 4 (0.13) | 3 (0.03) | 1 (0.01) | 0.000* |
| Using wheelchair or bedbound | 11 (0.34) | 15 (0.13) | 12 (0.05) | 0.000* |
| Weight loss in the past 3 mo | | | | |
| Yes | 30 (0.94) | 82 (0.73) | 50 (0.23) | 0.000* |
| No | 2 (0.06) | 30 (0.27) | 171 (0.77) | |
| Psychological trauma | | | | |
| Yes | 17 (0.53) | 21 (0.19) | 5 (0.02) | 0.000* |
| No | 15 (0.47) | 91 (0.81) | 216 (0.98) | |
| Mental disease | | | | |
| Yes | 14 (0.44) | 16 (0.14) | 4 (0.02) | 0.000* |
| No | 18 (0.56) | 96 (0.86) | 217 (0.98) | |

*$P$ value < 0.05.

**TABLE 4** Predictors of malnutrition among geriatric inpatients

| Variable | Categories | β | SE | Wald | *P* value | OR | 95% CI |
|---|---|---|---|---|---|---|---|
| Age, y | > 75 vs ≤ 75 | 0.462 | 0.173 | 7.101 | 0.008* | 1.587 | 1.130-2.228 |
| Alcohol | Yes or no | 0.712 | 0.273 | 6.819 | 0.009* | 2.038 | 1.194-3.478 |
| Cancer | Yes or no | 1.247 | 0.434 | 8.268 | 0.004* | 3.479 | 1.487-8.139 |
| Heart failure | Yes or no | 1.049 | 0.476 | 4.853 | 0.028* | 2.856 | 1.123-7.265 |
| GDS | > 5 vs ≤ 5 | 1.052 | 0.192 | 29.972 | 0.000* | 2.864 | 1.965-4.174 |
| BMI | < 24 vs ≥ 24 | 1.726 | 0.224 | 59.569 | 0.000* | 5.616 | 3.624-8.705 |
| ADL | Independent or dependent | 1.338 | 0.193 | 48.006 | 0.000* | 3.811 | 2.610-5.565 |
| IADL | ≥ 7 vs < 7 | 1.101 | 0.186 | 34.958 | 0.000* | 3.008 | 2.088-4.333 |
| Fall | Yes or no | 0.693 | 0.193 | 12.861 | 0.000* | 2.222 | 1.369-2.921 |
| MMSE | ≥ 24 vs < 24 | 0.594 | 0.170 | 12.256 | 0.000* | 1.811 | 1.299-2.526 |
| Insomnia | Yes or no | 0.396 | 0.167 | 5.655 | 0.017* | 1.486 | 1.072-2.060 |
| Hemoglobin | ≥ 12 vs < 12 | 0.539 | 0.193 | 7.793 | 0.005* | 1.715 | 1.174-2.504 |
| Albumin | ≥ 35 vs < 35 | 1.051 | 0.321 | 10.738 | 0.001* | 2.861 | 1.526-5.364 |

Abbreviations: ADL, activity of daily living; BMI, body mass index; CI, confidence interval; GDS, Geriatric Depression Scale; IADL, instrumental activities of daily living; MMSE, mini-mental state examination; OR, odds ratio; SE, standard error.

*$P$ value < 0.05.

with cancer.[9] Furthermore, two arguments have been proposed to explain the relationship between heart failure and malnutrition.[25] Malnutrition of patients with concurrent or a history of heart failure is associated with the loss of muscle, fat, and bone mass. These particular patients are prone to malnutrition because of a decreased food intake, an increased loss of nutrients, elevated metabolic rates, and a cytokine dysfunction of tumor necrosis factor alpha, cortisol, epinephrine, renin, and aldosterone.[26] In addition, several studies

have now also linked BMI[27] and albuminemia[28] with heart failure prognosis.

Consistent with our study, Pearson et al reported that nutritional risk was associated with cognitive impairment and independence, but not with living alone.[14] Elderly people with cognitive impairment and a reduced ability to take care of themselves were more than twice at risk of being malnourished.[14] Farid et al conducted a cohort study of 331 patients with a 4-year follow-up. They reported that, for elderly inpatients aged over 70 years, cognitive impairment and malnutrition are associated with cardiovascular disease.[27] Further, depression is a common psychiatric disorder characterized by reduced appetite and self-care, apathy, and physical weakness. These characteristics are likely to explain the relationship between malnutrition and depression.[28] Indeed, in our study, the overall depression rate was 28.77% and was an independent predictor of malnutrition. Vitamin and antioxidant supplements have been proven to reduce the risk of depression.[29] Malnutrition and depression are suggested to exacerbate each other in an adverse vicious cycle, thereby accelerating their progression.

In studies investigating the parameters associated with risk of malnutrition, patients' BMI, lymphocyte counts, and serum total cholesterol, hemoglobin, and albumin levels have been studied. In agreement with our study, albumin levels and BMI were also previously found to be significantly lower in malnourished patients.[30] Few studies focus on the relationship between the malnutrition and fall risk. Jacques et al[31] reported that malnutrition is associated with an increased risk of being a faller and with impaired activity in Dutch long-term care residents. Malnourished residents who receive nutritional intervention have a lower risk of being a faller. In a review of the literature of elderly inpatients, insomnia has not yet been found to be a predictor for risk of malnutrition. This is the first study to report this association.

Some limitations to our study are warranted to be acknowledged. First, the study group was very heterogeneous in terms of the different medical conditions and different stages that the subjects faced. This needs to be taken into account when generalizing our findings. In addition, as this was a single-institution study, there must be potential bias. Second, the relatively small number of patients enrolled in this study is also a potential limitation. Third, our results may have some weaknesses in unknown ways because self-reporting (personal statements) is known to be possibly not as accurate as other methods of data collection.

In conclusion, the prevalence of poor nutritional status in hospitalized patients aged 60 years or older was high. Age, alcohol consumption, chronic diseases (cancer and heart failure), depression, BMI, function status (ADL and IADL), recent fall(s), cognitive impairment, insomnia, and low hemoglobin and albumin levels were found to be independently associated with malnutrition in these patients. CGA yielded detailed information on the clinical, functional, and cognitive aspects of older patients, and was evidently demonstrated to be particularly useful in assessing malnutrition risk-associated factors. The prognosis of hospitalized patients is expected to improve, when their risk of developing malnutrition is minimized. In taking the findings of this study to the next step, we plan to validate this score in community-dwelling residents of the Chinese elderly population.

This study indicated the need to evaluate nutritional status because of high prevalence of malnutrition in Chinese elderly inpatients. In addition, we identified risk factors associated with malnutrition, which had important implications in guiding effective prevention and better intervention strategy. Malnutrition is associated with worse clinical outcomes, higher mortality and complication rates and longer recovery time.[32] It is crucial to detect patients with malnutrition and patients at risk of developing malnutrition, in order to start timely nutritional support. Nutritional risk screening is the first step of process of nutritional care. Detailed nutritional assessment should be performed if there are any indicators of nutritional risk according to the first step. A comprehensive nutritional care plan is developed to improve the outcome of elderly inpatients based on the result of the nutritional assessment.[33]

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## CONFLICTS OF INTEREST

Nothing to disclose.

## AUTHOR CONTRIBUTIONS

Liu supervised the project and designed the workflow and performed the statistical analysis. Shao, Sun, Zhou, Lai, and Ren performed material preparation and data collection. Liu wrote the first draft. Qiao prepared Tables. All authors commented on the manuscript. All authors read and approved the final manuscript.

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