Original Article

Determinants and nutritional assessment value of hand grip strength in patients hospitalized with cancer

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Background and Objectives: Hand grip strength (HGS) has emerged as a predictor of the nutritional status. However, many factors may modify the malnutrition–HGS association. This study explored the nutritional assessment value and determinants of HGS in patients hospitalized with cancer. **Methods and Study Design:** In this multicenter, retrospective, observational study (11,314 patients), the Receiver operator characteristic curve was used to observe HGS and nutritional status sensitivity/specificity. Sex; age; height; weight; mid-upper arm circumference (MAMC); Patient-Generated Subjective Global Assessment (PG-SGA) score; Karnofsky score; physical function (PF) domain; cognitive function (CF) domain; global health and quality of life (QL) domain of EORTC QLQ-C30 (a quality of life instrument designed by the European Organization for Research and Treatment of Cancer); and albumin, prealbumin, and hemoglobin levels were included in a Stepwise analysis model to identify the factors influencing HGS. **Results:** HGS showed a very low diagnostic value and accuracy for identifying severe malnourishment (area under the curve, 0.615–0.640; $p<0.01$). HGS positively correlated with sex; height; weight; MAMC; Karnofsky score; QL, PF, and CF domains; and hemoglobin and prealbumin levels (Beta=0.02–0.42, $p \leq 0.05$), and negatively with age (Beta=−0.19, $p<0.01$). However, the PG-SGA score was excluded because of its very limited contribution to HGS variability. **Conclusions:** HGS is a mutifactorial index. The use of HGS cutoff values to identify malnutrition is markedly challenging. Thus, HGS may be of limited use as a predictor of nutritional status.

Key Words: hand grip strength, PG-SGA, malnutrition, sarcopenia, cancer patients

INTRODUCTION

Hand grip strength (HGS) is considered a marker of nutritional status because it reflects early nutritional deprivation and repletion.[1,2] HGS measurement is rapid, easy, economical, and repeatable. Thus, it is more convenient than other currently used malnutrition screening tools and has gained considerable attention in recent years.

However, HGS is a multifactorial index. Many other patient characteristics have been identified as being associated with HGS, including sex, age, height, weight, mid-upper arm circumference (MAMC),[3] physical activity function (PAF),[4] cognitive status,[5] depression,[6] self-rated health,[7] and a high number of chronic diseases.[8,9] These variables may modify the association between malnutrition and HGS. Thus, a comprehensive analysis of these

factors might yield an improved understanding of the aforementioned association. Moreover, according to our review of relevant literature, no study has explored the potential of HGS to independently predict the nutritional status in patients hospitalized with cancer.

Thus, in the present study, a comprehensive analysis was conducted to explore the nutritional assessment value and determinants of HGS in patients hospitalized with cancer by using the data from a multicenter observation project, the Investigation on Nutrition Status and its Clinical Outcome of Common Cancers (INSCOC).

METHODS

Study population and design

The INSCOC was conducted by the Chinese Anti-Cancer Association, with approval from the human research ethics committees of all participating hospitals. Patients and their families were informed that the study was free, non-invasive, and would not interfere with treatments. Only the patients who provided informed consent and agreed to cooperate were eligible to participate in the study. This retrospective analysis enrolled 11,314 patients (5,812 men and 5,502 women) between January 2013 and June 2015.

The patients were enrolled from representative hospitals in different regions of China by using a consecutive sampling method. The patients were eligible to participate in the study if they were aged 18–90 years, were of Chinese descent, and had an expected hospital stay longer than 24 hours. The patients admitted from the emergency and terminal care departments or those in critical condition requiring active therapeutic support were excluded. The patients were recruited from the following hospital departments: oncology (47.4%, n=5366), internal medicine (including the digestive and respiratory divisions; 8.01%, n=906), hematology (3.39%, n=384), radiotherapy (5.65%, n=639), gynecology (3.28%, n=371), surgery (including the gastrointestinal, hepatobiliary, thoracic, urology, otolaryngology divisions; 29.3%, n=3,312), and pain treatment (2.97%, n=336). The patients had 18 common types of cancer: lung cancer (16.6%, n=1,877), gastric cancer (14.4%, n=1,625), liver cancer (4.6%, n=516), breast cancer (14.8%, n=1,672), oesophageal cancer (5.2%, n=591), cervical cancer (4.16%, n=471), leukemia (4.37%, n=494), bladder cancer (0.68%, n=77), pancreatic cancer (1.1%, n=125), prostate cancer (0.58%, n=66), ovarian cancer (2.64%, n=299), nasopharyngeal cancer (6.06%, n=686), colorectal cancer (18.8%, n=2,122), endometrial cancer (1.39%, n=157), lymphoma (2.39%, n=270), malignant glioma (0.58%, n=66), gastric stromal tumor (0.08%, n=9), and cholangiocarcinoma (0.04%, n=4). Moreover, 187 patients (1.65%) had 2 or 3 (n=15) types of cancers.

Hand grip strength measurement and anthropometry

Non-dominant HGS was measured using a calibrated Jamar Hydraulic Hand Dynamometer (Sammons Preston, Bolingbrook, IL, USA). The patients underwent the test while sitting in a chair in the posture reported to yield the most accurate results[10]: shoulder adducted and neutrally rotated, elbow flexed at 90°, and wrist neutrally positioned. Before the test, each patient was given a demonstration on how to complete a maximal isometric contraction. Each patient performed the test three times, at intervals of 10–30 seconds; the maximum value was used as the HGS value.

Evidence indicates that HGS data should be stratified

by sex and age.[3] According to the definition of age in studies on HGS,[4,11] our patients were divided into adult (18−64 y, n=8,810) and elderly (≥65 y, n=2,504) groups. For statistical analysis, the patients were further divided by sex into 4 groups: adult men, adult women, elderly men, and elderly women. However, no standard HGS range is available for hospitalized patients. To determine the general characteristics of our data, HGS was summarized using tertiles by sex alone, according to the cutoffs of sample distribution stratified by sex. For women, the cutoffs were ≤16.1, 16.1−22.2, and ≥22.2 kg; for men, they were ≤24.8, 24.8−33.6, and ≥33.6 kg. However, for elderly patients, the following defined sarcopenia screening criteria can be referenced: HGS ≤26 kg for men and ≤18 kg for women are defined as low HGS by the Asian Working Group for Sarcopenia (AWGS).[11]

All the anthropometric measurements were conducted while the patients were standing. The Arm circumference (AC) and triceps skin fold (TSF) were measured on the same arm for which the HGS was measured. The AC was measured at the midpoint between the acromion process of the scapula and olecranon, with the arms positioned on the belly and the forearm and upper arm at 90°. The TSF was measured using a caliper; the reading was performed on the rear portion of the arm at the midpoint, with the arm held alongside the body. The measurements were performed in triplicate, and the average value was adopted as the final result. The MAMC was measured using the following formula: MAMC (cm) = AC (cm) − 3.14 × [TSF (mm)/10].[12]

Nutritional status assessment

The Patient-Generated Subjective Global Assessment (PG-SGA) score is accepted by the American Society for Parenteral and Enteral Nutrition (ASPEN) as the gold standard nutritional assessment tool for patients with cancer.[13] The PG-SGA questionnaire has 2 sections: a medical history section that is completed by the patient, and a physical assessment section that is completed by the nursing, medical, or dietetic staff. The medical history section includes the history of weight change; dietary intake change; oncology nutrition impact symptoms, such as nausea and abdominal pain that have persisted for more than 2 weeks; and functional capacity. The health care professional section includes an evaluation of the metabolic demand, diagnosis, and comorbidities associated with nutritional requirements and elements of the physical examination. It yields both a qualitative diagnosis and quantitative evaluation, as follows: well nourished (category A; score=0–3); moderately malnourished or suspected malnutrition (category B; score=4−8), requiring intervention by a dietician with a clinical symptom survey; and severely malnourished (category C; score ≥9), in critical need of nutritional intervention and symptom management.

Quality of life and physical activity function assessment

A quality of life (QOL) instrument designed by the European Organization for Research and Treatment of Cancer (EORTC), the EORTC QLQ-C30, was used.[14] This instrument measures 15 domains that reflect the multidi-

mensionality of the QOL construct, and is completed by the patient. It includes 9 multi-item scales: 5 functional scales, 3 symptom scales, and a global health and QOL scale. It also includes 6 single items, each item is an independent scale. The standard score (SS) of each domain was calculated according to the formulae for the EORTC QLQ-C30,[14] and the physical function (PF), cognitive function (CF), and global health and QOL (QL) domains were analyzed in this phase.

We also used the Karnofsky score to evaluate the correlations between PAF and HGS. The Karnofsky score is a commonly used PAF assessment tool in clinical studies.[15] It includes 11 items scored from 100 to 0 points and is assessed by medical staff. We considered these scores as quantitative data in the statistical analysis.

Laboratory data
Laboratory data were collected from the routine tests performed on the day of patient registration. The plasma albumin, prealbumin, and hemoglobin levels of the patients were analyzed.

Statistical analysis
Statistical analysis was conducted using SPSS 19.0 (IBM, Armonk, New York, USA). Descriptive statistics, namely medians and interquartile range (IQR), were used to investigate the patient characteristics. Kolmogorov–Smirnov tests were used to evaluate the normality of the variable distributions. Depending on this normality, ANOVA or Kruskal–Wallis tests were used to conduct intragroup comparisons of types of clinical characteristics stratified by HGS tertiles in each group. To reduce the interference of other factors in addition to malnutrition and improve the diagnostic accuracy, ASPEN advises that HGS be applied as a test only in cases of severe malnourishment, because only in such cases is HGS markedly reduced. Thus, we used HGS to identify severely malnourished patients (PG-SGA category C) only. Receiver operator characteristic (ROC) curves were used to determine the sensitivity and specificity of HGS in detecting severe malnourishment; area under the curve (AUC), sensitivity, specificity, positive likelihood ratio (LR+), and negative likelihood ratio (LR-) were used to evaluate the diagnostic value and accuracy. Spearman's rho (rs) was used to determine correlations between HGS and the PG-SGA score because their data were non-normally distributed. A multivariable linear regression model was developed using both enter and stepwise analytical methods to establish and identify the main factors influencing HGS. Sex; age; height; weight; MAMC; PG-SGA score; PF; CF; QL; Karnofsky score; and albumin, prealbumin, and hemoglobin levels were included in the model. Standard regression coefficients (i.e., Beta values) were used to assess the contributions of the variables to HGS. Statistical significance was established at $p<0.05$ (2-sided).

RESULTS
General characteristics
The PG-SGA scores revealed that 30.3% and 36.4% of patients in the adult and elderly groups, respectively, had moderate or suspected malnutrition, whereas 22.3% and 37.8% of patients in the corresponding groups were se-

verely malnourished. Among all the participants, 44.4% experienced weight loss in the last month before completing the questionnaire.

Decreased HGS is a widespread problem in patients with cancer. The HGS levels of our adult patients (men, 31.4 ± 11.9 kg and women, 20.0 ± 7.6 kg) were even lower than those previously reported for ostensibly normal Chinese elderly individuals.[16] Among elderly patients, 68.2% had low HGS according to the AWGS criteria. Notably, among well-nourished elderly patients, 42.6% had low HGS, indicating that many of them may have sarcopenia.

Table 1 lists the patient characteristics according to tertiles of HGS and sex. From the lowest to highest HGS tertile, height; weight; MAMC; Karnofsky score; QL; PF; CF; and hemoglobin, albumin, and prealbumin levels showed increased values; All these variables showed significant differences in intragroup comparisons ($p\leq0.02$), indicating their positive correlation with HGS. In turn, from the lowest to highest HGS tertile, age and PG-SGA scores were significantly decreased ($p<0.01$), indicating their negative correlation with HGS.

Receiver operator characteristic curves
Table 2 and Figure 1 list the results of the ROC curve analysis. We identified the optimal cutoff values for each group: 30 kg for adult men, 19 kg for adult women, 26 kg for elderly men, and 14 kg for elderly women. All the analyses yielded a significant but very low AUC, ranging from 0.615 to 0.640 in each group and indicating a low diagnostic value. In addition, the sensitivity, specificity, LR+ and LR- were very low, indicating a low diagnostic accuracy and very high rate of both missed diagnosis and misdiagnosis.

Correlations between HGS and PG-SGA scores
As listed in Table 3, Spearman's rho analysis yielded a statistically significant but very low rs, ranging from −0.215 to −0.259 in each group and indicating weak or no correlation.

Multifactorial analysis
To determine why the diagnostic value and accuracy were so poor in our study, we further developed a multivariable model to evaluate the effects of malnutrition on HGS and identify the main factors affecting it, which may modify its association with malnutrition. In the preliminary analysis, the PG-SGA score was included in the multivariate model by using the "enter method." However, its contribution to HGS variability was very limited (Beta=−0.011, p=0.047). Thus, we performed a further analysis by using the stepwise method, which may eliminate the factors that have less influence on the model and establish an optimal regression equation with fewer factors. Subsequently, the PG-SGA score and albumin level were excluded from the multivariate model.

The determinants of HGS in the stepwise analysis are listed in Table 4. HGS positively correlated with sex (parameter definition: men=1 and women=0), height, weight, MAMC, Karnofsky score, QL, PF, CF, hemoglobin level, and prealbumin level (Beta=0.02−0.42, $p<0.05$), and negatively correlated with age (Beta=−0.19, $p<0.01$). These variables explained 60.4% of HGS. Sex had the highest

Table 1. Clinical characteristics stratified by HGS tertiles and sex (median and IQR)

Characteristics	Men				Women			
	Lowest, ≤24.8 kg (n=1945)	Middle, 24.8-33.6 kg (n=1940)	Highest, ≥33.6 kg (n=1927)	p value	Lowest, ≤16.1 kg (n=1834)	Middle, 16.1-22.2 kg (n=1843)	Highest, ≥22.2 kg (n=1825)	p value
	Median (interquartile range)				Median (interquartile range)			
Age, y	62 (15)	59 (15)	53 (15)	0.001[†]	58 (17)	52 (16)	49 (14)	0.001[†]
Height, cm	168 (9)	169 (7)	170 (9)	0.001[‡]	158 (6)	158 (7)	159 (7)	0.018[‡]
Body weight, kg	60.0 (15.4)	62.0 (14.0)	66.0 (13.0)	0.001[†]	55.0 (13.6)	56.0 (13.0)	59.0 (13.2)	0.001[†]
MAMC, cm	25.8 (4.8)	27.0 (4.7)	27.8 (4.0)	0.001[†]	25.5 (5.0)	26.4 (4.6)	27.0 (4.1)	0.001[‡]
Albumin, g/L	36.9 (8.0)	38.9 (6.9)	40.1 (6.4)	0.001[†]	38.8 (7.8)	40.4 (6.8)	41.3 (6.2)	0.001[†]
Prealbumin, mg/L	180.0 (120.0)	205.0 (100.0)	230.0 (110.0)	0.001[†]	190.7 (106.2)	210.0 (80.0)	222.0 (80.0)	0.001[†]
Hemoglobin, g/L	119.0 (31.0)	125.0 (29.0)	132.0 (27.0)	0.001[†]	114.0 (27.0)	118.0 (23.0)	121.0 (22.7)	0.001[†]
PG-SGA score, score	7 (9)	5 (7)	4 (6)	0.001[†]	6 (8)	4 (6)	2 (5)	0.001[†]
Karnofsky score, score	90 (20)	90 (10)	90 (0)	0.001[†]	90 (20)	90 (10)	90 (10)	0.016[†]
QL, standard score	50.0 (25.0)	66.7 (25.0)	66.7 (33.3)	0.001[†]	58.3 (16.7)	66.7 (33.3)	66.7 (33.3)	0.006[†]
PF, standard score	80.0 (33.3)	86.7 (20.0)	93.3 (13.3)	0.001[†]	86.7 (33.3)	86.7 (26.7)	93.3 (20.0)	0.001[†]
CF, standard score	83.3 (33.3)	100.0 (16.7)	100.0 (16.7)	0.001[†]	83.3 (33.3)	83.3 (16.7)	100.0 (16.7)	0.001[†]

MAMC: mid-upper arm circumference; PG-SGA: Patient-Generated Subjective Global Assessment; EORTC QLQ-C30: a quality of life (QOL) instrument designed by the European Organization for Research and Treatment of Cancer; PF: physical function domain of the EORTC QLQ-C30; CF: cognitive function domain of the EORTC QLQ-C30; QL: global health and QOL domain of the EORTC QLQ-C30.
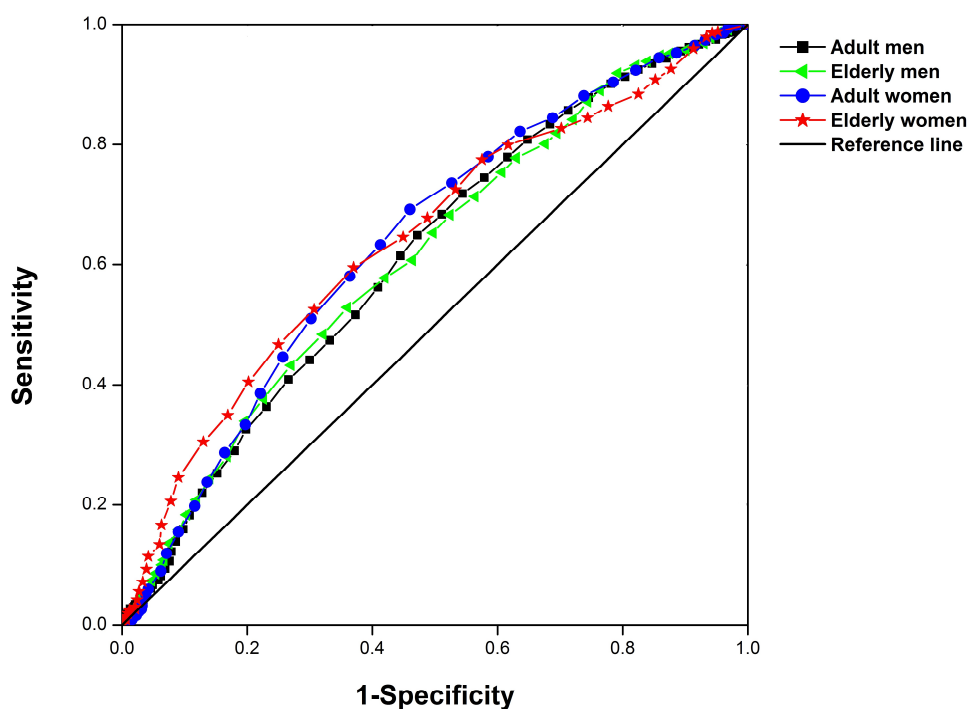[†]Kruskal–Wallis test.
[‡]ANOVA.

Table 2. Receiver operator characteristic (ROC) curve for determining the sensitivity and specificity of HGS for detecting severe malnourishment

Groups	Cutoff values (kg)	AUC (95% CI)	Sensitivity (%)	Specificity (%)	LR+	LR_	YI (%)	p value[†]
Adult men	30	0.595 to 0.634	63.5	54.1	1.38	0.68	17.6	<0.001
Adult women	19	0.619 to 0.660	67.2	55.8	1.52	0.59	23.0	<0.001
Elderly men	26	0.590 to 0.640	78.1	35.1	1.20	0.62	13.2	<0.001
Elderly women	14	0.596 to 0.641	61.8	57.3	1.45	0.67	19.1	<0.001

AUC: area under the curve; LR+: positive likelihood ratio; LR_: negative likelihood ratio; YI: Youden index; CI: confidence interval.
[†]p value by ROC curve analysis.

Figure 1. Receiver operator characteristic (ROC) curve for determining the sensitivity and specificity of HGS for detecting severe malnourishment

influence on HGS (Beta=0.42), accounting for 21.4% of the variability, followed by age (Beta=−0.19), explaining 7.6% of the variability. Height, weight, and PF also significantly affected HGS, accounting for 5.0%, 2.6%, and 2.5% of HGS variability, respectively.

DISCUSSION

Most patients with cancer (30%–90%) experience malnutrition because of both disease progression and treatment consequences.[17] Malnutrition is correlated to numerous clinically relevant adverse effects,[18] and approximately 40% of patients with cancer actually die of malnutrition.[17] Therefore, many guidelines stipulate that all patients with cancer must undergo nutritional screening and evaluation at frequent intervals and be managed accordingly through all the courses and periods of disease treatment.[19] However, the use of professional nutritional assessment tools, such as PG-SGA score, is not sufficiently convenient. The professionally designed scales of PG-SGA serve as an accurate nutritional assessment and diagnosis tool. However, professional staff and high time requirements make its frequent use less convenient. Thus, developing easy and rapid nutrition screening tools is always a demand in clinical practice.[1]

For this reason, HGS has gained considerable attention in recent years. Furthermore, several studies have encouraged the use of HGS as a nutrition screening tool.[20,21] However, some new studies have reported that HGS has a very low diagnostic accuracy for detecting malnutrition.[22,23] We considered that the negative results may, in part, be explained by the definition of malnutrition (PG-SGA categories B and C) in those studies. Thus, in this study, we used HGS only to identify severely malnourished (PG-SGA category C) patients. The ROC curve analysis revealed a very low diagnostic value and accuracy of HGS, with a very high rate of both missed diagnosis and misdiagnosis. In addition, we observed a weak correlation between the PG-SGA score and HGS.

Table 3. Correlation between HGS and the PG-SGA score (Spearman analysis)

Groups	Spearman's r	p value
Adult men	-0.215	<0.001
Adult women	-0.244	<0.001
Elderly men	-0.253	<0.001
Elder women	-0.259	<0.001

PG-SGA: Patient-Generated Subjective Global Assessment.

Results may differ among data. Existing evidence suggests that many other characteristics of patients, which are also associated with HGS, may modify the association between malnutrition and HGS. The complex clinical characteristics of patients hospitalized with cancer potentially contributed to our negative results. Thus, we further developed a multivariable model to identify the determinants of HGS, in addition to the nutritional status. Consistent with previous studies, sex, age, height, weight, and PAF had more marked influences on HGS than did other factors in our model.

Skeletal muscle protein degradation, quality reduction, and subsequent HGS decline are biomarkers of aging and are spontaneous, ubiquitous, and ongoing problems among elderly people.[24] Auyeung conducted an observational study of healthy Chinese individuals and reported that the annual decline rates of HGS were 0.80 kg and 1.24 kg in men and women, respectively.[16] Therefore, age-related HGS decline and muscle atrophy are notable and ubiquitous biomarkers.

The associations among PAF, daily activities, and muscle mass and strength were extensively confirmed.[4] To maintain skeletal muscle mass and strength, muscle protein must be constantly renewed. Physical activity is a key factor for stimulating muscle protein synthesis and reducing catabolism.[25] Muscle protein content significantly declines in conditions such as being bedridden and limb immobilization, in which muscles are non-weight-bearing. The associated muscle mass loss can be detected through MRI within only 2 weeks.[23] Thus, daily activities play a crucial role in maintaining muscle protein content and strength.[25] In our study, 68.2% of patients complained of PAF damage and reduced daily activity (PF, SS <100) in the last month before completing the questionnaire.

Many studies have reported that decreased muscle function is associated with QOL[6,7] and PAF; all these variables influence each another. Decreased muscle function can lead to PAF impairment and QOL reduction; in turn, reduced QOL and depression can lead to an inactive lifestyle and reduced muscle strength. In patients with cancer, these factors are confounded by cancer-related pain, antitumor treatment side effects, nutritional deterioration, economic pressures, and psychological characteristics, among other factors. In our study, almost all the patients complained of QOL reduction, and 70.7% reported marked QOL reduction (QL, SS <70) in the last month before completing the questionnaire.

Numerous studies have reported a negative association between body weight and HGS in healthy populations and patients with benign diseases, and ascribed this correlation to inactive lifestyle, sarcopenic obesity, and insulin resistance.[3,9] However, weight loss may be a more crucial problem in patients with cancer. Weight loss, particularly lean body mass loss, is a common feature in patients with cancer. In our study, 44.4% of patients had lost weight during the last month before completing the questionnaire, potentially accounting for the positive correlation between weight and HGS in our model.

Decreased HGS is associated with many chronic diseases.[8] It may be attributed to peripheral muscle tissue hypoperfusion and chronic hypoxia caused by arteriosclerosis[9] and anemia[8] or peripheral nerve degeneration caused by diabetes.[26] Because of nutritional deterioration, chronic blood loss, and myelosuppression, anemia is a ubiquitous condition in patients with cancer. In our study, 47.9% and 59.2% of patients in the adult and elderly groups, respectively, had anemia. In addition, we found a negative association between HGS and fasting blood glucose (FBG) in patients with FBG levels exceeding 10 mmol/L. However, we did not include FBG in our model because hypoglycemia can also result in reduced HGS.

The PG-SGA score was excluded from the multivariate model when using the stepwise method, which has never been reported previously. Although PG-SGA score was included in the multivariate model by using the enter method, its contribution to HGS variability was very limited. The PG-SGA score has been reported to have a limited contribution to HGS variability.[3,23] However, no study has analyzed whether the PG-SGA score should be excluded when using more rigorous statistical methods. In addition, the patients in the relevant studies were se-

Table 4. Determinants of HGS (kg), according to multivariable linear regression analysis

Model[†]	B	95% CI	Beta	$p^{‡}$
Sex (man vs women)	9.13	8.55 to 9.71	0.415	<0.001
PF, standard score	0.049	0.036 to 0.062	0.104	<0.001
Age, y	-0.174	-0.192 to -0.156	-0.189	<0.001
Body weight, kg	0.365	0.3 to 0.431	0.119	<0.001
Body height, cm	0.157	0.122 to 0.193	0.115	<0.001
Hemoglobin, mg/L	0.036	0.025 to 0.047	0.069	<0.001
QL, standard score	0.032	0.021 to 0.043	0.061	<0.001
Karnofsky score, score	0.055	0.036 to 0.074	0.077	<0.001
Prealbumin, mg/L	0.005	0.002 to 0.008	0.037	<0.001
CF, standard score	0.022	0.008 to 0.035	0.035	0.001
MAMC, cm	0.070	0.001 to 0.138	0.022	0.046

MAMC: mid-upper arm circumference; PG-SGA: Patient-Generated Subjective Global Assessment; EORTC QLQ-C30: a quality of life (QOL) instrument designed by the European Organization for Research and Treatment of Cancer; PF: physical function domain of the EORTC QLQ-C30; CF: cognitive function domain of the EORTC QLQ-C30; QL: global health and QOL domain of the EORTC QLQ-C30.
[†]R^2=0.604.
[‡]Stepwise analysis.

lected from general wards and not cancer wards. In contrast to patients admitted to general wards, those admitted to cancer wards have more complex clinical conditions such as chronic anemia, chronic pain, continuous fatigue caused by tumor and inflammatory cytokines, reduced QOL, and reduced social roles and functions. All these factors can cause patients to reduce their daily activities and adopt inactive lifestyles, which can eventually lead to HGS reduction. Furthermore, the aforementioned adverse factors are ubiquitous, continuous, and ongoing problems in patients with cancer as the disease progresses. This is likely why decreased HGS is a widespread problem in patients with cancer, including well-nourished patients. Thus, HGS is a multifactorial index. Cancer-related nutritional damage can accelerate the decrease in HGS, but it is not the sole cause. This potentially accounts for the weak correlation between HGS and the PG-SGA score and the low diagnostic accuracy when using HGS to detect malnutrition in our study.

Developing simple tools is a practical necessity in clinical practice. However, validity and reliability are also basic necessities. Due to interfering factors, simple tools might not adequately and precisely reflect changes in the nutritional status. The patients in the relevant studies, which promoted the use of HGS as a nutritional assessment tool, were mainly outpatients, were younger, had a short duration of benign diseases, and had less chronic diseases. Apparently, in those populations with less adverse factors affecting HGS, marked short-term nutritional damage might have been the main cause of decreased HGS, yielding a higher diagnostic value and accuracy when using HGS to detect malnutrition. Moreover, the patients in the studies that reported negative results were recruited from hospitals, were older, and had higher levels of chronic disease. Thus, the use of cutoff values of HGS as an indicator of nutritional status is more challenging in patients hospitalized with cancer because more interfering factors need to be considered. Considering the low diagnostic accuracy, the cutoff values of a single HGS measurement may be of limited use as a predictor of malnutrition in patients hospitalized with cancer.

ACKNOWLEDGEMENTS

AUTHOR DISCLOSURES

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