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Association between quality of life and handgrip strength among malnourished gynaecological cancer outpatients, National Cancer Institute

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ABSTRACT

Introduction: Malnutrition is common among cancer patients and it is reported in a significant proportion of patients with gynaecological cancer (GC). The aim of this study was to determine the association between quality of life (QOL) and hand grip strength (HGS) among malnourished GC outpatients in the National Cancer Institute (NCI). **Methods:** This study was carried out in a Multidisciplinary Clinic of NCI. HGS was measured using Jamar Hand Dynamometer. Nutritional status was assessed using the scored Patient-Generated Subjective Global Assessment (PG-SGA). QOL was measured using the validated European Organisation for Research and Treatment of Cancer Questionnaire (EORTC-QLQ C30). **Results:** A total of 69 patients were selected for the study. Fifty eight (84.1%) were classified as moderately malnourished or at risk of malnutrition (PG-SGA B) and 11 (15.9%) were classified as severely malnourished (PG-SGA C). There was a moderate, significant positive relationship between HGS and functional status (r_s=0.275, p=0.022) observed in this study. Besides, in malnourished GC patients with low HGS, results indicated that they had problems with social functioning as well (r=0.255, p=0.035). Appetite was suggested as a predicting factor for low HGS among malnourished GC patients (F=12.253, p=0.001). **Conclusion:** HGS is a simple objective indicator of functionality and is, therefore, a valid item to be measured when assessing QOL of malnourished GC outpatients.

Keywords: Gynaecological cancer, nutritional status, quality of life, handgrip strength

INTRODUCTION

Gynaecologic cancer (GC) involves cancer of the ovarian, uterine, vaginal, cervical, and vulvar (Kehoe, 2006). GC accounts for 19% of new cases in female cancer worldwide (Sankaranarayanan & Ferlay, 2006). In 2018, the most commonly diagnosed cancer globally in females was cervix uteri, besides breast, colorectal and lung cancers. It is also one of the top four causes of death in females worldwide. Cervical cancer is the

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fourth most commonly diagnosed cancer in women, with the highest incidence and mortality rate in Africa. Meanwhile, 295,414 estimated new cases of ovary cancer were reported in 2018 worldwide, with 58% of new cases having occurred in developing countries (Freddie *et al.*, 2018).

In Malaysia, cervix uteri and ovary cancers were the ten most common cancers in the years 2012-2016 (Azizah *et al.*, 2019). Cervix uteri was the third most common cancer in females while ovary cancer was the fourth most common cancer in females registered at the National Cancer Registry of Malaysia. When compared among the major ethnic groups, the highest incidence rate was among the Chinese population, followed by Indians and Malays. More than 50% of females with cervical cancer were already at stages three and four at the point of first diagnosis (Azizah *et al.*, 2019).

Malnutrition is common in cancer patients and it is reported that the incidence ranges from 20% to >70% (Arends *et al.*, 2017). Prevalence of malnutrition is commonly reported in patients with colon, nasopharyngeal (NPC) and gastric cancers (Zaid *et al.*, 2017; Norshariza *et al.*, 2017; Nicolini *et al.*, 2013). The reported prevalence of malnutrition among GC patients varies (Laky *et al.*, 2007; Fuchs-Tarlovsky *et al.*, 2013; Nho, Kim & Kwon, 2014). A significant proportion of patients with GC were found to have malnutrition (Laky *et al.*, 2007; Fuchs-Tarlovsky *et al.*, 2013) and patients with advanced ovarian cancer were particularly at risk (Laky *et al.*, 2007; Fuchs-Tarlovsky *et al.*, 2013; Nho *et al.*, 2014). Besides, it has been documented that the prevalence of malnutrition among GC patients was higher in developing countries, whereby between 62% and 88% of patients were presented with malnutrition at diagnosis (Obermair *et al.*, 2017).

Malnutrition Screening Tools (MST) is both a sensitive and specific tool used to screen patients with malnutrition (Ferguson *et al.*, 1999). Screening patient for risk of malnutrition is very crucial as it provides an indication of the nutritional status of the patients (Davies, 2005). Once a patient has been screened as high risk for malnutrition, complete nutrition assessment should be carried out by a dietitian to provide an accurate diagnosis. There are various methods of assessing nutritional status in cancer patients such as Subjective Global Assessment (SGA) and Mini Nutritional Assessment (MNA).

To date, the scored Patient-Generated Subjective Global Assessment (PG-SGA) is the best validated tool to assess nutritional status and was developed specifically for cancer patients (Ottery, 1996). The Oncology Nutrition Dietetic Practice Group of the American Dietetic Association has accepted scored PG-SGA as the standard nutrition assessment tool for patients with cancer (Huhmann, 2008). However, the nutrition assessment using PG-SGA is made on the basis of lengthy consultation, which involves a degree of subjectivity (Thompson, 2013).

Previous studies reported multiple complications associated with malnutrition including poor wound healing, higher post-operative infection risk, increased mortality rate, and longer hospital stay (Kathiresan *et al.*, 2011; Santoso *et al.*, 2010; Laky *et al.*, 2007). Besides, malnutrition can also affect the quality of life (QOL) of patients and results in reduced muscle function. Cancer itself causes an alteration in the physiological and psychological functions of patients and subsequently, will give a negative impact on the patient's nutritional status. A decline in nutritional status is also associated with decreased functional status as determined by the European Organisation for Research and Treatment of Cancer (EORTC) Questionnaire–scale Physical Function (Norman *et al.*, 2010). Questions asked in Physical Function scale are regarding both muscle function of the lower extremities and upper extremities. Thus, it is reported that malnourished cancer patients with altered body composition will result in reduced hand grip strength (HGS). Lower HGS was also reported in the reduction of other QOL scales in Korean women (Kang, Lim & Park, 2018).

HGS is the most frequently used tool to measure muscle function as it is quick and cheap to perform. Traditionally, HGS is used for functional examination, but recent study supported the use of HGS as an early indicator of malnutrition. This is due to the faster reaction of muscle function in response to a decrease in food intake compared with other nutritional parameters (Norman *et al.*, 2010). Low HGS is commonly associated with malnutrition in the elderly population (Pieterse, Manandhar & Ismail, 2002). Besides that, disease-related malnutrition is also associated with decreased muscle function, where a study found a 25.8% lower absolute HGS value in malnourished hospitalised patients compared to well-nourished patients (Norman *et al.*, 2010). Decreased HGS has also been observed in malnourished cancer patients, but the study involved various types of cancers in inpatient setting (Norman *et al.*, 2010).

In this study, we aimed to investigate muscle function assessed by HGS in malnourished GC outpatients at the National Cancer Institute (NCI). A previous study highlighted the association of HGS and QOL, but the study involved the general population (Kang, Lim & Park, 2018). Thus, to our knowledge, no published article has explored the association between QOL and HGS specifically among malnourished GC outpatients, and particularly within the local setting. Besides, it is our interest to determine the predicting factors for the reduction in muscle function among malnourished GC patients.

MATERIALS AND METHODS

Respondents

This was an observational study, carried out between December 2017 till September 2018, in a Multidisciplinary Clinic (MDC) of NCI. A total of 69 patients meeting the inclusion criteria (aged ≥18 years of age, diagnosed with GC stages one to four, presented for diagnosis or therapy or follow-up at MDC, and patients with MST ≥ 2 were recruited into the study. MST ≥ 2 was defined as having lost weight within the last 6 months and eating poorly because of decreased appetite.

Ethical approval and permission to conduct the study was given by the Medical Research and Ethics Committee, Ministry of Health (NMRR-17-1113-36196). Written informed consent was obtained from patients prior to data collection.

Measurements

Anthropometric measurements

Weight and height were measured by a dietitian and taken according to standard techniques described by Gibson (2005). Body weight was measured with a calibrated TANITA electronic weighing scale to the nearest 0.1 kg with patients in light clothing, and height was measured with SECA stadiometer to the nearest 0.1 cm. During height measurement, patients were without shoes and were required to stand erected with their feet together and eyes in a parallax state. Body mass index (BMI) was computed as weight (kg) divided by height (m) squared.

Mid-upper arm circumference (MUAC) was taken twice to the nearest 0.1 cm and the average of the measurement was recorded. MUAC was measured at the midpoint between the shoulder and elbow, with a non-stretchable but flexible tape. Arm muscle area (AMA) and arm fat area were calculated using the formula by Gibson (Wang *et al.*, 2018).

Scored Patient Generated-Subjective Global Assessment (PG-SGA)

PG-SGA was derived from the SGA (Bauer, Capra & Ferguson, 2002) and was developed specifically for cancer patients (Ottery, 1996). PG-SGA is a valid procedure to determine nutritional status. The first four sections of PG-SGA include four items - weight change, dietary intake compared with usual intake, gastrointestinal symptoms, and functional destruction. The remainder part of the questionnaire includes all relevant diagnosis, metabolic stress, and physical examination. Physical examination in SGA method has three items, which include loss of subcutaneous fat (orbital, triceps and lower ribs area), muscle wasting (temporal areas, deltoids, and quadriceps with a loss of bulk and tone by palpation), and fluid status (oedema (ankle/sacral) and ascites).

Each component of the PG-SGA was scored from 0 to 4, based on the impact of symptoms on nutritional status. The total score was derived from adding the scores from these respective sections. Total scores were calculated and patients were classified as well nourished (A), moderately or suspected of being malnourished (B) or severely malnourished (C).

Hand grip strength (HGS)

HGS is an indicator of overall muscle strength and was measured using Jamar Hand Dynamometer. Patient was asked to be seated, with elbows by the side and flexed to right angles and in neutral wrist position (Pieterse *et al.*, 2002). HGS of the dominant hand was measured in triplicate and the mean of three trials was calculated and recorded. Results were compared to the reference value (Hillman *et al.*, 2005). Patients with HGS <85% of age and gender-related normal values were indicated as having muscle dysfunction (Norman, 2005).

Quality of life (QOL)

QOL was assessed using the EORTC Quality of Life Questionnaire version 3.0 (EORTC QLQ-C30). The EORTC QLQ-C30 is a QOL instrument specific for the cancer population (Ottery, 1996; Helena, 2015). This 30-item instrument examines six function scales (physical, emotional, cognitive, social, role and global health QOL), three symptom scales (e.g. fatigue, pain, nausea/vomiting) and six items assessing symptoms, along with the financial impact of the disease.

The questions appeared in Likert scale format with answers as follows: "Not at all", "A little", "Quite a bit" and "Very much". The scales ranged from 1 to 4 except for the global health status scale, which has 7 points ranging from 1 ("very poor") to 7 ("excellent") (Aaronson, *et al.*, 1993). Results of the EORTC QLQ-C30 were linearly transformed to obtain quantified scores within the range of 0 to 100. The scoring procedure was performed according to the scoring manual of EORTC QLQ-C30 for the QOL questionnaires. Then, overall scores were calculated according to the EORTC guidelines. The raw score for each scale was calculated. Then a linear transformation of a 0-100 score was computed for each category in the scale. Thus, the range of scores for each scale varied from 0 to 100. A higher score on the function scales indicated better functioning whilst higher score on the symptom scales and single items denoted increased symptomatology or worsened financial impairment (Ravasco, Monteiro-Grillo & Camilo, 2004).

Data analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows Version 24.0. Data were checked for normality by Kolmogorov-Smirnov analysis. All data were normally distributed as indicated by $p>0.05$ unless otherwise stated. If the data were not normally distributed, non-parametric analyses were used.

Descriptive statistics including mean, standard deviation and frequencies were used to present the patient's characteristics, PG-SGA, nutritional and functional status. Pearson's correlation and Spearman's correlation were used to examine the relationship between age, body composition, PGSGA, QOL and HGS among GC patients. The level of statistical significance was set at $p<0.05$. Meanwhile, multiple logistic regression analysis was used to identify predicting factors of HGS.

RESULTS

Patient characteristics

Out of 235 patients screened, only 29.4% (n=69) of patients who met the inclusion criteria agreed to participate in the study. Another 166 patients (70.6%) were excluded from the study either due to not meeting the inclusion criteria or they declined to participate. Patient characteristics are presented in Table 1. The mean age of the patients was 52.6±13.3 years. Majority of patients were Malays (58.0%) and have had secondary education (58.0%). The majority of subjects had ovarian cancer (32.9%), followed by endometrial cancer (31.4%), cervical cancer (22.9%) and others (11.4%). A total of 26.1% and 17.4% of patients were already in cancer stages four and three, respectively.

Table 2 shows the nutritional characteristics of GC patients. Of the 69 patients selected, 58 (84.1%) were classified as moderately malnourished or at risk of malnutrition (PG-SGA B) and 11 (15.9%) were classified as severely malnourished (PG-SGA C). The mean weight of GC patients was 63.8±14.9 kg and mean BMI was 20.48±4.62 kg/m^2. There were 52 malnourished GC patients who exhibited HGS <85% standard value.

Table 1. Background characteristics of GC patients at the NCI, Putrajaya, Malaysia (N=69)

Characteristics	*n (%)*	*Mean±SD*
Demographic characteristics		
Age (years)		52.6±13.3
Ethnicity		
Malay	40 (58.0)	
Chinese	15 (21.7)	
Indian	12 (17.4)	
Others	2 (2.9)	
Level of education		
Primary	14 (20.3)	
Secondary	40 (58.0)	
Tertiary	15 (21.7)	
Clinical characteristics		
Diagnosis		
Cervical cancer	16 (22.9)	
Endometrial cancer	22 (31.4)	
Ovarian cancer	23 (32.9)	
Vaginal cancer	2 (2.9)	
Uterine cancer	4 (5.7)	
Vulvar cancer	1(1.4)	
Fallapion tube cancer	1 (1.4)	
Cancer Stage		
Stage 1	29 (42.0)	
Stage 2	10 (14.5)	
Stage 3	12 (17.4)	
Stage 4	18 (26.1)	

Table 2. Nutritional characteristics in patients with GC (*N*=69)

Variable	*n (%)*	*Mean±SD*
Age (years)		52.6±13.3
% weight loss past 6 months		6.1±5.1
Weight (kg)		63.8±14.9
BMI (kg/m²)		20.48 ±4.62
BMI Category		
Underweight<18.5 kg/m², n(%)	23 (33.3)	
Normal weight (18.5 – 24.9 kg/m2)	34 (49.3)	
Overweight (≥25 kg/m2)	12 (17.4)	
AMA (mm²)		161.62±168.04
MUAC (cm)		28.23±5.12
Albumin (g/l)		39.68±4.89
Albumin <35 g/1	9 (13.0)	
PG-SGA B	58 (84.1)	
PG-SGA C	11 (15.9)	
Hand grip strength (kg)		15.92±7.46
Handgrip strength<85%	52 (75.4)	

Relationship between HGS and independent variables

Table 3 shows the relationship between HGS, age, body composition, PG-SGA and QOL among GC patients. There was a strong, significant negative relationship between age and HGS (r=-0.787, p=0.015). Besides, there was a moderate but significant correlation between HGS and BMI (r=0.388, p=0.001); the higher the BMI of patient, the stronger the HGS score.

There was a moderate and significant relationship shown between malnutrition and HGS (r=-0.391, p=0.001), as presented in Table 3. Malnourished GC patients had significantly lower muscle function. Meanwhile, the indicators of functional status, EORTC-Scale Physical Function showed a moderate, significant positive correlation with HGS (r_s=0.275, p=0.022). This indicated that patients with better functional status had higher HGS score. Besides, other QOL scales namely role functioning, emotional functioning, cognitive functioning, social functioning, fatigue and appetite were associated with HGS.

Factors related to HGS in GC patients

In the multiple logistic regression analysis, malnutrition was a significant factor predicting lower muscle function in patients with GC (PG-SGA, F=9.376, p=0.003) (Table 4). Appetite scale in EORTC-QLQ C30 was also a predicting factor for lower HGS among GC as presented in Table 4 (F=12.253, p=0.001).

DISCUSSION

A wide variety of methods are available for nutritional evaluation including anthropometry, albumin, pre-albumin and others. Specifically, the PG-SGA has been used extensively worldwide for assessing the nutritional status among GC patients (Laky *et al.*, 2007; Das *et al.*, 2014). On the other hand, measuring HGS represents the newest approach for evaluating nutritional status, as it is able to address a functional evaluation of malnutrition. In Malaysia, there is a recent emerging concern on determining the nutritional status among GC patients. There is one recent study

Table 3. Relationship between HGS and independent variables

Variables	*Relationship (r)*	*Significant (p-value)*†
Age	-0.787	0.015*
BMI	0.388	0.001**
PG-SGA	-0.391	0.001**
Physical functioning	0.275	0.022*
Role functioning	0.263	0.029*
Emotional functioning	0.337	0.005**
Cognitive functioning	0.238	0.049*
Social functioning	0.255	0.035*
Fatigue	0.322	0.007**
Appetite	-0.405	0.001**

†Spearman's correlation test
*$p<0.05$
**$p<0.01$

using PG-SGA to assess the nutritional status among patients prior to pelvic radiotherapy treatment, which included endometrium and cervix cancer patients (Rosli *et al.*, 2017). Although there are few studies which included GC patients, none actually evaluated the association between HGS and nutritional status in GC patients.

In the present study, majority (84.1%) of these GC patients were classified at PG-SGA B and 15.9% were already at PG-SGA C (Table 2). All selected GC patients in this study were malnourished as determined by PG-SGA. As reported by various studies, the prevalence of malnutrition among GC patients is high, especially in developing countries (Obermair *et al.*, 2017). In a study from India, the nutritional status of GC outpatients at the Gujarat Cancer Research Institute was also reported to be high (Das *et al.*, 2014). Their results showed that 48.3% of patients were at risk of malnutrition or moderately malnourished (PG-SGA B), whereas 40.0% of patients were severely malnourished (PG-SGA C). The majority (88.3%) of GC patients visiting the outpatient clinic for the first time were already malnourished or were at risk of malnutrition, who needed intervention by a dietitian. The prevalence of malnutrition among cancer patients was high because of pre-existing poor nutritional status and also the late stages of diagnosis. As evidenced in this study, 43.5% of patients were already in stages three and four (Table 1). Das *et al.* (2014) in their study highlighted that patients with severe malnutrition had advanced stages of cancer (stages three and four).

Even though all our patients were classified malnourished, but at the same time, most of them (66.7%) had normal

Table 4: Factors related to HGS in GC patients

Variables	*Unstandardised coefficient β*	*Standard error*	*Standardised coefficient β*	*p*	*R*	*R²*	*Adj R²*	*F*	*p*
Constant	31.32	5.105		0.000					
PG-SGA	-7.137	2.331	-0.350	0.003	0.350	0.123	0.110	9.376	0.003
Constant	21.65	1.842		0.000					
Appetite	-0.132	0.038	-0.393	0.001	0.393	0.155	0.142	12.253	0.001

or overweight/obese ranges of BMI (Table 2). This finding is supported by a study conducted by Fuchs-Tarlovsky *et al.* (2013), which found that GC patients were more likely to have a BMI classified as overweight and obese. Patients who had a BMI above the normal range, might lose considerable amount of weight which contributes to the loss of lean muscle mass, but may be masked by excess body fat. According to the European Society for Clinical Nutrition and Metabolism (ESPEN) Guidelines (Arends *et al.*, 2017), a patient is classified as malnourished if BMI is <18.5 kg/m^2. This contradicts our finding where only 33.3% of patients were classified as malnourished according to BMI classification. Hence, using BMI as a sole measure of nutritional status in patients with GC cancer might cause an overlook on malnourished cancer patients who fall within the normal or overweight BMI ranges.

Albumin is often used as well in clinical studies to measure long-standing malnutrition. In this study, GC patients reported normal serum albumin (Table 2). Again, even though malnutrition can cause a decrease in the rate of albumin synthesis, the change observed in albumin levels is small (Hellerstein, 1997). However, it is still an important part of the general evaluation of GC patients, as low serum albumin is a predictor of surgically related morbidity.

We found a significant association between malnutrition and HGS among GC patients, as defined by the PG-SGA categories (Table 3). It indicated that, as nutritional status of GC patients declines, the value of HGS also reduces significantly. These results were supported by the findings from Helena *et al.* (2015) and Pieterse *et al.* (2002), who investigated the relationship between nutritional status and HGS in older people. Both studies concluded that poor nutritional status was associated with poor HGS (Helena *et al.* 2015; Pieterse *et al.*, 2002). Besides, another study conducted among pre-dialysis patients also showed that patients who had some degree of malnutrition tended to have reduced HGS (Flood *et al.*, 2014).

The association demonstrated between PG-SGA categories and HGS was likely to be linked to the relationship between muscle function and nutritional status. In a cancer patient, reduced nutritional intake is common due to primary anorexia, nausea, side effects of the treatment and many more. This will result in a loss of whole-body protein, which is mainly losses from muscle mass. Muscle function represents a dynamic indicator of muscle mass. Hence, loss of weight or muscle mass will result in decreased muscle function or muscle strength. Therefore, Norman and colleagues in a systematic review recommended that HGS be used for detecting and monitoring changes in nutritional status (Norman *et al.*, 2011).

Further analysis was carried out to determine the relationship between HGS and other variables (Table 3). We found that HGS tended to decline with age. This finding was supported by a study conducted by Pieterse *et al.* (2002). The decrease of muscle mass and muscle strength with age is mainly due to the loss of muscle fibres. Moreover, BMI also showed a significant positive correlation with HGS, which suggested that with increasing BMI, there is an increase in HGS (Table 3). This finding was consistent with the studies by Pieterse *et al.* (2002), and Lad, Satyanarayana & Shisode-lad (2013). These studies concluded that this is due to greater muscle mass, which is a major determinant of muscle strength.

Malnourished patients are believed to have impaired functional status as determined by the EORTC-Functional scales (Norman *et al.*, 2010). In our study, we demonstrated that HGS was associated with reduced physical functioning (Table 3). Besides, our study also found that low HGS was associated with low role functioning score. Recent evidence suggests that HGS predicts activities of daily living because functional impairment correlates with several muscle strength indices (Barbat-Artigas *et al.*, 2013). Walking and doing daily activities require some level of muscle strength. Even though HGS does not represent the lower extremities, a study however concluded that decreased functionality is related with reduced muscle strength (Sallinen *et al.*, 2010).

In our study, reduced HGS was also associated with malnourished GC patients having problems in doing daily activities. Besides, reduced cognitive function was also associated with HGS among GC patients in this study. It is therefore suggested that HGS predicts a higher-level intellectual activity and social roles, in addition to usual daily activities (Sugiura *et al.*, 2013). A study conducted in Japan concluded that HGS was significantly correlated with a decline in higher-level competence.

Reduced appetite is significantly reported in patients with malnutrition. A study conducted by Nho *et al.* (2014) indicated that loss of appetite among GC patients was associated with malnutrition. In this study, malnourished GC patients were significantly associated with a reduction in appetite as well. Emotional functioning scale was also associated with HGS in the study as demonstrated in Table 4. Nho *et al.* (2014) in their study found that depression was associated with malnutrition in GC patients. Depression is one of the items in the emotional functioning scales. Even though we did not specifically look into depression of our patients in this study, it is however, important to appropriately evaluate the psychological status of GC patients in future studies. In addition, Laviano & Pichard (2007) stated that psychological aspects underline the importance of nutritional support in cancer patients, while a study conducted by Metz *et al.* (2005) concluded that cancer patients believe that nutrition and maintenance of nutritional status has a role in anticancer therapeutic strategy. Hence, by providing nutritional care and support, patients' confidence in the positive outcomes of their disease could be enhanced, leading to better emotion and subsequently better appetite. So, it is important to consider providing appropriate nutritional intervention as it helps improve patients' emotion and appetite.

Finally, nutritional status assessed using PG-SGA reported that malnutrition is an independent risk factor for reduced muscle strength in cancer patients (Norman *et al.*, 2010). This aligns with our study where malnutrition was a predicting factor for the reduction in HGS. Even though this result is not able to suggest that HGS can replace the current nutrition assessment practices, it is important to remember that HGS provides information on functionality as well, unlike PG-SGA. Besides, it is quick to perform, unlike PG-SGA that requires longer time. Thus, HGS may play an important role in outpatient setting. Furthermore, appetite as assessed using EORTC-QLQ C30 was also significant in predicting low HGS in GC patients. Appetite and malnutrition among GC patients were closely related with one another, where patients with malnutrition were often presented with poor appetite.

Limitations of our study were that we did not demonstrate how HGS can be used to predict the changes in nutritional status. As muscle function reacts earlier to nutritional restoration, thus using HGS as a target variable for monitoring changes in nutritional status is very tempting. Besides, since measuring HGS requires consistency, thus posture, arm side, handle position while taking measurements are crucial as it can affect maximum grip strength. Nevertheless, our study was able to demonstrate an overall association between HGS and QOL among malnourished GC outpatients at NCI.

CONCLUSION

In conclusion, low HGS increased with age, and was associated with BMI in GC patients. Malnourished GC patients with low HGS had low physical, role, emotional, cognitive and social functionings. HGS not only acts as an indicator of functionality, but is also a valid tool to predict nutritional status and QOL of GC outpatients.

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Authors' contributions

AMM, as principal investigator, conducted the study, data analysis and interpretation, drafting of the manuscript and review the manuscript; ZAZ, prepared, advised and reviewed the manuscript; HCY, assisted in conducting the study; ZI, prepared, advised and reviewed the manuscript; ZAMD, prepared, advised and reviewed the manuscript; NBMY, prepared, advised and reviewed the manuscript; NJ, assisted in conducting the study; ZAR, assisted in conducting the study.

Conflict of interest

There is no conflict of interest.

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