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RESEARCH ARTICLE

MALNUTRITION VIA GLIM CRITERIA IN GENERAL SURGERY PATIENTS

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ABSTRACT

Purpose: The purposes are to determine malnutrition in elective general surgery patients via GLIM criteria, and to determine the effect of malnutrition on Length of Stay (LoS).
Material and Methods: : In this cross-sectional study malnutrition was detected by GLIM after a pre-assessment via NRS2002. Reduced muscle mass in GLIM, was assessed using different anthropometric measurements and cut-off points and a handgrip. Length of hospital (LoS) and intensive care unit (ICU) stay were the outcomes. Data were collected within 48 hours of admission. Association between malnutrition and outcomes were determine by t-test. Logistic regression models were established to present the effect of malnutrition on long LoS. p<0.05 was deemed significant.
Results: Among participants (n=224) risk of malnutrition was 45.5% via NRS2002, malnutrition was 44-45 % via GLIM. The ones who are under risk of malnutrition and malnourished has significantly longer ICU stay and LoS. After controlling for confounding variables, being in malnutrition via GLIM, significantly increased long LoS 3.9-fold (p<0.001).
Conclusion: Malnutrition increased LoS. NRS2002 and GLIM yield similar results. Measured by a non-elastic tape, circumference measurements can be preferred to define reduced muscle mass in GLIM. Broader studies should be conducted to determine which anthropometric measurement would better define reduced muscle mass for GLIM.

Keywords: malnutrition, NRS2002, GLIM criteria, length of stay

INTRODUCTION

Malnutrition is a condition that causes deterioration in tissues and body composition due to insufficient intake or inability to use nutrients, therefore loss of physical and mental function and impaired clinical outcomes (1). Malnutrition is characterized by decreased food intake, involuntary weight loss, low BMI (<18.5 kg/m2), and/or decreased lean body mass (2). Prevalence of malnutrition in hospitalized patients ranges between 15-60% and it was approximately 30% according to ESPEN in 2002 (3, 4). In a national study conducted in 2009, approximately 30,000 people in 34 hospitals in 19 provinces were evaluated with NRS2002, and the prevalence of malnutrition in admission was found to be 15% and 52% in intensive care units (5). Since this study, no other study has been conducted at a national level. In hospitalized patients, malnutrition causes impaired clinical outcomes such as suppression of immunity, decreased muscle strength, difficulty in breathing, impaired thermoregulation, micronutrient imbalances, cachexia, sarcopenia, frailty, delayed wound healing, longer hospital stays (LoS), increased economic burden and increased deaths (6-8). Various indices are used in screening and detecting malnutrition. NRS2002 recommended by ESPEN, MUST (Malnutrition Universal Screening Tool), MNA (Mini Nutritional Assessment), or MST (Malnutrition Screening Tool) are some of them to name. Although many tools are used, the validity, reliability, generalizability, and consistency of these tools vary widely. These tools assess the clinical condition of the patient with objective criteria (recent weight loss, decrease/change in food intake, or physical or mental impairment associated with malabsorption) and classify patients in terms of malnutrition risk (2, 9). The GLIM criteria were prepared by four leading associations in clinical nutrition due to a 3-year (2016-2018) study to reach a consensus on determining malnutrition (10). It has a two-step structure; First, the risk is determined by a validated screening tool mentioned above, and then, the presence of malnutrition is determined according to phenotypic and etiological criteria for those at risk, and its severity is determined according to phenotypic characteristics (9, 11). However, there is no consensus on the best method for determining decreased muscle mass (MM). Although the GLIM criteria suggest the use of DEXA or other validated body composition detection methods such as ultrasound or computed tomography (CT), it was stated as “the use of these tools in many areas may not be possible or practical. In this case, it is said that anthropometric measurements showing muscle mass such as middle-upper arm circumference (MUAC) or calf circumference may be used and handgrip strength can be used as a supportive measurement” (9). However, cut-off points for anthropometric measurement or handgrip strength are not specified.

The objectives of this study are 1. to determine malnutrition in elective general surgery patients via GLIM criteria 2. to evaluate the effectiveness of different anthropometric measurements and cut-off points for decreased MM for the GLIM criteria, and 3. to evaluate the effect of malnutrition on LoS.

MATERIAL AND METHODS

This cross-sectional study was conducted between January-March 2020 in adult elective general surgery patients in a tertiary university hospital. Although the data were planned to be collected until the end of April, the data collection process had to be terminated after the COVID-19 pandemic was announced in our country on March 23, 2020, due to the suspension of elective surgeries. Bariatric surgery patients, patients with neurological diseases such as Alzheimer's/Dementia, and patients who were unable to communicate were excluded from the study.

Malnutrition was detected by GLIM criteria after NRS2002 was used as a screening test. NRS2002 was chosen as the screening test because it is the standard protocol to determine malnutrition risk in hospital as well as studies have indicated that NRS2002 can better determine clinical outcomes such as hospital stay and mortality (12). Information about NRS2002 is detailed elsewhere (3, 13).

Patients were screened by NRS2002 for malnutrition risk, and for the ones who were under risk for malnutrition, GLIM criteria were applied. For GLIM, there is no consensus method for determining decreased MM, it is seen that many different methods and cut-offs points are used in different studies [14-16]. Thus, MUAC (with different cut-off points), calf circumference (CC), neck circumference (NC) handgrip strength were used to determine the decreased MM (Figure 1).

For MUAC different cut-off points were used in the studies such as 21cm [17, 18], 23cm [18, 19], 23.5cm (20), 24.5cm (21). In this study, three different cut-points were used in determining the decreased MM. Considering the studies made, 23cm was taken as the first cut-off point (18, 19). For the second cut-off point, the ROC curve was drawn for the BMI of 20.5 in the study group, and the cut-off value was determined as 24.5cm according to the Youden index (highest sensitivity+selectivity-1) (22). For the third cut-off point, the 15th percentile presented by the CDC for adults for MUAC (29.8cm for men, 26.9cm for women) was used (23). Besides MUAC, CC (31cm) (17, 24), NC (<35cm for females and <38 cm for males) (25) and handgrip strength (according to EWGSOP-2, 27kg for men and 16kg for women) (26) were also used to determine decreased MM.

In the evaluation of disease burden/inflammation, the diseases specified in the GLIM criteria, such as acute events, organ failures, rheumatoid arthritis, and cancer were considered to be presence of inflammation (9).

Within the scope of the study, height, weight, and circumference measurements (CC, MUAC) were measured, and BMI was calculated. Handgrip strength was measured three times consecutively considering the means of measurement. All

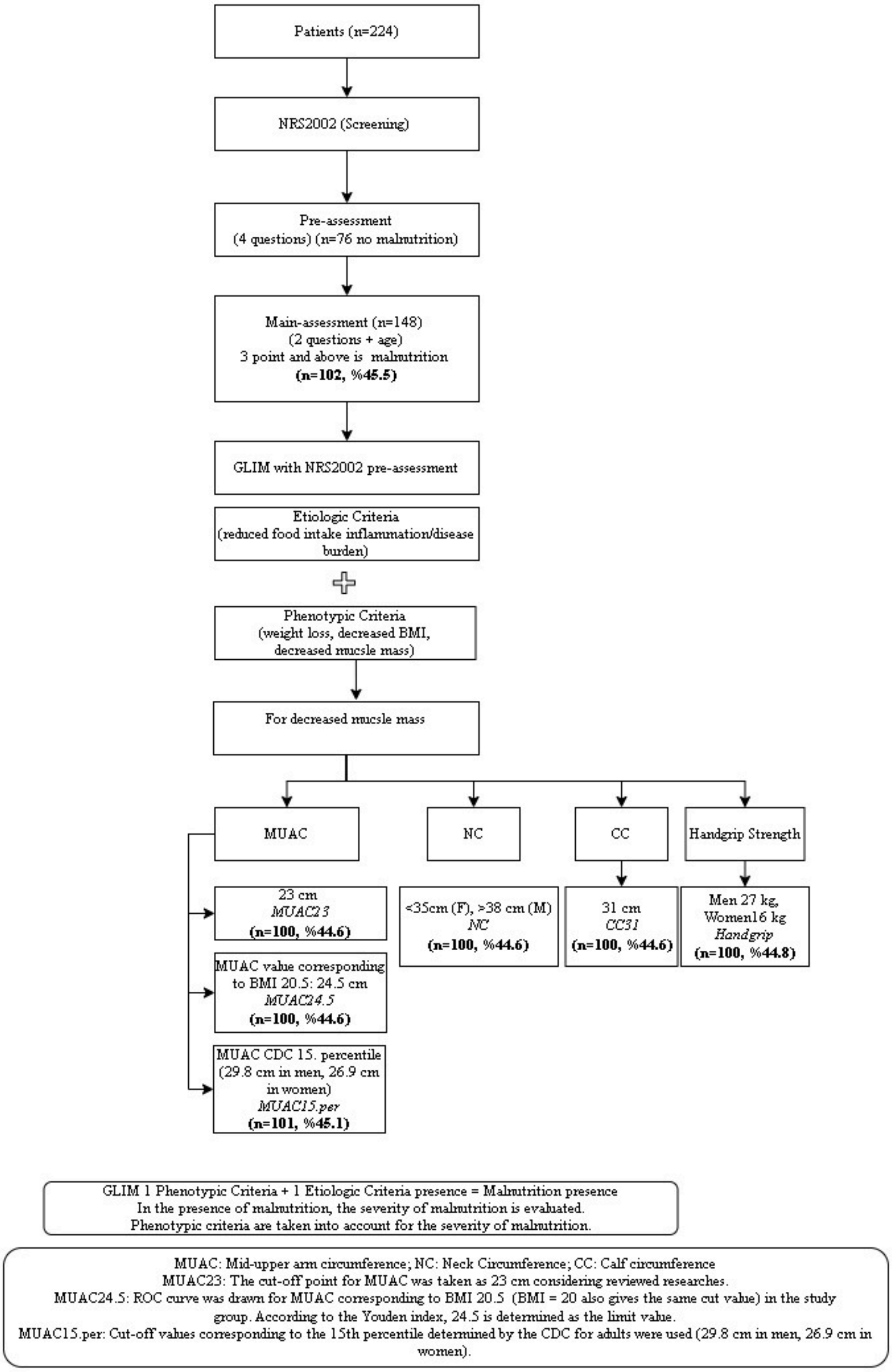

Figure 1. Malnutrition prevalence of patients according to different criteria

anthropometric measurements were done according to guidelines (25, 27).

Hospital (in days) and ICU (Intensive care unit, in hours) stay was recorded as outcomes. In the logistic regression analysis, the duration of hospitalization (Length of Stay-LoS) was evaluated in two groups short (≤7 days) and long (>8 days). Socio-demographic variables (age, sex, education level), presence of a co-morbidity, and surgical site in three groups as GIS hollow organs (esophagus, stomach, intestine, rectum), GIS solid organs (liver, pancreas, and bile), and other (breast, groin, thyroid, appendicitis, etc.) were evaluated as confounding variables.

The data were collected by the researchers/intern students of the Department of Nutrition and Dietetics through face-to-face interviews, within the first 48 hours of hospitalization. The data were analyzed with SPSS 25.0. Independent samples t-test was conducted to determine the association of malnutrition and LoS and ICU stay, and ROC curves were drawn to see if malnutrition predict LoS or ICU stay better. The effect of malnutrition on long LoS was evaluated by logistic regression models. A separate model was established for each criterion, and, age, sex, educational status, presence of chronic disease, and surgical site were included in the models as confounding factors. $p < 0.05$ was considered significant.

The research was conducted by the Helsinki Declaration. Ethical approval of the study was given by Ege University Ethics Committee (Decision number: 20-1T/22, Date:08.01.2020). Verbal and written consent was obtained from all participants. The researcher who analyzed the data (RM) did not participate in the data collection phase and kept blind to reduce bias.

RESULTS

Mean age of the participants (n=224) was 56.9±16.0 (min:18-max:93), among them 42.4% (n=95) were men, 45.1% were high-school graduate (≥12 years of education).

According to the surgical site, nearly half (46.9%, n=105) of the patients were planned to be operated on from GIS hollow organs, one-fifth (21.4%, n=48) GIS solid organs, rest were at other sites.

In table 1 components of GLIM and in Figure 1, the malnutrition prevalence of the patients according to different criteria was presented.

As presented in Figure 1, according to NRS2002, 76 patients were found to be risk-free whereas for 148 patients mean assessment was conducted. Among them, 45.5% (n=102) were found to be under risk for malnutrition. In Table 1 without a screening test, GLIM criteria define approximately 85% of the patients as malnourished whereas when pre-assessed with NRS2002 malnutrition prevalence was found 44-45%. Since different MM measures gave the same results, GLIM will be used here upon.

Table 1. Components of GLIM

Components	n	%
Etiologic criteria	182	81.3
- Inflammation	155	69.2
- Reduced food intake	110	49.1
Phenotypic criteria		
- Weight loss	76	33.9
- Low body mass index	4	1.8
- Reduced MM		
○ *MUAC23*	6	2.7
○ *MUAC24.5*	26	11.6
○ *MUAC15p*	88	39.3
○ *CC31*	22	9.8
○ *Handgrip*	66	29.5
○ *NC*	59	26.3
Presence of phenotypic criteria (Weight loss or low body mass index or reduced MM)		
- P_{MUAC23}	80	35.7
- $P_{MUAC24.5}$	86	39.7
- $P_{MUAC15p}$	126	56.3
- P_{CC31}	90	40.2
- $P_{Handgrip}$	118	52.7
- P_{NC}	109	48.7
One etiologic criteria + one phenotypic criteria		
- G_{MUAC23}	183	81.7
- $G_{MUAC24.5}$	186	83.0
- $G_{MUAC15p}$	198	88.4
- G_{CC31}	187	83.5
- $G_{Handgrip}$	193	86.5
- G_{NC}	190	84.8
NRS2002 as a screening test – Malnutrition risk	102	45.5
GLIM with NRS2002 as a screening test – Malnutrition prevalence		
- $GLIM_{MUAC23}$	100	44.6
- $GLIM_{MUAC24.5}$	100	44.6
- $GLIM_{MUAC15p}$	101	45.1
- $GLIM_{CC31}$	100	44.6
- $GLIM_{handgrip}$	100	44.6
- $GLIM_{NC}$	100	44.6

In table 2 association between malnutrition (or malnutrition risk) and outcomes were shown.

As presented in Table 2, the presence of malnutrition/ malnutrition risk significantly increases ICU stay and LoS ($p<0.05$ for all). The duration of hospital stay is 5 days in non-malnourished individuals, while it is

Table 2. The association between malnutrition and outcomes

	Post-op ICU stay (hours)			LoS (days)		
	Mean ± 1S	p	AUC	Mean ± 1S	p	AUC
NRS2002						
Malnutrition risk (+) (n=102)	36.64±42.82	0.002	0.706	11.38 ± 6.90	<0.001	0.792
Malnutrition risk (-) (n=122)	20.75±31.93			5.53 ± 4.01		
GLIM						
Malnutrition (+) (n=100)	37.32±42.97	0.001	0.722	11.56±6.85	<0.001	0.806
Malnutrition (-) (n=124)	20.46±31.76			5.48±4.00		

Table 3. The association of malnutrition and long LoS

	Model 1 (crude)			Model 2 (adjusted model)		
Variables	P	OR	95% CI	P	OR	95% CI
Presence of malnutrition (GLIM)	<0.001	6.362	3.543-11.423	<0.001	3.908	2.010-7.599
Age (cont.)				0.894	1.002	0.978-1.026
Sex (male)				0.761	0.899	0.454-1.781
Education status (low)				0.433	1.306	0.670-2.546
Presence of chronical disease (yes)				0.304	0.688	0.337-1.403
Surgical site						
Non-GIS				Ref		
GIS hollow organs				<0.001	6.528	2.842-14.996
GIS solid organs				0.196	1.864	0.725-4.790

(*) Crude model shows association of malnutrition on LoS, adjusted model was adjusted for age, sex, education status, presence of chronic disease, and surgical site. GIS: Gastrointestinal system

around 11 days for individuals with malnutrition (or malnutrition risk). When the AUC values were examined, it was found that all of them were significant (p<0.001 for all) and high, malnutrition is a better predictor of LoS then ICU stay.

After adjusting for age, sex, education, presence of chronic disease, and surgical site, the association of malnutrition with long LoS (>7 days) was presented in Table 3.

Malnutrition increased long LoS 6.36-fold (95%CI: 3.543-11.423). After the adjustments malnutrition still increased long LoS significantly (OR:3.908, 95%CI: 2.010-7.599). In addition to presence of malnutrition, having surgery in hollow organs increased long LoS (OR:6.528, 95%CI:2.842-14.996) (Table 3).

DISCUSSION

In the studies conducted, the frequency of hospital malnutrition is between 20-50%, although it varies according to the region, hospital, or the method used and it is higher in elderly, critically ill patients, especially the ones with gastrointestinal malignancies (28). In a study in the USA between 2009 and 2015, among approximately 10000 patients, the frequency of malnutrition was found to be 32.7% (29). It was observed that the frequency was lower in studies using only BMI, but it is higher when more valid criteria such as NRS2002, MUST, and SGA was used. In surgical wards (15 studies, n=5450), the prevalence of malnutrition was found to be between 55% and 66% (28). In a study conducted using SGA in approximately 1000 patients in 18 hospitals in Canada, the frequency of malnutrition was found to be 40% (6). In a study evaluating malnutrition with GLIM at the time of hospitalization in 18 hospitals over the records in Canada, the frequency of malnutrition was 33.3% (30), and a similar result was obtained from Japan, as 33% in those who applied to the emergency service within last month (31). As can be seen, the prevalence of malnutrition can vary greatly depending on the condition or disease evaluated the age of the patients, and the criteria used in the evaluation. In our study, we found that when NRS2002 is used as a screening test, malnutrition risk and presence of malnutrition can be similar as via NRS2002 malnutrition risk was 45% and with GLIM malnutrition prevalence was 44-45% since they share common evaluation criteria.

The number of studies performed on surgical patients is very few via GLIM. In a pilot study evaluating GLIM in patients who had undergone gastrointestinal surgery, each phenotypic and etiological factor association was evaluated as a separate GLIM criterion and a total of 10 GLIM criteria were established. The frequency of malnutrition was highest with weight loss + inflammation (41.3%) and decreased MM (determined by CC) + inflammation (40.3%) (32). In a pilot study on surgical IBD patients in Italy, the prevalence of malnutrition was found to be 42% (33). In our study the rates were similar as 44-45% with GLIM.

Having so many different assessment methods (NRS2002, MUST, MNA, MST, SGA, or even only BMI) creates difficulties in determining and standardizing malnutrition (2, 28, 34). For this reason, GLIM was presented (9, 11, 35). Keller et al (2020) stated that GLIM was not prepared to replace the current screening tools, it could be used in addition to those tools, it was prepared to speak a common language all over the world on malnutrition, to reveal different frequencies in the world and to support the updating of the malnutrition ICD code (35). In our study, we used NRS2002 as a pre-assessment tool for GLIM. When the NRS2002 and the items constituting the GLIM are examined, it is seen that the items are common except for decreased MM. The deterioration of nutritional status in NRS2002 is presented as “weight loss” and “reduced BMI as phenotypic area, and “Reduced food intake” in the etiological area in GLIM. Disease severity in NRS2002 is seen as "inflammation" in GLIM. In both tools, an adjustment was made for the elderly (≥70 years). Zhang et al. emphasized these similarities in their study on patients with cancer, therefore they stated that NRS2002 is more suitable to be used as a pre-screening tool for GLIM (36). Parallel to this, in our study, the results of GLIM and NRS2002, are very similar. In this study by Zhang et al comparing various screening tools in cancer patients, GLIM and NRS2002 were identified as the most compatible tools (kappa:0.82) (36). A similar result was obtained from our study, there were 102 patients who were under risk via NRS2002 and 100 patients who were malnourished via GLIM (in all anthropometric methods used) which makes 99% agreement.

For reduced MM if valid techniques such as DEXA, BIA, CT, and MRI are not available, standard anthropometric measures like MUAC or CC may be used whereas handgrip strength may be considered as a supportive measure. In addition to MUAC, CC and handgrip we also evaluated NC as a novel measurement and saw that the results are similar. For anthropometric measurements which one should be preferred with which cut-off points are not defined (9, 37). In a malnutrition decision tree study conducted by Yin et al (2020) on cancer patients in China, it is stated that the use of CC is the best anthropometric method (38). In the main article presenting the GLIM criteria, it was emphasized that the lack of a clear explanation on how to determine MM (the method and appropriate cut-off points) and disease burden/inflammation leads to differences in the interpretation of the results (16). Thus, for GLIM to be preferred in all settings and to provide standard results as it aimed to do so, it is very important to define the best/preferred anthropometric measurement with appropriate cut-off points.

Regardless of the method used in previous studies, malnutrition has been found to increase complications, LoS, costs, the need for re-hospitalization, and, consequently, death (6, 28, 39). In China, using NRS2002 as a pre-assessment for GLIM (via CC) showed that malnourished patients had significantly longer LoS (40). Our study also supports this finding. After adjusting for age, sex, educational status, presence of chronic disease, and surgical site, malnutrition by GLIM increased long LoS 3.9-fold significantly.

In our study anthropometric measurements and handgrip were used to determine reduced MM. It would be more valuable to compare reduced MM via valid techniques and anthropometric indices. Moreover, the inflammation status of the patients was determined only according to the disease state, biochemical measurements could not be evaluated. These shortcomings can be counted among the limitations of the study. Due to the COVID-19 pandemic, all elective surgeries were suspended for a while. Thus, this caused our sample size to be smaller than we planned. The study was conducted only in the general surgery ward, other surgeries or internal disease clinics were not included. This can also cause a limitation in terms of generalizability, and it may cause under or overestimation of malnutrition.

CONCLUSION

It was found that approximately half of the elective surgery patients were under risk of malnutrition according to NRS2002, malnourished according to GLIM. As expected, there was a high agreement between NRS2002 and GLIM (99%). According to all malnutrition tests, the presence of malnutrition or malnutrition risk significantly increased LoS. After adjusting for socio-demographic variables, presence of chronic disease, and the surgical site, the presence of malnutrition significantly increased the long (>7 days) LoS.

There were nearly no differences between the five different methods (MUAC23, MUAC24.5, MUAC15p, CC31, NC, Handgrip) used and they are not superior to each other. A non-elastic tape is cheaper, accessible, and practical, thus, instead of a handgrip dynamometer, using circumference measurements (MUAC, NC or CC) can be preferred. In absence of valid tools like DEXA, not being able to identify reduced MM through anthropometric measurements seems to be the utmost important lack of GLIM for today. Thus, for different endpoints such as mortality or re-hospitalization, prospective studies with larger samples can be conducted to improve GLIM in terms of reliable anthropometric methods for identifying reduced MM.

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