Disease-related malnutrition and nutritional assessment in clinical practice

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Risk for malnutrition in patients prior to vascular surgery

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ABSTRACT

Background Malnutrition is an important risk factor for adverse post-operative outcomes. The prevalence of risk for malnutrition is unknown in patients prior to vascular surgery. We aimed to assess prevalence and associated factors of risk for malnutrition in this patient group.

Methods Patients were assessed for risk for malnutrition by the Patient-Generated Subjective Global Assessment Short Form. Demographics and medical history were retrieved from the hospital registry. Uni- and multivariate analyses were performed to identify associated factors of risk for malnutrition.

Results Of 236 patients, 57 (24%) were categorized as medium/high risk for malnutrition. In the multivariate analyses, current smoking (P=0.032), female sex (P=0.031), and being scheduled for amputation (P=0.001) were significantly associated with medium/high risk for malnutrition.

Conclusions A substantial proportion (24%) of patients prior to vascular surgery is at risk for malnutrition, specifically smokers, females and patients awaiting amputation. Knowledge of these associated factors may help to appoint patients for screening.

INTRODUCTION

In surgical patients, malnutrition is an important risk factor for adverse post-operative outcome.[1] Patients with vascular disease requiring surgery may also be at risk for malnutrition when specific disease-related symptoms interfere with food intake. Symptoms such as pain, cramps and fatigue, as well as limitations in functioning, e.g. impairment in walking, are common among patients with vascular disease, and are reported to contribute to nutritional risk in this patient population.[2,3]

In the general hospital population, risk for malnutrition ranges from 15% to 24%.[4,5] Differences in prevalence may be explained by the use of different screening instruments and/or disease populations. The prevalence of risk for malnutrition in cardiac and general surgery patients is estimated at 19% and 24%, respectively.[6,1] The largest study reporting prevalence of risk for malnutrition in vascular surgery patients (n=133) dates from 1984, and revealed a prevalence of 4% to 18%, depending on severity of disease.[7] Risk for malnutrition differs largely between disease populations, and is associated with for instance older age, female sex, and comorbidity in patients aged 70+ in a general hospital population.[8,9] In a community-dwelling population aged 65+, risk for malnutrition has been associated with smoking, and comorbidities such as osteoporosis and cancer.[10]

Nutritional screening programs aim to detect patients at risk for malnutrition.[11] However, risk for malnutrition may be overlooked in vascular surgery patients as only 20% to 38% of surgical departments in parts of Western Europe and USA perform nutritional screening perioperatively.[12,13] Commonly used screening instruments include two up to five parameters, such as unintentional weight loss, Body Mass Index (BMI), disease severity, and loss of appetite.[14] These instruments, however, do not provide sufficient insight into treatable nutrition impact symptoms, such as nausea, changes in taste, fatigue or pain. Neither do they screen for a decrease in food intake or activity. If mainly weight loss or Body Mass Index (BMI) is used for screening, recognition of factors that may cause future malnutrition may be delayed. Timely and full identification of patients at risk for malnutrition, followed by proactive and interdisciplinary interventions may improve clinical outcomes. In order to address the different domains of malnutrition risk, a more comprehensive tool is needed. The Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) is one of the few instruments covering all domains of the malnutrition definition and has demonstrated high specificity and sensitivity for assessing risk for malnutrition in cancer populations.[15-17]

However, no studies are available that have assessed prevalence of risk for malnutrition in patients prior to vascular surgery, and knowledge on the associated factors of risk for malnutrition is lacking. Therefore, in this study, we aimed to assess the prevalence and associated factors of risk for malnutrition in patients prior to vascular surgery by utilizing the PG-SGA SF.

MATERIAL AND METHODS

Study design

In this observational cross-sectional study, all patients visiting the vascular surgery outpatient clinic at the University Medical Center Groningen (UMCG) in 2015 that were scheduled for surgery were assessed for risk for malnutrition by the Scored Patient-Generated Subjective Global Assessment Short Form (© FD Ottery 2005, 2006, 2015) (PG-SGA SF). Patients underwent surgery within three months after their first outpatient visit and study measurement. Usual care was provided.

For this study, the Medical Ethical Committee of the UMCG granted dispensation from the Dutch law regarding patient-based medical research (WMO) obligation (reference 2016/322). Patient data were processed according to the Declaration of Helsinki – Ethical principles for medical research involving human subjects.[18]

Measurements

To assess risk for malnutrition, patients completed the PG-SGA SF Dutch version 3.7 (with permission from the copyright holder) by themselves.[19] The PG-SGA SF includes four Boxes. Box 1 addresses the history of weight loss: percentage weight loss in the past month or past six months, and changes in weight in the past two weeks; Box 2 evaluates changes in food intake in the past month; Box 3 addresses presence of nutrition impact symptoms in the past two weeks; and Box 4 evaluates activities and function in the past month.[20] The scoring of the PG-SGA Short Form has been described in detail elsewhere.[21] In case of missing items in any Box, its Box score was taken as '0'. 'Medium risk for malnutrition' was defined as a total PG-SGA SF score of 4 to 8 points, since this corresponds to indication of the PG-SGA triage system for an intervention by a dietitian in conjunction with a nurse or physician. 'High risk for malnutrition' was defined as a PG-SGA SF score ≥9 points, as such is seen as critical need for improved symptom management and/or nutrient intervention options.[20] This classification of risk was considered appropriate as from a score of 4 points and higher the need for an intervention is present and screening for risk is aimed at identifying patients in need of an intervention.

Demographics, comorbidities, and type of scheduled surgery were retrieved from the electronic hospital registry. Current and historical smoking (yes/no) and current drinking habits (yes/no) were registered twice: it was asked by the nurse at the surgical ward and by the nurse at the pre-operative screening. Discrepancies were investigated by the physician involved in this study (LV). Packyears and amounts were not registered. Comorbidity was assessed using the Charlson Comorbidity Index (CCI), which predicts the 1-year mortality of a patient based on the coexisting medical conditions and age.[22] The self-reported PG-SGA SF data on current weight and length were used to calculate BMI (weight/[length*length]) that was subsequently categorized according to the WHO classification.[23]

Statistical analyses

Categorical variables were presented as frequencies and percentages. Continuous variables were presented as mean ± standard deviation (SD) for normally distributed variables, and as median with interquartile range (IQR) for skewed variables. Normality was tested by the Kolmogorov-Smirnov test. Based on the triage system of the PG-SGA, PG-SGA SF scores were dichotomized in two ways: 1) low risk (0-3 points) vs. medium/high risk (≥4 points) and 2) low/medium risk (0-8 points) vs. high risk (≥9 points).[24]

Univariate binary logistic regression analyses, Odds Ratios (OR) and 95% CI, were used to analyze associations between risk for malnutrition and the afore mentioned covariates (factors). A zero inflated model accounting for a relative large amount of zero scores was used to identify factors associated with PG-SGA SF scores.[25] Multivariate logistic regression with the minimum Akaike Information Criterion (AIC) was used to provide options for model selection by estimation of measure of fit.[26] Generalized Additive Modeling (GAM) was performed to explore unknown non-linear associations with risk for malnutrition.[27] Case wise deletion of data was performed to handle missing data. Two tailed P-values were used, with significance set at $P<0.05$. Data were analyzed using IBM SPSS version 23.0 (SPSS Inc., Chicago, IL, USA) and R version 3.4.0 (R Core Team, 2017).

RESULTS

In total, 236 patients were included in the analyses. **Table 1** shows baseline characteristics of this group. Age ranged from 23 to 93 years, with a mean (SD) age of 68.3 ± 11.1 years. The majority of the patients was male (72%). More than half of the study population (54%) had a BMI ≥25 kg/m^2, indicating overweight or obesity. Fourteen patients had a missing score in one of the four Boxes of the PG-SGA SF. Five patients had a missing score in Box 1, six in Box 3, and another three in Box 4. Eleven of these had a total score of 0, one had a score of 1, one of 2, and one patient had a score of 6 points.

Fifty-seven patients were categorized as medium/high risk for malnutrition, resulting in a prevalence of risk for malnutrition of 24% (95% CI: 19 to 30). Forty-two patients (18%; 95% CI: 13 to 23) were at medium risk for malnutrition, and 15 patients (6%; 95% CI: 4 to 10) at high risk. In total, 97 patients (41%) had a score of zero. Median PG-SGA SF score of all patients was 1 (IQR: 0 to 3), and scores ranged from 0 to 18. Scores for history of weight loss (Box 1) ranged from 0 to 5; for changes in food intake (Box 2) from 0 to 4; for nutrition impact symptoms (Box 3) from 0 to 13; and for activities and function (Box 4) from 0 to 3. **Table 2** shows median scores per risk group and frequency of nutrition impact symptoms (Box 2).

Table 1. Characteristics of study population (N=236 unless stated otherwise)

	Mean, SD[a]	Median (IQR[b])
Age	68.3 SD 11.1	
Comorbidity[c] N=234		5 (IQR: 4 to 6)
BMI[d] N=233		25.5 (IQR: 23.1 to 29.0)
	N	**%**
BMI		
<18.50 kg/m^2	4	1.7
18.50 - <25 kg/m^2	103	44.2
25 - 29.99 kg/m^2	85	36.5
≥30 kg/m^2	41	17.6
Sex		
Male	169	71.6
Female	67	28.4
Smoking N=234		
Never/quit	147	62.8
Currently	87	37.2
Drinking alcohol N=227		
Yes	123	54.2
No	104	45.8
DM[e] N=235	56	23.8
COPD[f] N=235	48	20.4
Impaired renal function[g] N=235	36	15.3
Type of planned surgery		
Percutaneous	52	22.0
Carotid	51	21.6
Endovascular	49	20.8
Peripheral bypass	37	15.7
Abdominal	20	8.5
Amputation below the knee	18	7.6
Other	9	3.8

[a]standard deviation, [b]inter quartile range, [c]Charlson Comorbidity Index (predicts 1-year mortality based on age and comorbidities; range 0-19), [d] Body Mass index (weight/length^2), [e]diabetes mellitus: documented use of oral anti-diabetic medicine or insulin, [f]chronic obstructive pulmonary disease (Society of Vascular Surgery classification), [g]glomerular filtration rate (eGFR); with values < 60 ml/min x 1.73 m^2 indicating impaired renal function

Table 2. Nutrition impact symptoms and Box scores across risk for malnutrition groups

PG-SGA SF[a] (N=236)	Low risk: 0-3 points N=179		Medium risk: 4-8 points N=42		High risk: ≥9 points N=15	
NIS	N	%	N	%	N	%
No appetite	-	-	12	28.6	12	80.0
Nausea	1	0.6	3	7.1	3	20.0
Constipation	2	1.1	3	7.1	2	13.3
Mouth sore	1	0.6	2	4.8	2	13.3
Funny/no taste	-	-	3	7.1	1	6.7
Problems swallowing	1	0.6	3	7.1	2	13.3
Pain	-	-	8	19.0	6	40.0
Vomiting	-	-	-	-	-	-
Diarrhea	-	-	2	4.8	2	13.3
Dry mouth	2	1.1	7	16.7	1	6.7
Smells bother me	-	-	-	-	2	13.3
Early satiation	1	0.6	7	16.7	5	33.3
Fatigue	6	3.4	12	28.6	7	46.7
Other	4	2.2	5	11.9	1	6.7
PG-SGA SF scores	Median (IQR)		Median (IQR)		Median (IQR)	
Box 1 weight history	0 (0-0)		0 (0-2)		2 (0-4)	
Box 2 food intake	0 (0-0)		0.5 (0-1)		1 (1-3)	
Box 3 symptoms	0 (0-0)		3 (0.75-4)		6 (4-7)	
Box 4 activity/function	0 (0-1)		1 (1-2)		2 (1-3)	
Total	0 (0-1)		6 (4-7.25)		11 (10-14)	

[a] Patient-Generated Subjective Global Assessment Short Form

In a sub-analysis performed in 222 patients with no missing data on PG-SGA SF, 56 patients were categorized at medium/high risk for malnutrition, showing a prevalence of risk for malnutrition of 25% [95% CI, 20 to 31]. Forty-one patients (19%) were at medium risk for malnutrition, and 15 patients (7%) at high risk for malnutrition. Prevalence of risk for malnutrition and the most frequently reported nutrition impact symptoms per type of surgery are displayed in **Table 3**.

Table 3. Type of planned surgery and risk for malnutrition assessed by PG-SGA SF[a] (N=236)

Type of surgery			Low risk: 0-3 points		Medium risk: 4-8 points		High risk: ≥ 9 points		Most frequently reported nutrition impact symptoms
	N	%	N	%	N	%	N	%	
Percutaneous[b]	52	22.0	42	80.1	9	17.3	1	1.9	fatigue, early satiation
Carotid	51	21.6	40	78.4	9	17.6	2	3.9	fatigue, lack of appetite
Endovascular	49	20.8	39	79.6	7	14.3	3	6.1	lack of appetite, pain
Peripheral bypass	37	15.7	26	70.2	8	21.6	3	8.1	fatigue and pain
Abdominal	20	8.5	18	90.0	1	5.0	1	5.0	lack of appetite, nausea, constipation, depression
Amputation	18	7.6	6	33.3	8	44.4	4	22.2	lack of appetite, fatigue, nausea
Other	9	3.8	8	88.8	-	0.0	1	11.1	-

[a] Patient-Generated Subjective Global Assessment Short Form, [b] All percutaneous procedures excluding endovascular aortic aneurysm repair or thoracic endovascular aortic aneurysm repair

Univariate analyses

The univariate analyses on associated factors of each of the malnutrition risk groups are shown in **Table 4.** Patients who smoked were significantly more frequently at risk for malnutrition than non-smoking patients, as indicated by OR=1.93 (95% CI: 1.05 to 3.54; P=0.032) for the medium/high risk group and OR 3.69 (95% CI: 1.22 to 11.18; P=0.021) for the high risk group. In addition, female patients were significantly more frequently at risk for malnutrition than male patients, as indicated by OR=2.30 (95% CI: 1.23 to 4.31; P=0.009) for the medium/high risk group and OR=3.14 (95% CI: 1.09 to 9.03; P=0.034) for the high risk group**.** When stratified by type of scheduled surgery, the prevalence of medium/high risk for malnutrition was highest in patients scheduled for amputation (66%; 12/18). This risk was significantly more frequently present in patients scheduled for amputation than patients scheduled for other types of surgery, as indicated by OR=7.69 (95% CI: 2.74 to 21.6; P=0.001) for the medium/high risk group and OR=5.38 (95% CI: 1.55 to 19.07; P=0.034) for the high risk group in each of the risk groups. BMI, age, drinking alcohol and comorbidity were not significantly associated with risk for malnutrition in either of the risk groups.

Table 4. Univariate analyses of associated factors of risk for malnutrition (n=236)

Associated factors	Risk for malnutrition, defined as ≥4 points (n=57)		Risk for malnutrition, defined as ≥9 points (n=15)	
	OR [95% CI]	P-value	OR [95% CI]	P-value
Smoking current yes/no	1.93 [1.05, 3.54]	0.033	3.69 [1.22, 11.18]	0.021
BMI continuous	0.93 [0.87, 1.01]	0.067	0.93 [0.82, 1.06]	0.283
Alcohol current yes/no	0.73 [0.40, 1.34]	0.302	0.40 [0.13, 1.21]	0.103
Female sex yes/no	2.30 [1.23, 4.31]	0.009	3.14 [1.09, 9.03]	0.034
Scheduled for amputation yes/no	7.69 [2.74, 21.6]	<0.001	5.38 [1.55, 19.07]	0.009
Comorbidity CCI score	1.16 [0.99, 1.36]	0.060	1.07 [0.82, 1.41]	0.620
Age years	1.00 [0.97, 1.03]	0.959	1.01 [0.96, 1.06]	0.729

Multivariate analyses

The zero inflation model showed a significant association between PG-SGA SF score and female sex (P<0.001), current smoking (P<0.001), comorbidity (P=0.042) and scheduled for amputation (P<0.001), as shown in **Table 5**.

Table 5. Multivariate analysis of associated factors of continuous PG-SGA SF[a] score

	Estimate	St Error	OR [95% CI]	P value
Female sex yes/no	0.30	0.09	1.34 [1.13, 1.61]	<0.001
Current smoking yes/no	0.41	0.09	1.51 [1.26, 1.80]	<0.001
Comorbidity CCI score	0.04	0.02	1.05 [1.00, 1.09]	0.042
Scheduled for amputation yes/no	0.50	0.12	1.64 [1.31, 2.06]	<0.001

[a]Patient-Generated Subjective Global Assessment Short Form

In the multivariate logistic regression model, the associated factors of medium/high risk for malnutrition were: female sex (P=0.031), current smoking (P=0.032), and scheduled for amputation (P=0.001) (**Table 6A**). Patients who smoked were more frequently at medium/high risk for malnutrition (OR=2.04; 95% CI: 1.07 to 3.93) than non-smoking patients. Furthermore, female patients were more frequently at medium/high risk for malnutrition

(OR=2.10; 95% CI: 1.06 to 4.11) than male patients. Medium/high risk for malnutrition was more frequently present in patients scheduled for amputation (OR=5.83; 95% CI: 2.05 to 18.19) than in patients scheduled for other types of surgery.

Table 6A. Multivariate analysis of associated factors of medium/high risk for malnutrition

Associated factors	Estimate	St Error	P value	OR, 95% CI
Female sex yes/no	0.74	0.34	0.031	2.10, [1.06, 4.11]
Smoking current yes/no	0.71	0.33	0.032	2.04, [1.06, 3.93]
Comorbidity range 0-11	0.14	0.08	0.095	1.15, [0.98, 1.36]
Scheduled for amputation yes/no	1.76	0.55	0.001	5.84, [2.05, 18.19]

However, high risk for malnutrition was significantly associated with current smoking (P=0.014), and this high risk was more frequently present in patients who currently smoked (OR=4.31: 95% CI: 1.40 to 14.93) than in non-smoking patients (**Table 6B**).

Table 6B. Multivariate analysis of associated factors of high risk for malnutrition

Associated factors	Estimate	St Error	P value	OR, 95% CI
Female sex yes/no	0.92	0.58	0.114	2.51, [0.79, 8.05]
Smoking current yes/no	1.46	0.59	0.014	4.31, [1.40, 14.93]
Drinking alcohol yes/no	-0.85	0.60	0.160	0.43, [0.12, 1.36]
Scheduled for amputation yes/no	1.24	0.69	0.073	3.47, [0.80, 12.78]

GAM analysis of non-linear associations

A non-linear association was found between age and medium/high risk for malnutrition. From the age of approximately 70 years, prevalence of medium/high risk for malnutrition increases as shown in **Figure 1**. However, this association was not significant (P=0.093).

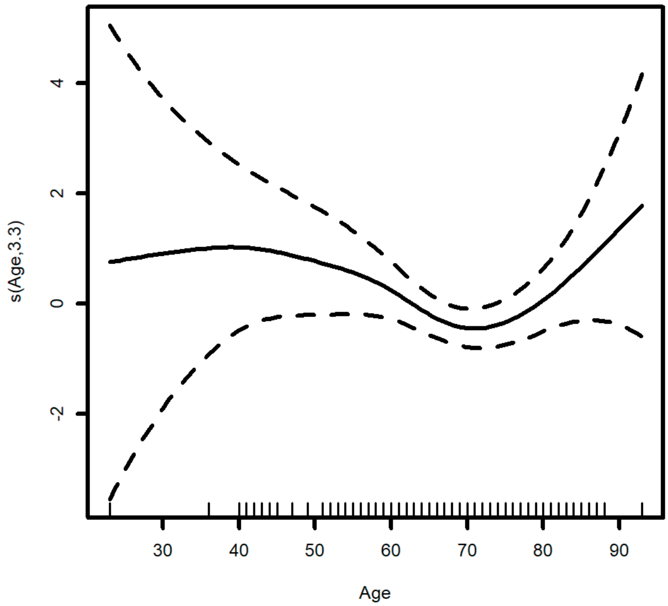

Figure 1. GAM analysis of age association with medium/high risk for malnutrition

DISCUSSION

This study shows that prior to vascular surgery, a substantial proportion (24%) of patients is at medium/high risk for malnutrition. Current smoking, female sex and scheduled for amputation are factors associated with risk for malnutrition in patients prior to vascular surgery.

Risk for malnutrition in our study population was predominantly characterized by the presence of nutrition impact symptoms, such as loss of appetite, fatigue and pain, combined with limitations in activities and function. These symptoms may be explained by the nature of the underlying vascular disease, especially in an advanced disease stage, such as in patients scheduled for amputation.[2,3] However, it is possible that patients in our study were scheduled for amputation because they were thought to be too debilitated to undergo more extensive procedures such as lower extremity bypass. Patients reporting to smoke were more frequently at risk for malnutrition, a finding consistent with findings in other populations, such as community-dwelling older adults.[10] This finding may be explained by the negative effect of smoking on taste and appetite, and early satiation.[28,29]

The higher scores on limitations in activities and function, such as in patients scheduled for amputation, may indicate the need for an intervention to improve physical function. The PG-SGA SF provides a global assessment, which identifies possible impediments in one or multiple domains. These may require not only intervention by a dietitian, but by other members of the multidisciplinary team as well, for example by a physical therapist in case of decreased activities and function.[30] When the patient is globally assessed and all aspects that require intervention are addressed, a more comprehensive preventive policy is facilitated, instead of a more reactive treatment for patients already malnourished. This way of proactively addressing patients' treatable symptoms is in line with the development of 'pre-habilitation' programs that improve physical fitness of patients before clinical interventions in order to shorten hospital stay and to improve clinical outcome.[31-33]

Only 28% of our study population was female and these female patients were more frequently at risk for malnutrition than male patients. Possibly pain or other disease symptoms are more often leading to nutrition-related problems in female patients. In BAPEN's nutrition screening surveys in hospitals in the United Kingdom, female patients (53%) were reported to be more frequently at risk for malnutrition as well, for all adult age groups starting from 18 years, and even more frequently from 65 years of age.[34] However, a study in a Brazilian general hospital population, on average 45 years of age, 53% female, males were reported to be more frequently at risk for malnutrition.[35] These findings indicate that sex differences with regard to risk for malnutrition may depend on the specific study population.

In our study, age was not an associated factor of risk for malnutrition. Possibly our relatively small sample size attributed to our non-significant finding. In contrast, in BAPEN's nutrition screening surveys in 31.637 patients aged 64.5 ± 19.3 years in hospitals in the United Kingdom, risk for malnutrition was associated with age.[34] Although not significant, interestingly the non-linear analysis of age in our study showed an increasing frequency of risk for malnutrition from the age of approximately 70 years. Since risk for malnutrition in our study was mainly characterized by the presence of nutrition impact symptoms and limitations in activities and function, which are reported to increase in presence and/or severity with ageing, we speculate that age may be an associated factor of risk for malnutrition in the older vascular surgery patient.[29,33]

In our study, comorbidity was only associated with the PG-SGA SF numerical scores, and not with dichotomized scores, whereas other studies have reported significant associations between comorbidity and risk for malnutrition in larger populations than our study population.[9,36] Since we dichotomized risk for malnutrition, some loss of information occurred. In combination with a relatively small study population used in the multivariate analyses, dichotomizing malnutrition risk may have led to the borderline non-significance of the association between comorbidity and risk for malnutrition. These findings may be explained by a type II error.

Despite its relatively small sample size, this is the largest study exploring prevalence, characteristics, and associated factors of malnutrition risk in patients prior to vascular surgery. We have described and analyzed the data profoundly in several statistical models. However, this study has some limitations that need to be addressed. First, a gold standard for malnutrition or malnutrition risk is not available, which complicates consensus on how concurrent validation should be performed.[37] Although the PG-SGA SF needs to be validated in vascular surgery patients, the PG-SGA SF has demonstrated high specificity and sensitivity for assessing risk for malnutrition in cancer populations.[15,16] The construct of malnutrition, which has been defined as *"a state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease"* [38] is not disease-specific, and therefore we consider it appropriate to use an instrument that covers all domains of the general malnutrition definition.[17] Second, the data on smoking and drinking habits may not have been completely accurate, since patients may not tell the truth on these specific topics in a hospital setting, and we are missing information on dose response. However, in our study 37% of the patients reported to smoke, which (as expected for a vascular disease population), is much higher than the average percentage smokers in the general Dutch adult population, (26% in 2015), which may indicate that patients in our study had no objection to disclose their smoking habits. Third, our university hospital is considered a tertiary referral center providing advanced specialized care. This may have led to some selection of more severely ill patients, making our results not completely comparable to patients with vascular disease in general. Finally, as in 14 patients a score on one of the Boxes of the PG-SGA SF was missing, the prevalence of risk for malnutrition may have been underestimated. However, since 11 out of these 14 patients scored 0 points on the other three Boxes, the possibility of crossing the threshold of 4 points or even 9 points in case of no missing data is minimal and this is unlikely to have influenced the results. This premise is supported by a sub-analysis in 222 patients with complete data on PG-SGA SF, showing a similar prevalence (25%) of medium/high risk for malnutrition.

In conclusion, our study shows that a substantial proportion (24%) of patients prior to vascular surgery is at risk for malnutrition. This risk is predominantly characterized by the presence of nutrition impact symptoms and limitations in activities and function. In patients prior to vascular surgery, females, patients who smoke, and patients awaiting amputation are specifically at risk for malnutrition. Knowledge of the associated factors of risk for malnutrition can be helpful in selecting groups of patients for screening purposes, as timely identification of patients at risk may improve post-operative outcome. Therefore, future research in this population should aim to assess the relationship between risk for malnutrition and post-operative outcomes.

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