

Malnutrition Risk at Solid Tumor Diagnosis: the Malnutrition Screening Tool in a Large US Cancer Institute

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Research Article

Keywords: Malnutrition, Cancer, Screening, Nutrition assessment, Medical Oncology

Posted Date: June 16th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-536488/v1>

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Version of Record: A version of this preprint was published at Supportive Care in Cancer on October 28th, 2021. See the published version at <https://doi.org/10.1007/s00520-021-06612-z>.

Abstract

Background

In cancer, malnutrition (MN) is common and negatively impacts tolerance and outcomes of anti-tumor therapies. The aim of this study was to evaluate the prevalence of MN risk and compare the clinicodemographic features between those with high Malnutrition Screening Tool (MST) scores (i.e., ≥ 2 of 5 = high risk for MN, H-MST) to low scores (L-MST).

Methods

A cohort of 3,585 patients (May 2017 through December 2018), who completed the MST at least once at the time of diagnosis of any stage solid tumor were analyzed. Logistic regression tested for associations between

clinicodemographic factors, symptom scores, and H-MST prevalence.

Results

The median age was 64 years (25-75 IQR, 55-72), with 62% females and 81% White. Most common tumor primary sites were breast (28%), gastrointestinal (GI) (21%), and thoracic (13%). Most had non-metastatic disease (80%). H-MST was found in 28% - most commonly in upper (58%) and lower GI (42%), and thoracic (42%) tumors. L-MST was most common in breast (90%). Multivariable regression confirmed that Black race (OR 1.9, 95% CI 1.5-2.4, $p < 0.001$), cancer primary site (OR 1.6-5.7, $p < 0.001$), stage IV disease (OR 1.8, 95% CI 1.4-2.2, $p < 0.001$), low BMI (OR 4.2, 95% CI 2.5-6.9 $p < 0.001$), and higher symptom scores were all independently associated with H-MST.

Conclusions

Nearly one-third of solid tumor oncology patients at diagnosis were at high risk of MN. Patients with breast cancer rarely had MN risk at diagnosis. Significant variation was found in MN risk by cancer site, stage, race, and presence of depression, distress, fatigue, and trouble eating/swallowing.

Introduction

In cancer, multiple factors contribute to malnutrition (MN) including tumor-related symptoms (e.g., anorexia, early satiety, fatigue), treatment-related complications (e.g., dysgeusia, mucositis, nausea), and psychological distress.¹ The prevalence of cancer-related MN ranges from 30–80% in ambulatory and hospitalized patients.^{2–7} Malnutrition has profound negative effects on performance status (PS), psychological well-being, and overall quality of life (QoL).^{8–10} Importantly, MN is a predictor of cancer survival independent of cancer site, PS, or stage.¹¹ Despite this, routine screening for MN in oncology is the exception with underutilization of potentially helpful nutritional support services.^{12–15}

Guidelines from the European Society for Clinical Nutrition and Metabolism (ESPEN) support universal nutritional screening as it might allow early nutritional interventions.¹⁶ Multiple validated MN screening tools of varying structure are available and incorporate patient, clinician, and objective data.^{17,18} Developed in 1999, the Malnutrition Screening Tool (MST) is a short tool validated in oncology outpatients (Supplementary Figure S1).^{3,19,20} An observational, cross-sectional study of 50 chemotherapy patients determined relative MST validity compared to the Patient Generated-Subjective Global Assessment (PG-SGA). MST was a strong predictor of MN risk relative to the PG-SGA (100% sensitivity, 92% specificity, 0.8 positive predictive value, 1.0 negative predictive value).²¹ Due to its ease of administration and test characteristics, the MST can screen cancer patients with relatively high sensitivity and specificity.

In January 2017, the Levine Cancer Institute (LCI), a high-volume, not-for-profit tertiary care academic-community cancer center, initiated an electronic distress screening (EDS) process. This aimed to screen all oncology ambulatory patients via an electronic tablet at initial consultation. The EDS includes patient-reported demographic, physical, and psychosocial parameters and linked to the electronic medical record. The MST was added to the EDS in May 2017 to identify those at high risk for MN.

Given the negative impact of MN on oncologic outcomes in cancer in general, it is imperative to understand the true prevalence of patient-reported MN and associated clinicodemographic and physical/psychologic characteristics. This retrospective study analyzed a patient cohort with any solid tumor who completed the MST at diagnosis. Specifically, we compared the clinicodemographic features of those at high risk for MN to those with low risk, and identified features associated with high risk.

Methods

Design

A retrospective review was conducted of adult patients ≥ 18 years of age diagnosed with any stage solid tumors and who completed at least one MST between May 2017 through December 2018. The Institution Review Board for Atrium Health approved this study, and requirements for consent were waived. The

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement was used as a guide for this manuscript.²²

Setting

LCI is a high-volume, not-for-profit tertiary care academic-community “hybrid” cancer center with a catchment area across 25 care locations in North and South Carolina.

Data sources and Variables

Data sources:

The LCI EDS database registry, the Enterprise Data Warehouse (EDW), and the institutional Tumor Registry identified patients and variables.

Variables:

Cancer type and stage at diagnosis were obtained from the institutional Tumor Registry. Cancer diagnostic groups were established which included breast, genitourinary (GU), gynecologic (GYN), head and neck (H&N), lower gastrointestinal (GI), other, thoracic, and upper GI. Sociodemographic variables included age at diagnosis, race, and sex. Patient characteristics included alcohol or tobacco use, height (cm.), and weight (lbs.) (used to derive BMI [kg/m^2])²³.

The EDS included the MST and patient-reported symptoms (anxiety, constipation/diarrhea, depression, distress, fatigued or tired, nausea/vomiting, pain, and trouble eating/swallowing). MST scores range from 0–5 with scores ≥ 2 indicating high risk for MN (H-MST) and 0–1 low risk for MN (L-MST).²¹ Anxiety was measured using the Two item Generalized Anxiety Disorder (GAD-2) score range 0-6.²⁴ GAD-2 scores of ≥ 3 are associated with high sensitivity and specificity for generalized anxiety disorder. Depression was assessed using the validated two-item Patient Health Questionnaire (PHQ-2) score range 0-6.²⁵ PHQ2 scores of ≥ 3 are associated with high sensitivity and specificity for major depression; it has been validated in oncology.²⁶ Distress was based on a single item “How much distress have you been feeling in the past week?”, low vs. high, ≥ 4 on 0–10 scale. A single item distress score is supported by the National Comprehensive Cancer Network (NCCN) Distress Management Panel.²⁷ All other symptoms were measured for severity on a 0–10 scale, a higher number reflecting greater symptom severity.

Data processing:

The above data sources were merged to identify all unique patients with complete case records i.e., no missing variables. This included at least one full EDS plus that MST done closest to the date of cancer diagnosis and all variables previously referenced.

Statistical Methods

MST scores were summarized descriptively overall and by cancer diagnostic groups separately. The prevalence of MST scores indicating high risk of MN were modeled using univariate and multivariable

logistic regression. Covariates included demographic variables (age; BMI; race; sex); oncologic variables (site and stage of cancer), and symptom scores. Patient-reported symptoms evaluated included anxiety and depression, distress score; and the following specific symptoms (as continuous variables on a 0–10 scale; constipation/diarrhea, fatigued or tired, nausea/vomiting, pain, and trouble eating/swallowing). Univariate analyses were used to identify factors that were individually associated with H-MST scores. These factors were included in a multivariable model; backwards elimination identified factors independently associated with H-MST scores. A significance level of $p < 0.05$ determined model selection.

Results

Patient Characteristics

A total of 7,479 unique subjects with either clinical or EDS data were retrieved (Fig. 1). Of these, complete case records as defined above were available for 4,272. Six-hundred and eighty-seven were removed due to “unknown” or “not stated” BMI, race, sex, or stage in the Tumor Registry with a final dataset of 3,585 subjects for analysis. The MST completed closest to date of cancer diagnosis was analyzed; median time from diagnosis to MST was 20 days (25–75 IQR, 11–33 days). Median age was 64 (25–75 IQR, 55–72) with range from 18–98. Most had Stage I-III disease (80%); 33%=Stage I, 27%=Stage II, 20%=Stage III. Median weight in pounds was 175 (25–75 IQR, 148–207) range 70–514. Additional clinical and demographic data are in Table 1.

Table 1
High versus Low MST scores by Demographics and Patient Reported Symptoms

Variable	High MST	Low MST	Total
	n (%)	n (%)	n (%)
All	1002 (28)	2583 (72)	3585 (100)
Age group			
≥65	497 (30)	1185 (70)	1682 (47)
>50 - <65	373 (30)	892 (70)	1265 (35)
≤50	132 (21)	506 (79)	638 (18)
Gender			
Female	524 (24)	1683 (76)	2207 (62)
Male	478 (35)	900 (65)	1378 (38)
Race			
White	766 (26)	2137 (74)	2903 (81)
Black	213 (35)	391 (65)	604 (17)
Other	23 (30)	55 (70)	78 (2)
Stage			
I-III	650 (23)	2222 (77)	2872 (80)
IV	352 (49)	361 (51)	713 (20)
Median BMI			
≥30	257 (20)	1055 (80)	1312 (37)
≥25-<30	271 (24)	841 (76)	1112 (31)
≥ 18.5-<25	404 (38)	653 (62)	1057 (29)
<18.5	70 (67)	34 (33)	104 (3)
Alcohol or Tobacco Use			
Yes	755 (30)	1772 (70)	2527 (71)
No	247 (23)	811 (77)	1058 (29)
Anxiety per GAD2			

Abbreviations: N = number; BMI = body mass index; IQR = interquartile range; PHQ2 = Patient Health Questionnaire 2-item; GAD2 = Generalized Anxiety Disorder 2-item

Variable	High MST	Low MST	Total
Yes	328 (41)	480 (59)	808 (22)
No	674 (24)	2103 (76)	2777 (78)
Depression per PHQ2			
Yes	313 (49)	328 (51)	641 (18)
No	689 (23)	2255 (77)	2944 (82)
Distress per 0–10 scale			
High ($\geq 4/10$)	777 (33)	1568 (67)	2527 (65)
Low	225 (18)	1015 (82)	1240 (35)
Symptoms per 0–10 scale, median (25–75 IQR)			
Pain	5 (2–7)	2 (0–5)	2 (0–5)
Fatigue	6 (4–8)	3 (1–6)	5 (2–7)
Nausea/Vomiting	0 (0–3)	0 (0–0)	0 (0–0)
Diarrhea/Constipation	2 (0–5)	0 (0–2)	0 (0–4)
Trouble eating/swallowing	3 (0–6)	0 (0–0)	0 (0–2)
Abbreviations: N = number; BMI = body mass index; IQR = interquartile range; PHQ2 = Patient Health Questionnaire 2-item; GAD2 = Generalized Anxiety Disorder 2-item			

Malnutrition Screening Tool Scores

The raw MST scores for all are in Supplementary Table S1. H-MST (score $\geq 2-5$) was present in 1,002 (28%); 2%=5, 4%=4, 22%=2–3. H- versus L-MST scores by demographics and symptom burden are in Table 1. Figure 2 provides H-MST prevalence by cancer diagnostic group.

Multivariate Analysis for Predictors of High-MST

Univariate logistic regression for H-MST identified age ≥ 65 , Black race, cancer diagnostic group, male sex, stage IV disease, and higher symptom scores to be associated with a greater probability of H-MST. As shown in Table 2, multivariate regression confirmed Black race, cancer diagnostic group, low BMI, and stage IV disease to be independently associated with H-MST. Additionally, higher scores for depression, distress, fatigue, and trouble eating/swallowing were all independently associated with H-MST whereas anxiety, constipation/diarrhea, nausea/vomiting, and pain were not.

Table 2

Multivariate Logistic Regression for Probability of High MST by Demographics and Symptom Burden

			Multivariable Results	
Factor	Reference Level	Factor Level	OR (CI)	P-Value
Race				< 0.001
	White	Black	1.91 (1.52, 2.39)	
		Other	1.26 (0.69, 2.29)	
Diagnosis				< 0.001
	Breast	Upper GI	5.72 (4.12, 7.93)	
		Lower GI	4.69 (3.39, 6.52)	
		Thoracic	3.25 (2.38, 4.44)	
		GYN	2.59 (1.83, 3.67)	
		GU	2.08 (1.48, 2.92)	
		Other	2.03 (1.46, 2.82)	
		H&N	1.63 (1.00, 2.65)	
Stage	I – III	IV	1.76 (1.43, 2.16)	< 0.001
BMI				< 0.001
	≥ 30	< 18.5	4.16 (2.50, 6.91)	
		≥ 18.5, < 25	2.13 (1.71, 2.65)	
		≥ 25, < 30	1.19 (0.95, 1.49)	
Distress	No	Yes	1.25 (1.01, 1.54)	0.040
Depression	No	Yes	1.33 (1.06, 1.67)	0.014
Fatigue	Continuous	–	1.15 (1.11, 1.19)	< 0.001
Trouble eating or swallowing	Continuous	–	1.22 (1.18, 1.26)	< 0.001
Abbreviations: MST = malnutrition score tool; N = number; OR = odds ratio; CI = confidence interval; GI = gastrointestinal; GYN = gynecologic; GU = genitourinary; H&N = head and neck; BMI = body mass index; EtOH = alcohol				

Discussion

In this US cohort of over 3,000 ambulatory solid tumor patients, nearly one-third were at high risk for MN at diagnosis. There was significant variation with the greatest risk of MN in those with lower GI, upper GI,

and thoracic cancers, advanced stage disease, Black race, and higher symptom scores.

These striking results are consistent with oncology cohort studies, particularly those that included early-stage disease and breast cancer.²⁸⁻³⁰ Despite nearly one-third being at high risk of MN, our observed rate is lower than other studies which suggests variation in prevalence is driven by the specific oncology population. For example, in the prospective Italian PreMiO study, of nearly 2,000 ambulatory solid and hematologic cancer patients, 51% had MN based on the mini nutritional assessment, a validated measure of nutritional status in the elderly.⁷ This study, unlike the current analysis, included more GI cancers and higher rates of stage IV disease, both factors associated with higher rates of MN.

A notable observation was the high rates of MN in those with high BMI. Of those classified as overweight or obese by BMI, H-MST was observed in 24% and 20%, respectively. The obesity epidemic means 40–60% of all new cancer diagnoses present in those with obesity, and this new clinical picture likely reduces the identification of MN by practicing clinicians. A portion of these malnourished obese patients will have sarcopenia which is associated with poor oncologic outcomes.^{31,32} This further highlights the importance of MN screening and evaluation of sarcopenia in all cancer patients independent of weight or BMI at diagnosis.

Unique to this analysis and related to our catchment area, Black patients accounted for one-fifth of those studied. They had numerically higher H-MST rates than White or other races and this was independently associated with a nearly two-fold increase in high MN risk. Smaller US cancer studies using varied screening tools have not reported the prevalence of MN by race.^{30,33} Notably, Black race is correlated with higher MN rates in community-dwelling older adults in non-cancer populations.³⁴ Sociodemographic factors, not included in the current analysis, disproportionately affects racial minorities and might also account for our findings and should be explored further in future investigations. The demographics analyzed suggest generalizability of these findings to other diverse US communities.

Aging, changes in end-organ function, and body composition remain well-documented risk factors for MN in non-cancer and cancer illnesses.³⁵⁻³⁷ In our sample, age was not an independent predictor of H-MST in multivariate analysis. We did, however, observe multiple symptoms to be independently associated with H-MST including depression, distress, fatigue, and trouble eating/swallowing. Studies of symptoms have observed their presence to be associated with a greater risk of MN, which appears to rise with age.³⁸

Although this study identified MN risk in a large US cancer center, certain limitations are noteworthy. As a goal was to evaluate the prevalence of MN risk by clinicodemographic variables, we limited the analysis to persons with complete case records. A sensitivity analysis of all subjects found similar MST distribution with 27% H-MST and therefore our complete case analysis is likely representative of the larger cohort (Supplementary Table S1). Additionally, this was a cross-sectional analysis and included MST scores only at diagnosis. Third, our analysis was based only on patient self-reported MST. Lastly, due to limitations of the institutional database, we were unable to analyze the impact of MN on short- and long-term oncologic outcomes like treatment tolerability and survival.

MN screening remains uncommon in routine clinical care.^{39,40} The high risk of MN in this cohort, including those with high BMI at diagnosis, support routine MN screening at diagnosis. Future studies should evaluate ongoing screening throughout the cancer trajectory. Understanding such findings will inform future interventional studies targeting MN early, cost-benefit analyses, registered dietitian nutritionist staffing patterns, and health outcomes in oncology.

Conclusions

Nearly one-third of solid tumor oncology outpatients at diagnosis who are screened are at high risk of MN. There was significant variation in MN risk by cancer site, stage, race, and greater symptom burden. This is the largest study of MN screening within a US ambulatory oncology population. These findings support current efforts to standardize MN screening to optimally target nutritional resource allocation to the highest risk groups early in their cancer trajectories.

Abbreviations

N
number; EDS = electronic distress screening; BMI = body mass index.

Declarations

Funding: This study was not funded.

Conflicts of interest/Competing interests: All authors report no conflicts of interest specific to the content of the submitted manuscript.

Availability of data and material: NA

Code availability: NA

Author Contributions/CRediT:

Kunal C. Kadakia: Conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing – original draft, and writing – review and editing.

James T. Symanowski: Data curation, formal analysis, methodology, validation, and writing – review and editing.

Aynur Aktas: Conceptualization, writing – original draft, and writing – review and editing.

Michele L. Szafranski: Conceptualization, writing – original draft, and writing – review and editing.

Jonathan C. Salo MD: Writing – original draft, and writing – review and editing.

Patrick L. Meadors: Conceptualization, methodology, writing – original draft, and writing – review and editing.

Declan Walsh: Conceptualization, methodology, writing – original draft, and writing – review and editing.

Ethics approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate: NA. Informed consent was not obtained as this was a retrospective study.

Consent for publication: NA

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Figures

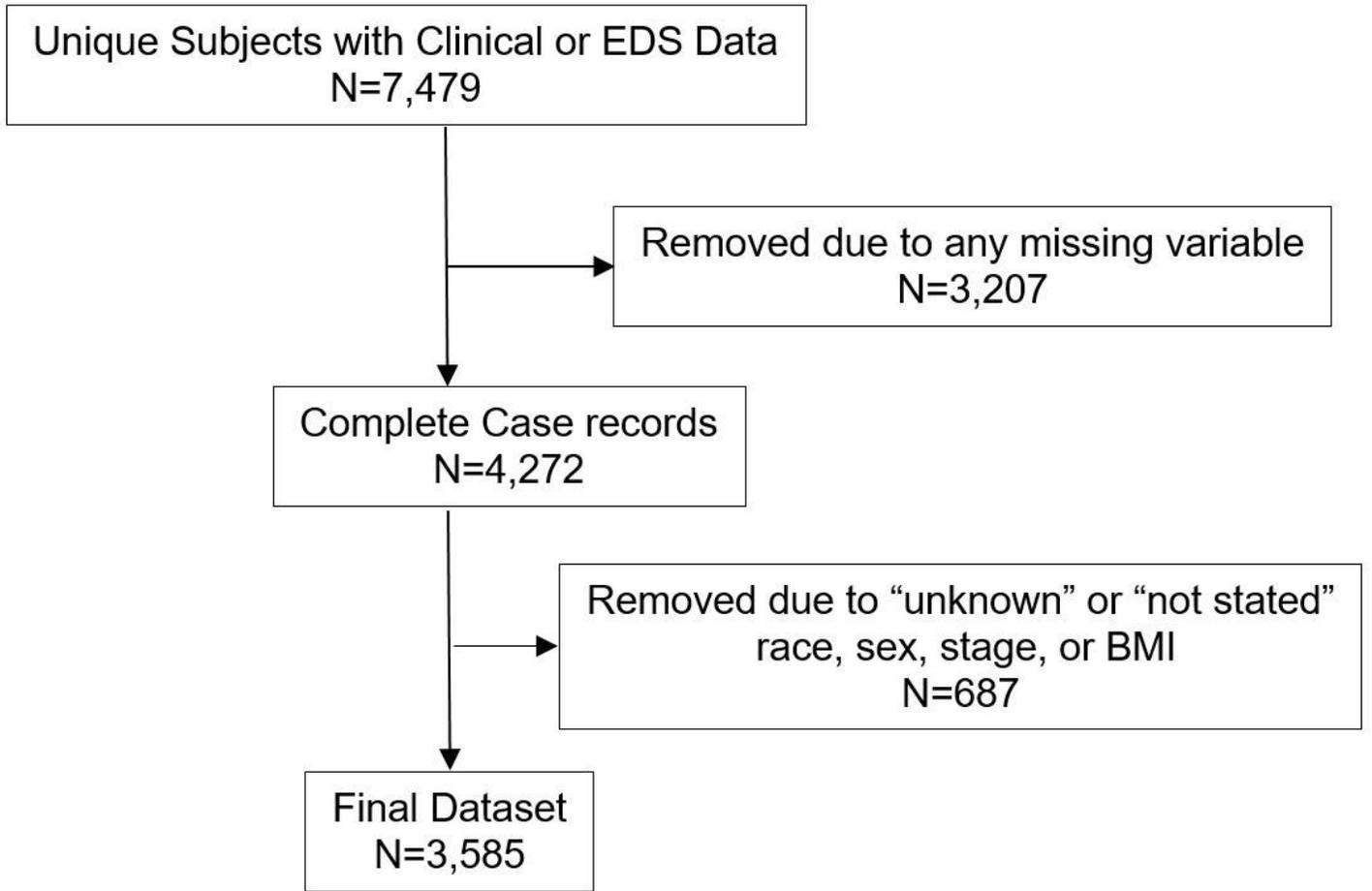


Figure 1

Patient Flow

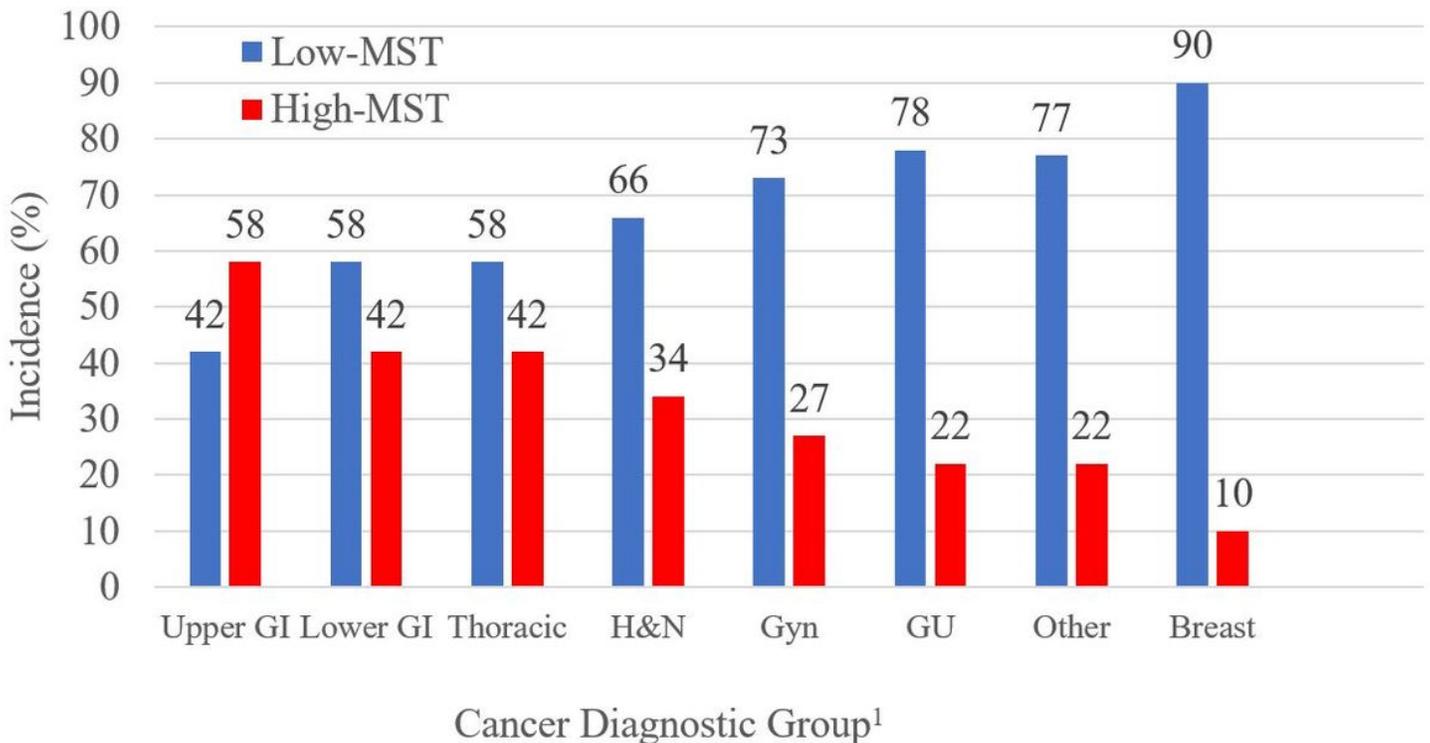


Figure 2

Prevalence of High versus Low MST by Cancer Diagnostic Group

Supplementary Files

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