

Nutritional Risk Stratification, Functional Impairment, and Symptom Burden Among Cancer Patients: An Integrative Study on PG-SGA Scoring and Biochemical Profiling

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Research Article

Keywords: Cancer, malnutrition, PG-SGA, nutritional status, body composition, biochemical data

Posted Date: October 13th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10897169/v1>

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Additional Declarations: No competing interests reported.

Nutritional Risk Stratification, Functional Impairment, and Symptom Burden Among Cancer Patients: An Integrative Study on PG-SGA Scoring and Biochemical Profiling

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Abstract

Cancer patients suffer from malnutrition, which adversely affects treatment tolerance, quality of life, and survival. PG-SGA (Patient-Generated Subjective Global Assessment) is a validated tool for identifying nutritional risk, but its application remains unexplored in a range of clinical settings, including Pakistan. It was intended to investigate the association between clinical, dietary, and functional factors and malnutrition among cancer patients undergoing treatment. The study involved 300 adult cancer patients (ages 18-65) at a public tertiary care oncology hospital. The PG-SGA was used to assess nutritional status. The collected data included demographics, cancer type and stage, food intake, nutrition impact symptoms, clinical data and physical activity.

The prevalence of malnutrition (PG-SGA B/C) was 42.7%, with 19.3% severely malnourished. A significant association was found between advancing cancer stage and worsening nutritional status ($\chi^2(6)=31.99$, $p<0.001$). Dietary patterns were strongly predictive; patients with reduced food

intake were significantly more likely to be malnourished compared to those with stable intake (67.3% vs. 27.7% in PG-SGA B/C; $\chi^2(4)=53.14$, $p<0.001$). A graded deterioration was observed as diet quality declined from normal food to minimal intake ($\chi^2(6)=42.03$, $p<0.001$). Furthermore, declining physical function and objective signs of muscle wasting on physical exam showed a strong, progressive association with higher PG-SGA categories. The prevalence of malnutrition is high, and it has been linked to disease progression, inadequate dietary intake, and functional decline. A PG-SGA is effective at identifying at-risk patients. A comprehensive nutritional screening program and early, targeted dietetic interventions are necessary for improving clinical outcomes in oncology.

Keywords: Cancer, malnutrition, PG-SGA, nutritional status, body composition, biochemical data

1. Introduction

Globally, cancer continues to impose a threateningly challenges, contributing substantially to morbidity and mortality, with implications extending from the direct effects of the disease itself to the complex interaction among pathophysiology, therapeutic interventions, and nutritional well-being. Nutrition is essential in oncology care, as it critically influences patient prognosis, treatment adherence, and overall quality of life [2, 10]. Malnutrition characterizes a prevalent and significant issue within this patient demographic, leading to adverse clinical outcomes, raised mortality rates, compromised quality of life, and amplified treatment-related morbidity [6, 22, 47]. Severe weight loss is a prominent factor of malnutrition, with a high prevalence of up to 80% among patients with upper gastrointestinal cancers, and is similarly observed in those with pancreatic cancer [30, 39]. The development of malnutrition in cancer patients is complex, stemming from multiple factors. The disease itself can trigger metabolic changes, including increased fat breakdown

(lipolysis), insulin resistance, and heightened protein turnover throughout the body. These processes collectively result in a progressive wasting condition known as cancer cachexia [4, 17]. At the same time, various "nutrition impact symptoms" such as anorexia, nausea, vomiting, dysgeusia, dysphagia, stomatitis, and pain directly interfere with the ability to eat. This interference creates a vicious cycle that further deteriorates nutritional status [32, 44]. Furthermore, cancer treatments like chemotherapy, radiotherapy, and surgery often have side effects that worsen these symptoms and further complicate the dietary patterns and nutrient absorption [1]. Malnutrition has profound consequences, weakening the immune system, reducing physical strength and functional capacity, decreasing tolerance to anti-cancer therapies, and independently contributing to poor survival rates [34]. Therefore, early identification and management of nutritional deficits are crucial. International clinical guidelines from the ESPEN and ASPEN recommend regular nutritional screening and assessment throughout the course of care for individuals with cancer [3, 33]. In malnourished patients, preoperative nutritional support has been shown to improve surgical outcomes [43].

The Patient-Generated Subjective Global Assessment (PG-SGA) has emerged as a gold-standard, validated tool for the comprehensive assessment of nutritional status in cancer patients [14, 18]. It is primarily designed to recognize and analyze the risk of malnutrition at an early stage, facilitating timely and appropriate nutritional interventions [23]. Researchers have used the PG-SGA in many diverse cancer populations, reporting high rates of moderate to severe malnutrition, often exceeding 50%, and demonstrating that low PG-SGA scores correlate with a worse survival rate, increased chemotherapy toxicity, and longer hospital stays [11, 41].

Despite global literature confirming the prevalence and negative impact of malnutrition in cancer, regional and hospital-based studies are important to understand local epidemiology and guide

clinical practice. Cancer patients' nutritional status during active treatment is poorly described in many regions, including Pakistan. This study was therefore designed as a hospital-based cross-sectional research project to evaluate the nutritional status of cancer patients at a major tertiary care oncology centre in Lahore, Pakistan, using the PG-SGA. This research has been performed in an approach to fill in this key knowledge gap and to emphasize the need to integrate systematic nutritional assessment into routine oncology care for better patient outcomes. We hypothesized that advancing cancer stage, reduced dietary intake, and declining functional status would be independently and significantly associated with a higher risk of malnutrition (PG-SGA categories B or C) in this cohort. The objectives of the study were to evaluate the prevalence of malnutrition, the most common cancer types, functional impairment, weight change during treatment, and their correlation with nutritional status. This research has been performed in an approach to fill in this key knowledge gap and to emphasis the need to integrate systematic nutritional assessment into routine oncology care for better patient outcomes.

2. Materials and Methods

2.1. Study Design and Setting

Cancer patients receiving active treatment were evaluated in a cross-sectional study for their nutritional status and functional capacity. This cross-sectional study was conducted among cancer patients undergoing active anticancer treatment at the National Institute of Medical Oncology (INMOL) Hospital. Approximately 500 patients were assessed for eligibility during the study period. After initial screening, 450 patients were evaluated against predefined inclusion and exclusion criteria. Patients were excluded if they were younger than 18 years or older than 65 years, had an Eastern Cooperative Oncology Group (ECOG) performance status of IV, declined participation, or had other clinical or logistical constraints. A total of 330 patients met the eligibility

criteria and were enrolled in the study. Following data verification and exclusion of incomplete records, 300 participants were included in the final analysis. The participant selection process is illustrated in Figure 1. Research was carried out with formal approval from the INMOL Cancer Hospital Institutional Ethics Committee, which approved a protocol (Approval No: 34502-RI-4930). The research was approved by the Research Ethics Committee of Grand Asian University, Sialkot (Protocol No. #GAUS-R25 445402-1950), and data procedures were also supervised by UVAS-Lahore experts. All participants provided informed consent before being included in the study. The privacy of patient data was respected during the study.

2.2. Study Participants and Sampling

In total, 300 cancer patients were recruited through convenience sampling (Figure 1). The study included participants who were aged 18 to 65 years, diagnosed with cancer (stage I-IV), and receiving or scheduled to receive anticancer treatment (e.g., chemotherapy, radiotherapy). Participants in the interview process were required to be communicative and capable of taking part in the process. Health problems (e.g., ECOG Performance Status IV), an inability to communicate effectively, and an unwillingness to participate were considered exclusion criteria.

Figure 1. STROBE-Compliant Flow Diagram of Participant Selection

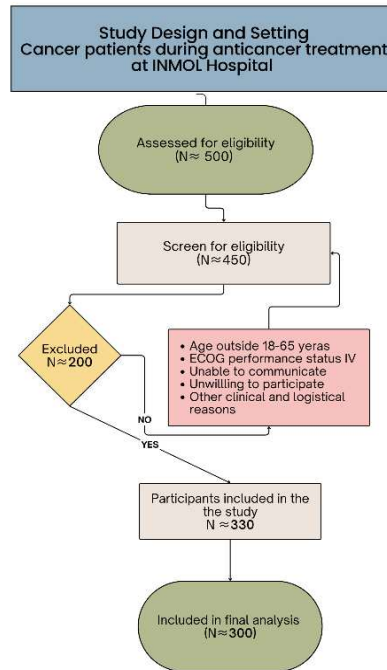


Figure 1. STROBE-compliant flow diagram showing participant selection and inclusion in the cross-sectional study of cancer patients at INMOL Cancer Hospital, Lahore (July 2024–July 2025). A total of 500 patients were initially assessed for eligibility. After applying inclusion and exclusion criteria (age 18–65 years, ECOG performance status < IV, and willingness to participate), 330 patients were enrolled. Following data verification and exclusion of incomplete records, 300 participants were included in the final analysis. ECOG = Eastern Cooperative Oncology Group performance status.

2.3. Data Collection

Data collection was carried out by structured interview, review of the patient's medical file, and physical examination in the time duration between July 2024 to July 2025. The main assessment tool for the nutritional evaluation was the scored Patient-Generated Subjective Global Assessment (PG-SGA) during the treatment phase patients.

2.3.1. Demographic and Clinical Data

Information on age, gender, cancer type, cancer stage, and treatment modality were extracted from the patient's hospital record and patients' files. The respondents were divided into three age brackets, specifically; 18-35 years, 36-50 years, and 51-65 years.

2.3.2. Anthropometric Measurements:

The current body weight was measured by using a digital weighing scale, and the height was measured in centimeters. Body Mass Index was computed using a digital BMI application on the spot. Past weight status, one month and six months, was obtained from the patient's file and was used to calculate weight change.

2.3.3. Nutritional Assessment using PG-SGA

Nutritional status was evaluated by scoring PG-SGA, which was conducted as a planned interview. There are two main sections to this assessment tool, the first is patient-generated and contains four boxes to assess weight history (current, one-month, and six-month weight for percentage of weight loss); dietary intake (changes in usual food intake ranging from regular food intake to normal-appearing but no oral intake or minimal liquid diet with supplements or tube feeding); nutrition impact symptoms; and activity & function.

2.3.4. Professional Assessment Component

Professional assessment part entailed a physical examination by the researcher to examine three main areas of body composition namely muscle condition, by measuring how stores are found in the standard sites such as; temporalis, clavicle, acromion, scapula, quadriceps, interosseous and calf muscles; fat stores, which were assessed by the presence of fat over the ribs, fat over the triceps and fat over the orbital fat pads; and fluid status, which were measured by examining the presence of edema or ascites. Based on the total score of all the elements of the PG-SGA, patients would

then be categorized into one of the three global categories, SGA-A (Well-nourished), SGA-B (Moderately or suspected of being malnourished) and SGA-C (Severely malnourished).

2.4. Statistical Analysis

Data analysis was performed using IBM SPSS version 20.0 (Armonk, NY, USA). The descriptive statistics to describe demographic, clinical, and nutritional characteristics on the basis of frequencies, percentages, means, and standard deviations. PG-SGA categories were examined by Chi-square tests to determine whether they are associated with cancer types or BMI classifications. The graphical representation conducted with the GraphPad Prism Pro version 10.6.1. Statistical significance was determined by a *p*-value less than 0.05.

3. Results

3.1. Demographic and Age Groups of the Study Population

In this cross-sectional study, 300 cancer patients who were actively undergoing treatment were included. A summary of the demographic aspects of the participants was presented into the Figure 2. The total number of participants were 174 (58%) males and 126 (42%) females. The respondents of the three age brackets were distributed as 18-35 years 48 (16.0%), 36-50 years 110 (36.7%), and 51-65 142 (47.3%) participants, respectively. This implies that the majority of the study population was in the older age group (51-65 years). An age-based gender analysis revealed that males formed a higher percentage (94, 31.3% of the total) than females (48, 16.0% of the total) among patients aged 51-65 years.

Figure 2. Demographic and Age Group Characteristics of Study Participants

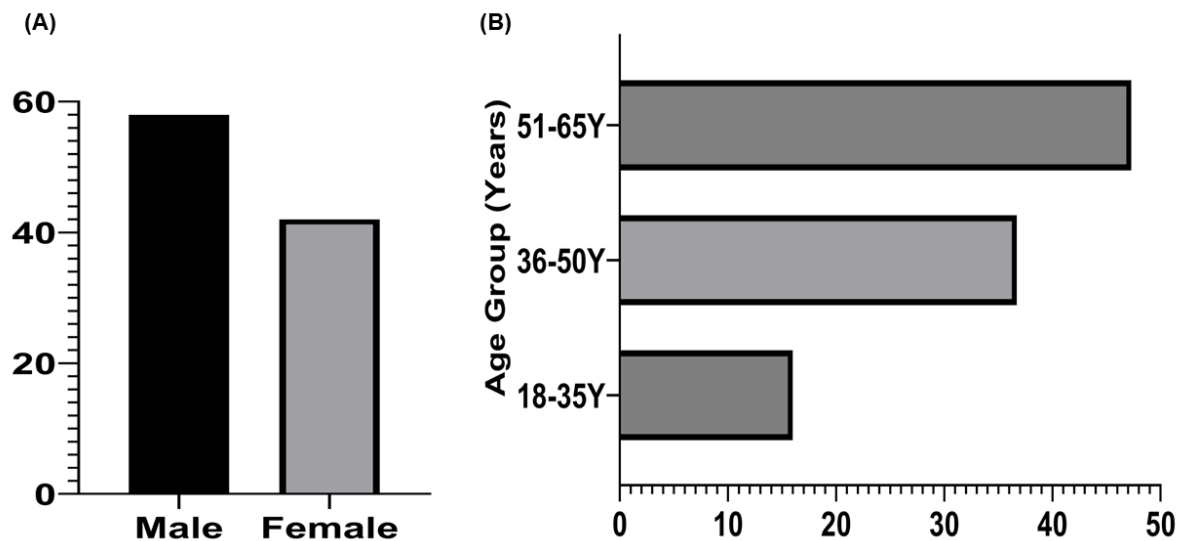


Figure 2. Demographic characteristics of the 300 cancer patients included in the study, stratified by gender and age group. The cohort comprised 174 males (58%) and 126 females (42%). Participants were categorized into three age groups: 18–35 years (16.0%), 36–50 years (36.7%), and 51–65 years (47.3%). The majority of the study population was in the older age group (51–65 years). Among patients aged 51–65 years, males constituted a higher proportion (31.3%) compared to females (16.0%).

3.2. Body Mass Index (BMI) Distribution

The Body Mass Index (BMI) of the participants was categorized based on the traditional WHO categorization to give a first estimate of the nutritional status. The general distribution in the cohort is shown in Table 1.

Most of the patients were classified as under the 'Normal' weight category (116 patients, 38.7%), then the 'Overweight' (82 patients, 27.3%) and the Obese (54 patients, 18.0%). One point six point zero per cent (16.0) of the study population was underweight, 12.0 per cent (n=36) of whom were Underweight and 4.0 per cent (n=12) severely Underweight.

179 Upon age and gender stratification, some interesting patterns were observed. The highest
180 prevalence of Underweight was found in males at the oldest age group (51-65 years), with 6.7%
181 (n=20) being 'Underweight' and 1.3% (n=4) being 'Severely Underweight'. On the other hand,
182 females in the 36-50 years range registered the highest prevalence rate of obesity at 6.0 per cent
183 (n=18) of the total population. The normal BMI category was mainly comprised of males (14.0
184 n=42) in the 51-65 years group.

185 **Table 1.** Distribution of Body Mass Index (BMI) Categories Among 300 Cancer Patients
186 Undergoing Active Treatment at INMOL Cancer Hospital, Lahore, Stratified by Age and Gender

Age Group (Years)	Gender	Severely Underweight n (%)	Underweight n (%)	Normal n (%)	Overweight n (%)	Obese n (%)
18-35	Male	4 (1.3)	2 (0.7)	12 (4.0)	2 (0.7)	2 (0.7)
	Female	2 (0.7)	0 (0.0)	10 (3.3)	8 (2.7)	6 (2.0)
36-50	Male	0 (0.0)	10 (3.3)	22 (7.3)	22 (7.3)	4 (1.3)
	Female	2 (0.7)	2 (0.7)	14 (4.7)	16 (5.3)	18 (6.0)
51-65	Male	4 (1.3)	20 (6.7)	42 (14.0)	14 (4.7)	14 (4.7)
	Female	0 (0.0)	2 (0.7)	16 (5.3)	20 (6.7)	10 (3.3)

Data are presented as n (%). BMI categories are based on World Health Organization (WHO) classification: Severely Underweight (<16.0 kg/m²), Underweight (16.0–18.49 kg/m²), Normal (18.5–24.9 kg/m²), Overweight (25.0–29.9 kg/m²), and Obese (≥ 30.0 kg/m²). N = total number of participants. Percentages are calculated within each age and gender subgroup.

3.3. Prevalence of Weight Change

The weight change assessment was an important element of the PG-SGA that showed that the prevalence of weight loss was high among the participants of the study. As shown into the Figure 2, 50.0% (n=150) of the cohort indicated that they had reduced body weight during the period prior to the assessment. Eighty patients (26.7%) and 70 patients (23.3%), respectively, reported a stable weight and weight gain.

3.4. Distribution of Cancer Stages

The distribution of cancer stages in the 300 patients who were enrolled Figure 3 (B). The statistics indicate that most of the patients were diagnosed at the early stages of the disease. The most prevalent was Stage I, which comprised 110 patients (36.7%), then Stage II constituted 90 patients (30.0%). There is an apparent negative correlation with progression of the stage, with higher stages being less common, with Stage III having 68 (22.7%) patients and Stage IV having the lowest number at 32 (10.7%). In figure 3 (B), the distribution is graphically highlighted by a downward stepwise slope in the number of patients between the Stage I and Stage IV.

Figure 3. Distribution of Cancer Stages

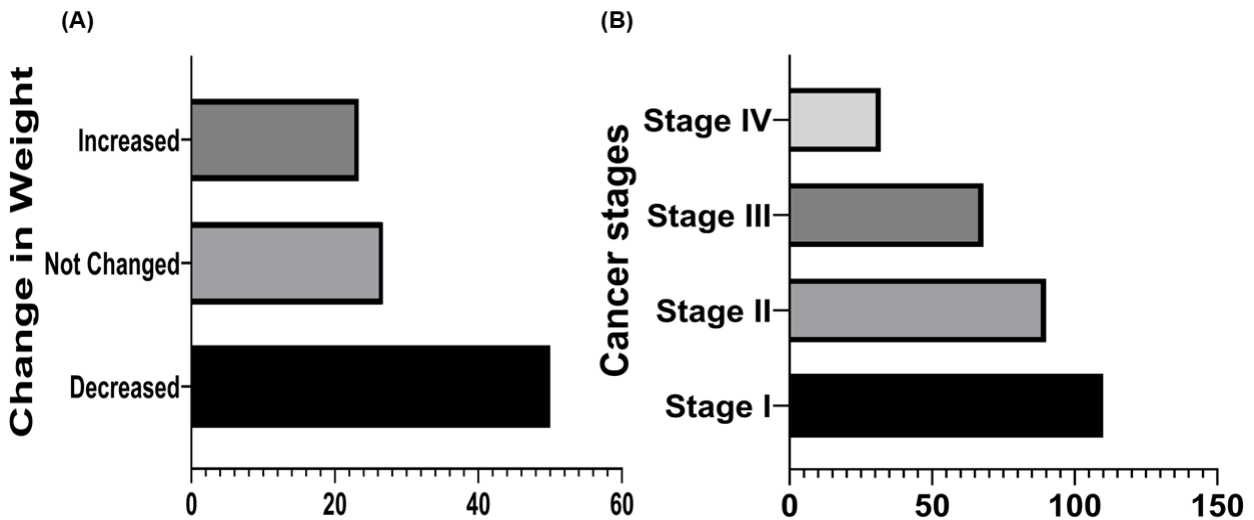


Figure 3. Distribution of cancer stages among 300 cancer patients at INMOL Cancer Hospital, Lahore. Stage I was the most common (36.7%, n=110), followed by Stage II (30.0%, n=90), Stage III (22.7%, n=68), and Stage IV (10.7%, n=32). A clear inverse relationship with stage progression is observed, showing a descending stepwise pattern in patient numbers from Stage I to Stage IV, indicating that most patients were diagnosed at earlier stages of the disease.

3.5. Distribution of Cancer Types

The results of the study describe the range of cancer types diagnoses among the all-ongoing treatment participants (Table 2). They have found 24 different types of cancer, with the prevalent single malignancy of breast cancer, which occurs in 66 patients (22.0%). This was succeeded by bladder cancer (10.0%), prostate and colon cancer were also as frequent (8.7% each). Most of the cancer cases were captured in the ten most common ones (74.0%). The other 14 types, with cancer being multiple myeloma, brain tumour, ovarian cancer, and lymphomas, each with 2.7% of the cohort, were combined, forming 26.0% (n=78) of the study population. The lowest cancer rate was in the rectum, which was presented in only 0.7% of patients.

Table 2. Frequency and Distribution of the Most Prevalent Cancer Types Among 300 Cancer Patients Undergoing Active Treatment at INMOL Cancer Hospital, Lahore

Rank	Cancer Type	Number of Patients (n)	Percentage (%)
1	Breast Cancer	66	22.0
2	Bladder Cancer	30	10.0
3	Prostate Cancer	26	8.7
4	Colon Cancer	26	8.7
5	Lung Cancer	20	6.7
6	Skin Cancer	12	4.0
7	Pharyngeal Cancer	10	3.3
8	Metastatic Cancer	10	3.3
9	Multiple Myeloma	8	2.7
10	Brain Tumor	8	2.7
	Other Cancers†	78	26.0

Data are presented as n (%). †Other Cancers (combined n=78, 26.0%) include: Ovarian, Testicular, Nasopharyngeal, Lymphoma of Head, Thyroid, Laryngeal, Oral, Hodgkin Lymphoma, Tonsil Lymphoma, Neck, Liver, Leukemia, Retinoblastoma, and Rectal Cancer. Percentages may not sum to 100.0% due to rounding. N = total number of participants.

3.6. Prevalence of Nutrition Impact Symptoms

Patients report of the prevalence of Nutrition Impact Symptoms (NIS) is summarized in Figure 4. Disease fatigue was the most common symptom observed, affecting most of the cohort (73.3%, n=220). This was followed by pain (54.0%) and constipation (47.3%). High prevalence was also observed for dry mouth (46.7%) and depression (45.3%).

In contrast, several symptoms important to oral intake were less common, with most patients reporting the absence of problems with eating (79.3%), nausea (90.0% absent), vomiting (95.3% absent), swallowing food (94.0% absent), and early satiety (94.0% absent). Altered taste was

reported by 13.3% of patients with mouth sores, and lack of appetite was reported by 17.3% and 18.0% of patients, respectively.

Figure 4. Prevalence of Nutrition Impact Symptoms

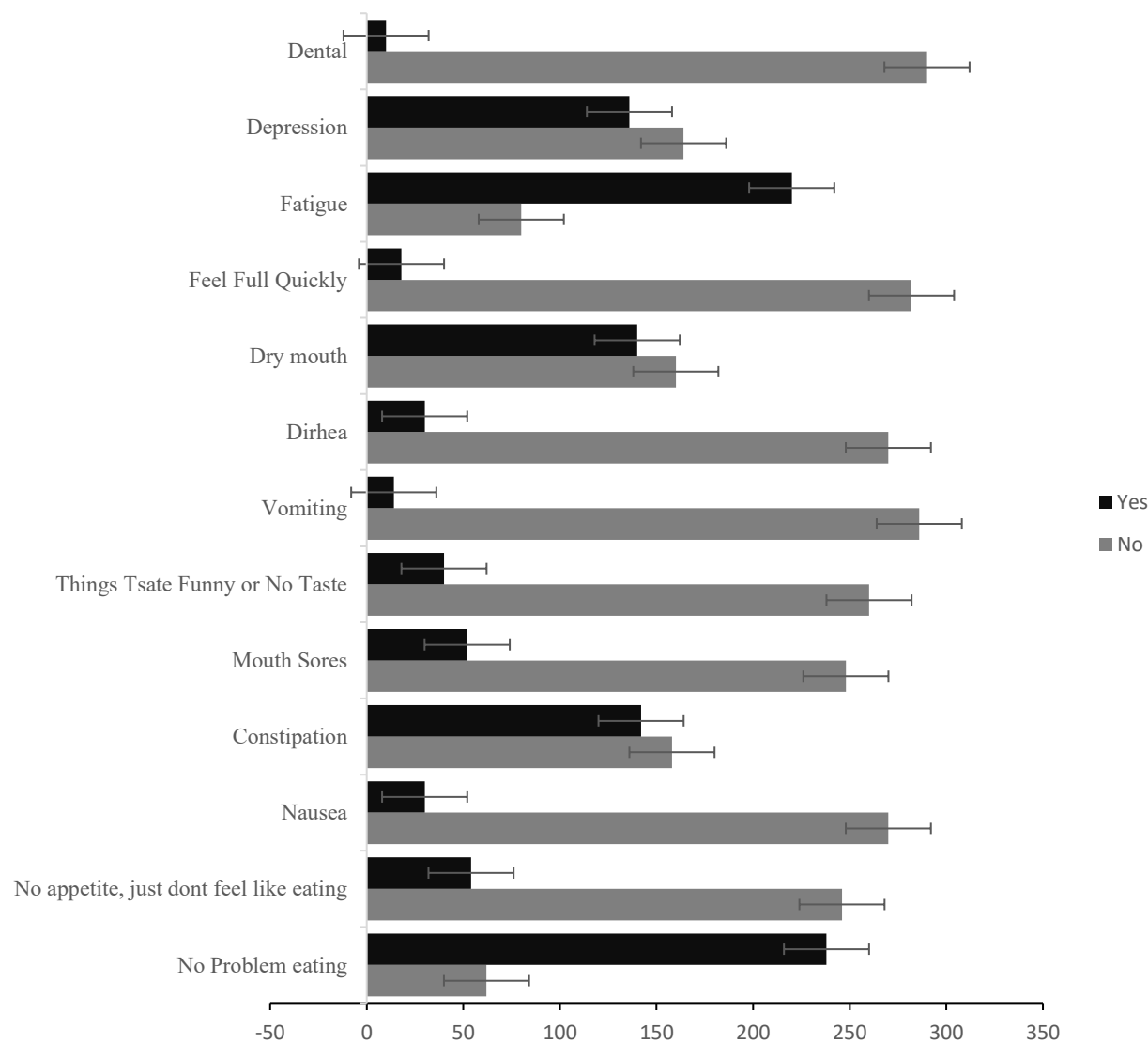


Figure 4. Prevalence of nutrition impact symptoms (NIS) reported by 300 cancer patients undergoing active treatment. Fatigue was the most common symptom (73.3%, n=220), followed by pain (54.0%, n=162), constipation (47.3%, n=142), dry mouth (46.7%, n=140), and depression

(45.3%, n=136). Other symptoms included lack of appetite (18.0%, n=54), mouth sores (17.3%, n=52), altered taste (13.3%, n=40), nausea (10.0%, n=30), diarrhea (10.0%, n=30), problem swallowing (6.0%, n=18), early satiety (6.0%, n=18), vomiting (4.7%, n=14), and dental problems (3.3%, n=10). Symptoms important to oral intake (nausea, vomiting, swallowing, early satiety, and altered taste) were less common. NIS = Nutrition Impact Symptoms.

3.7. Food Intake Patterns During Treatment

Dietary patterns during anti-cancer treatment showed a significant change in food consumption. When asked about the overall change, 55.3% (n=166) of the patients reported their intake to be 'Unchanged', while 36.7% (n=110) reported a 'Decrease' in overall food intake, and only 8.0% (n=24) reported an 'Increase'. A more detailed history of food intake, shown in Table 3 below, may give further granularity to these changes. All the patients with the most frequent pattern of consuming 'normal food, but less than the normal amount' was 67.3% (n = 202), followed by 20.0% (n=60) who were limited to 'little solid food', 10.0% (n=30) reported eating 'very little of anything'. There were a few patients, 2.7% (n=8), who lived solely on liquids. It is important to note that no patients in this cohort were exclusively reliant on nutritional supplements, tube feeding, or parenteral nutrition at the time of assessment. Although oral intake was maintained by most (90.0%), a significant majority consumed suboptimal quantities or differ types of foods.

Table 3. Self-Reported Changes in Food Intake and Dietary Patterns Among 300 Cancer Patients Undergoing Active Treatment at INMOL Cancer Hospital, Lahore

Category	Variable	Number of Patients (n)	Percentage (%)
Change in Overall Intake	Unchanged	166	55.3

Category	Variable	Number of Patients (n)	Percentage (%)
Type of Food Consumed	Decreased	110	36.7
	Increased	24	8.0
	Normal food, but less than normal amount	202	67.3
	Little solid food	60	20.0
	Very little of anything	30	10.0
	Only liquids	8	2.7
	Only nutritional supplements	0	0.0
	Only tube feedings or parenteral nutrition	0	0.0

Data are presented as n (%). Food intake categories are based on the Patient-Generated Subjective Global Assessment (PG-SGA) questionnaire. Percentages in the "Change in Overall Intake" section are calculated out of the total cohort (N=300). Percentages in the "Type of Food Consumed" section are also calculated out of the total cohort. N = total number of participants.

3.8. Physical Activity and Functional Status During Treatment

According to the assessment of physical activity and functional status, cancer patients had significant limitations. As presented in Table 4, only 38.7% (n=116) of subjects reported a 'Normal' activity level with no limitations. The majority of the cohort (61.3%) experienced some degree of functional impairment. Specifically, 29.3% (n=88) reported they were 'Not my normal self, but able to be up and about with fairly normal activities,' while 19.3% (n=58) were 'Not feeling up to

most things.' A notable proportion of patients, 12.7% (n=38), were severely limited, being 'Able to do little activity and spending most of the day in bed or chair.' No patients were reported as being completely bedridden.

Table 4. Self-Reported Physical Activity and Functional Status Levels Among 300 Cancer Patients Undergoing Active Treatment at INMOL Cancer Hospital, Lahore

Physical Activity Level	Number of Patients (n)	Percentage (%)
Normal with no limitations	116	38.7
Not my normal self, but able to be up and about with fairly normal activities	88	29.3
Not feeling up to most things, but in bed or chair less than half the day	58	19.3
Able to do little activity and spend most of the day in bed or chair	38	12.7
Pretty much bedridden, rarely out of bed	0	0.0

Data are presented as n (%). Physical activity levels are based on the Patient-Generated Subjective Global Assessment (PG-SGA) questionnaire. N = total number of participants. Percentages may not sum to 100.0% due to rounding.

3.9. Metabolic Demand Factors

The assessment of factors that increase metabolic demand is summarized in Figure 5. A high level of stress was the most commonly reported factor, affecting 33.3% (n=100) of the cohort, while only 18.0% (n=54) reported no stress. The prevalence of fever was low, with 86.0% (n=258) of patients being afebrile; 13.3% (n=40) had a low-grade fever (>99°F and <101°F). Regarding corticosteroid use, the majority of patients (88.7%, n=266) were not on any corticosteroid therapy.

However, 9.3% (n=28) were on a low dose (<10 mg prednisone equivalents/day), and 2.0% (n=6) were on a moderate dose.

Figure 5. Prevalence of Metabolic Demand Factors

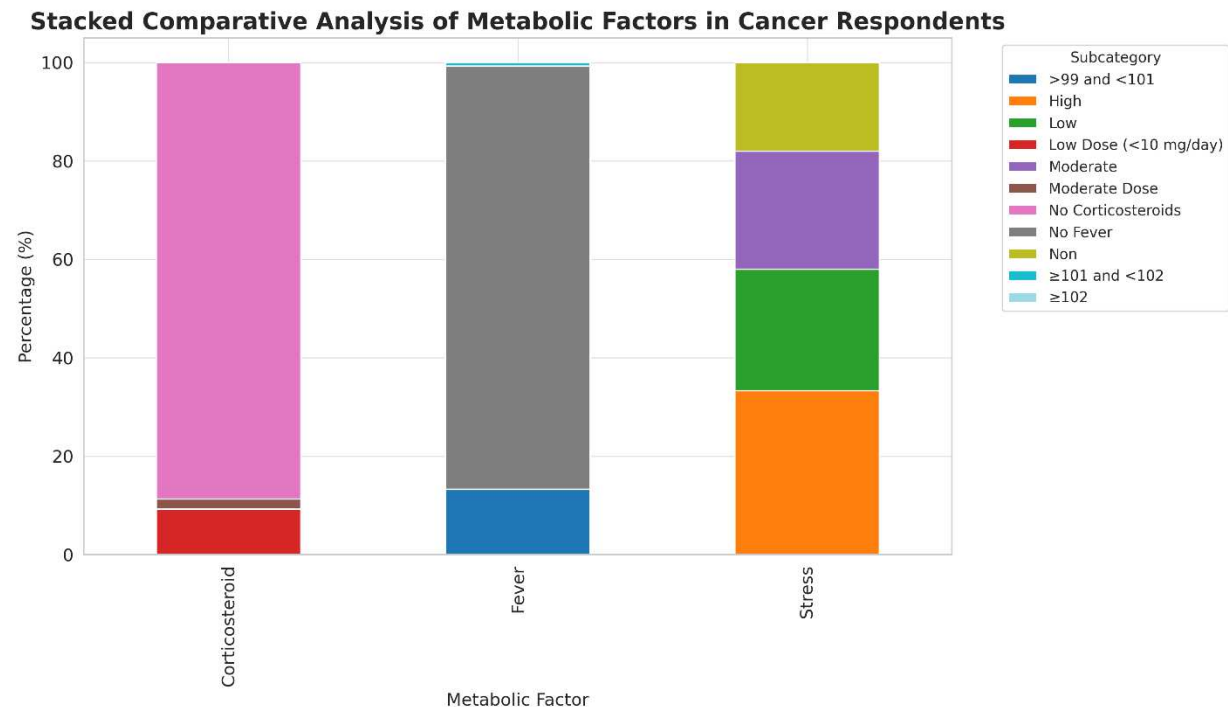


Figure 5. Prevalence of metabolic demand factors among 300 cancer patients. A high level of stress was the most commonly reported factor (33.3%, n=100), followed by low (24.7%, n=74) and moderate (24.0%, n=72) levels. Only 18.0% (n=54) reported no stress. Fever was uncommon, with 86.0% (n=258) being afebrile; low-grade fever (>99°F and <101°F) was reported by 13.3% (n=40). Corticosteroid use was rare, with 88.7% (n=266) not on any corticosteroid therapy; 9.3% (n=28) were on a low dose, and 2.0% (n=6) were on a moderate dose. Stress level categories: None, Low, Moderate, and High. Fever categories: No Fever, >99°F and <101°F, ≥101°F and <102°F. Corticosteroid use categories: No Corticosteroids, Low Dose (<10 mg prednisone equivalents/day), Moderate Dose (10–30 mg prednisone equivalents/day).

3.10. Physical Examination Findings

Assessment of deficits in muscle, fat, and fluid status by subjective clinical judgment was made by physical examination. The overall PG-SGA score ratios from the assessment are presented in Figure 6. The majority of patients, 68.7% (n=206), were rated as having 'No Deficit.' A large

percentage, 31.3%, of this population had some degree of tissue depletion. Of these, 16.0% (n=48) were rated as having a 'Mild Deficit,' 8.0% (n=24) having a 'Moderate Deficit,' and 7.3% (n=22) being considered as having a 'Severe Deficit.'

Figure 6. Physical Examination Findings

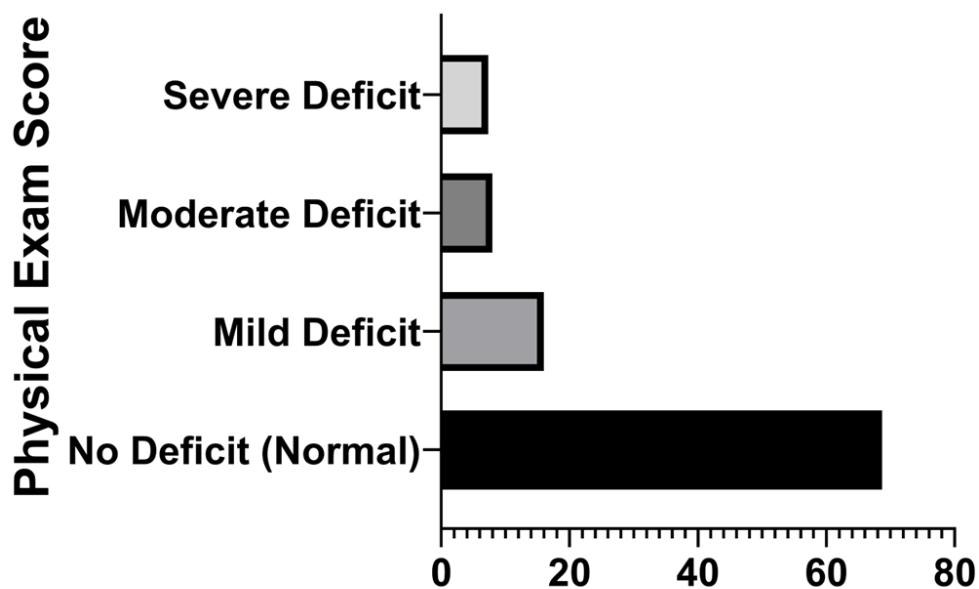


Figure 6: Global physical examination findings among 300 cancer patients based on PG-SGA assessment. The majority of patients (68.7%, n=206) were assessed as having no deficit. However, a significant proportion (31.3%) exhibited some level of tissue depletion: mild deficit (16.0%, n=48), moderate deficit (8.0%, n=24), and severe deficit (7.3%, n=22). Physical examination assessed deficits in muscle, fat, and fluid status through subjective evaluation of body composition. PG-SGA = Patient-Generated Subjective Global Assessment.

3.11. Global Nutritional Status by PG-SGA

The final PG-SGA global rating that summarizes information regarding the historical weight changes, the patients' symptoms, food intake, and physical examination findings, is shown in (Figure 7). The results reveal that there were 172 patients (57.3%) who were rated as well nourished (Stage A). The remaining patients, an abnormal 42.7%, were rated as malnourished. Of

these patients, 70 (23.3%) were moderately malnourished or suspected of being malnourished (Stage B) and 58 (19.3%) were severely malnourished (Stage C).

Figure 7. Global Nutritional Status by PG-SGA

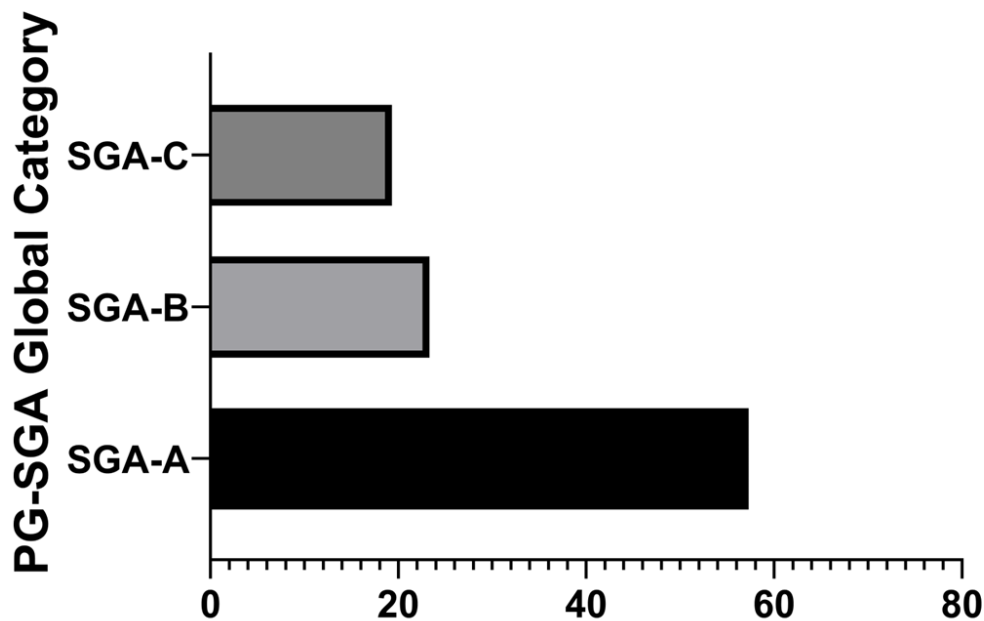


Figure 7. Nutritional status of 300 cancer patients as assessed by the Patient-Generated Subjective Global Assessment (PG-SGA). Overall, 172 patients (57.3%) were well-nourished (PG-SGA Stage A). However, 42.7% of the cohort was malnourished, with 70 patients (23.3%) moderately or suspected of being malnourished (Stage B) and 58 patients (19.3%) severely malnourished (Stage C). PG-SGA global rating synthesizes data from weight history, symptoms, food intake, and physical examination.

3.11. Factors Associated with Nutritional Status Based on Clinical and Dietary Data

Analysis of the entire cohort (N=300) demonstrated strong, statistically significant relationships between nutritional status and stage of cancer ($\chi^2(6)=31.99$, $p<0.001$), as well as dietary and food intake (Table 5). There was a strong association of nutritional status and stage of cancer ($\chi^2(6)=31.99$, $p<0.001$). The percentage of well-nourished patients (PG-SGA A) decreased sharply

from 76.4% in stage I to 38.2% in stage III, and there was a corresponding increase in the incidence of severe malnutrition (PG-SGA C) from 7.3% to 32.4%.

Dietary factors also predicted nutritional risk. Decreasing total food intake was strongly associated with nutritional risk ($\chi^2(4) = 53.14$, $p < 0.001$). In patients with unchanged intake 72.3% were well nourished, while in patients with decreased intake this figure dropped to 32.7% of whom 38.2% were in a state of severe malnutrition. The pattern of food eaten indicated a dose response relationship ($\chi^2(6) = 42.03$, $p < 0.001$). A normal food diet was associated with a 69.3% rate of well nourished. However, when the diet was changed to “little solid food” the percentage of satisfactorily nourished patients fell to 36.7%, and when it was “very little of anything” only 20.0% showed satisfactory nutrition, while 80.0% were moderately or severely malnourished. Close positive relations, Spearman’s rho, $p < 0.001$ for all, were found showing that advancing stage of disease, diminishing amount of food consumed, and deterioration in quality of diet were independently associated with progressive worsening of nutritive condition.

Table 5. Association of Cancer Stage, Food Intake, and Type of Food with Patient-Generated Subjective Global Assessment (PG-SGA) Categories Among 300 Cancer Patients at INMOL Cancer Hospital, Lahore

Variable	Category	PG-SGA A (Well Nourished) n (%)	PG-SGA B (Moderately Malnourished) n (%)	PG-SGA C (Severely Malnourished) n (%)	Total n (%)
Cancer Stage	Stage I	84 (76.4)	18 (16.4)	8 (7.3)	110 (100)
	Stage II	48 (53.3)	22 (24.4)	20 (22.2)	90 (100)

Variable	Category	PG-SGA A (Well Nourished) n (%)	PG-SGA B (Moderately Malnourished) n (%)	PG-SGA C (Severely Malnourished) n (%)	Total n (%)
Food Intake	Stage III	26 (38.2)	20 (29.4)	22 (32.4)	68 (100)
	Stage IV	14 (43.8)	10 (31.3)	8 (25.0)	32 (100)
	Unchanged	120 (72.3)	32 (19.3)	14 (8.4)	166 (100)
	More than Usual	16 (66.7)	6 (25.0)	2 (8.3)	24 (100)
	Less than Usual	36 (32.7)	32 (29.1)	42 (38.2)	110 (100)
Type of Food	Normal food	140 (69.3)	38 (18.8)	24 (11.9)	202 (100)
	Little solid food	22 (36.7)	18 (30.0)	20 (33.3)	60 (100)
	Only liquids	4 (50.0)	2 (25.0)	2 (25.0)	8 (100)
	Very little of anything	6 (20.0)	12 (40.0)	12 (40.0)	30 (100)

Data are presented as n (%). PG-SGA = Patient-Generated Subjective Global Assessment. Associations were evaluated using Pearson's chi-square test: Cancer Stage $\times$ PG-SGA, $\chi^2(6) = 31.99$, $p < .001$; Food Intake $\times$ PG-SGA, $\chi^2(4) = 53.14$, $p < .001$; Type of Food $\times$ PG-SGA, $\chi^2(6) = 42.03$, $p < .001$. A significant Spearman's rank correlation was observed between all three variables and PG-SGA category ($p < .001$ for all), indicating a monotonic trend. Percentages within each category row sum to 100%. N = total number of participants.

3.12. Comparing blood biochemical parameters across nutritional categories of the PG-SGA

The comparison of blood biochemical parameters among the PG-SGA nutritional status categories, using 300 subjects, revealed many significant associations. In this regard, the patients assigned to well-nourished (Stage A, n = 172) status had higher average serum albumin, prealbumin and protein levels than those at risk (Stage B, n = 70) or severely malnourished (Stage C, n = 58). Prealbumin ($p = 0.026$), TBIL ($p < 0.001$) and TBIL/DBIL ($p < 0.001$) indices exhibited the highest correlations with nutritional status, indicating that with increasing severity of malnutrition the hepatic function and protein reserves progressively deteriorate. Mild to moderate, yet significant differences were also seen in the activity of liver enzyme ALT, $p = 0.034$, and lymphocyte count, $p = 0.028$, which were decreased in malnourished groups. Other hematologic and biochemical parameters, including creatinine, urea, glucose, and lipid levels, showed mild fluctuations; however, these were not statistically significant. Overall, serum prealbumin, bilirubin, and lymphocyte levels could be sensitive biochemical markers reflecting nutritional impairment in hospitalized patients (Table 6).

Table 6. Comparison of Blood Biochemical Parameters Across Patient-Generated Subjective Global Assessment (PG-SGA) Nutritional Status Categories Among 300 Cancer Patients at INMOL Cancer Hospital, Lahore

Parameters	PG-SGA Stage A (n = 172)	Stage B (n = 70)	Stage C (n = 58)	F	P
TP (g/L)	66.45 ± 8.42	64.10 ± 6.71	64.98 ± 6.35	1.012	0.365
Cr (μmol/L)	74.88 ± 15.84	72.06 ± 14.60	73.02 ± 15.10	0.749	0.474
ALB (g/L)	38.72 ± 6.14	36.02 ± 4.63	36.84 ± 5.08	1.602	0.203
Urea (mmol/L)	4.81 ± 2.09	4.54 ± 2.33	4.69 ± 1.98	0.174	0.841
PA (mg/L)	227.15 ± 61.73	216.44 ± 62.11	199.52 ± 68.41	3.742	0.026*
TBIL (μmol/L)	8.91 ± 3.42	8.67 ± 3.26	10.93 ± 4.86	9.118	< 0.001 ***
DBIL (μmol/L)	2.71 ± 2.36	2.64 ± 1.47	3.14 ± 1.95	1.702	0.184
GLU (mmol/L)	5.04 ± 0.70	5.36 ± 1.31	5.22 ± 0.81	2.494	0.083

TG (mmol/L)	1.29 ± 0.67	2.13 ± 2.40	2.01 ± 1.42	0.559	0.573
AST (U/L)	26.47 ± 12.02	29.12 ± 18.30	27.88 ± 13.17	0.774	0.462
ALT (U/L)	37.15 ± 50.98	32.74 ± 34.85	24.09 ± 15.62	3.431	0.034*
HGB (g/L)	119.62 ± 16.35	117.92 ± 21.84	115.28 ± 18.93	0.694	0.050
WBC (×10⁹/L)	5.95 ± 2.31	6.84 ± 3.72	6.57 ± 2.95	2.816	0.060
NEUT (×10⁹/L)	3.90 ± 2.09	4.17 ± 2.19	4.63 ± 2.70	1.862	0.156
LYMPH (×10⁹/L)	1.46 ± 0.88	1.42 ± 0.75	1.18 ± 0.53	3.611	0.028*
RBC (×10¹²/L)	4.17 ± 0.73	3.94 ± 0.69	3.88 ± 0.59	2.603	0.075
PLT (×10⁹/L)	233.04 ± 108.25	235.81 ± 101.54	247.23 ± 84.56	0.731	0.483
NEUT/WBC	0.64 ± 0.19	0.66 ± 0.13	0.65 ± 0.18	0.962	0.382
WBC/RBC	1.47 ± 0.38	1.77 ± 1.06	1.72 ± 0.86	3.554	0.031*
TBIL/DBIL	3.72 ± 0.98	3.82 ± 1.25	4.86 ± 2.66	10.702	< 0.001***
PA/ALB	5.61 ± 1.81	5.49 ± 1.97	4.90 ± 1.32	1.674	0.188
PA/TB	3.40 ± 1.04	3.22 ± 1.12	2.94 ± 1.02	2.931	0.055

*Data are presented as mean ± standard deviation. PG-SGA = Patient-Generated Subjective Global Assessment. Stage A = Well-nourished (57.3%); Stage B = Moderately malnourished (23.3%); Stage C = Severely malnourished (19.3%). Analysis by one-way ANOVA. TP = Total Protein; Cr = Creatinine; ALB = Albumin; PA = Prealbumin; TBIL = Total Bilirubin; DBIL = Direct Bilirubin; GLU = Glucose; TG = Triglycerides; AST = Aspartate Aminotransferase; ALT = Alanine Aminotransferase; HGB = Hemoglobin; WBC = White Blood Cells; NEUT = Neutrophils; LYMPH = Lymphocytes; RBC = Red Blood Cells; PLT = Platelets. Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. N = total number of participants.

3.13. Functional capacity and physical examination findings

Functional capacity and physical examination of the participant also showed a significant multidimensional level with nutrition status, as outlined in Figure 8. Physical activity level was highly inversely correlated with nutrition status. In contrast, a loss of functional capacity was correlated with a significantly increased risk of being classified as severely malnourished; the highest prevalence of severe malnutrition (PG-SGA C) was observed in individuals whose activity was severely restricted, such that they spent most of their day either in bed or seated.

The physical examination results oppose these findings; patients rated as 'no deficit' were showed well-nourished. However, as the rating of physical deficit globally worsened from 'mild' to 'severe,' there was a marked and orderly shift in the distribution of patients from PG-SGA- A to categories B and C. The high degree of correlation between these functional and clinical measurements also suggests that the obvious indexes of disability and tissue depletion are good, measurable indicators of nutritional risk, underscoring the effectiveness of the PG-SGA as a comprehensive assessment tool.

Figure 8. Association of Functional Capacity and Physical Examination Findings with Nutritional Status

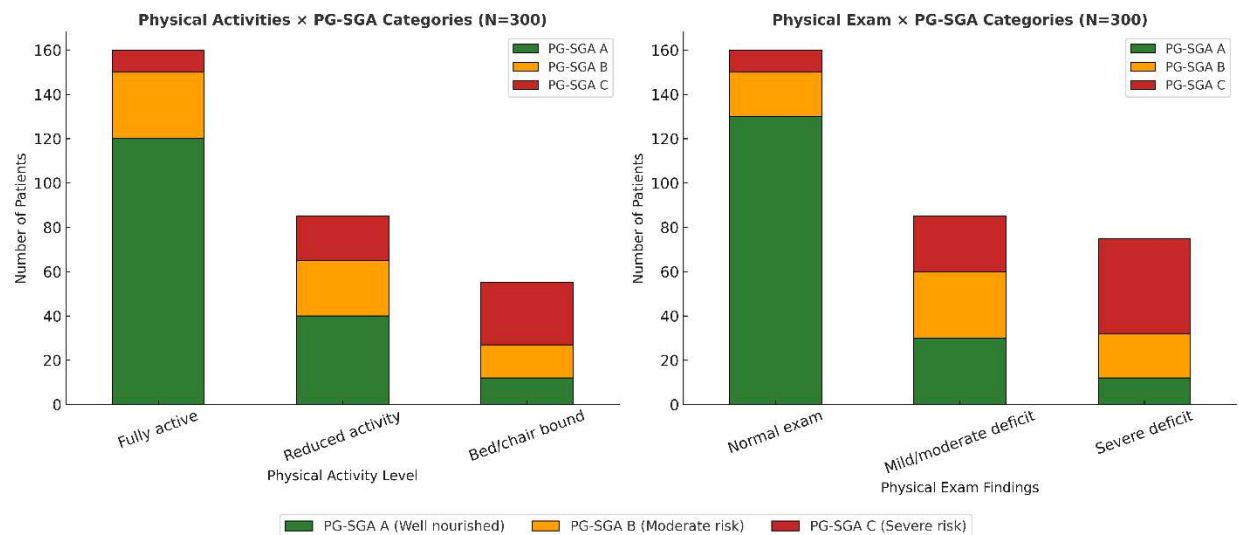


Figure 8. Association of physical activity levels and physical examination findings with nutritional status (PG-SGA categories) among 300 oncology patients. (A) Physical activity levels show a pronounced inverse relationship with nutritional well-being. Patients with normal activity were predominantly well-nourished, while those with reduced activity and bed/chair confinement exhibited progressively higher proportions of moderate (PG-SGA B) and severe malnutrition (PG-SGA C). (B) Physical examination findings show a strong gradient: patients with normal exams were mostly well-nourished, while those with mild to severe deficits shifted markedly into PG-SGA B and C. These results underscore the strong predictive value of functional status and physical examination in identifying patients at nutritional risk. PG-SGA = Patient-Generated Subjective Global Assessment.

413

414 **4. Discussion**

415 The hospital-based cross-sectional study comprehensively evaluated the nutritional status of
416 cancer patients undergoing active treatment in Pakistan. Using the validated PG-SGA tool, it was
417 found that 42.7% of the participants were moderately or severely malnourished, highlighting a
418 significant issue of disease-related malnutrition in this population. In the present study, we
419 identified three key, interdependent predictors of deteriorating nutrition: advanced cancer stage,
420 diminished food intake, and declining functional status. There was a strong statistical association
421 between higher-risk PG-SGA categories and advanced-stage disease, reduced oral intake, or
422 physical debilitation. The findings suggest a critical link between disease progression, nutritional
423 insufficiency, and functional decline in driving nutritional risk among cancer patients.

424 The prevalence of malnutrition found in study, 42.7%, documented significantly with the global
425 literature and explored cancer-associated malnutrition as a formidable public health problem.
426 These findings aligns with that of a study involving 3,561 cancer patients from twelve countries,
427 which also utilized the PG-SGA as the diagnostic tool, reporting an overall prevalence of 41.2%
428 malnutrition [26], published in Clinical Nutrition. The consistency across these divergent
429 geographical contexts suggests that, universally, cancer patients are at risk of nutritional decline.

430 As according to the literature, this study origin wise have strong alignment with the current literature
431 published in Asian pacific region by [16, 21, 36], which documented a 46.1% prevalence of
432 moderate to severe malnutrition (PG-SGA B/C) in a mixed-cancer patients. Similarly, a 2023 study
433 from China by [28] reported a 44.5% malnutrition rate in gastrointestinal cancer patients. The
434 study finds a significant consistency between our findings and those of these recent Asian studies,

indicating that nutritional risk is not only an issue in high-income countries but also in developing countries [19].

It is particularly concerning that 19.3% of study participants are severely malnourished (PG-SGA C). Our finding was higher than the 12.8% reported in a European cohort by [8], possibly due to delayed diagnosis or limited access to nutritional support. As a significant proportion of cancer patients present with advanced nutritional deficits that severely compromise treatment tolerance and survival, this disparity highlights the need to integrate systematic nutritional screening and triage into standard oncology care in Pakistan.

Our findings strongly support the cancer cachexia pathophysiology that advancing cancer stage is associated with worsening nutritional status. As a result of the metabolic dysregulation and systemic inflammation characteristic of advanced disease, the proportion of well-nourished patients declined from 76.4% in Stage I to 38.2% in Stage III, and severe malnutrition increased to 32.4%.

This association of the cancer cachexia, a multifactorial syndrome driven by a pro-inflammatory state and tumor-derived factors. Recent work by [5] emphasizes that advanced tumors increase the release of catabolic cytokines (e.g., TNF- α , IL-6), which promote hypermetabolism, accelerate muscle proteolysis, and induce anorexia, creating a vicious cycle of wasting that the study conducted clinically through the PG-SGA [31]. Our data provides a clear clinical-epidemiological confirmation of this established biological model.

Furthermore, our results are consistent with [7] following lung cancer patients confirmed that disease progression was the strongest predictor of a transition from PG-SGA A to PG-SGA B/C over a six-month period. Similarly, a meta-analysis by [47] consolidated evidence from 20 studies,

concluding that all the cancer types but with advanced cancer stage fall into the PG-SGA malnutrition score and another meta-analysis explored with the 23,235 participants established the fact that high level of malnutrition was in GI patients (2.02 (95% CI: 1.63–2.5) [35].

The significant alignment ($p < 0.001$) in our data strongly justify these findings, underscoring that nutritional status is not a static feature but a dynamic parameter directly linked to tumor burden. Therefore, nutritional assessment should be continuous, rather than performed once, throughout the cancer care continuum [37].

Beyond disease stage, findings identified reduced food intake and deteriorating diet quality as powerful, modifiable determinants of nutritional risk as same stated by [12]. The stark contrast where 72.3% of patients with unchanged intake were well-nourished compared to only 32.7% of those with reduced intake highlights dietary adequacy as a critical indicator of nutritional outcomes in cancer. These findings are strongly supported by a multicenter study by [33, 38], According to the study, reduced dietary intake was the single strongest independent cause of malnutrition development, outperforming both cancer type and BMI at the outset.

The assessed PG-SGA scored decline in nutritional status associated with the "type of food" consumed is a significant indicative finding. A gradual transition from "normal food" to "little solid food" and finally to "very little of anything" results in a nutritional decline, with the latter group showing an 80% malnutrition. There was strong support and evidence for the clinically established, which has often been observed but not measured with such precision. It aligns with the concept of "food deficiency" as a key diagnostic criterion, as emphasized in the recent ESPEN guidelines on nutritional assessment [42].

As a result of the high prevalence of Nutrition Impact Symptoms (NIS) in our cohort, these intake patterns can be attributed largely to these symptoms. Fatigue (73.3%), pain (54.0%), and dry mouth (46.7%) are significant barriers to adequate nutrition. This study confirms the findings of a study published in 2020 by [40], which showed that clustering of NIS symptoms improved dietary intake and halted nutritional decline better than single symptoms. The strong association ($p < 0.001$) observed between intake and PG-SGA category underscores that proactive screening and management of these symptoms is more than just supportive care; it is an integral part of anticancer treatment, essential for maintaining functional and nutritional integrity.

Present study provides strong context that functional impairment and physical signs of depletion are essential and clinically observable symptoms of malnutrition. The noticeable gradient we found, in which patients with normal activity were mostly well-nourished and those who were sedentary were overwhelmingly malnourished, illustrates the real functional impact of nutritional deterioration. This discovery illustrates the connection between insufficient energy, muscle degradation, and the ability to perform activities. It is notably corroborated by a recent study following subjects over time, conducted by (Shen, Xing, Shen, Niu, Tian, Ma, et al., 2025), which revealed that a drop in the PG-SGA score was a direct indicator of a substantial worsening in objectively assessed physical capabilities and the functional condition reported by patients as time progressed.

Further, the strong correlation between the PG-SGA physical exam findings (estimating muscle and fat stores) and the global nutritional categories validates the clinical utility of a structured physical exam. PG-SGA A to C shows a practical correlation to the more complex problem of sarcopenia in that the shift from 'no deficit' to 'severe deficit' shifts to the change from PG-SGA A to C. While computed tomography (CT) is considered the gold standard for diagnosing sarcopenia,

our results align with a 2015 study which advocates the integration of simple, validated clinical tools like the PG-SGA physical exam in routine oncology practice for sarcopenia case-finding, particularly in resource-limited settings [27].

In current study, self-reported functional limitation and objective signs of wasting a coherent picture of cancer malnutrition. According to [9, 24], the PG-SGA's "patient-generated" components (symptoms, function) act as synergistic indicators of a single catabolic process, whereas the "professional" components (physical examination) are independent indicators.

This study evidenced the efficacy of this PG-SGA in a Pakistani oncology setting by identifying highly standardized and statistically significant associations between PG-SGA categories and key clinical parameters, including disease stage, diet, and functional status. PG-SGA demonstrated better validity in differentiating nutritional risk according to well-defined clinical criteria, being far superior to BMI alone, which was unable to identify malnourished patients among those who had normal or overweight status. This is consistent with the results of a 2023 multinational validation study by [46], stating that PG-SGA's multi-dimensional provides a more valid and clinically relevant nutritional status assessment compared with simple anthropometric measures in diverse cultural contexts.

Our findings strongly support the use of the tool for effective triage. There was a direct correspondence between clearly stratified PG-SGA A, B, and C categories and distinct levels of intervention need, ranging from routine education to critical nutritional support. This fits well with the objective of nutritional triage itself, as suggested by the new ESPEN practical guidance on nutritional care in cancer, which recommends PG-SGA as the preferred tool for prioritization of patients and scarce dietetic resources [29]. The high prevalence of symptoms and functional limitations captured by the patient-generated component of the PG-SGA in our cohort underscores

its patient-centred design, ensuring that the patient's subjective experience is an integral part of the assessment.

The current study confirms that the PG-SGA is an essential tool for standardizing nutrition care in Pakistan and similar health care settings, by successfully establishing the complex interplay of factors that lead to malnutrition in our population [20]. This could be implemented to bridge a gap in supportive oncology care, enabling early identification of at-risk patients and timely, targeted interventions that improve outcomes; for instance, a recent interventional study demonstrated a 35% reduction in the rate of severe malnutrition using PG-SGA-guided care [15].

The results of this study have immediate and important implications for clinical practice and health care policy in Pakistan and similar settings. First, the high prevalence of malnutrition and its strong association with modifiable factors make the implementation of systematic nutritional screening at diagnosis an absolute necessity within the standard oncology workflow. The study proposes that the PG-SGA be adopted as a standard tool for this purpose, administered at the time of diagnosis and at regular intervals throughout treatment, especially given the dynamic relationship we observed with disease progression.

Current research findings support a paradigm shift from the traditional reactive to proactive, triage-based nutritional care. There are specific high-risk profiles for which a referral to a registered dietitian should be automatic, such as patients with advanced Stage III/IV disease of any diagnosis, those reporting "less than usual" food intake or subsisting on "very little of anything," and those who exhibit functional decline or physical signs of muscle wasting. By doing so, it ensures that patients with the greatest need are targeted with the limited clinical resources, aligning with the principle of efficient resource utilisation advocated by global oncology bodies [25].

At a policy level, these data provide a compelling evidence base for prioritizing supportive care services, including dietetic posts, within national cancer control plans and hospital budgets. The demonstrated burden of malnutrition is too significant to be addressed ad hoc. Nutritional support is a vital component of multidisciplinary cancer care and is essential for treatment tolerance, quality of life, and survival outcomes [13, 45].

The study featured 300 participants and employed the validated PG-SGA nutritional assessment tool, offering valuable insights into a Pakistani oncology population and filling a gap in the literature.

However, certain limitations must be in check the study was conducted at a cancer hospital setting, which may limit the generalizability of the findings to community oncology settings or other regions. Furthermore, while the PG-SGA physical exam is a validated subjective measure, the inclusion of objective measures, such as handgrip strength or body composition (e.g., BIA or DXA), in future research would increase robustness. These limitations suggest promising research directions. Prospective long-term studies are needed to track nutritional status from diagnosis and identify underlying pathways. Culturally customized, PG-SGA-guided nutritional assistance programs for this population must be developed and tested soon. Finally, research on the economic impact of malnutrition and the cost-effectiveness of early nutritional intervention in Pakistani healthcare will support policy change.

Conclusion

This study clearly shows that malnutrition is a prevalent and complex condition impacting a considerable number of cancer patients in Pakistan, influenced by the interaction of disease progression, insufficient dietary intake, and functional decline. The effective use of the PG-SGA

has quantified this burden and identified distinct, clinically actionable risk profiles. The findings highlight the necessity for the systematic incorporation of standardized nutritional screening and assessment into routine oncology practice. Nutritional evaluation and early, targeted intervention should be acknowledged as essential elements of multidisciplinary cancer care to reduce treatment-related morbidity, maintain functional status, and enhance patient outcomes.

Author contributions: The authors' responsibilities were as follows, AR and AUK: conceptualized and designed the study; RA and QM: performed data collection and clinical assessments; AR, MZK, and WA: conducted statistical analysis and interpreted the data; MMA and AUK: provided administrative support and project supervision; AR and AUK: drafted the initial manuscript; RA, QM, and WA: provided critical revisions for intellectual content; and all authors: read and approved the final manuscript.

Acknowledgments: We extend our sincere gratitude to the INMOL Cancer Hospital, Lahore, for providing access to patients and clinical facilities. We are deeply thankful to the study participants, nurses, and oncologists for their substantial contributions to data collection and patient follow-up. We also acknowledge the support of the Department of Food Science and Human Nutrition, University of Veterinary and Animal Sciences, Lahore, and Grand Asian University, Sialkot, for their administrative and academic support.

Data availability: The major finding has been provided in this article and the data presented in this study are available on request from the corresponding author.

Funding and Sources of Support

This project was funded by the Office of Research, Innovation, and Commercialization (ORIC), Grand Asian University, Sialkot, in collaboration with INMOL Cancer Hospital, Lahore, through

the collaborative research fund (Grant Number: GAUS-Ref-1935324A). The funders had no role in the study design, data collection, analysis, interpretation, or manuscript preparation.

Informed consent: All the participants were informed earlier and take their signed consent before data participants into the study.

Conflict of interest: The authors of this research declare no conflict of interest.

AI Assistance Declaration: The manuscript's language and grammar were refined using AI-based tools (e.g., Grammarly, language models) solely for purposes of copyediting and clarity enhancement. The content, scientific findings, interpretation, and conclusions remain the original work and sole responsibility of the authors.

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