

# Preoperative Depressive Mood of Patients With Esophageal Cancer Might Delay Recovery From Operation-Related Malnutrition

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## Abstract

**Background:** We investigated the relationship between the preoperative psychological state and the perioperative nutritional conditions of patients with esophageal cancer.

**Methods:** Seventy-three participants underwent operations for esophageal cancer in our hospital. Depressive state was evaluated using the Self-Rating Depression Scale (SDS). General quality of life (QOL) was assessed using the SF-8™, and the nutritional assessments were evaluated through anthropometric analysis, bioelectrical impedance analysis (BIA) and some biochemical assessments.

**Results:** In the preoperative stage, patients with higher SDS scores, representing a more depressive state, had low arm circumference, grip strength, serum albumin levels and prognostic nutritional index. Patients with higher SDS scores also had a tendency for a lower physical component summary, representing physical QOL by the Eight-Item Short Form Health Survey (SF-8™). At 3 months after surgery, patients with higher preoperative SDS scores had significantly lower body mass indexes (BMIs) and had a lower tendency of body fat masses. In the univariate and multivariate analyses on the recovery of BMI at 3 months after surgery, preoperative SDS score was the only independent risk factor (odd ratio (OR): 4.07, 95% confidence interval (CI): 1.15 - 14.35) in this study.

**Conclusion:** Preoperative depressive mood, as evaluated by the SDS,

was the sole relevant factor for postoperative body weight recovery of patients with esophageal cancer. Preoperative depressive mood of patients with esophageal cancer might delay recovery from operation-related malnutrition. Some measures against preoperative depressive mood might be necessary for early recovery from postoperative malnutrition in patients with esophageal cancer.

**Keywords:** Esophageal cancer; Depressive mood; Nutritional status after surgery

## Introduction

Unfeigned cancer notification sometimes causes severe psychological and/or physiological damage in patients with cancer. Any patients with cancer might have some degree of anxiety about disease progression or prognosis as well as anger and depressive mood after being notified by their doctors that they have cancer. It was reported that the most common psychological problem was depressive state in patients with cancer [1, 2]. Depressive state due to cancer notification might affect patient nutritional condition [3, 4]. Improvement of preoperative psychological condition may be essential for early recovery from heavily invasive surgeries such as esophagectomy. Esophagectomy is thought to be the most invasive surgery for gastrointestinal cancers, because, in addition to the tumor dissection, this surgery involves a wide operative field that includes the neck, chest and abdomen as well as lymph node dissection. The purpose of this study is to analyze the relationship between preoperative psychological conditions and postoperative nutritional recovery in patients with esophageal cancer.

## Materials and Methods

### Study design and participants

This study was a cohort study. A total of 78 patients at our hospital were enrolled in this study between June 1, 2009, and December 31, 2011. Five patients were excluded from the study because they did not undergo Self-Rating Depression Scale (SDS) test or were diagnosed with leiomyoma (Fig. 1). Fifty-

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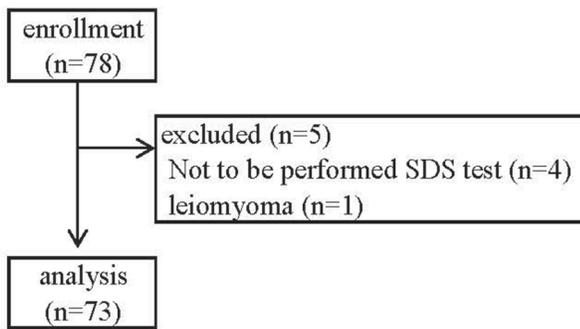
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**Figure 1.** Flow diagram according to selection and non-continuation.

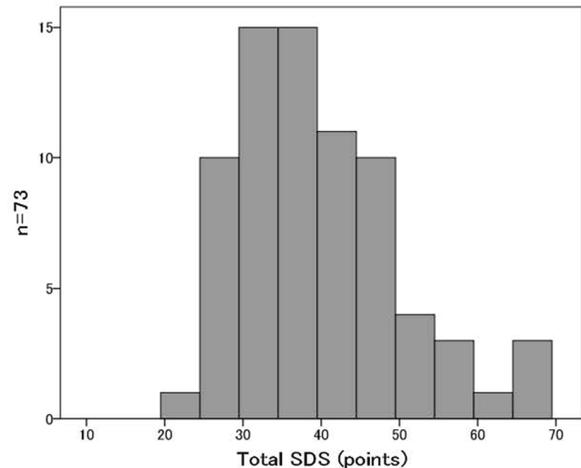
four were men and 19 were women with an average age of  $63.6 \pm 8.8$  years. All patients were diagnosed with esophageal cancer and underwent esophagectomy (thoracoscopic laparotomy or thoracotomy and enterostomy). Patients were surveyed preoperatively and postoperatively at 3 and 6 months. All of them agreed to participate in this study voluntarily and gave written informed consent.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

### Classification according to the SDS

A total of 73 patients with esophageal cancer were divided into two study groups based on their SDS scores [5]. Those with total SDS scores lower than 39 were placed in the normal group (normal SDS group), and those with total SDS scores of 39 or more were placed in the depressive group (high SDS group). We defined the cutoff value of SDS as 39 points in this cohort for the following two reasons: first, the median SDS of this cohort was 39 points (Fig. 2); and second, the mean SDS score for the Japanese general population was 39.3 points in a previous large scaled cross-sectional study [6]. We compared their health-related quality of life (QOL) as determined by a Japanese-validated version of the Eight-Item Short Form Health Survey (SF-8™), anthropometries, body composition data as determined by InBody S430 (InBody Japan Co., Ltd) and biochemical data at preoperative stage and postoperative stages of 3 and 6 months after surgery in this two groups.

We adopted the SF-8™ to assess the health-related quality of life of patients. This score can be compared to the Japanese normative sample scores of the SF-8™. The SF-8™ is an eight-item questionnaire that calculates eight physical and mental health domains: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE) and mental health (MH). The physical component score (PCS) and mental component score (MCS) were calculated based on the sum of the scores of the corresponding subscales: PF, RP, BP and GH for PCS, and VT, SF, RE and MH for MCS. PCS and MCS in the SF-8™ were expressed as the median percentage of Japanese



**Figure 2.** The distribution of SDS scores of all patients.

healthy men and women, respectively [7-10].

### Anthropometry and body composition

Each patient's height, preoperative weight, arm circumference (AC), triceps skinfold (TSF) and grip strength were measured during the nutritional status evaluation. The body mass index (BMI), arm muscle circumference (AMC) and arm muscle area (AMA) were subsequently calculated. All data were expressed as % of median of Japanese healthy individuals quoted from Japanese Anthropometric Reference Data (JARD 2001) [11].

InBody 430 (InBody Japan Co., Ltd) was used to perform body composition analysis (body weight, BMI, skeletal muscle volume and body fat). These data were expressed as % of median of Asian healthy individuals (data were presented by InBody Japan Co., Ltd).

The mean values of both hand grip strength measurements were expressed as a percentage by dividing the average of each age acquired from the Japanese Ministry of Education, Culture, Sports, Science and Technology, which performed a test of physical strength and Ex capacity in 2009.

### Laboratory data and nutritional status assessment

To evaluate nutritional status, data were collected for the following parameters: white blood cell count (WBC), total lymphocyte count (TLC), C-reactive protein (CRP), albumin (Alb), cholinesterase (ChE), triglyceride (TG), total cholesterol (T-Chol), high-density lipoprotein cholesterol (HDL-Chol), low-density lipoprotein cholesterol (LDL-Chol) and transthyretin (TTR).

To assess nutritional status, the prognostic nutritional index (PNI) [12] and creatinine height index [%] (CHI) [13] were used. PNI and CHI were calculated using the following formulae:

$$\text{PNI} = 10 \times \text{Alb} + 0.005 \times \text{TLC}$$

$$\text{CHI} = \text{measured 24-h urinary creatinine} \times 100/\text{normal}$$

**Table 1.** Patients' Preoperative Characteristics

	Normal SDS group (n = 36)	High SDS group (n = 37)	P value
SDS (points)	32.0 (29.0 - 35.0)	46.0 (40.0 - 51.0)	< 0.001
Sex (male/female)	31:5	23:14	0.032
Age (years)	65.0 (60.25 - 70.75)	62.0 (55.0 - 68.0)	0.047
BMI (kg/m <sup>2</sup> )	21.6 (20.5 - 23.1)	19.8 (18.0 - 21.8)	0.007
Stage			
I and II	22 (61.1)	20 (54.1)	0.638
III and IV	14 (38.9)	17 (45.9)	
Hospital stay (day)	27.5 (21.0 - 41.0)	28.0 (22.0 - 37.0)	0.908

Data are expressed as median (25th-75th percentile) or n (%). Mann-Whitney *U* test and Fisher's exact test were performed. SDS: Self-Rating Depression Scale; BMI: body mass index.

24-h urinary creatinine

### Statistical analysis

The outcomes are presented as median and interquartile range (IQR), numbers of patients or percentages. The Mann-Whitney *U* test was used to compare continuous variables among the two groups.

Univariate and multivariate logistic regression modeling was used to identify the relevant factors for recovery of %BMI as 85% or more at 3 months after surgery; 85% of %BMI was nearly equal to 18.5 kg/m<sup>2</sup> of BMI, which represented the cut-off value of emaciation or malnutrition. Therefore, we defined 85% of %BMI, nearly equal to 18.5 kg/m<sup>2</sup> of BMI or more at 3 months after surgery, as indicating recovery from critical malnutrition due to esophagectomy. Sex (male versus female), age (< 65 years versus ≥ 65 years), cancer stage (stages I - II versus stages III - V), chemotherapy (absence versus prescription), SDS score (< 39 versus ≥ 39) and PNI score (< 49 versus ≥ 49) were chosen as potential factors. Univariate and multivariate logistic regression modeling was used to obtain the crude and adjusted odd ratios (ORs) and 95% confidence intervals (95% CI) for the association between each factor and recovery of %BMI as 85% or more at 3 months after surgery.

SPSS statistical software for Windows (version 22; SPSS Inc., Chicago, IL, USA) was used for analytical comparisons of the two groups. SAS 9.4 software (SAS Institute, Inc., Cary, NC, USA) was used for the univariate and multivariate analyses. A *P* value of < 0.05 was considered statistically significant.

### Results

We divided the participants in to two groups. The normal SDS group contained 36 patients, and the high SDS group contained 37 patients. The patients' preoperative characteristics and nutritional status details are listed in Table 1. The high SDS group had significantly higher total SDS scores (median value: 46 points, *P* < 0.001), lower BMI (median value: 19.8 kg/m<sup>2</sup>, *P* = 0.007), younger than normal SDS group and lower percentage of men (*n* = 23, 62%, *P* = 0.032) than did the nor-

mal SDS group.

We compared the results in these two groups on each item of the SDS (Table 2) and SF-8 (Table 3), body compositions and anthropometrics (Table 4), and laboratory data (Table 5). As for respective items of the SDS, excluding only question number 19 about suicidal ideation, the high SDS group had significantly higher scores than did the normal SDS group in all other items (Table 2).

On QOL by SF-8<sup>TM</sup>, the high SDS group had significantly lower %PCS (median value: 95.1, *P* = 0.024), which means physical QOL, than did the normal SDS group. Additionally, the %PCS of the high SDS group was lower than that of the median for Japanese healthy individuals (Table 3).

As for body compositions and anthropometrics, the high SDS group had significantly lower %BMI (*P* = 0.015), %skeletal muscle volume (*P* = 0.036), %AC (*P* = 0.022), %AMA (*P* = 0.033) and %grip strength (*P* = 0.012) than did the normal SDS group (Table 4). As for laboratory data, the high SDS group had significantly lower TLC, Alb and TTR (*P* = 0.041, 0.018 and 0.009, respectively) than in the normal SDS group. The high SDS group also had lower PNI scores (median value: 46.9, *P* = 0.007) than did the normal SDS group. However, there was no significant difference on CHI between the two groups (Table 5).

We analyzed the following items sequentially preoperatively and at 3 and 6 months after surgery (Table 6). As for the SDS, the high SDS group had consistently higher scores than did the normal SDS group throughout the observation period. As for QOL by SF-8<sup>TM</sup>, only in preoperative %PCS, the high SDS group had significantly lower scores (median value: 89.3, *P* = 0.023) than did the normal SDS group. In other points, there were no significant differences between these two groups on either %PCS or %MCS; %BMI continued to decrease from the preoperative period (normal group: 99.8%, high group: 91.2%) to 6 months (89.1% and 78.9%, respectively) after surgery in both groups. The high SDS group had significantly lower %BMI than did the normal SDS group preoperatively and at 3 and 6 months postoperatively. Regarding anthropometric data, such as %skeletal muscle volume and %body fat, the results showed similar tendency to %BWI, too. However, only %grip strength increased from 3 months to 6 months after operation in both groups.

**Table 2.** Score of Each SDS Item Before Surgery

	Normal SDS group (n = 36)	High SDS group (n = 37)	P value
Global rating			
1. I feel down-hearted and blue	2.0 (1.0 - 2.0)	3.0 (2.0 - 4.0)	0.006
2. Morning is when I feel the best	3.0 (2.0 - 4.0)	4.0 (3.0 - 4.0)	< 0.001
3. I have crying spells or feel like it	1.0 (1.0 - 1.3)	1.0 (1.0 - 2.0)	0.003
4. I have trouble sleeping at night	1.5 (1.0 - 2.8)	2.0 (2.0 - 4.0)	0.014
5. I eat as much as I used to	1.0 (1.0 - 1.0)	3.0 (1.0 - 4.0)	0.006
6. I still enjoy sex	3.0 (2.3 - 4.0)	4.0 (3.0 - 4.0)	0.005
7. I notice that I am losing weight	1.0 (1.0 - 3.8)	4.0 (1.0 - 4.0)	0.021
8. I have trouble with constipation	1.0 (1.0 - 2.0)	2.0 (1.0 - 4.0)	0.009
9. My heart beats faster than usual	1.0 (1.0 - 1.0)	1.0 (1.0 - 1.0)	0.013
10. I get tired for no reason	1.0 (1.0 - 2.0)	2.0 (2.0 - 4.0)	< 0.001
11. My mind is as clear as it used to be	1.0 (1.0 - 3.0)	3.0 (1.0 - 4.0)	0.002
12. I find it easy to do the things I used to	1.0 (1.0 - 2.8)	3.0 (2.0 - 4.0)	< 0.001
13. I am restless and can't keep still	1.0 (1.0 - 1.0)	1.0 (1.0 - 2.5)	0.001
14. I feel hopeful about the future	1.0 (1.0 - 2.8)	3.0 (1.0 - 4.0)	0.014
15. I am more irritable than usual	1.0 (1.0 - 1.0)	2.0 (1.0 - 3.0)	0.001
16. I find it easy to make decisions	1.0 (1.0 - 1.0)	2.0 (1.0 - 3.0)	0.014
17. I feel that I am useful and needed	1.0 (1.0 - 2.0)	3.0 (1.0 - 3.0)	0.001
18. My life is pretty full	1.0 (1.0 - 2.0)	2.0 (1.0 - 3.0)	0.001
19. I feel that others would be better off if I were dead	1.0 (1.0 - 1.0)	1.0 (1.0 - 1.0)	0.574
20. I still enjoy the things I used to do	1.0 (1.0 - 1.0)	3.0 (1.0 - 4.0)	< 0.001
Total	32.0 (29.0 - 35.0)	46.0 (40.0 - 51.0)	< 0.001

Data are expressed as median (25th-75th percentile). Mann-Whitney *U* test was performed. SDS: Self-Rating Depression Scale.

**Table 3.** Comparison of SF-8 Between the Two Groups

	Normal SDS group (n = 33)	High SDS group (n = 35)	P value
%PCS (physical QOL)	101.4 (94.9 - 111.0)	95.1 (76.0 - 95.1)	0.024
%MCS (psychological QOL)	85.5 (78.4 - 97.3)	86.1 (74.8 - 95.0)	0.480

Data are expressed as median (25th-75th percentile). Mann-Whitney *U* test was performed. SDS: Self-Rating Depression Scale; QOL: quality of life; PCS: physical component summary; MCS: mental component summary.

**Table 4.** Comparison of Body Composition and Anthropometries Between the Two Groups

	Normal SDS group (n = 36)	High SDS group (n = 37)	P value
%BMI	98.6 (93.6 - 105.7)	91.4 (84.7 - 99.1)	0.015
%Body fat	123.0 (100.5 - 152.6)	100.0 (65.5 - 140.3)	0.081
%Skeletal muscle	93.6 (88.5 - 96.8)	89.4 (83.2 - 94.2)	0.036
%AC	100.4 (92.7 - 104.0)	94.4 (86.1 - 101.7)	0.022
%TSF	88.9 (77.8 - 111.1)	77.8 (65.6 - 119.6)	0.379
%AMC	101.2 (95.0 - 106.7)	98.0 (91.5 - 102.0)	0.052
%AMA	102.6 (90.0 - 113.5)	96.2 (86.9 - 104.5)	0.033
%Grip strength (n = 35:37)	83.0 (73.0 - 95.2)	73.1 (63.9 - 82.6)	0.012

Data are expressed as median (25th-75th percentile). Mann-Whitney *U* test was performed. SDS: Self-Rating Depression Scale; BMI: body mass index; AC: arm circumference; TSF: triceps skinfold; AMC: arm muscle circumference; AMA: arm muscle area.

**Table 5.** Comparison of Preoperative Laboratory Data and Nutritional Status Assessment Between the Two Groups

	Normal SDS group (n = 36)	High SDS group (n = 37)	P value
WBC (/mm <sup>3</sup> )	6,600 (5,000 - 7,200)	7,350 (5,825 - 9,100)	0.522
TLC (/mm <sup>3</sup> )	1,792 (1,407 - 2,088)	1,596 (1,199 - 1,976)	0.041
CRP (mg/dL)	0.09 (0.03 - 0.19)	0.24 (0.93 - 1.51)	0.064
Alb (g/dL)	4.1 (3.9 - 4.2)	4.0 (3.7 - 4.1)	0.018
ChE (IU/L)	299 (235 - 341)	300 (243 - 350)	0.669
		Failure: 1	
TG (mg/dL)	106 (92 - 142)	136 (76 - 183)	0.736
T-Cho (mg/dL)	197 (174 - 215)	177 (151 - 208)	0.787
HDL-Cho (mg/dL)	49 (40 - 62)	41 (35 - 52)	0.128
	Failure: 10	Failure: 11	
LDL-Cho (mg/dL)	112 (101 - 139)	100 (86 - 132)	0.783
	Failure: 10	Failure: 10	
TTR (mg/dL)	29.1 (24.1 - 32.2)	22.6 (19.4 - 27.9)	0.009
	Failure: 7	Failure: 8	
PNI (point)	50.9 (47.6 - 53.0)	46.9 (44.0 - 51.0)	0.007
CHI (%)	82.6 (48.6 - 102.0)	66.9 (56.7 - 77.9)	0.285
	Failure: 15	Failure: 13	

Data are expressed as median (25th-75th percentile). Mann-Whitney *U* test was performed. WBC: white blood cell count; TLC: total lymphocyte count; CRP: C-reactive protein; Alb: albumin; ChE: cholinesterase; TG: triglyceride; T-Cho: total cholesterol; HDL-Cho: high-density lipoprotein cholesterol; LDL-Cho: low-density lipoprotein cholesterol; TTR: transthyretin; PNI: prognostic nutritional index; CHI: creatinine height index.

Table 7 shows the results of univariate and multivariate logistic regression modeling, which were used to determine the relevant factors for the recovery of %BMI as 85% or more at 3 months after surgery. Fifty-one patients who could be fully checked for relevant factors were analyzed. Unadjusted univariate logistic regression modeling suggested that only two factors, SDS scores (OR: 4.38, 95% CI: 1.31 - 14.68) and PNI scores (OR: 3.77, 95% CI: 1.14 - 12.46), were significantly associated with the recovery of %BMI. In the multivariate logistic regression modeling included for SDS score and PNI score, SDS score alone was significantly associated with the recovery of %BMI. The OR of SDS score for the recovery of %BMI was 4.07 (95% CI: 1.15 - 14.35).

## Discussion

We tried to analyze the relationship between preoperative depressive mood due to unfeigned cancer notification and preoperative and postoperative nutritional states in patients with esophageal cancer. Almost half of the participants in this study were judged as having depressive state as evaluated by the SDS just before surgery (cutoff value of SDS: 39 point). The reasons for their depressive state might be that they thought that esophageal cancer was highly malignant with a poor prognosis and that the surgery for this disease was very invasive.

When it comes to the gender difference, we believe that the women in this cohort tended to have higher SDS scores than men did for the following reasons. First, in the high SDS

group, women accounted for 37.8% (14/37), while in the normal SDS group, women only accounted for 13.9 (5/36) (Table 1). Second, women had higher SDS scores (median value: 42 points) than men (median value: 37 points) ( $P = 0.017$ ) as a whole in this cohort.

The high SDS group also had lower PNI scores (median value: 46.9,  $P = 0.007$ ) than did the normal SDS group. In a previous report, the truth disclosure was associated with physical symptoms in patients with lung cancer [14]. Patients with depressive state due to notification of cancer frequently had somatic disorders such as general fatigue or body pain [15]. Therefore, these patients might experience more difficulties in physical conditions than in psychological conditions.

As for body compositions and anthropometries, the depressive group tended to show lower %BMI, %skeletal muscle volume and %grip strength in both preoperative and postoperative stages. As for the SDS, the depressive group showed continuously higher SDS scores than the normal group through perioperative period. Preoperative depressive state in patients with esophageal cancer seemed to remain for a rather long period. Lower physical activities in these patients due to depressive state might affect their postoperative physical conditions [16-18]. Although in the postoperative stage, there was no significant difference between the groups on %PCS, the depressive group showed lower values in anthropometries associated with skeletal muscles. If elderly patients in the depressive group might have difficulties in ordinary life due to muscle atrophy, they might not be aware of those symptoms. Therefore, we may pay more attention to those patients in terms of their

**Table 6.** Changes in Variables at 3 and 6 Months Among Two SDS Groups

		n	Normal SDS	n	High SDS	P value
SDS	Pre-operation	18	32.0 (29.0 - 35.0)	14	46.0 (39.0 - 50.5)	< 0.001
	3 months		36.5 (34.0 - 44.0)		49.5 (45.8 - 54.0)	0.002
	6 months		36.5 (31.0 - 41.5)		44.0 (37.8 - 51.0)	0.073
%PCS	Pre-operation	18	102.0 (93.1 - 114.0)	14	89.3 (74.1 - 103.5)	0.023
	3 months		86.6 (76.8 - 97.5)		81.8 (72.3 - 91.9)	0.303
	6 months		91.9 (78.6 - 102.6)		85.6 (80.0 - 93.4)	0.442
%MCS	Pre-operation	18	85.8 (77.6 - 99.8)	14	89.2 (78.4 - 97.4)	0.539
	3 months		85.6 (65.9 - 94.3)		86.3 (66.7 - 90.9)	0.594
	6 months		94.9 (82.5 - 102.5)		89.9 (83.6 - 100.5)	0.536
%BMI	Pre-operation	22	99.8 (93.5 - 105.7)	16	91.2 (81.6 - 106.0)	0.015
	3 months		91.1 (85.6 - 96.4)		79.3 (74.2 - 89.8)	0.03
	6 months		89.1 (84.2 - 94.2)		78.9 (74.4 - 87.8)	0.012
%Skeletal muscle	Pre-operation	22	94.8 (88.2 - 97.7)	16	88.1 (82.5 - 94.1)	0.036
	3 months		87.6 (81.3 - 92.3)		78.8 (75.3 - 85.5)	0.100
	6 months		86.9 (83.7 - 93.7)		80.5 (77.4 - 84.9)	0.013
%Body fat	Pre-operation	22	126.2 (105.1 - 147.0)	16	94.9 (71.4 - 169.6)	0.081
	3 months		102.6 (61.3 - 112.6)		61.4 (41.6 - 109.4)	0.096
	6 months		79.7 (63.0 - 106.9)		67.1 (39.2 - 96.1)	0.201
%Grip strength	Pre-operation	22	84.6 (68.3 - 103.0)	16	74.6 (65.4 - 85.7)	0.012
	3 months		67.8 (61.4 - 90.9)		62.8 (57.1 - 67.5)	0.019
	6 months		73.1 (64.2 - 90.7)		65.7 (55.1 - 76.8)	0.122

Median (25-75percentile), Mann-Whitney U test were performed; SDS, Self-rating Depression Scale; PCS, physical component summary; MCS, mental component summary.

difficulties in ordinary life.

The depressive group showed worse biochemical nutritional assessments such as TLC, Alb, TTR and PNI in the pre-

operative stage. In previous reports [19-21], one of the relevant factors for malnutrition was depressive state, and patients with depressive mood tended to have lower values of serum total

**Table 7.** Univariate and Multivariate ORs and 95% CIs for Association Recovery of %BMI as 85% or More at 3 Months after Surgery

		%BMI ≥ 85 (n = 32)	%BMI < 85 (n = 19)	Univariate OR (95% CI)	P value	Multivariate OR (95% CI) <sup>a</sup>	P value
Sex	Female	7	8	1			
	Male	25	11	2.60 (0.75 - 8.95)	0.131		
Age (years)	< 65	19	11	1			
	≥ 65	13	8	1.06 (0.34 - 3.36)	0.917		
Stage	I and II	20	8	1			
	III and IV	12	11	2.29 (0.72 - 7.30)	0.161		
Chemotherapy	Absence	14	9	1			
	Prescription	18	10	0.86 (0.28 - 2.70)	0.802		
SDS (point)	< 39	23	7	1		1	
	≥ 39	9	12	4.38 (1.31 - 14.68)	0.017	4.07 (1.15 - 14.35)	0.029
PNI (point)	≥ 49	22	7	1		1	
	< 49	10	12	3.77 (1.14 - 12.46)	0.029	3.47 (0.98 - 12.24)	0.053

<sup>a</sup>Model included SDS and PNI. chemo: chemotherapy; SDS: Self-Rating Depression Scale; PNI: prognostic nutritional index.

protein and Alb. Depressive mood might affect the appetite in these patients, lead to reduce the food intake and cause lower biochemical values representing their nutritional conditions.

In the univariate and multivariate analyses of the recovery of BMI at 3 months after surgery, preoperative SDS score was the only independent risk factor in this study. In other words, patients with preoperative depressive state tended to have difficulty recovering the nutritional condition represented by body weight at 3 months after surgery. In previous reports, depressive mental status was significantly related to nutritional conditions in patients with cancer [18] and community-dwelling elderly individuals [21].

In summary, there were more than a few patients with depressive state probably due to notification of esophageal cancer in the preoperative stage, and these depressive mental states might contribute to the poor nutritional conditions before surgery. This preoperative mental status might negatively affect the recovery of their nutritional conditions and their QOL after surgery. From these findings, in patients with preoperative depressive state, we might consider consulting psychiatrists or clinical psychotherapists to improve their mental states and then improve their nutritional conditions in both pre- and post-operative stages.

We considered potential limitations of this study. First, our study had a relatively small sample size and a short follow-up period. A prospective study with a large sample size may be warranted in the future. Second, our study did not investigate nutrient intakes from diagnosis to perioperative period and, therefore, we could not identify an association between perioperative nutrient intake and nutritional status. These issues will be addressed in a future study.

## Conclusions

In conclusion, we should give more attention to the preoperative mental status of patients with esophageal cancer to improve their pre- and postoperative nutritional conditions.

## Acknowledgments

We are grateful to the individuals who participated in this study.

## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

## Author Contributions

Yoshihiro Nakamura, Chika Momoki and Daiki Habu were responsible for study conception and design. Yasunori Matsuda, Shigeru Lee and Harushi Osugi were responsible for acquisition. Genya Okada, Yoshinari Matsumoto and Yoko Yasui

were responsible for acquisition, analysis and interpretation of data. Yoshihiro Nakamura, Chika Momoki and Daiki Habu were responsible for critical revision.

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