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Relationship Between Fatigue and Nutritional Status in Patients with Cancer Undergoing Radiotherapy

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Purpose. The purpose of this study was to identify the relationship between fatigue and nutritional status in patients undergoing radiotherapy.

Design. A correlational and crossectional study design was used.

Method. One-hundred-fifty-one subjects with cancer receiving radiotherapy were recruited from a university hospital in Chonan, Korea. Fatigue was measured using Piper's Fatigue Scale (PFS). The parameters for nutritional status included body weight, body mass index, hemoglobin, and lymphocyte counts. Cancer stage was controlled in analyzing the differences in fatigue, body weight and body mass index.

Results. The patients who experienced most fatigue were in their fifties, employed, had head and neck cancer, received radiotherapy on the head and neck, and had concomitant chemotherapy. Disease-related characteristics such as cancer type, and treatment type were frequently related to poorer nutritional status. Patients who showed poorer nutritional status, such as those with lower body weight, lower body mass index and lower hemoglobin levels were more fatigued than those who did not exhibit such characteristics. Lymphocyte counts did not correlate with fatigue. Conclusion: The findings can be used by nurses who are taking care of patients undergoing radiotherapy. Considering the relationship between fatigue and nutritional status, nurses can identify the risk group most vulnerable to fatigue and malnourishment in order to provide appropriate interventions for them.

Key Words: Fatigue; Nutritional status; Radiotherapy

INTRODUCTION

Radiotherapy is a major treatment modality for cancer and can be used alone or in conjunction with surgery and chemotherapy. According to Bentzen and Overgaard (1994), at least 50% of all cancer patients are expected to receive radiotherapy at some stage during the course of their illness.

Many studies have reported that fatigue is the most common side effect in cancer patients undergoing radiotherapy (Beach, Siebeneck, Buderer, & Ferner, 2001; Irvine, Vicent, Graydon, Bubela, & Thompson, 1994; Oberst, Hughes, Chang, & McCubbin, 1991; Vogelzang et al., 1997).

Even though fatigue may result from the disease itself, treatment, and/or physical and psychological comorbidities (Curt et al.,2000), patients receiving radiotherapy are particularly vulnerable to fatigue because of the necessity of daily travel to treatment centers for periods ranging from 2 to 7 weeks. Oberst and colleagues (1991) reported that coming for treatment was the most demanding work for 72 cancer patients receiving radiotherapy.

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Although acute fatigue serves a protective function, excessive or constant fatigue has adverse effects on individuals' adherence to cancer treatment regimens, interferes with functional performance, and ultimately can reduce quality of life (Yang, 2002; Yang, 2003). Cancer-related fatigue iincludes both excessive and constant fatigue. Cancer-related fatigue was recently accepted as a diagnosis in the International Classification of Disease 10th Revision Clinical Modification (Portenoy & Itri, 1999). The physiologic mechanism causing fatigue associated with radiotherapy is not yet understood.

Given the prevalence and impact of cancer-related fatigue, more studies are needed of this phenomenon. Cancer-related fatigue differs from normal fatigue caused by overexertion or lack of sleep. When patients were asked to compare cancer-related fatigue to the fatigue experienced before cancer treatment, they reported that cancer-related fatigue is significantly different and that it is more intense, lasts longer, and causes distress in many areas of the patients' lives (Holley, 2000).

Interest in fatigue experienced by patients receiving cancer treatment has increased substantially in recent years, but health providers still seem to neglect to monitor for or intervene in fatigue experienced by their patients with cancer (Curt et al., 2000; Vogelzang et al., 1997).

Fatigue is a subjective symptom. There are no biophysical markers or laboratory tests commonly used that highly and exclusively correlate with perceptions of fatigue (Maher, 2000). Other side effects - such as nausea, vomiting, and diarrhea - are visible, and major advances have been made in controlling their impact in the area of cancer-related symptom management. However, fatigue does not have such effective interventions. Therefore, fatigue has emerged as the most common unrelieved symptom of cancer (Volgelzang et al, 1997).

Nutritional status may influence fatigue levels. Like fatigue, malnutrition has been reported to be very common in patients with cancer (Brown & Radke, 1998; Singh & Khanna, 1985), resulting in reducing both the response to therapy and prognosis, worsening the immune function, and increasing the risk of infection. Malnutrition could result from side effects of cancer treatment, poor oral intake, and the cancer disease itself. Caloric intake in patients with cancer was only 30% to 40% of the caloric recommendations for normal adults (Yang, Kwon, & Kim, 2001). When protein and energy intake fail to meet individual needs (i.e., protein-energy malnutrition, or PEM), body stores are catabolized to meet nutrient demand, leading to loss of body weight. Fatigue and malnutrition can have an influence on continuation of or response to treatment and ultimately quality of life, but the relationship between fatigue and nutrition has seldom been studied, especially in patients undergoing radiotherapy. Moreover, in clinic settings, health providers rarely monitor or intervene with regard to fatigue and nutritional status. Information about the relationship between the influencing factors of fatigue and nutrition can be used to encourage health providers to assess and intervene in fatigue and nutritional status, and help patients and their family to cope with them.

This study was intended to identify the relationship between fatigue and nutrition in patients with cancer undergoing radiotherapy. The specific aims of this study were: 1) to determine the differences in fatigue according to characteristics of the subjects; 2) to determine the differences in nutritional status according to characteristics of the subjects; and 3) to identify the relationship between fatigue and nutritional status.

LITERATURE REVIEW

Cancer-related fatigue has repeatedly been identified as one of the most common and distressing problems for individuals with cancer (Irvine et al., 1994; Oberst et al., 1991).

Rhoten (1982) differentiated tiredness, fatigue, and exhaustion by their degrees of intensity. Tiredness was a normal physical phenomenon that is temporary and can be relieved by sleep or rest. Fatigue was viewed as a more extreme state of longer duration, with both mental and physical aspects. Exhaustion was seen as an uncompensatable final state of fatigue.

Fatigue symptoms tend to persist after treatment-related side effects subside (Maher, 2000). In a study of patients with cancer receiving radiotherapy for 6 weeks, Yang (2003) found that fatigue significantly increased ($F=6.043$, $p=.000$) during the 6-week radiotherapy period; fatigue during the first week was the most significant influencing variable (60.1% of the variance) on fatigue at the end of radiotherapy. Therefore, fatigue at the beginning point of radiotherapy has a lasting impact throughout the treatment and afterward. Graydon (1994) reported that women with breast cancer were still experiencing fatigue 7 weeks after the completion of radiotherapy; women who experienced the most fatigue had the most symptoms and the poorest levels of func-

tioning. This result suggested that nurses include information about the length of time that women can expect to experience the side effects of treatment. These above results were congruent with the findings of Holley (2000), who reported that cancer-related fatigue lasts longer than normal fatigue.

Fatigue in patients with cancer is an extremely prevalent condition that health care providers, family, and even patients themselves have neglected to assess and treat. Rather, they tend to accept it as a natural occurrence that is amenable to any intervention. Vogelzang and colleagues (1997) found that one third of patients reported mentioning fatigue to their physician at every visit, but very few oncologists (6%) remembered patients' complaints. Furthermore, they reported that most oncologists (80%) believed that fatigue was overlooked or undertreated by their colleagues. Another study revealed that 45% of patients believed that nothing could be done for their fatigue; furthermore, 40% of patients were offered no method of relief when they approached their healthcare providers about the problem (Curt et al., 2000).

Malnutrition is another prevalent issue in patients with cancer. Studies in the literature have reported the prevalence and negative effects of malnutrition in cancer patients (Brown & Radke, 1998; Yang et al., 2001). However, they have mainly explored malnutrition with patients receiving chemotherapy for cancer, and not patients undergoing radiotherapy. Yang and Lee (2000) reported that anthropometric parameters in patients with cancer after chemotherapy were reduced significantly compared to those before chemotherapy. Yang and colleagues (2001) reported that 29% of patients with stomach cancer receiving chemotherapy were classified as being malnourished.

The caloric intake of patients undergoing radiotherapy has been reported as less than recommended for adults, which is 2300 kcal for men, and 1900 kcal for women in their fifties (The Korean Nutrition Society, 2000). In a study of patients undergoing radiotherapy for cancer, Rho (1990) reported that the caloric intake of men was 1104.6 kcal, and that of women was 1031.4 kcal. Those subjects were taking only 48-54% of the recommended calories. In a study of 45 elderly patients (mean age=69.8 years) receiving radiotherapy for either breast (42%) or lung (58%) cancer, Lindsey, Larson, Dodd, Brecht, and Packer (1994) reported that their caloric intake was not adequate to meet to estimated energy requirements for usual activities and that there was a significant weight decrease from the beginning to the middle of therapy, and from the beginning to the conclusion of therapy.

When caloric intake is insufficient, the protein stored in muscles is broken down and is used to supply energy. Therefore, weight loss has been shown to indicate a change in one's protein content (Iwamoto, 1992). Weight-for-height is often the singular measure of nutritional status and may be the most useful indicator of nutritional status (Iwamoto, 1992). Thus, adequate amounts of calories and protein need to be provided to individuals undergoing radiotherapy to in order to preserve the body's store of protein.

Delmore (1997) reported that total lymphocyte and erythrocyte serve for assessing nutritional status, and it is considered to be severe malnutrition if body weight is reduced by 10% or more compared with usual body weight. In a study of patients with advanced cancer, Singh and Khanna (1985) reported that 80% of patients were classified as being malnourished, and the proportion of body weight lost was 24.1%. Yang and colleagues (2001) reported that after chemotherapy, 65.6% of patients with stomach cancer lost over 10% of their usual body weight, 91.6% showed less than normal values of hemoglobin, and 45.7% had less than normal lymphocyte counts.

Anemia is one of the many problems that cancer patients encounter as a result of either disease or cancer treatment. One of its cardinal symptoms includes fatigue. Anemia symptoms sometimes are difficult to differentiate from fatigue symptoms, and may contribute to fatigue. Fatigue associated with anemia can be disruptive to patients, affecting their quality of life (Cella, 1998). Immunological defense mechanisms are also impaired with protein-calorie malnutrition. This malnutrition-induced depression of cell-mediated immunity often has adverse effects on patients receiving radiotherapy. Cell-mediated immunity is evaluated by total peripheral lymphocyte counts. During radiotherapy, leukocytes are the first blood cell to decrease, followed by erythrocytes (Ellerhosrt-Rhyan, 2000).

Though malnutrition may increase fatigue, studies about fatigue and nutritional status are rarely found in the literature. Irvine and colleagues (1994) reported a significant relationship between fatigue and weight loss in patient undergoing cancer treatment. On the other hand, in a study of 45 patients with lung cancer receiving radiotherapy, Beach and colleagues (2001) reported

that weight loss over the course of treatment was significant, but did not correlate with fatigue. In studies of women undergoing radiotherapy for breast cancer, Greenberg, Sawicka, Eisenthal, and Ross (1992) and Geinitz and colleagues (2001) also reported that the fatigue and hematocrit or hemoglobin levels did not correlate with fatigue. In conclusion, the relationships between fatigue and nutritional parameters seem to be inconsistent.

METHODS

Research Design

To investigate the relationship between nutritional status and fatigue, this study used a correlational and crossectional design.

Sample

Subjects were recruited from a population of patients undergoing radiotherapy at a therapeutic radiation department in a university hospital in Chonan, Korea. Patients were invited to participate if they were over 18 years old. All patients undergoing radiotherapy were included, regardless of their disease, cancer stage, and treatment type in order to obtain broader information about radiotherapy. Patients with impaired cognitive functioning, however, were excluded because of their limited ability to respond to the questionnaire. Complete data was provided by 151 (78%) of the 191 patients enrolled in this study. Incomplete data was a consequence of either missing items on questionnaires or unavailable biochemistry data.

Measurement

1) Demographic and disease-related characteristics: Demographic data included age, sex, marriage, education, employment status, and economic status. Disease-related characteristics included cancer type, cancer stage, treatment goal, treatment type, radiation site, usual weight and weight change during the previous 3 months. The author developed the questions about the above-mentioned characteristics.

2) Fatigue: Fatigue was measured by the Korean version (Lee, 1999) of the Piper Fatigue Scale (Piper et al., 1998), a 19-item, 10 point self-report scale that has four dimensions: behavioral/severity, affective meaning, sensation, and cognitive/mood. A higher score indicates a higher perceived level of fatigue. The PFS has demonstrated validity and reliability in a number of other studies of patients with cancer. The strengths of the PFS are its comprehensive measure of multidimensional fatigue from a subjective point-of-view and its theoretical foundation (Wu & McSweeney, 2001). Internal consistency reliability was.963 in this study.

3) Nutritional status: Nutritional parameters included body weight (BW), Body Mass Index (BMI), hemoglobin (Hgb), and lymphocyte counts. These variables were measured as numeric values, but BMI, Hgb and lymphocyte counts were classified into normal and abnormal levels for determining the normalcy. Less than 13 gm/dl of Hgb for men, and less than 12 gm/dl of Hgb for women, indicated abnormal values. Less than 1500/mm^3 of lymphocyte counts was considered abnormal. A BMI of less than 20, which is considered to be underweight (Jang et al., 1998), was defined as abnormal.

Procedure

A research assistant who was a nurse working at a therapeutic radiological department in a university hospital collected data. For training the research assistant, the researcher explained the purposes of the research, the questionnaire's items and meanings, precautions regarding distributing and receiving questionnaires, procedures for measuring body weight, and the method of obtaining oral consent from prospective participants. In a therapeutic radiological department, the patients who agreed to participate in this study were asked to respond to the questionnaire. If the patients could not read, the research assistant assisted them in completing it.

Data Analysis

Demographic characteristics were analyzed using frequency, mean and standard deviation. The differences in fatigue, BW and BMI according to demographic and disease-related characteristics were analyzed using analysis of covariance (ANCOVA) for correcting for confounding effect caused by the variable 'cancer stage'. The differences in Hgb and lymphocyte among nutritional parameters were analyzed using Student's t-test and ANOVA because the correlation coefficient of these two dependent variables and cancer stage was less than 0.3 and the assumption for using ANOCVA can not be met (Lee et al., 2002). The classification of categorized nutritional parameters was analyzed using frequency. The relationships between fatigue and nutritional parameters were analyzed using Pearson's correlation.

RESULTS

Characteristics of the subjects

Demographic Characteristics

The sample consisted of subjects 20 to 79 years of age, and the mean age was 55.2 (SD=13.9). The patients with an age range of 50-59 years (25.2%) and those with an age range of 60-69 years (24.5%) were the most dominant groups. The number of female subjects was 89 (58.9%), with more females than males (62, 41.1%). Most patients were married (79.5%). Over half of the subjects had a middle/high school level of education (56%), no employment (50.3%) and middle-class economic status (54.4%) (see Table 1).

Disease-related Characteristics

As shown in Table 2, the prevalent cancer types were breast cancer (30.5%) and head and neck cancer (20.5%); 48.3% of the patients had received a stage I or II diagnosis, and 35.1% of the patients had received a stage IV diagnosis. The proportion of patients who underwent a curative radiotherapy was 86.1%. The most frequent radiation site was the chest (45.7%), followed by the head & neck (27.2%) and the abdomen/pelvis (27.2%). Forty-nine patients (32.5%) underwent radiotherapy alone, 55 patients (36.4%) received adjuvant radiotherapy after chemotherapy and/or surgery, and 47 patients (31.1%) received concomitant chemotherapy combined with radiotherapy.

In terms of the time of the survey during radiotherapy, 41.7% of patients were in the first or second week of treatment, 37.1% of patients were in the third or fourth week, and 21.2% were in the fifth or sixth week.

Forty-four patients (32.8%) had decreased weight compared with their usual body weight, and 90 patients (67.2%) either increased or showed no change in their body weight compared with their usual weight.

Descriptive results of fatigue and nutritional parameters

Table 3 shows the means and standard deviations of fa-

Table 1. Demographic Characteristics (N = 151)

Variable		Frequency	%
Age (years)	20-39	27	17.9
	40-49	22	14.6
	50-59	38	25.2
	60-69	37	24.5
	70-79	27	17.9
Sex	Male	62	41.1
	Female	89	58.9
Marital status	Single	7	4.6
	Married	120	79.5
	Separated/Divorced	24	15.9
Education level	None	8	5.3
	Elementary school	50	33.3
	Middle/high school	84	56.0
	College and over	8	5.3
Employment status	Yes	75	49.7
	No	76	50.3
Economic status	Upper class	0	0
	Middle class	80	54.4
	Lower class	67	45.6

Table 2. Disease-Related Characteristics (N = 151)

Variable		Frequency	%
Diagnosis	Breast cancer	46	30.5
	Lung cancer	21	13.9
	Head & Neck cancer	31	20.5
	GI cancer	18	11.9
	Others	35	23.2
Cancer stage	I	36	23.8
	II	37	24.5
	III	25	16.6
	IV	53	35.1
Treatment goal	Cure	130	86.1
	Symptom control	21	13.9
Radiation site	Head & neck	41	27.2
	Chest	69	45.7
	Abdomen/pelvis	41	27.2
Treatment type	RT alone	49	32.5
	Adjuvant RT	55	36.4
	Concomitant CT	47	31.1
Survey time point	1st-2nd week	63	41.7
	3rd-4th week	56	37.1
	5th-6th week	32	21.2
Weight change	Decreased	44	32.8
	No change	47	35.1
	Increased	43	32.1

RT: radiotherapy, CT: chemotherapy

Table 3. Descriptive Results of Variables

Variable	Mean	SD	Minimum	Maximum
Fatigue	5.0	2.1	0	9.1
BW (kg)	58.5	8.2	37.2	77.2
Height (m)	159.3	7.3	145.0	180.0
BMI	23.0	2.7	17.7	28.6
Hgb (gm/dl)	11.8	1.3	7.9	15.2
Lymphocyte counts (/mm^3)	904.1	482.3	93.6	3032.6

BW: body weight, BMI: body mass index, Hgb: hemoglobin
SD: Standard deviation

tigue and nutritional parameters. The mean of fatigue was 5.0 (SD=2.1). Among nutritional parameters, BW mean was 58.5kg (SD=8.2), and BMI mean was 23.0 (SD =2.7). The range of Hgb was 7.9 to 15.2 with a mean of 11.8 gm/dl (SD=1.3), and the range of lymphocyte counts was 93.6-3032.6/mm^3 with a mean lymphocyte count of 904.1 /mm^3 (SD=482.3). When BMI, Hgb, and lymphocyte counts were classified into normal and abnormal values, most patients (83.4%) were included in the normal value group for BMI (see Table 4). On the other hand, the proportion of patients who had abnormal levels of Hgb was 65.6%, and the proportion of those with abnormal lymphocyte counts was 80.1%.

Differences in fatigue according to demographic and disease-related characteristics

Fatigue scores according to characteristics were analyzed using ANCOVA for controlling the effect of cancer stage, a confounding variable.

As shown in Table 5, fatigue scores differed significantly according to age, employment status, radiation site, and treatment type. Other variables such as sex, cancer type, goal of treatment, the time of the survey during radiotherapy and weight change did not show a significant difference.

Patients in their fifties experienced more fatigue than patients overall (F=3.441, p=.010). Patients who were employed were more fatigued than those who were not

Table 4. Classification of Nutritional Parameters

Variables	Normal No (%)	Abnormal No (%)
BMI	126 (83.4)	25 (16.6)
Hgb	52 (34.4)	89 (65.6)
Lymphocyte counts	15 (9.9)	136 (80.1)

Table 5. Fatigue According to the Characteristics of the Subjects

Variables		No	Mean	SD	F	p
Age (years)	20-39	27	4.9	1.6	3.441	.010
	40-49	21	4.4	2.0		
	50-59	38	6.2	1.4		
	60-69	37	4.8	2.4		
	70-79	27	4.3	2.4		
Sex	Male	62	5.2	2.4	.565	.453
	Female	88	4.9	1.8		
Employment status	Yes	74	5.6	1.7	5.336	.022
	No	76	4.5	2.3		
Economic status	Middle	79	5.3	2.1	3.553	.061
	Low	67	4.8	2.0		
Diagnosis	Breast	46	5.1	1.5	2.124	.081
	Lung	21	5.6	2.5		
	Head & Neck	31	5.8	1.7		
	GI	17	5.2	2.4		
	Others	35	3.8	2.3		
Goal of Treatment	Cure	129	4.9	2.2	.023	.879
	Symptom Control	21	5.7	1.7		
Radiation site	Head & neck	41	5.8	1.6	5.720	.004
	Chest	69	5.2	1.9		
	Abdomen/pelvis	40	4.0	2.5		
Treatment type	RT alone	48	4.7	2.2	7.194	.001
	Adjuvant RT	55	4.6	2.1		
	Concomitant CT	47	5.9	1.8		
Suvey time point	1-2 week	62	4.9	2.4	.948	.390
	3-4 week	56	5.1	1.9		
	5-6 week	32	5.2	2.1		
Weight change	Decreased	44	5.7	1.8	1.614	.203
	No change	47	4.6	2.3		
	Increased	42	4.7	2.1		

RT: radiotherapy, CT: chemotherapy

(F=5.336, p=.022).

In terms of radiation site, patients who received radiation to the head and neck and chest experienced more fatigue than those who received it on the abdomen/pelvis (F=5.720, p=.004). The patients who had radiotherapy alone or adjuvant radiotherapy after chemotherapy or surgery were significantly less fatigued than those who had concomitant chemotherapy (F=7.194, p=.001).

Nutritional status according to demographic and disease-related characteristics

BW, BMI were analyzed using ANCOVA to determine whether they were different, according to the characteristics of the subjects (see Table 6). The variable 'cancer stage' was controlled in these results. Hgb and lymphocyte were analyzed using Student's t-test and ANOVA (see Table 6).

Female patients had lower BW(F=8.38, p<.05), higher BMI (F=-4.29, p<.05), and lower Hgb levels (t=2.67, p<.05). Patients in their forties and fifties had the lowest Hgb levels (F=3.54, p<.05).

Cancer types were related to all of nutritional parameters. The patients with head and neck cancer had the lowest BWs (F=9.63, p<.05) and BMIs (F=19.49, p<.05). Patients with lung cancer had the lowest lymphocyte counts (F=6.05, p<.05).

Radiation sites were significantly related to BW, and BMI. Patients who received radiation to the head and neck had the lowest BWs (F=11.48, p<.05) and BMIs

Table 6. Nutritional Status According to the Characteristics of the Subjects

Variables	BW	BMI	Hgb	Lymphocyte						
		Mean (SD)	F	Mean (SD)	F	Mean (SD) [c]	t or F	Mean (SD) [c]	t or F	
Age (years)	20-39	57.7 (7.3)	.93	22.4 (1.7)	2.11	12.2 (1.3) B	3.85*	805.6 (335.3)		.78
	40-49	59.8 (6.9)		23.8 (1.6)		11.4 (.9) A		1026.1 (357.6)		
	50-59	56.3 (10.1)		23.4 (3.4)		11.3 (1.1) A		870.3 (643.3)		
	60-69	60.3 (8.1)		22.7 (2.4)		12.1 (1.3) B		889.9 (499.3)		
	70-79	58.7 (7.1)		22.9 (3.4)		12.2 (1.3) B		972.8 (399.2)		
Sex	Male	59.9 (8.3)	8.38*	22.1 (2.6)	4.29*	12.2 (1.5)	2.67*	807.7 (356.7)		-2.13*
	Female	57.5 (8.0)		23.7 (2.6)		11.6 (1.0)		968.8 (543.3)		
Employment status	Yes	56.8 (8.6)	4.02*	22.4 (2.5)	3.07	11.9 (1.3)	.95	900.7 (528.2)		-.08
	No	60.1 (7.6)		23.6 (2.7)		11.7 (1.2)		907.9 (429.1)		
Economic Status	Middle	56.7 (8.9)	8.38*	22.7 (2.6)	4.45*	11.7 (1.3)	.29	916.5 (516.7)		-.11
	Lower	60.3 (7.1)		23.2 (2.7)		11.8 (1.1)		907.1 (446.6)		
Diagnosis	Breast	56.8 (6.6)	9.63*	23.3 (2.1)	19.49*	11.9 (.9)	1.93	859.6 (357.9)	A	6.05*
	Lung	61.9 (4.4)		23.0 (1.9)		11.2(1.0)		746.1 (312.6)	A	
	Head & Neck	52.7 (9.7)		20.0 (1.9)		11.9 (1.6)		763.4 (421.4)	A	
	GI	58.4 (8.2)		23.0 (2.5)		12.3 (1.2)		817.5 (407.1)	A	
	Others	63.9 (6.6)		25.4 (1.9)		11.8 (1.4)		1247.4 (650.4)	B	
Goal of Treatment	Cure	58.7 (8.3)	.96	23.2(2.6)	.073	11.8 (1.3)	.64	919.2 (492.1)		.92
	Sx Control	56.8 (7.6)		21.8 (2.9)		11.7 (1.2)		812.3 (417.3)		
Radiation site	Head & neck	54.1 (9.4)	11.48*	20.9 (2.5)	20.57*	12.0 (1.4)	.55	1009.9 (659.1)		2.09
	Chest	58.5 (6.3)		23.4 (2.1)		11.8 (1.1)		820.0 (354.3)		
	Abdomen/pelvis	62.9 (7.7)		24.6 (2.5)		11.7 (1.3)		942.6 (446.4)		
Treatment type	RT alone	60.7 (7.1)	4.26*	23.5 (2.4)	1.99	12.2 (1.3) B	4.84*	1056.0 (602.6)	B	5.35*
	Adjuvant RT[a]	58.5 (7.8)		22.9 (2.8)		11.8 (1.3) AB		913.9 (382.6)	AB	
	Concomitant CT[b]	56.1 (9.3)		22.6 (2.8)		11.4 (1.1) A		733.6 (393.2)	A	
Survey time point	1-2 week	59.6 (7.9)	1.75	23.4 (2.7)	2.94	11.8 (1.2)	33	1065.8 (556.0)	B	5.81*
	3-4 week	58.2 (8.6)		22.9 (2.5)		11.8 (1.2)		812.6 (412.9)	A	
	5-6 week	56.7 (8.2)		22.5 (2.9)		12.0 (1.4)		766.2 (350.1)	A	
Weight change	Decreased	57.5 (6.7)	1.23	22.2 (2.7)	2.33	11.4 (1.0) A	9.56*	788.4(372.3)		2.57
	No change	58.4 (9.4)		23.3 (3.2)		11.6 (1.3) B		918.0 (620.8)		
	Increased	60.8 (7.5)		24.1 (1.5)		12.5 (1.3) B		1032.1 (447.2)		

* p<.05, a) RT: radiotherapy, b) CT : chemotherapy

c) In the raw of mean, cell with the same letters are significantly different between groups.

(F=20.57, $p<.05$). Treatment types were significantly related to BW, Hgb levels, and lymphocyte counts. The patients who underwent concomitant chemotherapy or adjuvant radiotherapy had lower BWs (F=4.26, $p<.05$), Hgb levels (F=4.84, $p<.05$) and lymphocyte counts (F=5.35, $p<.05$).

The survey time point was related to lymphocyte counts. Patients who underwent radiotherapy for 5 or more weeks had the lowest lymphocyte counts (F=5.81, $p<.05$). Weight change during the previous 3 months was related to Hgb levels. Patients who decreased or did not change their BW had lower Hgb levels (F=9.56, $p<.05$). Goal of treatment was not related to all of nutritional parameters.

The relationship between fatigue and nutritional parameters

Fatigue scores were significantly correlated with BWs (r=-.38, $p<.01$), BMIs (r=-.34 $p<.01$) and Hgb levels (r=-.27, $p<.01$) and were not correlated with lymphocyte counts (see Table 7).

DISCUSSION

These subjects were mainly in their fifties or sixties (49.7%) and married (79.5%). They experienced moderate fatigue (average score 5 on a 10 point scale). Their BMIs were within the normal range, but their average Hgb levels and lymphocyte counts were below-normal values. Over half of the patients (65.6%) had abnormal hemoglobin values, and 80% of them had abnormal lymphocyte counts.

In a study of patients receiving chemotherapy, Yang and colleagues (2001) reported that 93.6% of patients showed below normal values of hemoglobin, and 45.7% showed deficient lymphocyte counts. Compared to the findings of Yang and colleagues (2001), fewer patients had low hemoglobin levels, but lymphocyte counts were very much affected by radiotherapy. This finding was supported by Ellerhorst-Ryan (2000), who explained that during radiotherapy, leukocytes are the first blood cell to decrease. Lymphatic tissue is also susceptible to malnutrition. In the malnourished state, T-cell generation is repressed and results in a decrease of lymphocytes (Delmore, 1997). Therefore, malnourished patients have a higher risk of infection.

Table 7. Correlation between Fatigue and Nutritional Parameters

	BW	BMI	Hgb	lymphocyte counts
Fatigue	-.38**	-.34**	-.27**	-.09

**: $p<.01$

Anemia is important in radiotherapy because of its role in oxygen transport. Cella (1998) assessed fatigue and anemia in 50 patients with cancer. Twenty-five percent of the high-level fatigue patients reported an inability to work, regardless of whether their hemoglobin levels were high or low. On the other hand, none of the low-level fatigue patients with high hemoglobin levels reported an inability to work, whereas 30% of the patients with low hemoglobin levels reported not being able to work. Cella concluded that fatigue is not the only anemia-related symptom impairing work functioning.

In this study, hemoglobin levels significantly correlated with fatigue, and generally the patients with higher fatigue scores had lower hemoglobin levels. However, some cases did not fit with this pattern. For example, patients who received radiation to head and neck had higher Hgb level (M=12.0), but their fatigue levels were the highest among the total subjects (M=5.8). In another example, patients in their forties had very low hemoglobin levels (11.4 gm/dl), but their fatigue levels were relatively low (M=4.4). The relationship between fatigue and low hemoglobin levels (anemia) is controversial. Beach and colleagues (2001) and Geinitz and colleagues (2001) reported that fatigue and hemoglobin were not correlated. Thus, the findings in this study partly support Cella's conclusion.

In this study, the average BMI of patients was 23.0 and the proportion of patients who had BMIs below 20 was 16.6%. The percentage of the patients with abnormal BMIs was less than that of the study by Yang and colleagues (2001), which was reported to be 37.6% after chemotherapy.

Brown and Radke (1998) assessed the nutritional status in patients who died of lung cancer using their medical records. They reported that among them, the percentage of the patients in cancer stage IV was the highest (42%) and their BMI decreased from 23.8 at the time of diagnosis to 22.0 at the last follow-up before death.

In this study, specific age group, cancer type, and concurrent cancer treatments had very significant adverse effects on fatigue and nutritional status. Patients with head and neck cancer had the lowest body weight and BMI, and patients with lung cancer had the lowest lymphocyte counts. Those patients with head and neck cancer and lung cancer were the most fatigued group.

Patients in their fifties were the most fatigued and had the lowest hemoglobin levels. The patients who underwent concomitant chemotherapy were the most fatigued and showed poorer nutritional parameters. Indeed, the patients who have these characteristics can be classified as a risk group which is most vulnerable to fatigue and malnutrition.

The previous studies supported the finding that cancer stage and treatment type significantly affected fatigue. Buera and MacDonald (1988) found that 51% of patients with advanced cancer and 80% of patients with terminal cancer were malnourished, compared with only 2.3% of patients with breast cancer in the early stages of the disease. In addition, Woo, Dibble, Piper, Keating, and Weiss (1998) investigated the differences between various cancer therapies in 322 breast cancer survivors. They reported that women who received combination treatments had the highest fatigue scores, compared to women who received radiation alone, who had the lowest fatigue scores.

Fatigue is a totally subjective phenomenon. Winningham (1996) proposed that since there are no definite diagnostic indicators for detecting or monitoring fatigue, clinicians must accept their patients' reports. Even though this notion could be accepted as appropriate, we must heed the alternative notion that if fatigue correlates with nutritional status, perhaps implementing nutritional measures would help to combat these symptoms (Beach et al., 2001). When objective observations are combined with subjective ones, we can expect a more precise assessment of fatigue. From this view, further study needs to be conducted in this area.

What is important is that nurses and physicians recognize the influence of fatigue and nutrition on patients. It is recommended that health care providers make observations about fatigue and nutritional status and provide proper interventions for their patients.

One limitation of this study was that it did not control for cancer disease, cancer stage or treatment type. In addition, because the research assistant helped subjects who could not read by themselves to respond to the questionnaire, the data obtained by interviewing may be different from the data obtained by the self-reported method. In interpreting these findings, these limitations should be taken into consideration as possibly confounding the findings.

CONCLUSION SUGGESTION

From this study, the following findings were obtained: fatigue levels differed according to age, employment status, radiation site, and treatment type. Patients who were in their fifties, had head and neck cancer, had received radiation to the head and neck area, and who underwent concomitant chemotherapy combined with radiotherapy experienced significantly more fatigue.

Nutritional parameters differed significantly, mainly according to cancer type and treatment type. The patients who had head and neck cancer, radiation to the head and neck areas, and who underwent concomitant chemotherapy were the most vulnerable to malnourishment. Fatigue significantly correlated with BW, BMI and Hgb levels.

These findings can help heath care professionals understand the relationship between fatigue and nutrition, and can possibly help to identify the risk groups for timely intervention. Further research is needed in order to confirm these findings. A longitudinal and controlled design and multi-dimensional studies would be useful in obtaining more detailed information about fatigue and nutritional status.

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