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Predictors of Pain among Head and Neck Cancer Patients

Andrew G. Shuman, MD[1,*], **Jeffrey E. Terrell, MD**[1], **Emily Light, MS**[2], **Gregory T. Wolf, MD**[1], **Carol R. Bradford, MD**[1], **Douglas Chepeha, MD**[1], **Yunyun Jiang, MS**[3], **Scott McLean, MD, PhD**[1], **Tamer A. Ghanem, MD, PhD**[4], and **Sonia A. Duffy, PhD, RN**[1,3,5]

[1]Department of Otolaryngology – Head and Neck Surgery, University of Michigan Medical School, Ann Arbor, MI

[2]University of Michigan Comprehensive Cancer Center, Biostatistics Core, Ann Arbor, MI

[3]School of Nursing, University of Michigan, Ann Arbor, MI

[4]Department of Otolaryngology – Head and Neck Surgery, Henry Ford Health System

[5]Ann Arbor Veterans Affairs (VA) Center for Clinical Management Research, VA Ann Arbor Healthcare System, Ann Arbor, MI

Abstract

Objective—Pain is a strong contributor to cancer patients' quality of life. The objective of this study was to determine predictors of pain 1 year after the diagnosis of head and neck cancer.

Design—Prospective, multi-site cohort study.

Setting—Three academically-affiliated medical centers.

Patients—Previously untreated patients with carcinoma of the upper aerodigestive tract (n=374).

Main Outcome Measures—Participants were surveyed pre-treatment and 1 year thereafter. Multivariate analyses were conducted to determine predictors of the SF-36 bodily pain score 1 year after diagnosis.

Results—The mean SF-36 bodily pain score at 1 year was 65, compared to 61 at diagnosis (p=.004), compared to 75 among population norms (lower scores indicate worse pain). Variables independently associated with pain included pre-treatment pain score (p<0.001), less education (p=0.02), neck dissection (p=0.001), feeding tube (p=0.05), xerostomia (p<0.001), depressive symptoms (p<0.001), taking more pain medication (p<0.001), less physical activity (p=.02), and poor sleep quality (p=0.006). Current smoking and problem drinking were marginally significant (p=0.07 and 0.08, respectively).

Conclusions—Aggressive pain management may be indicated for head and neck cancer patients who undergo neck dissections, complain of xerostomia, require feeding tubes, and have medical

Corresponding author and reprint requests: Sonia A. Duffy, PhD, RN, FAAN, 2215 Fuller Rd, Ann Arbor, MI 48105, USA, Telephone: 1-734-395-0613, Fax: 1-734-845-3250, bump@umich.edu.
*Current affiliation: Head and Neck Service, Department of Surgery, Memorial Sloan-Kettering Cancer Center, New York, NY

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comorbidities. Treatment of modifiable risk factors such as depression, poor sleep quality, tobacco and alcohol abuse may also reduce pain and improve quality of life among head and neck cancer patients.

Keywords

Head and neck cancer; pain; quality of life; symptom management; analgesia

Introduction

The Institute of Medicine considers effective analgesia a moral imperative and has recently challenged medical providers to better understand, prevent and treat pain.[1] Head and neck cancer patients frequently experience pain, even long after the completion of treatment.[2] The prevalence of bodily pain among head and neck cancer patients has been estimated at 70%, considerably higher than what has been reported in other cancer patients.[3] Pain experienced 1 year after diagnosis strongly predicts long-term quality of life,[4] and is associated with poorer survival among head and neck patients, particularly those with advanced disease.[5] Bodily pain is also a robust predictor of disability in head and neck cancer patients.[6]

Many studies have investigated the factors associated with bodily pain among cancer patients, which include age, underlying physical and mental health, and depression.[7, 8] Specific to head and neck cancer, medical comorbidities, chemotherapy, and presence of a feeding tube are associated with significant bodily pain.[9] Tumor site and stage have been correlated with pain reported by patients with oral cavity cancer.[10]

Tobacco use has been temporally associated with pain severity,[11, 12] and problem drinking has been associated with pain.[13] Diet and physical activity also influence physical pain among cancer patients.[14, 15] While increased physical activity[16] and fruit and vegetable intake[14] have been shown to improve quality of life among head and neck cancer patients, no studies have shown a relationship between these factors and pain. Moreover, bodily pain predicts poor sleep quality, and is significantly associated with insomnia.[17, 18]

While effective pain treatments exist, identifying those most at risk for pain could facilitate targeted assessment and intervention. Thus, the objective of this study was to determine the variables associated with pain among head and neck cancer patients 1 year following diagnosis.

Materials and Methods

Design

This investigation was conducted as part of a prospective cohort study involving patients enrolled in the University of Michigan Head and Neck Cancer Specialized Program of Research Excellence. This sub-study was performed to determine variables associated with pain 1 year after diagnosis among head and neck cancer patients. The dependent variable was the SF-36 bodily pain score at 1 year post-diagnosis. The independent variables included demographic characteristics, clinical factors, and health behaviors. Institutional review board approval was obtained at each study site.

Sample

Subjects were recruited from the waiting rooms in head and neck cancer clinics within three institutions: the University of Michigan Health System, the Veterans Affairs (VA) Ann Arbor Healthcare System, and the Henry Ford Health System (HFHS). Patients with squamous cell carcinoma of the upper aerodigestive tract mucosa (excluding skin and esophagus) were eligible for enrollment. Patients who were less than 18 years of age, pregnant, non-English speaking, psychologically or cognitively unable to complete the survey, or with different tumor sites and/or histologies were excluded. Research assistants recruited patients after obtaining informed consent, and administered a written survey. Clinical data were collected directly from the surveys and were confirmed and/or abstracted from the medical record. The survey was repeated 1 year post-diagnosis. Participants received $10 compensation after the completion of each questionnaire. Of 811 patients recruited to the study, 559 had 1-year SF-36 scores, and the 374 with complete data were included in the final multivariate analysis.

Dependent Variable

The 36-item Short-Form Health Survey (SF-36) is a comprehensively validated index used to assess quality of life.[19, 20] It has been accepted as one of the most widely used and exhaustively studied survey-based patient assessed health outcome measures.[21] It has been successfully employed to study head and neck cancer patients, and independently predicts survival within this cohort.[22, 23] The SF-36 bodily pain score is an independently-validated subscale that has high fidelity and reproducibility in describing patient-reported pain;[24] based on a scale of 0-100, the population norm (in a cohort with a mean age of 58 years) is 75 (lower scores indicate worse pain).[25]

Independent Variables

Demographics—Demographic information included patient age at the time of diagnosis (in years), sex, race, marital status (yes/no), and education level (high school or less vs. some college or more). Since race has been shown to effect outcomes among head and neck cancer patients, respondents were asked to self-identify their ethnicity/race using the US census two-tiered question: 1) a two category question about Hispanic/Latino origins; and 2) a five category question about race (of which respondents could select multiple categories).[26] Since there were few respondents in many of the categories, race was collapsed into white and non-white for analysis.

Clinical Factors—Cancer descriptors included the primary tumor site and disease stage according to the American Joint Committee on Cancer (AJCC) sixth edition.[27] For the purposes of statistical analysis, tumor sites were grouped in aggregate (into pharynx, larynx, and oral cavity [including other/sinus]), and stage was separated into stages I/II versus stages III/IV.

Treatment variables included whether subjects received (yes/no) radiation, chemotherapy, primary site surgery, and/or neck dissection. Also assessed was the presence (yes/no) of an indwelling feeding tube and/or tracheotomy at 1 year post-diagnosis. Neck dissections were

defined as any systematic cervical nodal extirpation regardless of level(s) dissected or additional structure(s) removed.

Xerostomia was described by a question taken verbatim from the Head and Neck Quality of Life (HNQOL), a validated, disease-specific QOL instrument for patients with head and neck cancer.[28] Medical comorbidities were assessed by chart abstraction using the validated Adult Comorbidity Evaluation-27 (ACE-27) index and classified into two groups: moderate to severe comorbidity versus no to mild comorbidity.[29] Depression was measured using the validated 5-item Geriatric Depression Scale-Short Form (GDS-SF): a score of 4 or higher on this scale indicates probable depression.[30] Pain medicine usage by subjects at 1 year was assessed with one question measured on a 5-point Likert scale from 1 (never) to 5 (always).

Health Behaviors—Subjects were asked about their prior and current tobacco use; respondents who reported any tobacco use within the past month were considered current smokers; those who reported use prior to 1 month ago were considered former smokers. The 10-item Alcohol Use Disorders Identification Test (AUDIT) was used to assess the amount of alcohol intake and related problems; a score of 8 or higher on this test indicates a high risk of alcohol-related disorders.[31] Selected questions from the validated Willett food frequency questionnaire were used; respondents reported the average number of servings of fruit, vegetables and fried foods consumed over the past year.[32] The validated Physical Activity Scale for the Elderly (PASE) was used to measure activity; scores ranged from 0-400 or more (higher scores indicate more activity), and the population mean for people age 65-100 was 103.[33] Sleep quality was assessed using the validated Medical Outcomes Study sleep measure (MOS-Sleep); lower scores indicate poorer sleep.[34, 35]

Statistical Analysis

Descriptive statistics were calculated for all measures. Frequencies and percentages are presented for categorical variables, and means and standard deviation are presented for continuous measures. A correlation matrix was employed to determine the co-linearity between variables (not shown). Bivariate analyses (analysis of variance and Spearman rho) were used to test correlations between SF-36 Pain Index and each independent variable. Based upon the bivariate analyses, ordinary least squares multiple linear regression was conducted to determine independent variables associated with the dependent variable at 1 year after diagnosis. All analyses were conducted using SAS 9.3 software (Cary, NC).

Results

Description of Sample

The demographic and health characteristics of the sample are summarized in Table 1. The mean age of participants was 58 years, most were male (78%), Caucasian (91%) and married (60%) and just over half had some college education or more (56%). The majority of primary sites were pharyngeal (53%), and advanced stage disease was common (75% stages III, IV). About 84% had radiation, 62% had chemotherapy, 38% had primary site surgery, and 43% underwent neck dissection. At 1 year post-treatment, 18% of patients had an indwelling feeding tube, and 4% had a tracheotomy. Xerostomia was frequent, with 44%

complaining of “a lot” or “extreme” symptoms at 1 year. Approximately 39% screened positive for depression. Most patients (54%) never or rarely used pain medicine at 1 year. About one-quarter (22%) were current smokers, and only 12% were problem drinkers.

Bivariate Analysis

The mean SF-36 pain score was lower (worse) pre-treatment than 1 year later (61 vs. 65; p=0.004). Factors associated with 1 year pain on bivariate analysis are summarized in Table 2 and included marital status, educational level, cancer site, primary site surgery, neck dissection, feeding tube, tracheotomy, xerostomia, depression, smoking, problem drinking, vegetable and fruit intake, physical activity, and sleep.

Multivariate Analysis

The multivariate analysis is reported in Table 3. Multivariate analysis indicated that pre-treatment pain (p<0.001), less education (p=0.02), neck dissection (p=0.001), presence of a feeding tube (p=0.05), xerostomia (p<0.001), depressive symptoms (p<0.001), taking more pain medication (p<0.001), less physical activity (p=.006), and poor sleep quality (p=0.02) were independently associated with worse pain 1 year after diagnosis. Current smoking and problem drinking approached significance in the multivariate analyses (p=.07 and .08, respectively). While cancer site, primary site surgery, tracheotomy, comorbidities, and vegetable and fruit intake were significant in the bivariate analyses, they were no longer significant in the multivariate analyses.

Alternative regression models were created in order to control for potential confounders and statistical limitations (data not shown). Models that did not incorporate pre-treatment pain scores and those that excluded analgesic usage both yielded similar results to the reported data. Cancer stage re-stratified into stages I/II/III versus stage IV, inclusion of tumor N stage, inclusion of recurrent disease, and chemoradiation (as a yes/no variable) also did not change the results.

Discussion

Bodily pain scores among patients with head and neck cancer are better at 1 year follow-up in comparison with the pre-treatment value. The improvement at 1 year is intuitive given the pain inherent to an untreated tumor burden at the time of diagnosis and the likelihood that the acute stigmata of cancer treatment have resolved by 1 year. Nonetheless, the mean 1 year pain score is worse than scores seen in the general population of similar age, and is predicted by pre-treatment pain.[19] Our prior work with head and neck cancer patients has shown that a ten point decrement in SF-36 bodily pain scores is associated with a 20% increased risk of disability.[6] In another study, the incidence of oral pain among 5-year head and neck cancer survivors was 43%.[36] Our data corroborate that head and neck cancer patients continue to experience pain 1 year after diagnosis, and that dedicated, evidence-based strategies for effective analgesia are likely to be critical in order to optimize our patients’ qualities of life.

Demographics

Lower educational level was associated with more pain, corroborating data suggesting that educational level also predicts quality of life among nasopharyngeal cancer patients, and overall disability in a population of treated head and neck cancer patients.[6, 37] Interestingly, none of the other demographic characteristics evaluated were independently associated with bodily pain scores. Our findings support the notion that physical and psychological factors influence pain to a greater extent than do demographics,[38] and are in accordance with a large study which found that no demographic factors predicted pain among a diverse cohort of cancer patients.[39]

Cancer Characteristics and Treatment

While cancer site, stage, and treatment would seemingly affect pain, these were surprisingly not significant in the multivariate analyses. Instead, the adverse consequences of treatment, which were studied as independent variables as well, were more indicative of pain at 1 year. For example, xerostomia was closely associated with pain, but radiation therapy was not similarly related thus we postulate that salivary gland-sparing regimens delivered with intensity modulated radiation treatment (IMRT) might limit xerostomia and resultant pain perception.[40] Data suggesting that IMRT broadly improves quality of life when compared with conventional radiation delivery algorithms confirm this conjecture.[41, 42] Unfortunately, specific data on radiation fields was not collected and could not be included in the analyses.

The presence of a feeding tube at 1 year strongly influences quality of life and was significantly associated with pain in the multivariate analysis.[9] In many cases, consequences of treatment (regardless of modality) influence post-treatment function related to eating and drinking. The presence of a tracheotomy at 1 year, which also indirectly reflects tissue effects of cancer-directed treatment, was not significantly associated with pain, possibly due to the low incidence of tracheotomies at 1 year. While primary site surgery was not associated with pain, the one treatment that was significantly associated with pain was neck dissection. This finding supports prior data that highlights the tangible, long-term functional consequences of neck dissections, particularly in post-treatment settings.[43] Patients undergoing neck dissection were likely to also have been treated with radiation which might also contribute to pain. We did not compare pain scores for neck dissection alone to neck dissection prior to or following radiation, nor specifically control for the type of neck dissection. While the era of “radical” neck surgery has been supplanted by movements toward “selective” operations, these observations confirm that neck dissections, even those performed by experienced surgeons and that aim to limit morbidity, are not always innocuous.[44]

Comorbidities and Depression

Medical comorbidities were not associated with pain, which does not corroborate findings in the general cancer patient population, however, 70% of the population had none or mild comorbidities. A relationship exists between medical comorbidities and many quality of life-related metrics in head and neck cancer patients.[45, 46] Among head and neck cancer patients with multiple medical problems, amelioration of symptoms may require diligent titration of pharmacologic regimens and close collaboration with other clinicians.

As has been seen in other studies of cancer patients, depression is highly correlated with pain.[47] Depressed patients are more sensitive to somatic discomfort, which also engenders depressive symptoms, particularly among cancer patients.[48] Depression is also associated with health behaviors, some of which were associated with pain, and which must be considered in treating pain.[49, 50] Smoking, alcohol abuse and depression are interrelated, and treating depression may enhance substance abuse cessation efforts. Also, depression has been shown to be correlated with sleep disturbances.[51] The data suggest that clinicians should seek to diagnose and treat depression among head and neck cancer patients complaining of pain, and also that depressed patients may require aggressive analgesia in addition to treating their mood and/or sleep disorders.

Health Behaviors

Cancer patients' smoking status is closely linked with quality of life, and we identified a trend towards more pain in current tobacco users.[52] The mechanisms by which tobacco influences head and neck cancer pain are undoubtedly multifactorial, involving central nociceptive processing mechanisms, psychological factors, and direct mucosal irritation, among others.[53] Maladaptive strategies in which tobacco is relied upon for pain relief are prevalent; educational and pharmaceutical initiatives in which tobacco is recast as an accomplice to pain may improve success rates in achieving abstinence.[54]

Problem drinking approached significance with head and neck cancer pain. In general, patients with better function are more likely to drink alcohol socially, but alcohol may also be utilized for its analgesic properties among those in pain. Self-medication of pain with alcohol has been associated with pain frequency, depression, and use of pain medications.[55] Moreover, problem drinkers have a higher incidence of tobacco abuse, and are less likely to quit.[56] Clinicians should individualize counseling and interventional strategies for patients with problem drinking, being mindful of its complex relationship with clinical factors and other health behaviors.[57]

There was an association between increased physical activity and less pain. Directed rehabilitative interventions also appear to improve somatic function in head and neck cancer patients, specifically regarding dysphagia treatment/prevention, and shoulder/neck range of motion after surgery.[58, 59] Poor sleep was closely associated with worse pain, which is supported by prior research[60] as sleep disturbances are likely to be caused by severe pain. Our findings support the need to screen for sleep disturbances among patients with bothersome pain, and also suggest that undertreated pain may contribute to seemingly idiopathic insomnia.

Treating Pain Effectively

While one might postulate instead that efficacious medication usage should decrease pain, our data reinforce that head and neck cancer patients who use analgesics still report pain, suggesting their regimens may not be adequately effective. While we did not specifically address analgesic efficacy or regimens, data suggest that relatively simple interventions, such as prescribing medications on a schedule, rather than as needed, more effectively manage post-surgical head and neck cancer patients' pain.[61] The World Health Organization

pain ladder offers a practical, stepwise approach to managing cancer pain that is readily applicable to head and neck cancer patients.[62] . Head and neck cancer patients are at risk for cancer recurrence and for second primaries; pain is a frequent harbinger of such phenomena, and clinicians must remain ever-vigilant during continued oncologic surveillance.

Limitations

The SF-36 bodily pain index does not distinguish head and neck symptoms, thus pain scores may or may not relate directly to patients' cancer and its treatment. In quality of life research in head and neck cancer, no single metric can effectively encapsulate the patient experience or perspective.[63] Given that quality of life among head and neck cancer patients may decline over many years, 1-year pain scores do not necessarily encompass the evolution of longer-term symptoms.[64] Despite extra efforts to recruit minorities, the study over-represented Caucasian men, potentially limiting the ability to extrapolate our findings in other populations.

Conclusion

Many head and neck cancer patients experience pain 1 year after diagnosis. Pain, more than any other symptom or disease, is the single greatest source of financial expense and patient complaints in America.[65] Reducing the potential for pain from neck dissection, minimizing xerostomia, and utilizing evidence-based strategies for effective analgesia are opportunities worth considering in order to limit pain and improve quality of life for these patients. An understanding of the complex relationships among cancer treatment, health behaviors and pain is instructive to clinicians faced with preventing, anticipating, counseling and treating bothersome symptoms in a challenging patient population.

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Table 1

Patient Characteristics (N=559)[a]

Characteristics	N	Mean or %	SD
SF-36 Pain Index			
Baseline	537	60.5	27.1
1 Year follow up	559	65.1	26.2
Demographics			
Age	559	58.4	10.7
Sex			
Male	433	77.5	
Female	126	22.5	
Race			
Caucasian	506	90.5	
Non-Caucasian	53	9.5	
Marital Status (at one year)			
Married	304	60.0	
Single	203	40.0	
Education			
High school or less	245	43.9	
Some college or more	313	56.1	
Clinical Characteristics			
Cancer Site			
Pharynx	296	53.0	
Larynx	129	24.0	
Oral cavity	134	23.1	
Cancer Stage			
I,II	140	25.0	
III, IV	419	75.0	
Primary Site Surgery			
Yes	211	37.8	
No	347	62.2	
Neck Dissection			
Yes	239	42.8	
No	319	57.2	
Radiation			
Yes	472	84.4	
No	87	15.6	
Chemotherapy			
Yes	346	61.9	
No	213	38.1	
Feeding tube at one year			
Yes	102	18.3	

Characteristics	N	Mean or %	SD
No	455	81.7	
Tracheotomy at one year			
Yes	21	3.8	
No	536	96.2	
Xerostomia at one year			
Not at all	113	20.8	
Slightly	93	17.1	
Moderately	100	18.4	
A lot	145	26.7	
Extremely	92	16.9	
Medical Comorbidity			
None or mild comorbidity	391	70.0	
Moderate or severe comorbidity	168	30.0	
Depressive Symptoms at one year[b]			
Yes	214	39.3	
No	330	60.7	
Health Behaviors			
Use of pain medicine at one year			
Never	207	37.3	
Rarely	95	17.1	
Sometimes	91	16.4	
Frequently	71	12.8	
Always	91	16.4	
Smoking status at one year			
Current smoker (population norm 19.3%)	125	22.4	
Former smoker	346	61.9	
Never smoker	88	15.7	
Problem Drinking at one year[c]			
Yes (population norm 7-13%)	65	11.9	
No	481	88.1	
Vegetable intake			
None to 1 per week	225	53.6	
2-4 per week to 5-6 per week	56	13.3	
1 per day or more	139	33.1	
Fruit intake			
None to 1-3 per month	172	40.9	
1 per week to 2-4 per week	131	31.1	
5-6 per week or more	118	28.0	
Physical Activity at one year (population norm 103)[d]	558	131.7	87.6
Sleep at one year (population norm 72)[e]	557	68.5	20.8

[a] 559 patients had SF-36 pain index reported at one year after diagnosis; numbers may not add to total for other variables due to missing data.

[b] Geriatric Depressive Scale Short Form ≥ 4

[c] Alcohol Use Disorders Identification Test (AUDIT) ≥ 8

[d] Physical Activity Scale for the Elderly (PASE); scores ranged from 0-400 or more; higher scores indicate more activity.

[e] Medical Outcomes Study sleep measure (MOS-Sleep); lower scores indicate poorer sleep.

Table 2

Bivariate Association with SF-36 pain score at one year post-treatment (N=559)[a]

Characteristics	N	Mean SF-36 Pain Score*	SD	P-value
Demographics				
Age				
≤ 58	301	62.9	26.5	0.10
> 58	258	67.8	25.7	
Sex				
Male	433	65.2	26.1	0.89
Female	126	64.9	26.8	
Race				
Caucasian	506	65.5	25.9	0.32
Non-Caucasian	53	61.7	29.3	
Marital Status (at one year)				
Married	304	68.0	25.0	**0.003**
Single	203	60.9	27.4	
Education				
High school or less	245	62.7	27.5	**0.05**
Some college or more	313	67.1	25.1	
Clinical Characteristics				
Cancer Site				
Pharynx	296	68.3	25.0	(Reference)
Oral cavity	134	63.2	26.5	**0.04**
Larynx	129	61.4	27.6	**0.01**
Cancer Stage				
I,II	140	65.3	26.8	0.94
III,IV	419	65.1	26.1	
Primary Site Surgery				
Yes	211	61.8	27.0	**0.02**
No	347	67.2	25.6	
Neck Dissection				
Yes	239	61.0	26.7	**0.001**
No	319	68.2	25.5	
Radiation				
Yes	472	65.0	25.7	0.84
No	87	65.7	26.4	
Chemotherapy				
Yes	346	65.3	26.1	0.85
No	213	64.9	26.5	
Feeding tube at one year				
Yes	102	53.3	25.3	**<0.001**
No	455	67.9	25.7	

Characteristics	N	Mean SF-36 Pain Score*	SD	P-value
Tracheotomy at one year				
Yes	21	53.4	29.5	**0.04**
No	536	65.7	26.0	
Xerostomia at one year				
Not at all	113	71.5	27.2	**<0.001**
Slightly	93	70.2	23.7	
Moderately	100	71.1	23.3	
A lot	145	63.3	24.6	
Extremely	92	49.4	25.6	
Comorbidity				
None or mild comorbidity	391	67.8	25.9	**<0.001**
Moderate or Severe comorbidity	168	59.0	26.1	
Depressive Symptoms at one year[c]				
Yes	214	50.5	25.0	**<0.001**
No	330	74.9	22.1	
Health Behaviors				
Use of pain medicine at one year				
Never	207	83.7	18.3	**<0.001**
Rarely	95	68.1	22.6	
Sometimes	91	57.3	17.9	
Frequently	71	48.0	23.0	
Always	91	41.6	23.1	
Smoking status at one year				
Current smoker	88	50.9	25.0	**<0.001**
Former smoker	346	65.6	26.0	
Never smoker	125	73.8	23.6	
Problem Drinking at one year[d]				
Yes	65	48.8	25.9	**<0.001**
No	481	67.2	25.6	
Vegetable intake				
None to 1 per week	225	62.9	25.7	**<0.001**
2-4 per week to 5-6 per week	56	64.8	21.9	
1 per day or more	139	74.0	23.6	
Fruit intake				
None to 1-3 per month	172	62.6	25.7	**0.002**
1 per week to 2-4 per week	131	66.9	23.6	
5-6 per week or more	118	73.2	24.4	
Physical Activity Score at one year				
≤121	283	58.3	27.1	**<0.001**
>121	275	72.0	23.3	
Sleep Score at one year				
≤73	276	52.2	24.8	**<0.001**

Characteristics	N	Mean SF-36 Pain Score*	SD	P-value
>73	281	77.9	21.0	

*Lower scores signify worse pain

[a]559 patients had SF-36 pain index at one year after diagnosis; numbers may not add to 559 for other variables due to missing data.

[b]p-values derived from ANOVA methods (categorical variables) or Spearman test (continuous variables). Continuous variables are dichotomized by median for purpose of summarizing the means in this table.

[c]Geriatric Depressive Scale Short Form ≥ 4

[d]Alcohol Use Disorders Identification Test (AUDIT) ≥ 8

Table 3

Multivariate predictors of SF-36 pain score at one year post-treatment (N=374)[a]

	Parameter Estimate	95% CI Interval	P-value
Baseline SF-36 pain score	0.20	(0.13, 0.27)	**<0.001**
Demographics			
Age (10 year increase)	0.50	(-1.37, 2.38)	0.60
Sex (female vs. male)	2.93	(-1.25, 7.10)	0.17
White	1.15	(-5.39, 7.69)	0.73
Marital Status (married vs. single)	-0.74	(-4.40, 2.92)	0.69
Education (High school or less vs. some college or more)	4.19	(0.64, 7.75)	**0.02**
Clinical Characteristics			
Cancer Site			
Oral cavity (vs. Pharynx)	4.13	(-0.72, 8.97)	0.10
Larynx (vs. Pharynx)	-2.26	(-7.27, 2.74)	0.38
Cancer Stage (III, IV vs. I, II)	1.69	(-3.37, 6.75)	0.51
Primary Site Surgery	2.69	(-2.52, 7.90)	0.31
Neck Dissection	-6.83	(-10.94, -2.72)	**0.001**
Radiation	5.29	(-1.04, 11.62)	0.10
Chemotherapy	3.14	(-1.91, 8.19)	0.22
Feeding tube at one year	-5.11	(-10.24, 0.01)	**0.05**
Tracheotomy at one year	4.00	(-7.21, 15.20)	0.49
Xerostomia at one year Extremely/A lot (vs. Moderate/Slightly/Not at all)	-6.69	(-10.58, -2.81)	**<0.001**
Comorbidity (moderate/severe vs. mild/none)	-2.79	(-6.67, 1.09)	0.16
Depressive symptoms at one year[b]	-9.95	(-14.23, -5.67)	**<0.001**
Health Behaviors			
Use of pain medicine at one year			**<0.001**
Never	19.75	(14.09, 25.42)	**<0.001**
Rarely	9.42	(3.01, 15.83)	**0.004**
Sometimes	3.72	(-2.68, 10.12)	0.26
Frequently	-0.06	(-6.50, 6.38)	0.99
Always (Reference)			
Current smoker (vs. never) **at one year**	-5.94	(-12.33, 0.44)	0.07
Former smoker (vs. never) **at one year**	-1.55	(-5.83, 2.72)	0.49
Problem Drinking at one year[c]	-5.54	(-11.77, 0.68)	0.08
Vegetable intake			0.28
1 per day or more	0.98	(-3.13, 5.09)	0.64
2-4 per week to 5-6 per week	-3.37	(-8.77, 2.02)	0.22
None to 1 per week (reference)			
Fruit intake			0.30
5-6 per week or more	-3.38	(-8.12, 1.36)	0.16
1 per week to 2-4 per week	-2.71	(-6.83, 1.40)	0.20
None to 1-3 per month (reference)			

	Parameter Estimate	95% CI Interval	P-value
Sleep Score at one year[d]	0.15	(0.03, 0.26)	**0.02**
Physical Activity Score at one year[e]	0.03	(0.01, 0.06)	**0.006**

Note: Bold values have $p \leq 0.05$

CI: confidence interval

[a] 374 patients had complete data on all variables.

[b] Geriatric Depressive Scale Short Form ≥ 4

[c] Alcohol Use Disorders Identification Test (AUDIT) ≥ 8

[d] Physical Activity Scale for the Elderly (PASE); scores ranged from 0-400 or more; higher scores indicate more activity; reference is one unit increase.

[e] Medical Outcomes Study sleep measure (MOS-Sleep); lower scores indicate poorer sleep; reference is one unit increase.