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Employment outcomes among survivors of common cancers: the Symptom Outcomes and Practice Patterns (SOAPP) study

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Abstract

Introduction—Risk factors for employment difficulties after cancer diagnosis are incompletely understood, and interventions to improve post-cancer employment remain few. New targets for intervention are needed.

Methods—We assessed a cohort of 530 nonmetastatic cancer patients (aged ≥65 years, >6 months from diagnosis, off chemo- or radiotherapy) from the observational multi-site Symptom Outcomes and Practice Patterns study. Participants reported employment change, current employment, and symptoms. Groups were based on employment at survey (working full- or part-time versus not working) and whether there had been a change due to illness (yes versus no). The predictive power of symptom interference with work was evaluated for employment group (working stably versus no longer working). Race/ethnicity, gender, cancer type, therapy, and time

since diagnosis were also assessed. Association between employment group and specific symptoms was examined.

Results—The cohort was largely non-Hispanic white (76 %), female (85 %), and diagnosed with breast cancer (75 %); 24 % reported a change in employment. On multivariable analysis, participants with *at least* moderate symptom interference were more likely to report no longer working than their less affected counterparts (odds ratio (OR)=8.0, 95 % CI, 4.2–15.4), as were minority participants compared with their non-Hispanic white counterparts (OR=3.2, 95 % CI, 1.8– 5.6). Results from the multiple regression model indicated the combination of fatigue (OR=2.3, 95 % CI, 1.1–4.7), distress (OR=3.9, 95 % CI, 1.7–9.0), and dry mouth (OR=2.6, 95 % CI, 1.1–6.2) together with race/ethnicity and time since diagnosis adequately predicted for employment group.

Conclusions—Our findings support the hypothesis that residual symptom burden affects post-cancer employment: Residual symptoms may be targets for intervention to improve work outcomes among cancer survivors.

Implications for Cancer Survivors—This analysis examines whether increased symptom burden predicts a change to not working following a cancer diagnosis. We also examined individual symptoms to assess which symptoms were most strongly associated with not working after a cancer diagnosis. Our hope is that we will be able to use this information to both screen survivors post-active treatment and to identify those at risk, as well as target high-risk symptoms for further and more aggressive intervention, in an attempt to improve post-cancer work outcomes.

Keywords

Cancer survivor; Post-cancer employment; Work disability; Survivor symptom burden; Return to work

Introduction

There are an estimated 4.8 million cancer survivors of working age in the United States [1, 2]. These numbers are predicted to increase substantially in the upcoming decade [2]. Among working-age adults, employment impacts quality of life through access to health insurance, economic stability, professional identity, and supportive social relationships. However, following a cancer diagnosis, previously employed survivors may not return to work or report working with new limitations. The proportion failing to return to work and the degree of work limitations compared with non-cancer controls varies substantially based on the population and study [3, 4]. For instance, Taskila et al. analyzed the work ability of Finnish cancer survivors (2–6 years post-diagnosis) versus non-cancer controls and found no difference [5]. Importantly, this study excluded non-working individuals due to the focus on work ability. Looking at adult cancer survivors within the United States, Hansen et al. examined female breast cancer survivors (nearly 4 years post diagnosis) and found that survivors reported significantly higher rates of work limitations than individuals without cancer [6]. In addition, a metaanalysis of survivors of varying cancer types found that survivors had a greater risk of being unemployed than non-cancer controls [3]. The differences in employment outcomes may be due to variations in the outcomes measured, variable distance from diagnosis, and differing social systems. The preponderance of the data is such that the difficulties experienced by survivors at work are considered an escalating and important public health problem [7].

Necessary steps in addressing these difficulties include identifying those survivors most at risk for poor employment outcomes, as well as the underlying reasons why survivors do not return to work post-cancer. Potentially remediable causes should be targeted for

intervention. However, cancer could lead to changes in employment via several potential mechanisms [8–12]. The factors affecting post-cancer work outcomes are complex and multifactorial, as suggested in the models developed by Feurerstein et al [12] and Mehnert et al. [4]. Medical factors such as cancer stage or the treatments used are not readily amenable to change. Mediator variables such as age, race, or social status may allow studies to select survivors at increased risk for poor outcomes but would probably require widespread social changes to ameliorate. Vocational and rehabilitation services to target work-related factors have been attempted with variable success [13, 14]. Other mediators of survivor work outcomes include the significant, persistent symptom burden [15, 16] produced by curative treatments, which may cause work limitations and thus lead to employment difficulties. Post-treatment symptoms are amenable to intervention [17] and could be targeted by the health care team to improve post-cancer work outcomes.

Studies suggest that work activities with increased physical or cognitive demands can be particularly problematic for cancer survivors [9, 18–25]. Survivors reported difficulties at work with physically demanding tasks, lifting, concentrating, keeping pace with others, and learning new things [19, 26, 27]. As an example of how symptoms might contribute, symptom clusters (typically fatigue, pain, sleep insufficiency, and depression) are commonly reported among breast cancer survivors [28–31]. These effects negatively impact function and may persist despite rehabilitation [32–36]. Lymphedema, with the accompanying mobility restrictions, swelling, and discomfort, occurs in as many as 42 % of women who have had axillary node dissection or radiation [37]. Issues with body image and depression may make return to work more challenging [21, 22]. Changes in neurocognitive ability (“chemobrain”) may complicate tasks that were previously routine and increase risk of work disability [38–41]. Treatments including chemotherapy and axillary node dissection may result in upper extremity pain, mobility restrictions, and neuropathy, which can negatively affect work ability [10, 18, 21, 42–45]. Importantly, these treatment choices are driven largely by the cancer itself and are not readily modifiable.

To assess whether post-treatment symptom burden was associated with poorer employment outcomes, we undertook a secondary analysis of the Eastern Cooperative Oncology Group (ECOG) Symptom Outcomes and Practice Patterns (SOAPP) study database [46] to test the hypothesis that survivors reporting a change in employment to “no longer working” had a higher symptom burden than their stably employed counterparts. We then conducted further analysis to identify which 19 symptoms assessed by the MD Anderson Symptom Inventory (MDASI)-ECOG [47] were most associated with a change in employment to “no longer working,” in an effort to define potential targets for future research and interventions.

Methods

Population

The SOAPP study [48] accrued outpatients with a diagnosis of primary breast, prostate, colon, or lung cancer were eligible irrespective of time since diagnosis, therapy, or stage. Between March 2006 and May 2008, 3,123 patients were enrolled on the study from 38 institutions (6 academic and 32 community medical oncology practices), including one non-US site (Peru). Local institutional review boards approved the protocol. Written informed consent was required from each participant before registration onto the study.

Figure 1 shows how the cohort of interest, employment groups, and analysis population were defined from the SOAPP study. First, the “cohort of interest” was defined by limiting analysis to participants ≥ 65 years (because this age represents a significant milestone for retirement). We further limited the cohort to participants who had nonmetastatic disease, completed active treatment, and who were at least 6 months from diagnosis (based on our

previous analyses [49]). Active treatments were defined as chemotherapy, immunotherapy, antibody therapy, and/or radiation; endocrine therapy was not included among active treatments.

We divided the cohort of interest into four “employment groups” based on self-reported employment level at survey (working full- or part-time versus not working) and whether there had been a change due to illness (yes versus no). Pre-diagnosis employment was inferred based on current employment status and reported change or lack of change. Group A reported no change due to illness and working full- or part-time (“stably working”). Group B reported change due to illness and not working (“no longer working”). Groups A and B are collectively referred to as the “analysis population.” Groups C and D were not included in the analysis: Either no change was reported (group C: stably not working) or the participants were still working despite a change of unspecified nature and/or direction (group D; unstably working). Although not included in the analysis, descriptive information is provided for groups C and D (see Table 3).

Measures

Participant-reported employment stability (“Has your employment status changed due to illness?”) and status (“What is your current employment status?”) are available. Participants were queried about 19 individual symptoms (pain, fatigue, nausea, disturbed sleep, being distressed, shortness of breath, remembering, lack of appetite, feeling drowsy dry mouth, feeling sad, vomiting, numbness/tingling, diarrhea, constipation, mouth sores, rash, hair loss, coughing) using a modified MDASI [47] known as the MDASI-ECOG. The MDASI-ECOG also queried the degree of symptom interference with respect to work over the last 24 h. All the items on the MDASI-ECOG were rated on an 11-point scale (0=not present or did not interfere at all; 10=as bad as you can imagine or interfered completely). Treating clinicians reported the cancer diagnosis and treatment data.

Statistical analysis

Categorical data were summarized with frequency/percentage and compared between groups using Fisher’s exact test. Logistic regression analysis of employment group (group A: working stably, group B: no longer working) on symptom interference with work was performed, with the “no longer working” group being modeled. The 11-point interference rating was dichotomized into the moderate/severe level (5) and the zero/mild level (0–4) for the analysis, based on cut-offs established for the MDASI [50–53]. In addition, cancer type, age, time from diagnosis, gender, race/ethnicity, and therapy were examined as covariates for employment group. We used generalized estimating equations (GEE) to account for the intra-cluster correlation by institution [54]. Univariable and multivariable logistic regression analyses (via PROC GENMOD) with an exchangeable working correlation structure (i.e., assuming every patient within a cluster is equally correlated with every other patient from that cluster) were performed to identify predictors for employment group. Any significant explanatory variable ($p < 0.10$) in the univariable model was further fitted into the multivariable model. In each model, participants with missing values on any of the variables were excluded from data analysis.

A similar analysis was performed to evaluate the association between individual symptoms and employment group, while controlling for personal and/or disease factors identified on multivariable analyses. All 19 symptoms assessed by the MDASI-ECOG were likewise dichotomized into moderate/severe (5) versus zero/mild (0–4). Among the 19 symptoms, 16 were identified with at least 10 % of patients in one of the employment groups reporting moderate/severe level of that symptom. The univariable regression model was fitted to each of these symptoms. Due to multiple testing on these symptoms, Bonferroni correction was

used to safeguard family-wise error rate. Symptoms with a p value less than 0.003 were further included in the multivariable model along with the confounding patient and disease characteristics identified in the initial multivariable analysis for employment group, in order to identify the symptoms most associated with employment group. The best model was built by the stepwise forward selection of symptom predictors considering the QICu criterion measure (quasi-likelihood under the independence model information criterion). Only models fitted with significant symptom predictors ($p < 0.10$) were further considered; the model with the smallest QICu measure was preferred. The QICu statistic, defined as $Q + 2p$ where Q refers to the quasi-likelihood and p refers to the number of parameters in the model, was used as a criteria for model selection in the GEE analysis [55]. All p values are two-sided. A level of 5 % was considered statistically significant, unless specified otherwise. SAS 9.2 (SAS Institute, Cary, NC) was used for all data analyses.

Results

Demographics

Tables 1 and 2 present detailed demographics and disease characteristics for the cohort of interest and the four employment groups. As a whole, the cohort was largely non-Hispanic white (76 %), had breast cancer (75 %), female (85 %), and more than 2 years from diagnosis (61 %). Median age was 56 years (range, 18–65). More patients in group A were non-Hispanic white (80 % versus 56 %) and over 2 years from diagnosis (67 versus 49 %) than group B (both p values < 0.005).

Employment status and changes

Tables 1 and 2 also show employment status based on reported change due to illness for the 530 participants in the cohort of interest. Among nonmetastatic participants no longer receiving active treatment and who were at least 6 months from diagnosis, 15 % reported both undergoing change as well as not working due to illness (group B). A further 9 % reported change due to illness but continued to work full- or part-time (group D). For group D, the direction of change is not known (i.e., change from full- to part-time versus change from not working to full-time or part-time), nor is the nature of change (i.e., from a difficult job to an easier job or vice versa). As a whole, nearly one quarter (24 %) of the cohort reported some change in employment due to illness.

Symptom interference with work

As shown in Table 3, fewer patients in group A reported moderate or severe symptom interference than group B (7 % versus 40 %), $p < 0.001$). The majority (93 %) of those in group A reported mild or less interference from symptoms, while moderate or greater symptom interference was reported by 40 % of group B.

Predictors for employment group

Table 3 summarizes the results from the univariable and multivariable logistic regression models. The univariable analysis demonstrated that symptom interference with work was a significant predictor ($p < 0.001$). Time from diagnosis and race/ethnicity were also significant; more time since diagnosis and being non-Hispanic white were associated with working stably (see Table 3). Even after adjusting for race/ethnicity and time since diagnosis, symptom interference remained a highly significant predictor. Specifically, participants reporting moderate or greater interference from symptoms had eight times the odds of reporting that they were no longer working as their less-affected counterparts (OR=8.0, 95 % CI, 4.2–15.4).

In Table 4, 19 symptom items (from the MDASI-ECOG) were tested for association with employment group; 16 were identified as having at least 10 % of patients in one of the employment groups reporting moderate/severe level of that symptom (the three excluded symptoms were vomiting, diarrhea, and mouth sores). Group B participants were more likely to report moderate/severe burden of certain symptoms (pain, fatigue, disturbed sleep, being distressed, shortness of breath, cognitive difficulties, dry mouth, feeling sad, and numbness/tingling) than group A ($p < 0.003$). Table 5 lists the QICu values for several evaluated regression models (sorted first by the number of covariates in the model and then by the QICu measure) and highlights that fatigue and being distressed are important predictors of employment group after adjusting for race/ethnicity and time since diagnosis (based on the fact that these had remained significant differences on the initial multivariable analysis). Dry mouth (xerostomia), pain, and sleep disturbance were also notable. Model 10 is the most parsimonious model that predicts employment group, while retaining fatigue as a significant predictor and holding a comparing QICu value, and was selected as the best model. As demonstrated in Table 5, the QICu value improved significantly from 375.3 with the null model (model 1 without any predictor) to 313.8 with race/ethnicity and time since diagnosis as the predictors (model 2). It further decreased markedly to 260.5 if fatigue, dry mouth, and distress were fitted into the model as well. The working correlation computed from the final selected model was -0.01 , signifying no intra-cluster correlation existed in this set of data. Results from the Hosmer–Lemeshow goodness-of-fit test ($\chi^2(5) = 2.67$, $p = .75$) and adjusted R^2 (0.34) further indicate that the final selected model (with fatigue, being distressed, dry mouth, race/ethnicity, and time since diagnosis as predictors) was fitted adequately.

Attribution of symptoms

As part of the SOAPP study, participants were asked about their overall degree of bother by difficulties related to: (1) cancer, (2) cancer treatment, or (3) non-cancer health problems. Participants in group B were more likely to report moderate or greater bother by difficulties related to cancer or cancer treatment (OR=5.3, 95 % CI, 3.0–9.3; OR=2.9, 95 % CI, 1.6–5.3) but were also more likely to endorse moderate or greater bother by difficulties related to health problems other than cancer (OR = 3.6, 95 % CI, 2.2–5.8).

Discussion

We performed a secondary analysis of the SOAPP study to elucidate whether higher post-treatment symptom burden was associated with poorer work outcomes after a cancer diagnosis. The SOAPP study consisted of outpatients seen in a medical oncology clinic setting at any point in the trajectory of care for invasive breast, lung, prostate, or colorectal cancer. Based on previous analyses [49], we limited the SOAPP dataset to working age adults at least 6 months from diagnosis, nonmetastatic, and no longer on treatments such as chemotherapy or radiation—the “cohort of interest.” We then modeled a series of variables to elucidate factors that predicted belonging to one of two employment groups (group A: working stably versus group B: no longer working). Participants with moderate or greater symptom interference had significantly higher odds of reporting a change to no longer working than their counterparts. Once we demonstrated that higher post-treatment symptom burden was associated with poorer work outcomes, we modeled 19 symptoms to see which best predicted employment group. Pain, fatigue, and psychological distress are prevalent symptoms often noted in survivorship care [56]. Our results from Table 5 support these findings. Our data further show that the addition of dry mouth to fatigue and distress further help predict employment group (stably working versus no longer working) (model 10 versus model 6 in Table 5). In addition, minority participants were at greater risk than their non-Hispanic white counterparts at being no longer working, while participants further from

diagnosis (and thus further out from treatment) were at decreased risk. Age, gender, cancer type, and therapy were not predictive.

Our findings about the proportion of survivors affected (24 %) is consistent with existing literature [3, 4]. However, our findings differ substantially from the published literature with regard to the impact of various risk factors on employment. Previous studies have indicated that chemotherapy recipients were more likely than nonrecipients to report long-term disability, discontinue working, retire, or declare personal bankruptcy [8, 47, 57, 58]. However, receipt of medical therapy was not predictive of belonging to group A versus B. The category “medical therapy” included both chemotherapy and endocrine therapy; therefore, it is possible that the inclusion of endocrine therapy diluted chemotherapy impact on employment. Alternatively, it is possible that receipt of chemotherapy is really a marker for those with higher symptom burden post-cancer diagnosis, as chemotherapy may be more likely result in residual symptoms. Since the SOAPP study allowed us to directly assess symptom burden, the effect of medical therapy (which included both chemotherapy and endocrine therapy), while controlling for symptom burden, did not result in employment change. Age has also been reported as being associated with poorer work outcomes [21, 59–62], but again our study did not confirm this association. This finding may be due to the fact that we had pre-emptively eliminated individuals over 65 years of age from the analysis. Our findings do confirm existing literature with respect to racial and ethnic minorities and poorer work outcomes [63].

We built a statistical model to assess which symptoms (of the 19 assessed by the MDASI-ECOG) in combination most impacted employment after controlling for race/ethnicity and time since diagnosis. The most parsimonious model uses fatigue, distress, and dry mouth together with race/ethnicity and time since diagnosis to predict employment group. The association between fatigue and post-cancer return to work has been previously reported [64] and the impact of fatigue on post-cancer work outcomes is clear from this analysis. However, our data highlight the impact of distress and dry mouth as additional priority problem areas. While under-reported to date, the link between post-cancer unemployment and distress is not surprising: Psychological distress is a known and significant predictor of disability across multiple health conditions [65]. However, the impact of dry mouth (xerostomia) is unexpected in this population of solid tumor survivors. Xerostomia has been noted to impact quality of life and outcomes such as social function in those with Sjögren syndrome [66] or head and neck cancers [67]. Xerostomia becomes more frequent with age (although age was not a significant variable in our model) and with a number of commonly used medications in the post-treatment setting (such as analgesics, antidepressants, and even aromatase inhibitors used in the adjuvant treatment of breast cancer [68]). Additionally, xerostomia could be a product of comorbid conditions interacting with cancer diagnosis and treatment. Thus, xerostomia might reflect other comorbid conditions or use of certain medications, rather than a symptom that directly impacts work. When considered as a symptom, xerostomia might impact work by affecting the ability to speak for long periods of time [69]. The impact of disturbed sleep and pain on employment also deserve further exploration, as they accounted for a significant degree of the difference in QICu between the employment groups in prediction models. Although other symptoms (difficulty with memory, feeling sad, dyspnea, and numbness) were more prevalent among those no longer working compared with the stably working, they did not add to the predictive power of the model after fatigue, xerostomia, and distress were taken into account (as indicated by the similar or even larger QICu values in models 11–14).

Particular strengths of this study include collection of the treatment and diagnosis data from clinicians (reflecting the medical record) rather than self-report. In addition, local or distant recurrence status was accounted for in this study (failure to account for recurrence, which

can lead to new symptoms because of further treatment or the disease itself, would have confounded the analyses.) Third, the distribution of cancer type in the “cohort of interest” is generally representative of the working-age long-term survivor population in the US, where breast and colorectal cancer predominate [1, 70]. Nevertheless, there are important limitations to this study. First, the illness causing change in employment may not be malignancy in every patient; it is possible that employment status changed for other health reasons. Second, the study query about employment was ambiguous regarding whether the change was positive (e.g., unemployed to employed) versus negative (e.g., employed to unemployed.) In the case of those who reported no longer working, the change clearly occurred in the direction of loss. However, direction could not be ascertained for group D, which was thus excluded from analysis. Finally, potentially important variables related to income, education, insurance, job type, and co-worker/employer support were not assessed in this study.

Symptoms have long had a place in models of survivor work outcomes such as Feuerstein et al. [12] and Mehnert et al. [4]. These findings add increased understanding of the overall contribution of symptoms burden and the relative contribution of specific symptoms (fatigue, distress, and xerostomia). High symptom burden has been shown to persist well after termination of active treatment in a significant number of cancer survivors [15]. Our findings provide support for our hypothesis that this residual symptom burden affects post-cancer employment. Importantly, symptoms may be remediable to further intervention. Current interventions to improve post-cancer work outcomes remain few and have demonstrated limited success [71]. The published literature [62] suggests many survivors resume full-time *employment*, but this does not necessarily equal return to full work *ability*—the frequency and degree of post-cancer work *disability* is an area that requires further study. The SOAPP study’s observational nature limits our ability to define a causal link between increased symptoms and poorer work outcomes. However, our findings suggest one potential approach for improving post-cancer work outcomes: targeted interventions that more effectively reduce symptoms such as distress or xerostomia. Not only could such interventions improve the overall percentage returning to the work force, reduced symptom burden might enable more rapid and complete return. Further prospective study is required to understand the optimal nature, timing, duration, and effect of symptom-targeted interventions to improve post-cancer work outcomes and the interaction of symptoms with other important factors and their effect on work outcomes.

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Fig. 1.
Defining the cohort of interest, employment groups, and analysis population

Table 1

Current employment status by employment stability for the cohort of interest

Self-reported Employment stability	Self-reported employment status			
	Working, N (%)		Not in the workforce, N (%)	
No change	279 (53 %)	^a Group A	123 (23%)	Group C
Change	45 (9 %)	^b Group D	77 (15%)	Group B
Total	324 (62 %)	^c	200 (38 %)	
524 (100 %)				

Frequency missing = 6; four patients missing employment status stability, another two missing current employment status

^a Full-time 221, part-time 58

^b Full-time 23, part-time 22

^c Full-time 244, part-time 80

Table 2
Demographics and disease characteristics for the cohort of interest and various employment groups

	Cohort of interest ^a (N = 530)				Analysis population				Group C ^f (N = 123)		Group D ^g (N = 45)		Group A versus B (pvalue)
			Group A ^d (N = 279)		Group B ^e (N = 77)								
	N	%	N	%	N	%	N	%	N	%	N	%	
Cancer type													0.25
Breast	395	75	212	76	51	66	93	76	35	78			
Colorectal	73	14	41	15	13	17	13	10	6	13			
Prostate	24	4	10	3	5	7	6	5	1	2			
Lung	38	7	16	6	8	10	11	9	3	7			
Age, years													0.41
Age 45	76	14	46	16	12	16	10	8	8	18			
45<age 55	183	35	111	40	25	32	22	18	22	49			
55<age 65	271	51	122	44	40	52	91	74	15	33			
Sex													0.50
Male	79	15	42	15	14	18	15	12	6	13			
Female	451	85	237	85	63	82	108	88	39	87			
Race/ethnicity													<0.0001
Non-Hispanic, white	368	76	202	80	39	56	92	80	31	74			
Minority ^b	116	24	49	20	31	44	23	20	11	26			
Time from diagnosis													0.002
>6 to 12 months	80	15	27	10	18	24	21	17	13	29			
>12 to 24 months	125	24	65	23	21	27	26	21	11	24			
>24 months	325	61	187	67	38	49	76	62	21	47			
Therapy													0.79
No MT, no XRT	37	7	15	6	5	6	11	9	5	11			
MT only	166	32	89	32	25	33	35	28	15	33			
XRT only	44	8	28	10	5	6	8	7	2	5			
MT and XRT	280	53	144	52	42	55	69	56	23	51			
Unknown	3	—	3	—	0	0	0	0	0	0			

	Cohort of interest ^a (N = 530)		Analysis population				Group C ^f (N = 123)		Group D ^g (N = 45)		Group A versus B (pvalue)	
			Group A ^d (N = 279)		Group B ^e (N = 77)							
	N	%	N	%	N	%	N	%	N	%		
Employment status ^c												
Working	324	62	279	100	-	-	-	-	45	100		
Not working	200	38	-	-	77	100	123	100	-	-		
Employment stability ^c												
No change	402	77	279	100	-	-	123	100	-	-		
Change	122	23	-	-	77	100	-	-	45	100		

The level bolded is the reference group

MT medical therapy (chemotherapy and/or endocrine therapy), XRT radiation therapy, n/a not applicable; for instance, group A was defined based on the percentage working without change, thus there cannot be any individuals reporting change in employment

^aNonmetastatic, age 65 years, off active treatment, >6 months out from diagnosis; four patients are missing data on employment status stability and another two are missing current employment status; 46 patients are missing data on race/ethnicity status

^bIndividuals who are not non-Hispanic white

^cFrequency missing =6; four patients missing employment status stability, another two missing current employment status

^dReport working full or part-time and no change due to illness

^eReport not working and change due to illness

^fReport not working but no change due to illness

^gReport working with some unidentified change due to illness

Table 3

Logistic regression analysis of employment group on covariates

Predictor	Group A		Group B		Univariable (N = 356 ^a , b)		Multivariable (N = 318)	
	N	%	N	%	pvalue	OR (95 %)	pvalue	OR (95 %)
Work interference					<0.001	9.5 (5.3, 17.0)	0.002	8.0 (4.2, 15.4)
Less than moderate interference of symptoms (<5)	258	93	46	60				
Moderate or greater interference of symptoms (≥ 5)	18	7	31	40				
Cancer type					0.21			
Breast	212	76	51	66				
Colorectal	41	15	13	17				
Prostate	10	3	5	7				
Lung	16	6	8	10				
Age, years					0.39			
Age 45	46	16	12	16				
45<age 55	111	40	25	32				
55<age 65	122	44	40	52				
Sex					0.63			
Male	42	15	14	18				
Female	237	85	63	82				
Race/ethnicity ^a					<0.001	3.3 (1.8, 5.8)	<0.00	3.2 (1.8, 5.6)
Non-Hispanic white	202	80	39	56				
Minority	49	20	31	44				
Time since diagnosis					0.06	–	0.098	–
>6 to <12 months	27	10	18	24				
>12 to <24 months	65	23	21	27		0.5 (0.3, 1.0) [*]		0.4 (0.2, 0.9) [*]
>24 months	187	67	38	49		0.3 (0.2, 0.6) ^{**}		0.3 (0.1, 0.6) ^{**}
Treatment modalities ^b					0.65			
No MT, no XRT	15	6	5	6				
MT only	89	32	25	33				
XRT only	28	10	5	6				
MT and XRT	144	52	42	55				

The employment group B “no longer working” is being modeled. The level bolded in each predictor is the reference group in the regression model *OR* odds ratio, *MT* medical therapy (chemotherapy and/or endocrine therapy), *XR7* radiation therapy

^a *N* = 321 for race/ethnicity

^b *N* = 353 for analysis on work interference and treatment modalities

* *p* < 0.05;

** *p* < 0.001

Table 4

Logistic regression analysis of employment group by symptom severity

Symptom	Group A		Group B		Univariable (N = 345-354)		Multivariable (N = 307)	
	N	%	N	%	p value	OR (95 %)	p value	OR(95 %)
Pain					0.0002	7.2 (3.8, 13.6)		
Less than 5	253	92	46	60				
5 or more	23	8	31	40				
Fatigue					<0.0001	5.8 (3.6, 9.4)	0.054	2.3 (1.1, 4.7)
Less than 5	225	84	35	46				
5 or more	44	16	41	54				
Nausea					0.0617			
Less than 5	268	98	69	90				
5 or more	6	2	8	10				
Disturbed sleep					0.0002	4.6 (3.0, 7.2)		
Less than 5	226	82	38	50				
5 or more	48	18	38	50				
Being distressed					0.0002	8.2 (4.8, 14.1)	0.045	3.9 (1.7, 9.0)
Less than 5	253	92	45	58				
5 or more	21	8	32	42				
Dyspnea					0.0023	9.2 (4.1, 20.3)		
Less than 5	264	96	55	71				
5 or more	11	4	22	29				
Memory difficulties					0.0002	4.6 (3.0, 7.1)		
Less than 5	238	87	45	58				
5 or more	36	13	32	42				
Anorexia/cachexia					0.0397			
Less than 5	264	96	65	84				
5 or more	11	4	12	16				
Drowsiness					0.0124			
Less than 5	244	88	54	70				
5 or more	32	12	23	30				

Symptom	Group A		Group B		Univariable (N = 345-354)		Multivariable (N = 307)	
	N	%	N	%	p value	OR (95 %)	p value	OR (95 %)
Dry mouth								
Less than 5	256	93	51	67				
5 or more	19	7	25	33				
Sad								
Less than 5	255	93	52	68	0.0010	5.9 (3.1, 11.1)		
5 or more	20	7	25	32				
Vomiting								
Less than 5	274	100	72	94				
5 or more	0	0	5	6				
Numbness/tingling								
Less than 5	245	89	49	64	0.0027	4.7 (2.7, 8.2)		
5 or more	29	11	28	36				
Diarrhea								
Less than 5	265	96	70	91				
5 or more	12	4	7	9				
Constipation					0.0198			
Less than 5	258	93	61	80				
5 or more	18	7	15	20				
Sore mouth								
Less than 5	275	100	75	97				
5 or more	1	0	2	3				
Rash/pruritis					0.0228			
Less than 5	274	99	68	88				
5 or more	3	1	9	12				
Hair loss					0.0352			
Less than 5	269	97	69	90				
5 or more	7	3	8	10				
Coughing								
Less than 5	268	97	63	82	0.0049	6.5 (2.7, 16.0)		
5 or more	9	3	14	18				

Employment Group B “no longer working” is being modeled in the analysis model. The level bolded in each predictor is the reference group in the regression model. Race/ethnicity and time from diagnosis were also fitted into the multivariable model

Table 5

Information for various prediction models

Model	Covariates (+race/ethnicity and time since diagnosis if not specified)	Number of covariates	Coefficients of covariates ^a	QICu
17	Fatigue/dry mouth/being distressed/disturbed sleep/pain	7	0.51 ^b /0.76 ^b /1.04/0.57 ^b /0.70 ^b	256.5
16	Fatigue/dry mouth/being distressed/disturbed sleep	6	0.68 ^b /0.86/1.15/0.62 ^b	257.1
15	Fatigue/dry mouth/being distressed/pain	6	0.62 ^b /0.81/1/22/0.83	258.8
14	Fatigue/dry mouth/being distressed/numbness	6	0.67 ^b /0.90/1.33/0.53 ^b	259.7
13	Fatigue/dry mouth/being distressed/dyspnea	6	0.74 ^b /0.77 ^b /1.26/0.60 ^b	261.4
12	Fatigue/dry mouth/being distressed/sadness	6	0.80/0.90/1.24/0.22 ^b	262.3
11	Fatigue/dry mouth/being distressed/memory difficulties	6	0.85/0.94/1.40/−0.08 ^b	262.5
10	Fatigue/dry mouth/being distressed	5	0.83/0.93/1.36	260.5
9	Fatigue/being distressed/disturbed sleep	5	0.88/1.25/0.64	264.8
8	Fatigue/being distressed/pain	5	0.79/1.27/0.92	265.9
7	Fatigue/dry mouth	4	1.34/1.10	268.4
6	Fatigue/being distressed	4	1.06/1.46	268.7
5	Fatigue	3	1.69	279.1
4	Being distressed	3	2.13	279.7
3	Pain	3	1.84	285.8
2	Race/ethnicity, time since diagnosis	2	–	313.8
1	–	0	–	375.3

Although models 13–16 have smaller QICu values than model 9, fatigue failed to meet statistical significance (defined as $p < 0.10$) as additional covariates were fitted into the model. Because fatigue was the single best predictor for employment group, model 7 has been selected as the most parsimonious model for predicting employment group

^aCovariates listed in each cell of this column are corresponding to those listed for the model

^bThe figure indicated by the symbol refers to the symptom predictor associated with it, not statistically significant at 0.10