

# Diabetes and Cancer: Impact on Health-Related Quality of Life

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**D**iabetes and cancer are two commonly occurring diseases in the worldwide population (Giovanucci et al., 2010). In the United States, about 11% of individuals aged 20 years and older have diabetes (Giovanucci et al., 2010). Among individuals with cancer, 8%–18% have preexisting diabetes (Barone et al., 2010). Patients with cancer and diabetes have higher mortality and complication rates and are more likely to be hospitalized than patients with cancer who do not have diabetes (Attili et al., 2007; Barone et al., 2008; Giovanucci et al., 2010; Peairs et al., 2011; Psarakis, 2006).

Barone et al. (2010) found that individuals with preexisting diabetes and cancer had a 50% increased risk of mortality after surgery for cancer compared to those who had cancer without diabetes. Patients with cancer and preexisting diabetes have an increased risk for all-cause mortality (hazard ratio = 1.41, 95% confidence interval [1.28, 1.55]) compared to individuals who had cancer without diabetes (Barone et al., 2008). The presence of hyperglycemia in patients with cancer and diabetes is associated with higher infection rates and shorter remission periods (Psarakis, 2006). Individuals with diabetes and cancer are more likely to be hospitalized for chemotherapy-related toxicity, infections, fever, neutropenia, or anemia (Peairs et al., 2011; Srokowski, Fang, Hortobagyi, & Giordano, 2009). Patients with cancer and diabetes also have poorer response rates to treatment, which may account for the higher mortality rates in this population (Attili et al., 2007).

The science is lacking in regard to how patients with cancer, with and without diabetes, differ in physical function, mental health, and social function while undergoing chemotherapy. Nurses may need to intervene sooner or differently in this population to maintain or improve overall health-related quality of life (HRQOL) during treatment. Patients with diabetes and cancer should be informed of the impact their cancer treatment may have on their overall HRQOL. The purpose of this study is to explore whether the HRQOL factors of physical function,

**Purpose/Objectives:** To explore whether three factors (physical function, mental health, and social function) of health-related quality of life (HRQOL) are impacted differently in patients with cancer and diabetes when compared to those with cancer who do not have diabetes at the beginning of chemotherapy.

**Design:** Secondary analysis using baseline data from two randomized, controlled trials.

**Setting:** Two comprehensive cancer centers, one community cancer oncology program, and six hospital-affiliated community oncology centers.

**Sample:** 661 patients aged 21 years or older with a solid tumor cancer or lymphoma undergoing cancer treatment.

**Methods:** Baseline data from both randomized, controlled trials were used. The SF-36® was used to measure physical function, mental health, and social function. Analysis included descriptive statistics and a general linear model.

**Main Research Variables:** Presence or absence of diabetes and physical function, social function, and mental health.

**Findings:** Patients with cancer and diabetes had significantly lower levels of physical function ( $p < 0.001$ ) when compared to those who had cancer without diabetes. The interaction of diabetes and age was found to be significantly predictive of mental health ( $p < 0.05$ ).

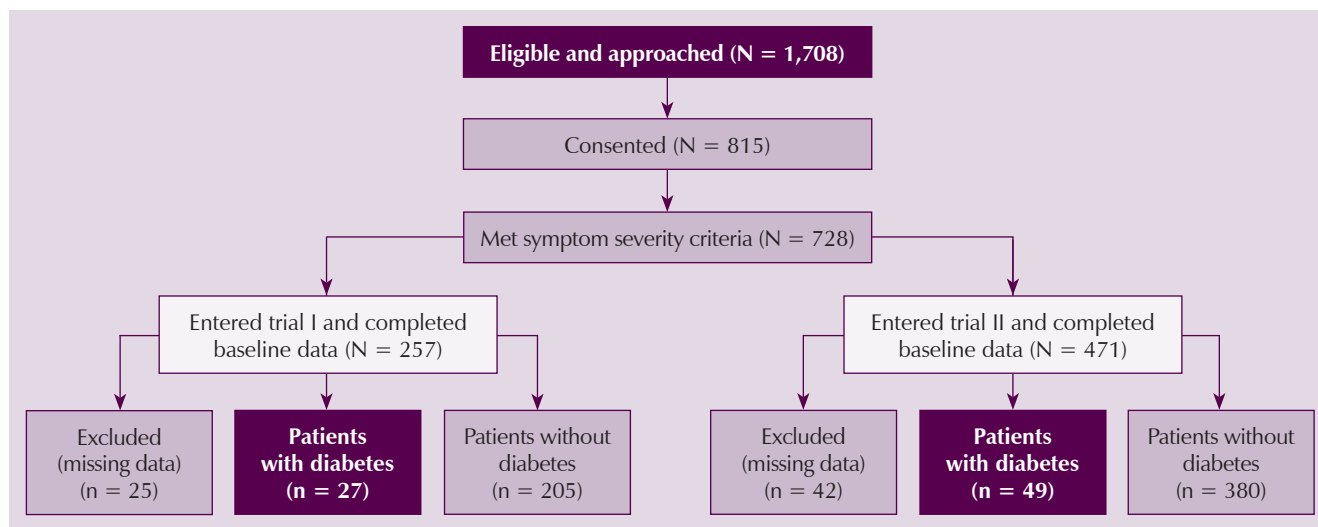
**Conclusions:** The presence of diabetes negatively impacts physical function and mental health in patients undergoing chemotherapy.

**Implications for Nursing:** Nurses should be aware of diabetes' effect on HRQOL in patients with cancer. In addition, nurses may need to intervene earlier for patients with diabetes and cancer to maintain or improve their quality of life.

mental health, and social function differ in patients with cancer and diabetes compared to those with cancer who do not have diabetes at the start of chemotherapy.

## Study Framework

Wilson and Cleary's (1995) HRQOL model was adapted for the current study. The model hypothesizes causal relationships among the following dimensions: biologic



**Figure 1. Study Enrollment From Recruitment to Completion of Baseline Data Collection**

and physiologic variables, symptom status, functional status, general health perceptions, and overall quality of life. Wilson and Cleary (1995) identified biologic and physiologic variables as the fundamental determinants of health status. For the current study, the presence or absence of diabetes in individuals was used to define that component of the model. Symptom burden was used as a measure of symptom status and is defined by the symptom severity reported by the individual. Functional status includes components of physical function, social function, and mental health using the SF-36®. Physical functioning was defined as the individual's perceived ability to perform specific tasks such as walking, climbing stairs, and carrying groceries. Social functioning is considered individuals' perception of how much their health interferes with social activities. Mental health is defined as individuals' perception of their emotional status and mood state. The relationship between symptom burden and physical function, social function, and mental health is considered reciprocal rather than linear. Specific individual and clinical characteristics also can have a direct influence on the components of symptom burden, functioning, and HRQOL. Individual characteristics were defined as the sociodemographic variables of age and gender. Finally, clinical characteristics were defined by the number of comorbidities that were present other than diabetes or cancer, site of cancer, and chemotherapy type.

## Literature Review

Diabetes and cancer both can impact overall HRQOL of an individual, but the relationship between those

diseases is unclear. Glycemic control has been hypothesized to play a role in how well individuals respond to treatment and their overall survival (Giovanucci et al., 2010; Psarakis, 2006; Srokowski et al., 2009). Barone et al. (2010), Peairs et al. (2011), and Srokowski et al. (2009) found that individuals with cancer and preexisting diabetes have poorer survival rates, higher infection rates, and are more likely to be hospitalized compared to those without diabetes while undergoing treatment for cancer. The following sections will explore what is known about physical function, social function, and mental health in patients with diabetes and cancer.

## Physical Function

Having either diabetes or cancer increases the odds of having poorer physical function (Dacal, Sereika, & Greenspan, 2006; Doorenbos, Given, Given, & Varbitsky, 2006; Sayer et al., 2005). Kuo et al. (2005) found diabetes mellitus was independently associated with functional problems, and individuals with diabetes experienced a steady decline in physical function over time compared

**Table 1. Comparison of Symptom Severity and Outcome Scores in Patients Who Have Cancer With and Without Diabetes**

Variable	Range	Total (N = 661)		Cancer With Diabetes (N = 76)		Cancer Without Diabetes (N = 585)	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Symptom severity*	0–117	36.42	22.32	41.71	23.78	35.74	22.05
Physical function**	0–100	57.61	27.17	41.71	25.5	59.69	26.71
Mental health	0–100	74.42	17.95	74	18.19	74.38	17.93
Social function	0–100	63.84	25.32	62.82	27.68	63.97	25.02

\*  $p < 0.05$ ; \*\*  $p < 0.001$  (difference between groups)

Note. Higher scores indicate greater symptom severity or better health and functioning.

to those without diabetes. Individuals with type 2 diabetes report significantly poorer physical function, less vitality, and more role limitations because of emotional problems compared to individuals with type 1 diabetes (Trief, Wade, Pine, & Weinstock, 2003). Men and women with type 2 diabetes have reported an impact on their overall physical function (Ghanbari, Yekta, Roushan, & Lakeh, 2005). Cancer treatment, such as chemotherapy, has been found to impact the physical function of adults with cancer (Doorenbos et al., 2006; Given, Given, Sikoroski, & Hadar, 2007; Kurtz, Kurtz, Stommel, Given, & Given, 2001; Levy et al., 2008). A decline in physical function in patients with cancer was found to be correlated with the presence of symptoms (Given et al., 2007; Kurtz et al., 2001).

### Mental Health and Social Function

Lower levels of both mental and social function have been reported in individuals who have either diabetes or cancer (Sawhney, Sehl, & Naeim, 2005; Trief et al., 2003). The presence of depression and depressive symptoms occurs in about 31% of individuals with diabetes (de Groot et al., 2010). Women with diabetes who have other comorbidities or more depressive symptoms are at higher risk of developing depression (Bell et al., 2005). Diabetes also has been associated with poorer social function, particularly in individuals younger than 65 years of age and those who have type 1 diabetes (Trief et al., 2003).

Cancer and its treatment are risk factors for poorer mental health and lower levels of social function (Sawhney et al., 2005). Patients with cancer have lower levels of mental and social function compared to the general population (Papadopoulos et al., 2011; Rawl et al., 2002; Trentham-Dietz et al., 2003). Symptoms associated with cancer and its treatment can negatively impact individuals' social function and mental health (Foster, Salinas, Mansell, Williamson, & Casebeer, 2010; Kurtz, Kurtz, Stommel, Given, & Given, 1999). Patients who reported pain, numbness, and tingling were more likely to have higher levels of depression and poorer mental health (Foster et al., 2010). The effects of chemotherapy can have a negative impact on social function shortly after initial treatment (Bezjak et al., 2004).

The specific impact of diabetes on physical function and other HRQOL factors in patients undergoing treatment for cancer is unknown.

**Table 2. Characteristics of Patients Who Have Cancer With and Without Diabetes**

Characteristic	Total (N = 661)		Cancer With Diabetes (N = 76)		Cancer Without Diabetes (N = 585)	
	n	%	n	%	n	%
<b>Age (years)**</b>						
59 or younger	373	56	28	37	345	59
60–69	178	27	29	38	149	26
70 or older	109	17	19	25	90	15
Missing data	1	< 1	–	–	1	< 1
<b>Gender*</b>						
Male	204	31	32	42	172	29
Female	457	69	44	58	413	71
<b>Education level**</b>						
Grade school	9	1	4	5	5	1
Some high school	50	8	11	15	39	7
High school	159	24	13	17	146	25
Some college	198	30	29	38	169	29
College	129	20	10	13	119	20
Graduate school	116	18	9	12	107	18
<b>Race</b>						
Caucasian	570	86	59	78	511	87
African American	65	10	13	17	52	9
Hispanic or Mexican	7	1	–	–	7	1
Other	11	2	2	3	9	2
Missing	8	1	2	3	6	1
<b>Marital status</b>						
Never married	69	10	5	7	64	11
Married	432	65	49	65	383	65
Divorced or separated	101	15	11	15	90	15
Widowed	48	7	10	13	38	6
Living together	10	2	1	1	9	2
Missing	1	< 1	–	–	1	< 1
<b>Cancer site by gender</b>						
Breast (female only)	232	35	18	24	214	37
Colon (male)	63	10	10	13	53	9
Colon (female)	74	11	7	9	67	11
Lung (male)	27	4	5	7	22	4
Lung (female)	53	8	6	8	47	8
Other (male)	114	17	17	22	97	17
Other (female)	98	15	13	17	85	15
<b>Chemotherapy type</b>						
Adjuvant and radiation	160	24	21	28	139	24
Neoadjuvant	59	9	6	8	53	9
First-line	263	40	30	40	233	40
Second-line	165	25	18	24	147	25
Missing	14	2	1	1	13	2
<b>Household income (\$)</b>						
24,999 or less	93	14	15	20	78	13
25,000–49,999	172	26	20	26	152	26
50,000–74,999	128	19	15	20	113	19
75,000–99,999	65	10	8	11	57	10
100,000–124,999	61	9	6	8	55	9
125,000–144,999	15	2	1	1	14	2
145,000–174,999	23	4	1	1	22	4
175,000 or higher	27	4	2	3	25	4
Missing	77	12	8	11	69	12
<b>Other comorbidities**</b>						
Zero to one	335	51	21	28	314	54
Two	147	22	14	18	133	23
Three or more	179	27	41	54	138	24

\*  $p < 0.05$ ; \*\*  $p \leq 0.001$  (difference between groups)

Note. Because of rounding, not all percentages total 100.

The role of diabetes regarding HRQOL in patients with cancer, particularly those receiving chemotherapy, needs to be further understood. Individuals with diabetes are likely to be already experiencing an impact on HRQOL prior to their diagnosis and treatment for cancer.

This study aimed to identify whether a difference exists in HRQOL factors related to physical function, mental health, and social function in patients with diabetes and cancer compared to those with cancer who do not have diabetes. The specific research questions were (a) do patients with cancer and diabetes report lower levels of physical function compared to individuals with cancer who do not have diabetes while undergoing chemotherapy and (b) do patients with cancer and diabetes report lower levels of social function and mental health compared to those with cancer who do not have diabetes while undergoing chemotherapy?

**Table 3. Final General Linear Model for Physical Function With Parameter Estimates and Adjusted Mean**

Variable	F	b	95% CI	p
<b>Presence of diabetes</b>	18.55			< 0.001
No		11.98	[6.62, 17.59]	< 0.001
Yes		0 <sup>a</sup>		
<b>Age (years)</b>	1.37			0.256
59 or younger		-6.63	[-15.26, 1.99]	0.131 <sup>b</sup>
60-69		-6.95	[-16.17, 2.27]	0.14
70 or older		0 <sup>a</sup>		
<b>Chemotherapy type</b>	7.16			< 0.001
Adjuvant and radiation		5.91	[1.05, 10.77]	0.017 <sup>c</sup>
Neoadjuvant		14.73	[8.14, 21.33]	< 0.001 <sup>d</sup>
First-line		6.65	[2.22, 11.07]	0.003 <sup>e</sup>
Second-line		0 <sup>a</sup>		
<b>Cancer site by gender</b>	5.04			< 0.001
Breast (female only)		-0.84	[-6.25, 4.58]	0.761
Colon (male)		1.25	[-5.87, 8.38]	0.729
Colon (female)		-13.82	[-20.71, -6.94]	< 0.001 <sup>f</sup>
Lung (male)		3.75	[-5.97, 13.48]	0.449
Lung (female)		1.61	[-5.9, 9.11]	0.674
Other (male)		3.35	[-2.68, 9.39]	0.276
Other (female)		0 <sup>a</sup>		
<b>Other comorbidities</b>	5.53			0.004
Zero to one		7.44	[2.86, 11.93]	0.001 <sup>g</sup>
Two		3.47	[-1.54, 8.49]	0.174
Three or more		0 <sup>a</sup>		
<b>Symptom severity</b>	201.01	-0.81	[-0.99, -0.62]	< 0.001
<b>Interaction of age (years) and symptom severity</b>	5.05			0.007
59 or younger		0.34	[0.12, 0.55]	0.002
60-69		0.2	[-0.04, 0.43]	0.107
70 or older		0 <sup>a</sup>		

CI—confidence interval

<sup>a</sup> Indicates reference category

<sup>b</sup> Patients aged 59 years or younger were significantly different from those aged 60-69 ( $p = 0.009$ ) and 70 or older ( $p = 0.034$ ).

<sup>c</sup> Adjuvant and radiation were significantly different from neoadjuvant ( $p = 0.008$ ) and second-line chemotherapy ( $p = 0.017$ ).

<sup>d</sup> Neoadjuvant was significantly different from first-line chemotherapy ( $p = 0.015$ ) and second-line chemotherapy ( $p < 0.001$ ).

<sup>e</sup> First-line chemotherapy was significantly different from second-line chemotherapy ( $p = 0.003$ ).

<sup>f</sup> Female colon cancer was significantly different from female breast cancer ( $p < 0.001$ ), male colon cancer ( $p < 0.001$ ), male lung cancer ( $p = 0.001$ ), female lung cancer ( $p < 0.001$ ), male other cancer ( $p < 0.001$ ), and female other cancer ( $p < 0.001$ ).

<sup>g</sup> Three or more comorbidities was significantly different from zero to one comorbidity ( $p = 0.001$ ).

Note.  $R^2 = 0.375$

## Methods

### Design and Setting

The current study is a secondary analysis of baseline data from two randomized, controlled trials. In the first trial (Family Home Care for Cancer—A Community-Based Model), patients received a nurse-delivered cognitive behavioral intervention or a coach-directed intervention. In the second trial (Automated Telephone Monitoring for Symptom Management), patients received a nurse-delivered intervention or automated voice response intervention. Participants were recruited from two comprehensive cancer centers, one community cancer oncology program, and six hospital-affiliated community oncology centers. Recruitment was performed by nurses from the clinical trial offices, who also obtained signed consent. Prior to enrollment into either study, patients were screened for symptom severity; those who scored 2 or higher on severity for at least one cancer-related symptom were entered into one of two trials (see Figure 1).

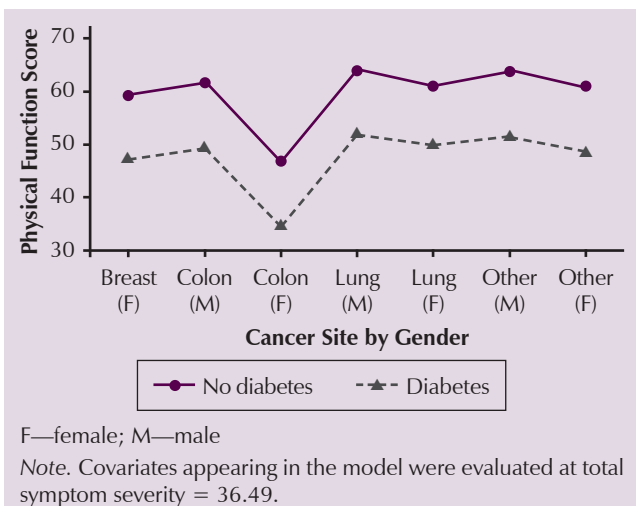
### Sample

Inclusion criteria for the original studies were being aged 21 years or older, having a diagnosis of a solid tumor cancer or non-Hodgkin lymphoma, undergoing a course of chemotherapy, being able to speak and read English, and having a touchtone telephone. Exclusion criterion was having hearing deficits that would prevent participants from using a telephone. Both original studies randomized patients into a six-contact, eight-week intervention trial.

### Variables and Measurement

For the purposes of the current study, the gender of an individual was classified as male





**Figure 2. Physical Function Scores Comparing Gender and Site of Cancer in Patients With and Without Diabetes**

or female. Age was self-reported, and age categories created for this study were 59 years or younger, 60–69, and 70 or older. Those cut points were established to keep a comparable number of individuals with diabetes in each age category. The number of comorbidities and type of comorbidities were determined by a medical audit conducted by the investigators at the end of the original studies. Patients were identified as either having or not having diabetes. The number of other comorbidities was summed for each patient and then categorized as zero to one, two, and three or more for each participant. Individuals also were classified by gender and cancer site. Cancer site was highly skewed by gender (i.e., all patients with breast cancer were

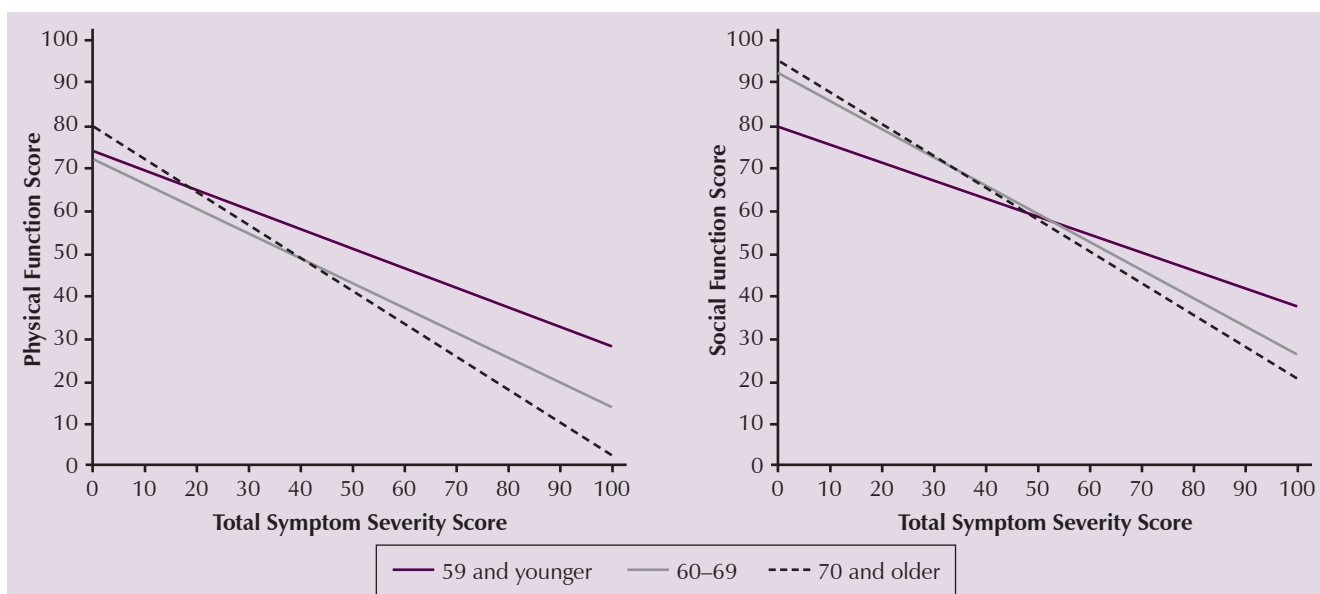
women); therefore, a category for male breast cancer was not created. Symptom severity measurement was based on the **MD Anderson Symptom Inventory (MDASI)**, which has a reported Cronbach alpha of 0.85 (Cleeland et al., 2000). For the current study, alpha was 0.87.

Total symptom severity was determined by summing the severity scores for 16 common cancer-related symptoms. Severity for individual symptoms was measured using a 0–10 scale (0 = not present, 10 = worse possible). For current chemotherapy treatment status, patients were categorized as adjuvant and radiation, neoadjuvant, first-line chemotherapy, or second-line chemotherapy.

The physical function, social function, and mental health subscales of the **SF-36** were used to measure physical and social function and mental health, respectively. Reported reliabilities (Cronbach alpha) for the subscales were 0.93 for physical function, 0.85 for social function, and 0.9 for mental health (McHorney, Ware, Lu, & Sherbourne, 1994). For the current study, Cronbach alphas for the SF-36 subscales were 0.91 for physical function, 0.8 for social function, and 0.84 for mental health.

### Data Analysis

Analysis was done with a univariate general linear model in SPSS®, version 18. Backwards regression was used to achieve a parsimonious model. Initially, all main effects and possible two-way interactions were entered into the model; only significant two-way interactions will be reported. Multicollinearity was checked by running a linear regression model, and no issues were detected. Predictor variables used were age, presence of diabetes, number of other comorbidities, cancer site by gender, total symptom



**Figure 3. Relationship of Physical and Social Function With Symptom Severity by Age Group (Years)**

severity, and current chemotherapy treatment. The dependent variables were the subscales for physical function, social function, and mental health from the SF-36. To confirm the findings from the general linear model, a linear regression model was run using a hierarchical approach, where all covariates were entered in the first block and the presence or absence of diabetes was entered in the second block. The linear regression model produced similar results to the general linear model. The results of the general linear model will be reported because they allowed for a pairwise comparison of the variables.

## Results

### Sample

The sample for the current study comprised 661 adults with cancer who were beginning chemotherapy. Most participants were women, aged younger than 60 years, and Caucasian. The most common cancer sites were colon and breast. Most participants were married and had a household income of \$50,000 or higher. See Table 1 for symptom severity and outcome variables and Table 2 for comparison of groups based on demographic characteristics.

### Physical Function

A univariate general linear model was used to determine whether the presence of diabetes contributed to lower physical function (see Table 3). The presence of diabetes was significantly related to lower levels of physical function ( $p < 0.001$ ) after adjusting for all other variables. Other factors also noted to be significantly ( $p < 0.05$ ) related to level of physical function were age, type of chemotherapy, cancer site by gender, level of symptom severity, and number of comorbidities. Higher level of symptom severity overall was significantly related to lower levels of physical function ( $p < 0.001$ ). A pair-wise comparison indicated women with colon cancer were more likely to have lower levels of physical function ( $p < 0.001$ ) when compared to all other categories (see Figure 2). Patients undergoing second-line chemotherapy had significantly lower levels of physical function than those undergoing adjuvant, neoadjuvant, or first-line chemotherapy ( $p < 0.001$ ). Patients with three or more comorbidities were more likely to have lower levels of physical function ( $p < 0.05$ ). The only interaction term

to show a significant relationship to level of physical function was age and symptom severity (see Figure 3). Older patients with higher levels of symptom severity reported significantly lower levels of physical function ( $p = 0.01$ ).

### Social Function and Mental Health

The presence of diabetes was not a significant predictor of social function. The variables age, cancer site by gender, symptom severity, and the interaction of age and symptom severity all were significantly related

**Table 4. Final General Linear Model for Social Function With Parameter Estimates and Adjusted Mean**

Variable	F	b	95% CI	p
<b>Presence of diabetes</b>	0.19			0.662
No		-1.19	[-6.52, 4.15]	0.662
Yes		0 <sup>a</sup>		
<b>Age (years)</b>	9.22			< 0.001
59 or younger		-15.05	[-23.52, -6.59]	0.001 <sup>b</sup>
60–69		-1.53	[-10.57, 7.51]	0.74
70 or older		0 <sup>a</sup>		
<b>Chemotherapy type</b>	1.38			0.247
Adjuvant and radiation		-2.7	[-7.44, 2.04]	0.264
Neoadjuvant		2.63	[-3.79, 9.06]	0.422
First-line		1.29	[-3.02, 5.61]	0.556
Second-line		0 <sup>a</sup>		
<b>Cancer site by gender</b>	3.29			0.003
Breast (female only)		-1.24	[-6.52, 4.05]	0.645
Colon (male)		2.37	[-4.61, 9.35]	0.505
Colon (female)		-8.71	[-15.4, -2.01]	0.011 <sup>c</sup>
Lung (male)		6.87	[-2.48, 16.23]	0.15
Lung (female)		-1.19	[-8.51, 6.14]	0.75
Other (male)		-6.48	[-12.37, -0.59]	0.031 <sup>d</sup>
Other (female)		0 <sup>a</sup>		
<b>Other comorbidities</b>	0.53			0.592
Zero to one		1.59	[-2.78, 5.96]	0.475
Two		2.53	[-2.36, 7.4]	0.311
Three or more		0 <sup>a</sup>		
<b>Symptom severity</b>	212.62	-0.77	[-0.96, -0.59]	< 0.001
<b>Interaction of age (years) and symptom severity</b>	5			0.002
59 or younger		0.34	[0.13, 0.55]	0.002
60–69		0.08	[-0.16, 0.31]	0.514
70 or older		0 <sup>a</sup>		

CI—confidence interval

<sup>a</sup> Indicates reference category

<sup>b</sup> Patients aged 59 or younger were significantly different from those aged 60–69 ( $p = 0.03$ ).

<sup>c</sup> Female colon cancer was significantly different from female breast cancer ( $p = 0.018$ ), male colon cancer ( $p = 0.003$ ), male lung cancer ( $p = 0.002$ ), and female other cancer ( $p = 0.011$ ).

<sup>d</sup> Male other cancer was significantly different from female breast cancer ( $p = 0.045$ ), male colon cancer ( $p = 0.01$ ), male lung cancer ( $p = 0.004$ ), and female other cancer ( $p = 0.031$ ).

Note.  $R^2 = 0.32$

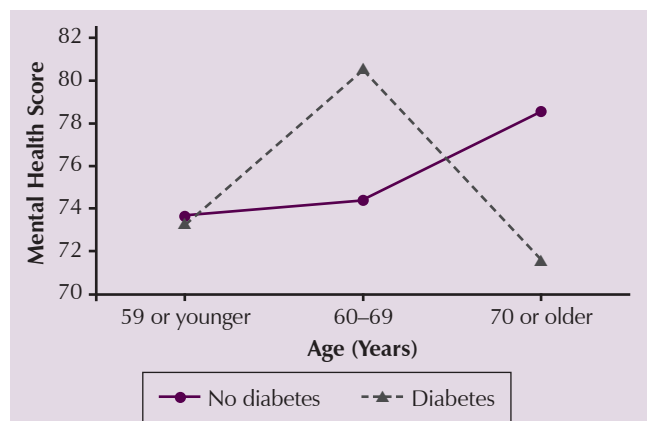
to level of social function ( $p < 0.05$ ). As the symptom severity increased, social function score decreased. Social function decreased more quickly in older adults (aged 70 years or older) than in those aged 59 years or younger ( $p = 0.002$ ). A pair-wise comparison indicated adults aged 59 years or younger were more likely to have lower levels of social function compared to those aged 60–69 years ( $p = 0.05$ ). Women with colon cancer were found to have lower social function compared to women with breast or any other cancer and men with colon and lung cancer ( $p < 0.01$ ). Men with other types of cancer were noted to have significantly lower levels of social function compared to women with breast or any other cancer and men with colon or lung cancer ( $p = 0.03$ ) (see Table 4).

Having diabetes alone was not a significant predictor of overall mental health. The interaction between the presence of diabetes and age category was significantly predictive of level of mental health ( $p = 0.03$ ). Individuals aged 60–69 years had significantly ( $p = 0.009$ ) better levels of mental health compared to patients in the other two age categories with diabetes and to all patients without diabetes (see Figure 4). Symptom severity was found to be predictive of level of mental health, with higher levels being significantly related to poorer mental health ( $p < 0.001$ ). A pair-wise comparison indicated individuals receiving second-line chemotherapy had significantly lower levels of mental health compared to those receiving neoadjuvant ( $p = 0.025$ ) and first-line chemotherapy ( $p = 0.022$ ) (see Table 5).

## Discussion

HRQOL is an important issue that needs to be addressed in patients with cancer and diabetes. Findings from the current study indicate patients with diabetes and cancer who are undergoing chemotherapy may experience lower levels of physical and mental function compared to patients with cancer who do not have diabetes. Patients with diabetes and cancer had significantly ( $p = 0.03$ ) higher levels of symptom severity ( $\bar{X} = 41.75$ ,  $SD = 23.78$ ) compared to individuals with cancer who did not have diabetes ( $\bar{X} = 35.81$ ,  $SD = 22.3$ ). In addition, higher levels of symptom severity were predictive of lower levels of physical function, social function, and mental health.

Physical function was significantly lower ( $p < 0.001$ ) in patients with diabetes and cancer compared to those with cancer who did not have diabetes. Patients who are diabetic may present at the time of cancer treatment with already impaired physical function levels associated with their diabetes (Sayer et al., 2005; Sinclair, Conroy, & Bayer, 2008). The differences noted between the groups may be attributed to that preexisting impairment. Whether individuals with diabetes developed further impairment



Note. Covariates appearing in the model were evaluated at total symptom severity = 36.48.

**Figure 4. Mental Health Scores Comparing Age and Symptom Severity in Patients Who Have Cancer With and Without Diabetes**

associated with their cancer treatment is unknown. Additional studies need to evaluate the impact of cancer treatment on physical function in patients with diabetes to develop a better understanding of that relationship.

The presence of diabetes in patients with cancer was not predictive of level of social function. Level of symptom severity and the interaction of age and symptom severity were predictive of level of social function. Older adults with higher levels of symptom severity had significantly ( $p < 0.05$ ) lower levels of social function. The presence of diabetes may still play a role in the level of social function in adults with diabetes and cancer. Overall symptom severity was higher in patients with cancer and diabetes ( $\bar{X} = 41.24$ ) compared to those with cancer who did not have diabetes ( $\bar{X} = 35.8$ ). Additional research with a larger cohort of patients with diabetes is needed to determine the effect of diabetes on overall level of social function and how the presence of diabetes may impact the symptom severity experienced while undergoing cancer treatment.

The interaction of diabetes and age was predictive of overall mental health. Patients with and without diabetes aged 59 years or younger had similar levels of mental health. Mental health improved in patients with diabetes aged 60–69 years, but declined in patients with diabetes and cancer older than 70. However, in patients with cancer who did not have diabetes, mental health steadily increased as individuals' age increased. One can hypothesize that the level of symptom severity experienced by adults aged 70 years or older with diabetes creates an increased burden and has a negative effect on their overall mental health. Future research is warranted on why that difference may occur.

Patients with diabetes and cancer had significantly ( $p < 0.001$ ) more comorbidities than patients with cancer

**Table 5. Final General Linear Model for Mental Health With Parameter Estimates and Adjusted Mean**

Variable	F	b	95% CI	p
<b>Presence of diabetes</b>	0.03			0.871
No		6.7	[-0.82, 14.59]	0.08
Yes		0 <sup>a</sup>		
<b>Age (years)</b>	1.56			0.211
59 or younger		1.7	[-7.43, 10.83]	0.714
60–69		9.06	[0.03, 18.08]	0.05
70 or older		0 <sup>a</sup>		
<b>Chemotherapy type</b>	2.53			0.056
Adjuvant and radiation		2.43	[-1, 5.85]	0.165
Neoadjuvant		5.3	[0.66, 9.95]	0.025 <sup>b</sup>
First-line		3.64	[0.53, 6.76]	0.022 <sup>b</sup>
Second-line		0 <sup>a</sup>		
<b>Cancer site by gender</b>	1			0.425
Breast (female only)		-1.97	[-5.79, 1.86]	0.313
Colon (male)		1.67	[-3.35, 6.69]	0.514
Colon (female)		-3.57	[-8.4, 1.27]	0.148
Lung (male)		2.11	[-4.66, 8.88]	0.541
Lung (female)		-0.43	[-5.73, 4.87]	0.874
Other (male)		-0.95	[-5.21, 3.31]	0.663
Other (female)		0 <sup>a</sup>		
<b>Other comorbidities</b>	0.39			0.677
Zero to one		-0.11	[-3.27, 3.05]	0.947
Two		-1.35	[-4.87, 2.16]	0.451
Three or more		0 <sup>a</sup>		
<b>Symptom severity</b>	202.87	-0.39	[-0.45, -0.34]	< 0.001
<b>Interaction of age (years) and no presence of diabetes<sup>c</sup></b>	3.54			0.03
59 or younger		-6.42	[-16.14, -3.3]	0.195
60–69		-13.27	[-23.17, -3.36]	0.009
70 or older		0 <sup>a</sup>		

CI—confidence interval

<sup>a</sup> Indicates reference category<sup>b</sup> Second-line chemotherapy was significantly different from neoadjuvant ( $p = 0.025$ ) and first-line chemotherapy ( $p = 0.022$ ).<sup>c</sup> Positive presence of diabetes was a reference category ( $b = 0$ ) for all age groups.Note.  $R^2 = 0.298$ 

who did not have diabetes. The higher number of comorbidities also may explain the noted differences related to increase in symptom severity. The reporting of higher symptom severity, greater symptom interference, and impaired social and physical function may be attributed to having more comorbidities. Whether the presence of diabetes or the higher number of comorbidities contributes to greater symptom severity is unknown. Comparative studies of patients with diabetes who do not have other comorbidities versus those with comorbidities should be performed to address that question. In addition, future studies should explore the relationship between comorbidities and HRQOL outcomes in pa-

tients with cancer and address the relationship between other comorbidities such as congestive heart failure and chronic obstructive pulmonary disease, specifically in patients with cancer who are undergoing chemotherapy.

## Limitations

This study used secondary analysis of data, and the data from the parent studies were not collected specifically to evaluate differences between HRQOL outcomes in patients with cancer and diabetes versus those with cancer who did not have diabetes. In addition, the sample size of patients with diabetes and cancer was small compared to individuals with cancer who did not have diabetes. Although all patients were at the beginning of their cancer treatment process, the timing of when individuals received their cancer treatments in relation to data collection was not considered in the analysis. Specific clinical data associated with diabetes were not included in the analysis, as they were not part of the original studies' data collection. Information regarding glycemic control, severity of diabetes, and length of time patients had diabetes was unknown. That information, as well as other possible clinical data related to diabetes, should be collected in future studies.

## Conclusions and Implications for Nursing

Additional nursing research in the area of diabetes and cancer is needed. Future studies should focus on the relationship between glycemic control and HRQOL outcomes in patients with diabetes and cancer, as well as the relationship between cancer treatment and glycemic control. Long-term studies that focus on HRQOL outcomes in patients with cancer, with and without diabetes, also should be conducted to determine whether patients with diabetes continue to have differences from those without diabetes over time. Future research also should address the development and testing of interventions to improve symptom burden, physical and social function, and other comorbidities in individuals with diabetes and cancer. The relationship between individuals with cancer and other comorbidities also should be explored to understand the effects of cancer treatment in this population.

The current study highlights some potential HRQOL differences between patients with diabetes and cancer compared to those with cancer who do not have diabetes at the beginning of cancer treatment. Nurses



at all levels play an essential role in increasing awareness regarding the HRQOL issues in individuals with diabetes and cancer. By being aware of the issues that individuals with diabetes and cancer may develop or encounter, nurses can intervene earlier and help patients understand how chemotherapy and other cancer treatments may affect them. Based on the results of the current study, patients with diabetes and cancer may need earlier and different interventions than patients who only have cancer to improve their HRQOL while undergoing cancer treatment.

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