Older Breast Cancer Survivors: Can Interaction Analyses Identify Vulnerable Subgroups? A Report From the American Cancer Society Studies of Cancer Survivors

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Purpose/Objectives: To explore interactions among personal, cancer, aging, and symptom variables relative to physical function (PF) in older adult breast cancer survivors to better identify vulnerable subgroups.

Design: Secondary analysis of the American Cancer Society Studies of Cancer Survivors II.

Setting: U.S. population-based mail and telephone survey.

Sample: 2,885 breast cancer survivors from 14 different state cancer registries stratified by cancer type and time since diagnosis. A total of 184 female breast cancer survivors, aged 70 years or older, had complete data on variables of interest and were, therefore, included in this analysis.

Methods: Chi-Square Automatic Interaction Detector (CHAID) analysis was used to examine variable interactions.

Main Research Variables: PF, symptom bother, comorbidity, social support, length of survivorship, treatment, stage, body mass index, physical activity, emotional health, and personal characteristics.

Findings: An interaction effect between symptom bother and comorbidity was found in 39% of older adult breast cancer survivors, and an interaction effect between symptom bother and marital status was found in 40%. The most vulnerable group (8%) had high symptom bother and more than four comorbid conditions.

Conclusions: Symptom bother, comorbidity, and marital status were found to have significant interactions such that high comorbidity and high symptom bother were significantly related to lower PF. Married participants with lower symptom bother had significantly higher PF scores. Comorbidity may be the best predictor of PF for the extreme ends of the symptom bother continuum. Advancing age alone was not a sufficient predictor of PF in this analysis.

Implications for Nursing: Specific attention to symptom reports, comorbidity, and marital status can guide identification of older adult cancer survivors in need of ongoing survivorship care. The findings support use of a comprehensive assessment and tailored approach to care based on factors other than age.

Knowledge Translation: CHAID interaction analysis may be useful in exploring complex nursing problems, such as the needs of older adult cancer survivors, and help oncology nurses develop appropriate interventions and referrals.

The expected exponential increase in older adult survivors has added to the concerns regarding the care needs of this population (Grunfeld et al., 2006; Mao et al., 2009). In addition, the predicted decline in the number of oncology providers has caused many to question whether cancer survivors may be best served by primary care or specialist providers (Erikson, Salsberg, Gorte, Bruinooge, & Goldstein, 2007; Nevidjon et al., 2010). Cancer survivorship clinics have been suggested as a model for care but have not yet been shown to be sustainable (Jacobs et al., 2009; McCabe & Jacobs, 2008). Survivorship is a priority research area at the National Cancer Institute and the National Institute on Aging (Institute of Medicine, 2007). Integration of gerontology and oncology research and care models for older adult cancer survivors is imperative in response to the growing demographic shift. The purpose of this study was to identify subgroups of older survivors who would benefit most from more intensive survivorship care by exploring interactions among personal, cancer, aging, and symptom variables in older adult breast cancer survivors. The specific aim guiding this research was exploratory in nature, namely, to explore interactions among these variables as they relate to health status. The research question examined was: To what extent are interaction effects among the variables related to physical function (PF) and symptom experience?

Background

Fifty-nine percent of the 13.7 million cancer survivors in the United States are at least 65 years of age (Siegel, et al., 2012). Of the estimated 2.4 million breast cancer survivors in 2007, about 60% were aged 65 years or older (Ries et al., 2008). A growing body of evidence describes the post-treatment physical and psychological health of older cancer survivors, but basic descriptive data pertinent to the intersection of aging and cancer survivorship has been lacking (Bellizzi, Mustian,

Palesh, & Diefenbach, 2008). Although the majority of breast cancer survivors report health status comparable to noncancer groups (Deimling, Sterns, Bowman, & Kahana, 2005; Stava, Lopez, & Vassilopoulou-Sellin, 2007; Tomich & Helgeson, 2002), about 20% of survivors report significant and long-lasting health problems (Casso, Buist, & Taplin, 2004; Deimling et al., 2005; Ganz et al., 2002; Mols, Vingerhoets, Coebergh, & van de Poll-Franse, 2005; Tomich & Helgeson, 2002), including well-documented long-term and late effects of cancer and its treatment (Boyle, 2006; Costanzo, Ryff, & Singer, 2009; Maccormick, 2006; Mao et al., 2007; Stein, Syrjala, & Andrykowski, 2008).

Maintaining PF among older adults is a primary goal of gerontology. Although consideration of physiologic age is more instructive than chronologic age, Balducci (2000) stated that physical aging generally becomes apparent in the clinical setting at 70 years of age. Declines associated with aging, such as declining physical activity and increasing numbers of comorbid conditions, may play a more prominent role in decreased PF than a cancer diagnosis itself (Girones, Torregrosa, & Diaz-Beveridge, 2009; Grov, Fossa, & Dahl, 2009; Paskett et al., 2009; Schmitz, Cappola, Stricker, Sweeney, & Norman, 2007; Stava et al., 2007). Persistent symptoms, unhealthy lifestyle behaviors, long-term side effects of treatment, and psychosocial risk factors have been linked to decreased quality of life in older adults (Casso et al., 2004; Deimling et al., 2005; Mehta et al., 2003; Paskett et al., 2009; Perkins et al., 2007; Sweeney et al., 2006; Vogelzangs et al., 2007). Identification of subgroups at risk for these declines has been minimally addressed.

Moderators, variables that differentially influence the effect of a predictor variable on an outcome, often are defined by interaction analysis. Interactions have been considered in breast cancer survivor studies using regression by adding individual significant interaction terms to the models (Costanzo et al., 2009; Garman, Pieper, Seo, & Cohen, 2003; Li, Daling, Porter, Tang, & Malone, 2009; Mao et al., 2007). No studies were located that broadly examined interaction effects among variables pertinent to older breast cancer survivors. The current study was designed to address that gap. To summarize, standard care for the large and growing number of cancer survivors has not been defined, and although many survivors thrive post-treatment, an estimated 20% of 12 million survivors sustain long-term and late effects of cancer treatment. An additional aim of the current study was to identify vulnerable subgroups of older survivors who may need ongoing survivorship care through interaction analysis.

Methods

Secondary data analysis of the population-based American Cancer Society Studies of Cancer Survivors II (ACS SCS II) allowed access to data from a large number of survivors. Researchers have reported difficulty locating survivors post-treatment as well as difficulty accessing medical records when treatment occurred many years previously and at different provider locations because of unique problems associated with original data collection related to cancer survivor research (Ganz et al., 2009; Morey et al., 2009). Therefore, secondary analysis of existing survivor data was a logical and expedient way to explore interactions among variables in an effort to identify vulnerable subgroups of older survivors.

The Chi-Square Automatic Interaction Detector (CHAID) is a type of classification tree that aids in identifying interactions among variables. CHAID was chosen for this analysis because interactions were expected among the many predictor variables and are difficult to identify with regression or other parametric analyses (Ma, Jong, Uneg, & Chou, 2005; Trujillano, Badia, Servia, March, & Rodriguez-Pozo, 2009). CHAID is not

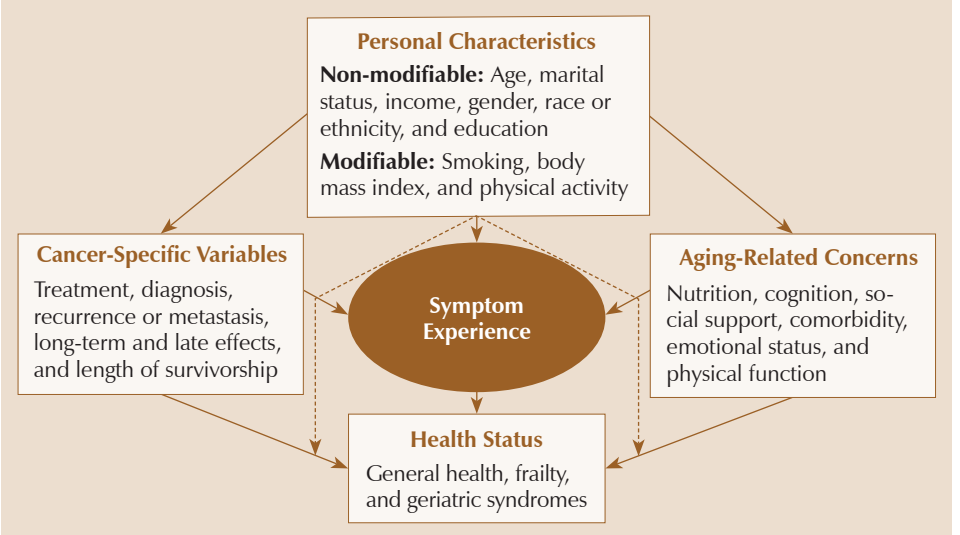

Figure 1. Conceptual Model of Elderly Cancer Survivorship

Note. From "Elderly Cancer Survivorship: Integrative Review and Conceptual Framework," by L.M. Bellury, L. Ellington, S.L. Beck, K. Stein, and J. Clark, 2011, *European Journal of Oncology Nursing, 15,* p. 239. Copyright 2011 by Elsevier Ltd. Reprinted with permission.

Table 1. Instrument Descriptions, Scoring, Range, Reliability, and Interpretation

Variable	Instrument	Subscale	Number of Items	Range	Scoring	Interpretation	Reported Reliability
Body mass index	–	–	1	–	Computed using height, weight, and age	Scores of 30–34.9 indicate obesity; scores greater than 35 indicate severe obesity.	–
Comorbidity	List of conditions	–	13	0–13	Sum	Higher score indicates higher comorbidity.	–
Emotional status	SF-36®	Mental health	5	5–30	Six-point Likert	Higher score indicates higher emotional status.	0.7–0.92
Length of survivorship	–	–	1	2-, 5-, 10-year cohort	Determined by sampling	–	–
Number of treatments	–	–	7	0–7	Sum	Higher score indicates higher number of treatments.	–
Physical activity	Godin WLA	–	3	0–91	Computed	Higher score indicates more physical activity.	Test-retest 0.62–0.81
Physical function	SF-36®	Physical function	10	10–30	Three-point Likert	Higher score indicates higher physical function.	0.88–0.93
Social support	MSPSS	Total score	12	12–84	Seven-point Likert	Higher score indicates higher social support.	0.82–0.95
Stage	–	–	1	–	Three categories	Local, regional, or distant disease	–
Symptom bother	RSCL-M	Total score	30	4–120	Four-point Likert	Higher score indicates higher symptom bother.	0.8–0.87

MSPSS—Multidimensional Scale of Perceived Social Support; RSCL-M—Modified Rotterdam Symptom Checklist; WLA—weekly leisure activity
Note. Based on information from Cheng & Chan, 2004; Godin & Shephard, 1985; McDowell, 2006; Stein et al., 2003; Ware & Sherbourne, 1992.

limited by assumptions of linear relationships or normal distributions of variables but explores interactions within the data and has the potential to reveal subsets that may confound normal distributions (Pagan, Pratt, & Sun, 2009; Ture, Kurt, & Kurum, 2007). Compared to multiple logistic regression models, classification trees have been reported to be easier to interpret within a clinical problem focus (Trujillano et al., 2009). CHAID analysis has been reported in a wide range of health-related topics including electronic prescription use (Pagan et al., 2009), phase II research drug dosing (Penel et al., 2010), and pressure ulcer risk factors (Lahmann, Tannen, Dassen, & Kottner, 2011).

Sample

The ACS SCS II was designed to include representation of poor, rural, and minority survivors, all identified as lacking in prior survivorship research. Participants were chosen from 14 state cancer registries with mature data (registries with data available 10 years prior to data collection) and stratified by cancer type (female breast, colorectal, prostate, bladder, skin melanoma, or uterine). Time since diagnosis groups (2, 5, and 10 years) were equally represented in each diagnostic group (Smith et al., 2006). Survivors were eligible if they were aged 18 years or older at diagnosis, a resident of the targeted states, and diagnosed with local, regional, or distant cancer. Survivors were ineligible if they were unable to complete the survey or unable to communicate in English or Spanish. Of a total of 2,885 breast cancer survivors in the database, 896 survivors were aged 70 years or older, the lower limit chosen based on the Balducci (2000) estimate of the onset of clinically apparent physiologic aging. The final sample included 184 participants with complete data on all variables of interest. Body mass index (BMI) and physical activity measures were added midway through data collection; therefore, early cases did not include these variables. The deidentified data were exempt from review by the institutional review boards at Emory University and the University of Utah.

Table 2. Mean, Standard Deviation, Range, and Reliability of Scale Variables for the Study Population

Variable	$\bar{X}$	SD	Range	Cronbach Alpha
MSPSS	68.8	12.6	12–84	0.96
RSCL-M Symptom Bother	45.7	9.4	30–80	0.87
SF-36® Mental Health	52.5	8.8	27.7–64.1	0.78
SF-36® Physical Function	39.1	11.2	15.2–57.1	0.91

MSPSS—Multidimensional Scale of Perceived Social Support; RSCL-M—Modified Rotterdam Symptom Checklist

Measures

A previously developed conceptual model (see Figure 1) merged personal, oncology, and gerontology concerns for older survivors and guided variable choice for this research (Bellury, Ellington, Beck, Stein, & Clark, 2011). Personal characteristics (demographics and modifiable lifestyle behaviors), cancer-specific variables (e.g., disease stage, time since diagnosis, treatment, symptoms), and aging-related characteristics (e.g., physical function, comorbidities, emotional status, social support) were identified in the model as expected predictors of health status (e.g., general health, frailty, geriatric syndromes). The personal and cancer variables were chosen based on an extensive literature review to identify the needs of older adult cancer survivors (Bellury et al., 2011). The aging concerns reflected the components of a comprehensive geriatric assessment (CGA) that generally includes assessment of function, comorbidity (and polypharmacy), psychosocial factors, cognition, and nutrition (Hurria et al., 2007; Hurria, Lachs, Cohen, Muss, & Kornblith, 2006). No measure of cognition was available in the data set, and it was generally assumed that participation in the study required intact cognitive function. The nutrition measure was not included because of preliminary analysis that revealed lack of variation in the data. A summary of measures chosen from the ACS SCS II survey to represent the model components in this study is included in Table 1.

Instruments chosen by ACS SCS II researchers had demonstrated reliability and validity. Reported reliability for the instruments is included in Table 1 and internal consistency for this analysis is included in Table 2. PF and emotional status were measured by the **SF-36®** (Ware & Sherbourne, 1992). The PF subscale included 10 questions about how activities are impacted by health. The mental health subscale included five questions about nervousness and mood. The 12-item **Multidimensional Scale of Perceived Social Support**, with a seven-point Likert scale ranging from 1 (very strongly disagree) to 7 (very strongly agree), assessed support from family, friends, and significant others and was used for the social support variable (Cheng & Chan, 2004). The physical activity score was calculated based on the **Godin Leisure-Time Exercise Questionnaire** (Godin & Shephard, 1985). The activity score was obtained by multiplying the reported incidence of levels of activity with a factor to weight strenuousness. Those products were then summed for a weekly leisure activity score. Symptom bother was measured by the **Modified Rotterdam Symptom Checklist (RSCL-M)** (Stein et al., 2003), which included a list of 30 common symptoms reported during cancer treatment (e.g., pain, fatigue, nausea, diarrhea, decreased sexual interest) and asked for the extent of bother created by that symptom on a four-point Likert scale ranging from 1 (no bother) to 4 (bothered very much).

Several measures without established instruments were created and pilot tested by the ACS SCS II researchers. Thirteen common medical conditions and a short explanation were listed and participants were asked to mark all conditions that they had experienced in the past year. The comorbidity score represented the number of conditions chosen (0–13). Length of survivorship, race, and stage of disease were verified through the registry data. Types of treatments received (surgery, radiation, chemotherapy, hormone therapy, bone marrow transplantation, immunotherapy, and other) were self-reported, and because of the nonclinical level of this data and the overlap of treatment types, a variable was created that summed the number of treatment types received. Demographics included date of birth, marital status, and education. BMI was calculated by self-reported height and weight data.

Analysis

SPSS®, version 18, and the decision tree application in SPSS were used in this analysis. In CHAID, the relationship between each predictor variable and the outcome variable is considered in an automated, forward stepwise fashion. The program partitions into mutually exclusive subgroups based on the significance level of each variable in relation to the outcome. Significance levels were adjusted based on a Bonferroni correction. The output is reported in two ways: a visual tree model with branches (nodes) illustrating the significance testing within multiple levels of interactions, and a table ranking subgroups by mean score on the outcome and indicating the percent (individual and cumulative) of the cases represented by each subgroup. Exhaustive CHAID allows each predictor variable to be evaluated at each node of analysis so that the inclusion of a variable in one branch of the tree does not exclude it from other branches. Terminal node size affects the number of tree branches allowed in the CHAID classification

tree. Node size limits are infrequently reported in the literature and vary widely. Node limits of 20 for parent and 10 for children were set based on the sample size and the desire for clinically relevant nodes.

Results

Sample Characteristics

Considerable non-normal distributions of the variables existed in the data that supported the choice of the nonparametric, exploratory CHAID analysis. Transformations of data were not helpful in improving normality. The majority of the exclusively female participants were Caucasian, with at least a high school education, and had two or more comorbid conditions. The mean age was 76.55 years (SD = 4.7). Symptoms reported by more than 50% of the sample included tiredness, lack of energy, sore muscles, pain, difficulty sleeping, and low back pain. Demographics and descriptive statistics are included in Tables 3–5.

Table 3. Demographic Sample Characteristics (N = 184)

Characteristic	$\bar{X}$	SD	Range
Age (years)	76.5	4.7	70.1–94.9
Physical activity Godin score[a]	11.3	15.1	0–91
Body mass index	28.8	6	17.7–54.3
Characteristic		**n**	**%**
Marital status			
Married		81	44
Widowed		76	41
Divorced		18	10
Single, never married		9	5
Race			
Caucasian		147	80
African American		29	16
Other		8	4
Education			
Eighth grade or less		4	2
Some high school		36	20
High school diploma		68	37
Vocational or some college		43	23
College graduate		13	7
Professional or graduate school		20	11
Income ($)			
Less than 20,000		56	30
20,000–39,999		43	23
40,000–74,999		28	15
75,000 or more		7	4
Unknown		50	27
Body mass index			
Underweight (less than 18.5)		1	1
Normal (18.5–24.9)		43	23
Overweight (25–29.9)		77	42
Obese (30–35)		40	22
Severe obesity (higher than 35)		23	13

[a] Scores range from 0 (completely sedentary) to 24 or higher (meets recommendation for physical activity).

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

Exhaustive Chi-Square Automatic Interaction Detector Classification Tree 1

All predictor variables were entered into CHAID with PF as the outcome measure. Results are displayed in Figure 2 and Table 6. The F statistics are found in Figure 2 in the text above the splits. The variable most significantly related to PF was symptom bother, which was subdivided into four groupings at the first level of branching. Those groupings were labeled low symptom bother (node 1), moderately low symptom bother (node 2), moderately high symptom bother (node 3), and high symptom bother (node 4) (see Table 7).

The terminal splits (nodes 3, 5–10) represent identified subgroups with significantly different PF scores. The terminal nodes ranked by mean PF score in Table 6 showed that the highest PF scores (node 5) were participants with the lowest symptom bother and one or fewer comorbid conditions. The second highest PF scores (node 7) were participants with moderately low symptom bother, who were married, single, or never married. The two poorest PF scores (nodes 9 and 10) were those with high symptom bother with a split between four or fewer comorbidities compared with four or more comorbidities.

The largest percentage of participants (40%), found in terminal nodes 7 and 8, had an interaction detected between moderately low symptom bother and marital status, meaning that for participants with moderately low symptom bother, the married subgroup had significantly higher PF compared to the widowed or divorced subgroup. At the two ends of the symptom bother continuum (terminal nodes 5, 6, 9, and 10), symptom bother and comorbidity had interactions representing 39% of the sample, meaning that for participants reporting low or high symptom bother, higher number of comorbidities were related to lower PF. Node 3, also a terminal node, represented 21% of the sample with moderately high symptom bother and low PF, and had no other interaction effects. This means that symptom bother was the only significant predictor of lower PF for a little more than one-fifth of these survivors.

Exhaustive Chi-Square Automatic Interaction Detector Classification Tree 2

Additional analyses to explore the possible interactions among individual symptoms, individual treatment types, and comorbidities are presented in Figure 3 and Table 8. For this CHAID, in addition to the symptom bother score and the total number of comorbidities, the 30 symptoms in the RSCL-M, the six treatment types, and the 13 distinct comorbid conditions were recoded as present or absent and were added to the CHAID analysis. The first branching was

Table 4. Cancer-Related Sample Characteristics (N = 184)

Characteristic	$\bar{X}$	SD	Range
Number of treatments	2.8	1.2	0–6
Characteristic		**n**	**%**
Number of treatments			
0		3	2
1		17	9
2		49	27
3		73	40
4 or more		42	23
Stage of disease			
Localized		142	77
Regional		41	22
Distant		1	1
Treatment[a]			
Surgery		174	95
Radiation		121	66
Hormone therapy		116	63
Chemotherapy		81	44
Bone marrow transplantation		18	10
Immunotherapy		15	8
Length of survivorship			
2 years		49	27
5 years		68	37
10 years		67	36

[a] Participants could choose multiple responses.
Note. Because of rounding, not all percentages total 100.

identical to the first CHAID but three specific comorbid conditions interacted with the four levels of symptom bother. Also, the 21% reporting moderately high symptom bother, which had no further interactions in the first analysis, had a significant interaction with the comorbidity "heart problems" in the second. In the low symptom bother group, those without arthritis had significantly better PF scores. In the subgroup with high symptom bother, an interaction was found with the comorbidity of diabetes such that high symptom bother and diabetes resulted in the lowest PF score over all groups. Again, treatment type was not found to be significant.

Discussion

The purpose of this study was to identify subgroups of older breast cancer survivors who are likely to benefit from specialty care and/or interventions. Two classification trees using CHAID examined variable interactions in a subset of older breast cancer survivors from the ACS SCS II survey. Complex interactions existed between PF, symptom bother, number of comorbidities, arthritis, diabetes, heart problems, low back pain, and marital status. Normed comparisons indicated the sample had comparable PF and slightly better emotional status compared with population norms for older female groups (Ware, 1998). Survivors with higher levels of symptom bother and more than four comorbid conditions had the lowest levels of physical functioning in the first CHAID. A small number of participants (5%) with high symptom bother and diabetes reported the lowest PF across both analyses. Variables that did not demonstrate significant interaction effects included length of survivorship, treatment, stage, BMI, physical activity, social support, emotional health, race, education, and age.

Age

No significant interactions were noted with age in the CHAID analyses. Although PF generally declines with age, these findings supported the importance of considerable heterogeneity of health status with aging. Gerontologists recommend the use of comprehensive geriatric assessment instead of chronologic age for decision making in older adults because of heterogeneity of health status with respect to age (Balducci, 2000; Balducci & Beghe, 2000; Hurria et al., 2006, 2007; Pasetto et al., 2007; White & Cohen, 2008). The finding that age

Table 5. Comorbidities by Number and Type (N = 184)

Variable	$\bar{X}$	SD	Range
Comorbidities	2.6	1.8	0–10
Variable		**n**	**%**
Comorbidities			
0		13	7
1		41	22
2		49	27
3		31	17
4		24	13
5		12	7
6 or more		14	8
Reported comorbidities[a]			
Arthritis		118	64
Hypertension		101	55
Chronic back pain		47	26
Osteoporosis		46	25
Heart problems		36	20
Diabetes		31	17
Neuropathy		24	13
Asthma, emphysema, or COPD		22	12
Stomach or intestinal problems		19	10
Depression		14	8
Anxiety or nervousness		13	7
Memory or concentration		11	6
Stroke		5	3
None of the above		11	6
Other condition		23	13

[a] Participants could choose multiple responses.
COPD—chronic obstructive pulmonary disorder
Note. Because of rounding, not all percentages total 100.

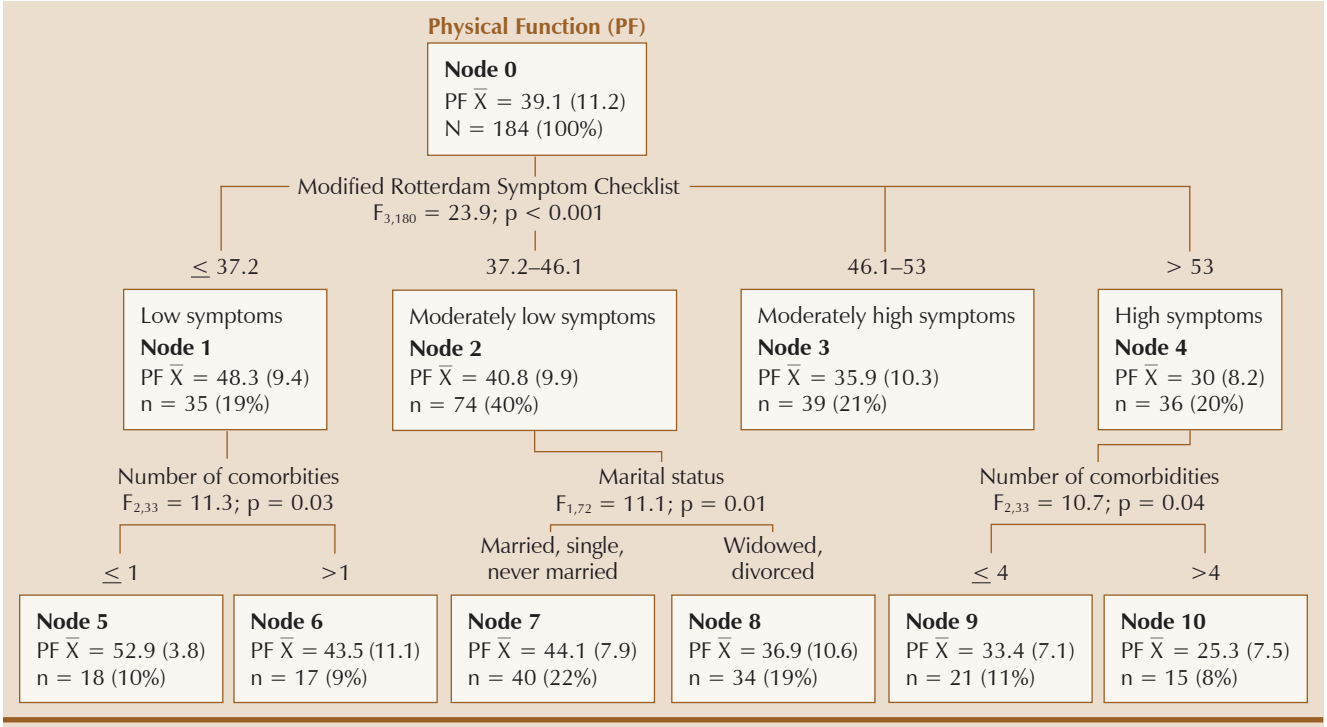

Figure 2. Classification Tree 1: Interactions Influencing Physical Function

was not a predictor in this analysis may support the need for a comprehensive assessment and tailored approach to care based on factors other than age.

Emotional Status

No interaction effects were found in the CHAID analysis specific to the effect of emotional status on PF. The emotional status mean for this sample was higher than the population norms that supported literature reporting that psychosocial functioning for the majority of older cancer survivors is comparable or better than peers without cancer (Costanzo et al., 2009; Mols et al., 2005; Mosher et al., 2009; Stava et al., 2007). However, both analyses uncovered an interaction between symptom bother and marital status with respect to PF for a large subgroup (40%). Married, single, or never married participants had significantly better PF compared to widowed and divorced. Because only 5% of the sample were single or never married, the psychosocial implications of being married versus widowed or divorced may be the drivers of the distinction in PF based on marital status.

Symptoms and Comorbidity

The interactions of symptom bother and comorbidity were significant in distinguishing survivors with the lowest and highest PF. An increase in the incidence of comorbidities has been associated with increased symptoms as well as decreased survival, function, and treatment tolerance (Extermann & Hurria, 2007; Garman et al., 2003; Paskett et al., 2009; Reiner & Lacasse, 2006; White & Cohen, 2008). Although symptom experience specific to gero-oncology populations is understudied (Reiner & Lacasse, 2006), pain, fatigue, mood, and sleep disturbances are symptoms commonly experienced by patients of all ages with cancer. The symptoms most commonly reported in this study were similar. Symptom severity has been associated with multiple comorbidities and PF deficits in older adult patients after treatment (Deimling, Bowman, & Wagner, 2007; Grov et al., 2009; Paskett et al., 2009; Sweeney et al., 2006). As a result, symptom intensity, perception, and experience among older adults seems to vary from that of younger patient populations, possibly because of comorbid conditions that cause multiple symptom interactions (Reiner & Lacasse, 2006).

Only low back pain as an individual symptom exhibited an interaction effect. The clinical significance for this is unknown, but low back pain may be associated with more functional impairment than other cancer-related symptoms. Interactions with the specific comorbid conditions of arthritis, heart problems, and diabetes were identified. All three of these comorbid conditions are associated with aging, but the reports of heart problems may be of special interest to survivors of breast cancer. Cancer treatment modalities common in breast cancer, such as chest irradiation, cytotoxic chemotherapy, and biotherapy, increase the risk of long-term and late cardiovascular compromise, including cardiomyopathy, congestive heart failure, and arrhythmias. These findings suggest that symptom bother

Table 6. Terminal Node Summary Ranking of Mean Physical Function Scores for Classification Tree 1 (N = 184)

	Node by Node			Cumulative Nodes		
Node	n	%	Physical Function $\bar{X}$	n	%	Physical Function $\bar{X}$
5	18	10	52.9	18	10	52.9
7	40	22	44.1	58	32	46.8
6	17	9	43.5	75	41	46.1
8	34	19	36.9	109	59	43.2
3	39	21	35.9	148	80	41.3
9	21	11	33.4	169	92	40.3
10	15	8	25.3	184	100	39.1

was the strongest predictor of PF and comorbidity may be the best predictor of PF for the extreme ends of the symptom bother continuum.

Cancer-Specific Variables

Different forms of cancer treatment have specific long-term sequelae related to regimens, dose, and extent of therapy. Some studies suggest that the passage of time may moderate treatment effects and certainly the most common surgical complications subside in long-term survivorship (Ganz et al., 2002; Schroevers, Ranchor, & Sanderman, 2004; Sweeney et al., 2006). None of the cancer-specific variables included in the authors' analysis (e.g., treatment, length of survivorship, stage) exhibited interactions; however, the nonclinical, self-reported treatment data and the limited variation found in stage of disease data may have contributed to this finding.

Length of survivorship was not significantly related to PF. This seems to support prior research that indicated most survivors return to baseline functioning within the first two years after treatment and that length of survivorship is not related to PF (Ganz et al., 2003; Garman et al., 2003). In addition, some research has proposed that a history of cancer may be of diminished concern to older long-term cancer survivors because of competing concerns that have more immediate meaning in their lives (Pieters & Heilemann, 2011; Sinding & Wiernikowski, 2008).

Lifestyle Behaviors

Research has indicated that modifiable lifestyle behaviors are related to PF (Demark-Wahnefried et al., 2004; Grov et al., 2009; Hurria et al., 2006; Li et al., 2009; Morey et al., 2009; Mosher et al., 2009; Sweeney et al., 2006). No interaction effects were found with either of the modifiable lifestyle behaviors, perhaps partially explained by findings that only moderate and severe obesity have been related to decreased mobility in older adults (Sergi et al., 2007; Vincent, Vincent, & Lamb, 2010). The self-reported nature of the BMI data and the relatively small number of severely obese participants (13%) may have influenced these findings and additional research is recommended.

Limitations

This study was descriptive in nature and not intended as hypothesis testing. This study was limited by the substantial loss of cases from missing data necessary for the inclusion of all the variables in the model. Although the original ACS study oversampled racial and ethnic groups, this subsample was predominantly Caucasian, and the results should be interpreted cautiously given the low numbers of minority populations in the subsample. The selection of only breast cancer survivors also limits application to other diagnostic groups of survivors, and additional research is needed specific to other diagnoses and to men. Survivorship is a dynamic trajectory, difficult to surmise from a cross-sectional, single-point-in-time measurement, particularly given the aging and group effects the authors were attempting to evaluate.

Implications for Research and Practice

Because a growing body of evidence—including this study—has supported geriatric assessment as an essential component of the care of older survivors, the first research recommendation is to develop and adopt a standard CGA measure that is valid, reliable, survivor-specific, efficient, and feasible. The tool must consider the issues of measurement burden both to the survivor and the healthcare provider. Incorporated into the tool must be consensus regarding the measurement of PF for older survivors. Oncology performance tools (e.g., Karnofsky), standard gerontology measures (e.g., Activities of Daily Living, Instrumental Activities of Daily Living), objective performance measures (e.g., Timed Up and Go), and self-report of common activities have been used to measure functional status among cancer survivors (Mathias, Nayak, & Isaacs, 1986; Paskett et al., 2009; Schmitz et al., 2007; Sweeney et al., 2006). Hurria

Table 7. Symptom Bother Groupings and Labels From Significant Interactions in Classification Tree 1 (N = 184)

Node	n	%	Label	Symptom Bother Score
1	35	19	Low symptoms	$\leq$ 37.2
2	74	40	Moderately low symptoms	37.3–46.1
3	39	21	Moderately high symptoms	46.2–53
4	36	20	High symptoms	> 53

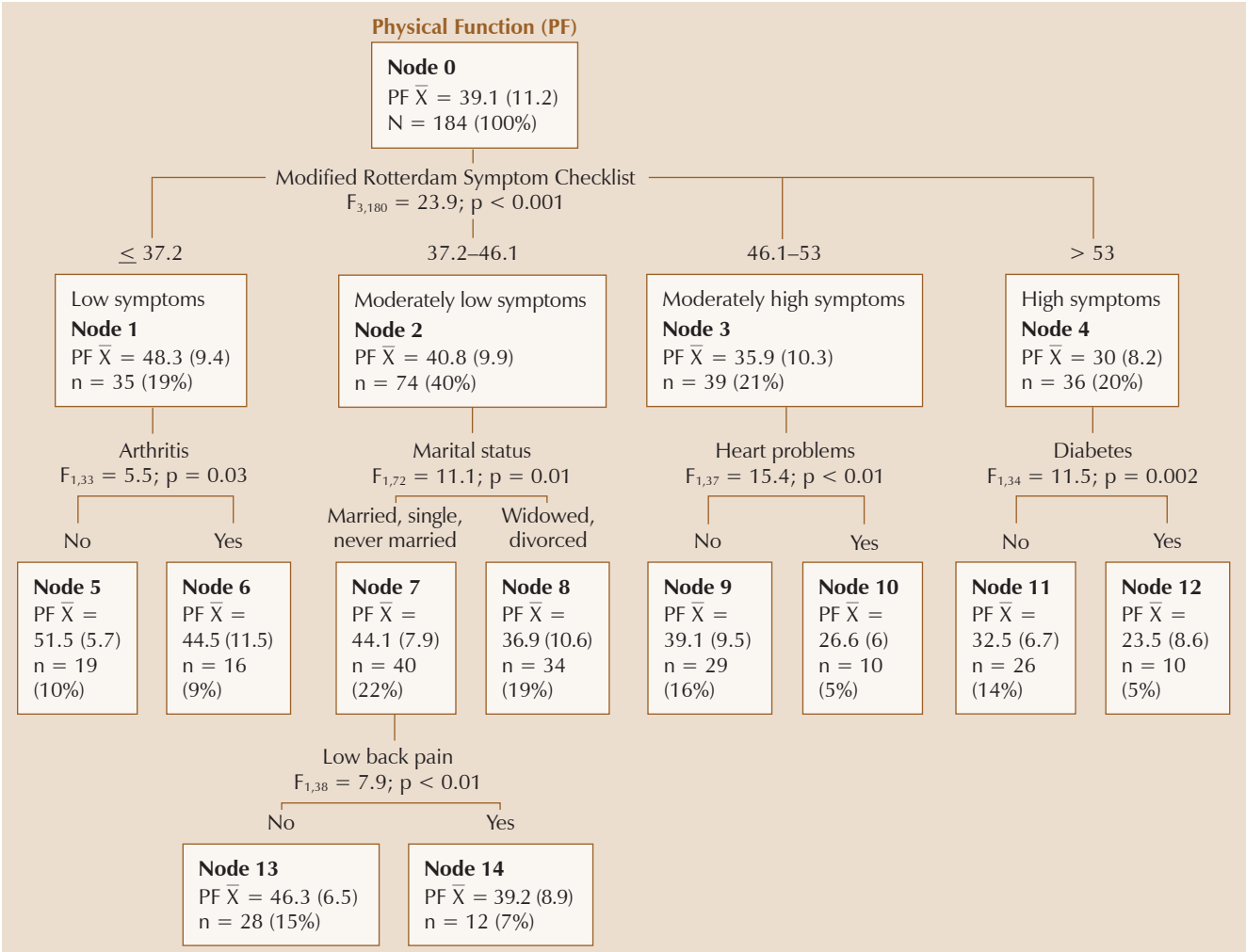

Figure 3. Classification Tree 2: Addition of Specific Symptom and Comorbid Condition Interactions Influencing Physical Function

et al. (2006) reported the development of an oncology CGA tool, but additional research is needed to accelerate broad acceptance and dissemination.

The conceptual model suggested outcome measures pertinent to gero-oncology, including measures of frailty or predictors of geriatric syndromes. Other outcome measures could be developed specific to the concerns of older adults, including independence, autonomy, or mobility measures (Balducci, 2000; Bellizzi et al., 2008). Similarly, consensus regarding comorbidity and symptom measurement of particular concern to older survivors also would accelerate scientific advances. Stein et al. (2008) concluded that measures of physical and psychological long-term and late effects are underdeveloped and additional research is needed.

Not only is symptom measurement a research priority, work is needed in symptom management including development of screening tools, investigation of symptom clusters, identification of effective interventions, and appropriate follow-up care (Bellizzi et al., 2008). The current study suggested that increased symptom burden was associated with lower PF. The interactions between comorbidity and symptoms need to be explored further. Research of the mediators and moderators of outcomes important to older survivors, which can inform the development of quick screening tools to identify those survivors at risk for untoward outcomes is needed in the future (Bellizzi et al., 2008; So et al., 2009). CHAID methodology may be particularly useful in identifying vulnerable groups of older survivors. Although CHAID has seldom been used in nursing research, this introduction to the technique may encourage the wider use of this potentially beneficial analytic strategy. Replication with a comparison group is recommended.

Care plans for cancer survivors typically include a treatment summary, provider contact information, health promotion recommendations, and a follow-up plan that includes risks and continuing assessment for long-term and late effects, cancer recurrence, and assessment of psychosocial needs. Since the seminal

Table 8. Terminal Node Summary of Mean Physical Function Scores for Classification Tree 2 (N = 184)

	Node by Node			Cumulative		
Node	n	%	Physical Function $\bar{X}$	n	%	Physical Function $\bar{X}$
5	19	10	51.5	19	10	51.5
13	28	15	46.2	47	26	48.4
6	16	9	44.5	63	34	47.4
14	12	7	39.2	75	41	46.1
9	29	16	39.1	104	57	44.1
8	34	19	36.9	138	75	42.4
11	26	14	32.5	164	89	40.8
10	10	5	26.6	174	95	40
12	10	5	23.4	184	100	39.1

Institute of Medicine report on cancer survivorship, *From Cancer Patient to Cancer Survivor: Lost in Transition* (Hewitt, Greenfield, & Stovall, 2006), much work has been done to standardize and implement survivorship care plans to aid the transition to survivorship. Nurses can be instrumental in creating, maintaining, and interpreting those care plans for patients within a comprehensive, multidisciplinary paradigm. The findings from this research suggest that follow-up plans for older survivors should include symptom assessment, comorbidity monitoring and treatment plans, psychosocial support, evaluation, and possible referrals. Finally, this study identified subgroups of survivors at risk for PF decline. Oncology nurses must provide a careful assessment of symptoms, comorbidities, and marital status in clinical practice and advocate for appropriate referrals and interventions. The predominance of pain- and fatigue-related symptoms, in addition to overall symptom bother in this analysis, should alert providers to the need for targeted assessments of these symptoms.

Care of survivors requires a shift from disease-focused treatment to wellness interventions that promote health and function. Whereas care for cancer survivors within oncology practice has historically focused on surveillance for cancer recurrence, a wellness focus would shift toward a comprehensive evaluation of lifestyle behaviors, cancer prevention, health promotion, psychosocial interventions, preservation of independence, and symptom management. The Institute of Medicine report *Cancer Care for the Whole Patient: Meeting Psychosocial Health Needs* focused on psychosocial needs as a component of holistic cancer care and recommended the collocation and integration of psychosocial and biomedical care (Adler & Page, 2007). Nurses need to be part of the solution to survivorship care by designing integrated, transdisciplinary care models.

Conclusions

This research complements the accumulating knowledge relative to older adult cancer survivors. Specific attention to symptoms and comorbidity can guide identification of subgroups vulnerable to functional decline. In addition, these analyses support a holistic view of survivorship that incorporates a comprehensive assessment of cumulative symptom bother and comorbidity rather than limiting assessment to individual symptoms or comorbid conditions. Consideration of marital status and the psychosocial implications of widowhood or divorce also are necessary for comprehensive survivorship care. Advocated as a way to guide survivorship care, survivorship care plans should include identification and ongoing assessment of symptoms, comorbidities, and psychosocial concerns. Interaction analysis is a viable and important method to further understand complex systems such as those presented by older adult cancer survivors. Additional investigation is warranted to expand this type of analysis to additional diagnoses and more inclusive samples.

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