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Cognitive Dysfunction Prevalence and Associated Factors in Older Breast Cancer Survivors

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Abstract

Objectives: The purpose of this study was to examine the prevalence and factors associated with objective and subjective cognitive dysfunction in older breast cancer survivors (BCS).

Materials and Methods: This cross-sectional descriptive study leveraged previously collected data from older BCS (n=335). Separate linear regression models were used to determine relationships between demographic factors (age, education), medical factors (comorbidities), disease factors (time since diagnosis, cancer stage), cancer-related symptoms (depressive symptoms, anxiety, fatigue, sleep disturbance) and cognitive dysfunction measures, including objective learning, delayed recall, attention, executive function-working memory, verbal fluency and subjective attentional function.

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Results: Cognitive dysfunction was prevalent with up to 18.6% of older BCS experiencing mild-moderate dysfunction (1.5 standard deviations below mean of non-cancer controls) in at least one cognitive domain. Poor to moderate subjective attentional function was reported by 26% of older BCS. More depressive symptoms were significantly related to poorer cognitive function including learning ($p<.01$), delayed recall ($p<.05$), verbal fluency ($p<.001$), and subjective attentional function ($p<.001$) but not attention and executive function-working memory. Age, education, anxiety, and fatigue were also negatively associated with cognitive function in some models ($p <.05$-$.001$).

Conclusion: Cognitive dysfunction is common among older BCS and depressive symptoms, anxiety, and fatigue are related factors. Importantly, depressive symptoms were not only related to self-report, but also to cognitive performance. Healthcare providers should be aware of and assess for related factors and cognitive dysfunction itself in older BCS even years after diagnosis and treatment thorough geriatric assessment. Future longitudinal research is needed to discern these relationships.

Keywords

breast cancer survivors; older adults; cognitive dysfunction; associated factors

Introduction

Older breast cancer survivors (BCS) face many symptoms and unique care needs during and following their diagnosis and treatment (1). Many of the symptoms linger well into survivorship and may be compounded with normal aging (2). One concern many BCS face is cognitive dysfunction (2, 3). Older BCS (≥60 years old), specifically, may be at an increased risk for cognitive dysfunction due to a number of factors related to the normal aging processes, lower cognitive reserve prior to cancer and treatment, and the neurotoxic effects of cancer treatment (4). Researchers have emphasized that systemic cancer treatment may induce an accelerated aging process (e.g., telomere attrition, stem cell exhaustion, cellular senescence, DNA damage, and epigenetic alterations) which in turn may result in long-term effects, especially for older BCS who may already be struggling with their physical and functional ability, level of independence and decision-making capacity (5, 6). These concerns are compounded for the older BCS, who may not have the social (family or social support) or financial (fixed or low income) resources readily available to them (7). With the increased risk for cognitive concerns following cancer and cancer treatment for older BCS and the potential for negative implications it is critical to examine cognitive dysfunction in older BCS.

Cognitive dysfunction has been defined as a complex symptom identified by cognitive changes that negatively impact higher-order mental processes (8). Rates of cognitive dysfunction vary among all aged BCS depending on the measures and impairment definition used but have been reported to impact 40% to 75% of BCS (1, 8, 9). Due to the paucity of research among older BCS specifically we do not fully understand the prevalence and impact of cognitive dysfunction within this population. Cognitive dysfunction has been measured in BCS by both standardized objective (neuropsychological) assessments and subjective (self-report) assessments (8). Self-report is frequently used in the clinical setting

and is often the first indication from the BCS that there is a cognitive concern or problem for the healthcare provider to address (10, 11). Depending upon the severity of the problem or level of concern, a neuropsychological assessment may be warranted (11). Thus, the use of both objective and subjective cognitive assessments may assist in characterizing cognitive dysfunction. However, there remains a paucity of information regarding the prevalence of cognitive dysfunction in older BCS, with most literature being published with all age BCS. More work is needed to understand the prevalence of cognitive dysfunction among older BCS.

Examining the prevalence as well as the factors that may be associated with both objective and subjective cognitive dysfunction is crucial. Previous research in all age BCS have identified potential risk factors for cognitive dysfunction; however, less is known about the potential risk factors for cognitive dysfunction in the older BCS population specifically. Based upon Hess and Insel's conceptual model and relevant literature, there are factors that may be significantly related to cognitive dysfunction and help to identify and characterize cognitive dysfunction in older BSC (12). Demographic (age and education), medical (comorbidities), and disease factors (time since diagnosis and breast cancer stage) have been shown to be significantly related to cognitive dysfunction (3, 13–15). In addition, other cancer-related symptoms, including depressive symptoms, anxiety, fatigue, and sleep disturbance have been previously linked with cognitive dysfunction (13, 14, 16–18). However, in all age BCS and the smaller volume of literature focusing on older BCS, these findings have been mixed (19). In addition, studies in older BCS have only followed BCS for up to 2-3 years post-diagnosis, and thus have failed to elucidate significant factors associated with cognitive dysfunction in older BCS who are further into survivorship and may be experiencing long term symptoms or late effects of treatment (2).

Therefore, the purpose of this study was to describe the prevalence of cognitive dysfunction and associated factors in older BCS who were 3 to 8 years post-treatment. Specific aims were to: 1) describe the prevalence of objective and subjective cognitive dysfunction in older BCS, and 2) examine the relationships between demographic (age and education), medical (comorbidities). and disease factors (time since diagnosis and breast cancer stage), cancer-related symptoms (depressive symptoms, anxiety, fatigue, and sleep disturbance), and objective cognitive function (learning, delayed recall, attention, executive function-working memory, and verbal fluency) and subjective ratings of cognitive function (subjective attentional function) in older BCS. This information may be useful in identifying targets for treatment and remediation.

Materials and Methods

This is a secondary analysis of cross-sectional data leveraged from a large, United States wide, American Cancer Society-funded BCS study seeking to understand quality of life of younger versus older BCS (RSGPB-04-089-01, PI: Champion) (20). Participants were eligible for this study if they were: 1) female BCS, 2) 60 years of age and older at the time of breast cancer diagnosis, 3) three to eight years post-diagnosis at the time of survey completion/data collection without a recurrence or other cancers (exception skin cancer), 4) stage I-IIIa at initial breast cancer diagnosis, 5) able to read and write English, 6) treated

with a similar chemotherapy regimen (Adriamycin, Paclitaxel, and Cyclophosphamide), and 7) completed neuropsychological assessment.

Recruitment information for the original study is published previously (20). Briefly, participants were recruited (2006-2010) from a Midwestern United States University and 97 Eastern Cooperative Oncology Group (ECOG) sites. Human subjects protection was obtained for the study from the Institutional Review Boards at all sites. Potential participants were identified by the ECOG sites, the BCS's treating physician then obtained permission to forward the BCS's contact information to study staff. BCS were mailed information and then were contacted via telephone. Interested BCS were mailed an informed consent and questionnaire and a date was set for the neuropsychological assessment. Neuropsychological assessments were performed by trained staff via the telephone, which was found to be reliable, valid, and comparable to in-person assessment (21). Participants received compensation for completing the study.

Measures

Demographic, Medical and Disease Factors.—Demographic, medical and disease related data were collected via investigator-initiated questionnaire (self-report) and medical record. Participants responded to questions and provided information on date of birth, age at breast cancer diagnosis, race, ethnicity, years of education, current income, marital status, number of comorbidities (from a list of 18 common conditions) and breast cancer stage and treatments received (e.g., surgery type, radiation-yes/no).

Cancer-Related Symptoms.—Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D), a 20-item instrument where higher scores indicate more depressive symptoms and symptom scores ≥16 indicate clinically significant depressive symptoms (22, 23). Anxiety was measured using the Spielberger State-Trait Anxiety Inventory (STAI)-State sub-scale, a 20-item scale where higher scores indicate more anxiety (24). Fatigue was measured using the Functional Assessment of Cancer Therapy-Fatigue (FACT-F), a 13-item measure where higher scores indicate less fatigue (25). Sleep was measured using the Pittsburgh Sleep Quality Index (PSQI) - sleep disturbance sub-scale, a 9-item sub-scale, where higher scores indicate more sleep disturbance or worse sleep (26).

Objective Cognitive Function.—Objective cognitive function, including learning, delayed recall, attention, executive function-working memory, and verbal fluency were measured using a neuropsychological battery. Learning and delayed recall were assessed with the Rey Auditory Verbal Learning Test (AVLT), a 15-item five trial word list learning task with a delayed free recall (27–29). The learning score is calculated as the sum of recall across the 5 learning trials. The delayed recall score is calculated as the delayed recall score. Attention and executive function-working memory were assessed using the Wechsler Adult Intelligence Scale Digit Span Forward and Backward (respectively) (30, 31) where the subject repeats number strings of increasing length forward and backward. The Attention score is the total correct across forward and executive function-working memory is the total correct across backward span. Verbal fluency was measured using the Controlled Oral Word

Association Test (COWA), in which participants are asked to verbally generate as many words as possible in 60 seconds beginning with the letters C, F, and L (32–34). Higher scores across the objective measures indicate better functioning.

Subjective Cognitive Function.—The Attentional Function Index (AFI) is a 13-item scale used to assess perceived effectiveness in common activities requiring attention, working memory, and executive function with higher scores indicating better function (35). The AFI has predetermined cut points to indicate level of attentional function. The published cut-points include: scores <50 indicate low/poor attentional function, scores 50-70 indicate moderate attentional function, and scores >75 indicated good attentional function (35).

Statistical Analysis

Descriptive statistics were calculated for sociodemographic, medical, and treatment variables. Prevalence of cognitive dysfunction was determined as the percent of the BCS sample scoring at or below the 16th, 7th, and 2nd percentile of non-cancer controls (NCC). NCC data was derived from the Indiana Alzheimer Disease Center Clinical Core Study, which includes cognitive data from healthy older adults with no known neurological disease recruited from the community via self-referral or clinicians caring for family member with Alzheimer's disease. NCCs were group matched to the BCS sample based on age (+/− 5 years) and female sex. We identified the raw score equivalent of 3 cut-points within the NCC sample on each test to characterize performance/dysfunction as follows: 1.0 SD (<16th percentile) below the mean or 'mild dysfunction', 1.5 SD (< 7th percentile) below the mean or 'mild-moderate dysfunction', and 2.0 SDs (<2nd percentile) below the mean or 'moderate dysfunction' (36). Predetermined cut-points from the literature were used to provide count and percent of BCS with subjective cognitive dysfunction (35).

Linear regression models were used to examine the relationship between the **independent variables** (1. age at neuropsychological assessment, 2. number of years of education, 3. number of comorbidities, 4. time since diagnosis 5. breast cancer stage, 6. depressive symptoms, 7. anxiety, 8. fatigue, and 9. sleep disturbance) and **dependent variables** (objective and subjective cognitive function - 1. learning, 2. delayed recall, 3. attention, 4. executive function-working memory, 5. verbal fluency, and 6. subjective attentional function) in older BCS. Level of significance was set at 0.05. SPSS statistical software, version 26, was used for all data analysis.

Results

Participants included 335 older BCS who ranged in age from 60 to 70 years old and were on average 63.9 (SD 3.0) years old at the time of their breast cancer diagnosis. Table 1 reflects characteristics of the older BCS. BCS in this study were on average 6.0 (SD 1.5) years post-diagnosis. At initial diagnosis, most of the older BCS had stage II breast cancer (n=227; 67.8%). The majority of the BCS were white (n=313; 93.4%), married (n=218; 65.1%), educated with at least some college (n=173; 51.6%), and had an income of less than $50,001 per year (n=194; 57.9%). All older BCS in this study received chemotherapy as part of their initial treatment and the majority had a mastectomy (n=178; 53.1%) and radiation therapy (n=203; 60.6%) as part of their breast cancer treatment regimen. Table 1

presents descriptive information including the means and standard deviation (SD) for the cancer-related symptoms (depressive symptoms, anxiety, fatigue, and sleep disturbance). In this sample, depressive symptoms (CES-D) scores were on average 8.7 (SD 7.8); however, 16.8% (n=56) had depressive symptom scores ≥ 16 or over, indicating individuals at risk for clinical depression (22, 23).

Older BCS demonstrated cognitive dysfunction with levels ranging from mild (1 SD below NCC), mild to moderate (1.5 SD), and moderate (2 SDs) for each neuropsychological assessment (36). Table 2 depicts mean, standard deviation (SD), potential and actual score range, and the percentage of older BCS within each level of objective cognitive dysfunction. For learning (AVLT), older BCS demonstrated mild (27.8%; n=93) mild-moderate (12.8%; n=43) and moderate (5.7%; n=19) cognitive dysfunction. For delayed recall (AVLT), older BCS demonstrated mild (19.1%; n=64), mild-moderate (11.0%; n=37), and moderate (3.3%; n=11) cognitive dysfunction. For attention (Digit Span-Forward), older BCS demonstrated mild (4.2%; n=14) cognitive dysfunction, no older BCS in this sample scored 1.5 SD or 2 SDs below NCC. For executive function-working memory (Digit Span-Backward), older BCS demonstrated mild (9.9%; n=33), mild-moderate (2.1%; n=7), and moderate (1.2%; n=4) cognitive dysfunction. For verbal fluency (COWA), older BCS demonstrated mild (40.3%; n=135), mild-moderate (18.5%; n=62), and moderate (7.5%; n=25) cognitive dysfunction (36).

In Table 2, the mean, standard deviation (SD), potential and actual score range, and the percentage of older BCS within each level of subjective attentional function can be found. On average older BCS scores on the AFI were 91.5 (SD 21.7) out of a potential 130, where higher scores indicate better attentional function. Based on predetermined cut-points in the literature, 3.0% (n=10) reported poor (scores <50) and 23.0% (n= 77) moderate (scores 50-75) attentional function and the majority 70.7% (n= 237) reported effective (scores >75) attentional function (35).

Table 3 displays the results of the separate regression analysis. The models for learning [$F(9,300)=2.59$, adjusted $r^2=.04$, $p<.01$], delayed recall [$F(9,300)=1.98$, adjusted $r^2=.03$, $p<.05$], verbal fluency [$F(9,300)=4.11$, adjusted $r^2=.08$, $p<.001$], and subjective attentional function [$F(9,291)=26.54$, adjusted $r^2=.43$, $p<.001$] were statistically significant. Models with objective attention and executive function-working memory were not significant. **Learning:** Age ($\beta=-0.14$, $p<.05$) and depressive symptoms ($\beta=-0.24$, $p<.01$) were significantly related to learning, the model explained 4% of the variance. These results indicated that older age and more depressive symptoms were negatively related to learning. **Delayed recall:** Depressive symptoms ($\beta=-0.23$, $p<.01$) were significantly related to delayed recall, the model accounted for 3% of the variance. These results indicated that more depressive symptoms were negatively related to delayed recall. **Verbal Fluency:** Education ($\beta=0.23$, $p<.01$) and depressive symptoms ($\beta=-0.24$, $p<.01$) were significantly related to verbal fluency, explaining 8% of the variance. These results indicated that more education was positively related to verbal fluency and more depressive symptoms were negatively related to verbal fluency. **Subjective Attentional Function:** The model explained 43% of the variance of subjective attentional function, with education ($\beta=0.10$, $p<.05$),

depressive symptoms (β=−0.24, p<.01), anxiety (β=−0.15, p<.05), and fatigue (β=0.39, p<.01) related to subjective attentional function.

Discussion

Older BCS are a growing population with unique needs. Many older BCS experience cognitive dysfunction, which has been previously understudied. This study helps to elucidate some of the complexity of cognitive dysfunction in older BCS by examining the prevalence of objective and subjective cognitive dysfunction and associated factors.

Older BCS in this study were noted to have cognitive dysfunction. Up to 18.6% of the older BCS demonstrated mild-moderate dysfunction (1.5 SD below the mean of NCCs) on at least one out of five neuropsychological assessments or cognitive domains. Learning and verbal fluency appeared to be the cognitive domains most affected, which is similar to what was seen in prior studies on all age BCS and the limited research in older BCS (19, 37). This finding is consistent and extends the findings of other studies completed among older BCS compared to an older non-breast cancer (or NCC) population (3, 15, 16). For example, Mandelblatt and colleagues (2018) examined cognitive function in 344 nonmetastatic older BCS (≥60 years of age) compared to 347 NCC pre-systemic treatment/control enrollment and at 12- and 24-months post-treatment (3). These researchers found that cancer treatment was related to longitudinal cognition scores, with older BCS who received chemotherapy having increasingly worse attention, processing speed, and executive function and those who received hormonal therapy had worse scores on learning and memory than the NCC. Taken together, these findings suggest that older BCS are at risk for cognitive dysfunction across the entire cancer survivorship trajectory.

Subjective reports also indicated that over a quarter (26%, n=87) of the older BCS reported moderate to poor subjective attentional function. The percentage of older BCS reporting cognitive concerns were somewhat higher than those demonstrating impairment on neuropsychological exam. This finding is consistent with previous reviews and individual studies of the larger BCS literature in which subjective cognitive concerns are more prevalent than objective cognitive dysfunction (38–40). Some researchers hypothesize that the subjective reports may also be confounded with other correlated symptoms (psychological distress, fatigue, and health status) (38). Although, it is widely acknowledged that self-reported cognitive concerns can be an initial indicator of cognitive dysfunction (11). Overall, these findings indicate that there is a sub-set of older BCS who incur substantial cognitive dysfunction after diagnosis and treatment. Thus, conducting a thorough assessment and identifying those older BCS at most risk is crucial to ensuring independence and improving quality care.

Although the overall models for objective cognitive measures were not very explanatory (adjusted $r^{2=}$.03-.08) and more work is needed, some important relationships were noted. Most notably, depressive symptoms (measured by the CES-D) were significantly related to both objective (learning, delayed recall, and verbal fluency) and subjective cognitive dysfunction (attentional function) in this study. This finding is important because unlike

previous BCS studies, depressive symptoms and objective cognitive dysfunction have not always been correlated (3, 15, 16, 41–43).

Depressive symptoms and cognitive dysfunction may significantly affect older BCS, leading to potential disability (44). Cognitive dysfunction can impede proper diagnosis and treatment or lead to underreporting of depressive symptoms in older adults (45). In this sample, 16.8% (n=56) had depressive symptom scores ≥16, indicating clinically significant depressive symptoms (22, 23, 45). Depressive symptoms have also been associated with cognitive dysfunction in the larger aging literature (45). In fact, researchers have shown that depressive symptoms in older adults are related to female sex, cognitive dysfunction, and stressful life events (45). Together these findings would indicate that older female BCS may be a greater risk of both depressive symptoms and cognitive dysfunction (45). This finding highlights the importance of a comprehensive geriatric assessment in older BCS that includes the assessment of both depressive symptoms and cognitive dysfunction, which is in line with recommendations from multiple oncology experts and organizations (1, 46). Geriatric assessment is often used prior to or during treatment to help identify vulnerabilities among older cancer patients (46); however, this study completed 3-8 years beyond initial diagnosis and treatment for breast cancer underscores the importance of continued geriatric assessment across the cancer survivorship trajectory. Proper management of depression may also improve cognitive dysfunction. Management of depressive symptoms, which is part of the National Comprehensive Cancer Networks guidelines for addressing cognitive dysfunction, is important first step in clinical practice (10, 11, 45). Overall, depressive symptoms are important, potentially modifiable and amenable to treatment, and thus, should not be overlooked in addressing the needs of older BCS.

Other common cancer-related symptoms are also important factors associated with cognitive dysfunction. In this study, anxiety and fatigue were related to subjective cognitive dysfunction; but in contrast to previous studies sleep disturbance was not significantly correlated (17, 47). Although somewhat inconsistent in the literature, other cancer-related symptoms such as anxiety, fatigue, and sleep disturbance have been shown to be significantly correlated with perceived cognitive dysfunction either as independent symptoms or as a cluster of symptoms (identified as the psychoneurological symptom cluster) and these relationships have been noted in all age BCS (43, 48) as well as older BCS (13, 14, 16, 47, 49). For example, Cimprich and colleagues (2005) found that the lower scores on the AFI (poorer subjective cognitive function) were related to increased symptom distress (including fatigue and sleep disturbance/insomnia) and mood state (including anxiety and depression) in a group of BCS age 55-70 (50). Fatigue, one of the most common symptoms in BCS, has also been found to correlate with subjective cognitive dysfunction (14, 16). Similarly, anxiety and depression have also been shown to be correlated with cognitive dysfunction in BCS (13, 14, 16, 51). In fact, Mandelblatt and colleagues (2016), using a broader definition/measurement of subjective cognitive function, found anxiety and depression were associated with subjective cognitive decline among older BCS specifically (13). In addition, as mentioned previously, these cancer-related symptoms have been shown to be correlated and form a symptom cluster. Tometich and colleagues (2019) examined the psychoneurological symptom cluster (depression, anxiety, fatigue, sleep disturbance and pain) and its relationship with cognitive functioning before systemic treatment and twelve

months and 24 months post-treatment in 319 older BCS. These researchers noted that older BCS with higher levels of psychoneurological symptoms had significantly greater objective and subjective cognitive dysfunction than those with lower levels of psychoneurological symptoms at baseline and 24 months later (47). Overall, our work here and the work of others support the potential for the importance of the psychoneurological phenotype and the need for future research in this area to address predictors, mechanisms, and management to improve cognitive dysfunction.

Limitations

Study findings should be noted within the context of some limitations. The use of existing cross-sectional data prohibited both employing other measures that may be related to cognitive dysfunction as well as limited interpretation of the data to association versus causal inferences. The use of endocrine therapies (including tamoxifen and/or aromatase inhibitors) was not included in this analysis due to the amount of missing data. The inclusion of endocrine therapy variables would have been useful to better understanding cognitive dysfunction in this group of older BCS. Only one aspect of subjective cognitive function was examined in this study, subjective attentional function measured by the AFI. Although this is a widely used reliable and valid instrument, additional measures including the Patient Reported Outcomes Measurement Information System (PROMIS) Cognitive Function measures may be useful to more comprehensively characterize and standardize the assessment of subjective cognitive dysfunction for comparison among BCS (younger vs. older) or other patient populations (52–54). In addition, similar to previous studies, the majority of the participants in this study were non-Hispanic white and well-educated, which limits generalizability to the larger BCS population. However, this study does provide a foundation to build from and to better understand the complex issue of cognitive dysfunction in older BCS.

Conclusion

This study identifies cognitive dysfunction as a significant concern for older BCS three to eight years post breast cancer diagnosis. Older BCS with more depressive symptoms, anxiety, and fatigue were most likely to have cognitive dysfunction. Healthcare providers should be aware of and assess for cognitive dysfunction in older BCS even years after diagnosis and treatment as it is clear cognitive dysfunction can still be a concern years after treatment as evident by the findings of this study.

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Table 1.

Sample Characteristics and Cancer-Related Symptoms (n=335)

Variable	Mean	SD
Age at breast cancer diagnosis, years	63.9	3.0
Time since diagnosis, years	6.0	1.5
Time duration initially treated for breast cancer, months	8.0	4.1
Depressive Symptoms (CES-D)	8.7	7.8
Anxiety (STAI-State)	30.6	9.6
Fatigue (FACT-F)	41.4	9.3
Sleep Disturbance (PSQI)	1.3	0.5
	n	**%**
Cancer stage at diagnosis		
Stage I	67	20.0%
Stage II	227	67.8%
Stage III	33	9.9%
Missing/No response	8	2.4%
Race		
White	313	93.4%
Non-white, Black, Asian, Multi-racial	22	6.6%
Marital Status		
Married/Partnered	218	65.1%
Single/divorced/widow	110	32.8%
Missing/No response	7	2.1%
Highest level of education		
Post-graduate	65	19.4%
College graduate (4-year Bachelor degree)	25	7.5%
Some college	83	24.8%
Technical or trade school	33	9.9%
High school graduate or GED	106	31.6%
< High school	14	4.2%
Missing/No response	9	2.7%
Income		
≤ $30,000	102	30.4%
$30,001 - $50,000	92	27.5%
$50,001 - $100,000	96	28.7%
>$100,001	27	8.1%

Variable	Mean	SD
Unsure/No response	18	5.4%
Surgery Type		
Lumpectomy	157	46.9%
Mastectomy	178	53.1%
Radiation Therapy		
Yes	203	60.6%
No	121	36.1%

SD=standard deviation; CES-D = Center for Epidemiological Studies Depression Scale; STAI = State-Trait Anxiety Inventory – State subscale; FACT-F = Functional Assessment of Cancer Therapy Fatigue; PSQI = Pittsburgh Sleep Quality Index

Table 2.

Objective and Subjective Cognitive Measures and Function (N=335)

Variable (Objective Measure)	Mean	SD	Potential Range	Actual Range	Dysfunction					
					Mild 16th percentile 1 SD<NCC		Mild-Moderate 7th percentile 1.5 SD<NCC		Moderate 2nd Percentile 2 SD<NCC	
					n	%	n	%	n	%
Learning (Sum recall from the Rey AVLT)	45.8	9.0	0-75	17-70	93	27.8%	43	12.8%	19	5.7%
Delayed Recall (Delayed recall of the Rey AVLT)	9.1	2.9	0-15	1-15	64	19.1%	37	11.0%	11	3.3%
Attention (Digit Span-Forward)	10.1	2.6	0-16	5-16	14	4.2%	0	0.0%	0	0.0%
Executive function-working memory (Digit Span-Backwards)	7.5	2.6	0-14	1-14	33	9.9%	7	2.1%	4	1.2%
Verbal fluency (COWA)	34.7	11.5	N/A	10-76	135	40.3%	62	18.5%	25	7.5%
Variable (Subjective Measure)	**Mean**	**SD**	**Potential Range**	**Actual Range**	**Function**					
					Effective (scores >75)		**Moderate (scores 50-75)**		**Poor (scores <50)**	
					n	**%**	**n**	**%**	**n**	**%**
Subjective Attention (AFI)	91.5	21.7	0-130	34-130	237	70.7%	77	23.0%	10	3.0%

SD=standard deviation; AVLT=Rey Auditory Verbal Learning Test; COWA=Controlled Oral Word Association; SD=standard deviation; NCC=non-cancer control, AFI=Attention Function Index

Table 3.

Relation of Demographic Factors, Medical Factors, Treatment Factors, and Cancer-Related Symptoms to Objective and Subjective Cognitive Function in Older Breast Cancer Survivors

	Age	Education	Comorbidities (number)	Time Since Diagnosis	Breast Cancer Stage	Depressive Symptoms	Anxiety	Fatigue	Sleep Disturbance	F	R^2	Adjusted r^2
	standardized β coefficient											
Learning	**−.14** *	.09	−.02	.02	.03	**−.24** **	.04	−.02	.03	**2.59** **	.07	.04
Delayed Recall	−.08	.08	−.04	.01	.04	**−.23** **	.09	−.01	.09	**1.98** **	.06	.03
Attention	−.03	.03	.01	.01	.01	−.08	.01	.07	.01	0.58	.02	−.01
Executive function working memory	−.02	.05	.02	.03	−.01	−.04	−.03	.11	.07	0.74	.02	−.01
Verbal Fluency	−.01	**.23** **	−.04	−.10	.04	**−.24** **	.07	−.01	.05	**4.11** **	.11	.08
Subjective Attention	−.01	**.10** *	−.06	.03	.06	**−.24** **	**−.15** *	**.39** **	.07	**26.54** **	.45	.43

* p<.05;

** p<.01