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Short Physical Performance Battery, Usual Gait Speed, Grip Strength and Vulnerable Elders Survey Each Predict Functional Decline among Older Women with Breast Cancer

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Abstract

Objective—To determine the ability of three performance-based measures [Short Physical Performance Battery (SPPB), gait speed, and Grip Strength] and a self-report measure [Vulnerable Elders Survey (VES-13)] to predict functional decline among older women with breast cancer.

Patients and Methods—Longitudinal data from a study of women ≥ 65 years, with newly diagnosed stage I–III breast cancer, recruited from ambulatory oncology clinics between July 2010 and April 2014, was used. The primary outcome was functional decline, *Yes or No*, defined as a decrease in ≥ 1-point from baseline to 12 months, on Activities of Daily Living Scales. Multivariable logistic regression and Receiver Operator Curve analyses were conducted

Results—Among 123 participants 18 (15%) developed functional decline. The predictive abilities for measures were: SPPB [Adjusted odds ratio (AOR) = 1.65 per unit decrease in scores, 95% confidence interval (CI) = 1.33–2.05; area under the receiver operator curve (AUC) = 0.93; sensitivity=94%, specificity=80%]; gait speed (AOR = 1.76 per unit increase in usual walking time, CI=1.29–2.41; AUC=0.93; sensitivity=87%, specificity=79%); VES-13 (AOR = 1.64 per unit increase in scores, CI=1.31–2.05; AUC=0.87; sensitivity=83%, specificity=84%); and grip

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Disclosures and Conflict of Interest Statements

The authors have no conflicts of interest to disclose.

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strength: (AOR = 1.18 per unit decrease in grip strength, CI=1.06–1.30; AUC=0.80; sensitivity=67%, specificity=77%).

Conclusion—SPPB, gait speed, grip strength and VES-13 all demonstrated excellent predictive abilities for functional decline. Larger studies are warranted to confirm the utility of these measures for identifying older adults with cancer at increased risk for functional decline, who may then be targeted for studies to explore the effects of interventions to improve function.

Keywords

Functional Decline physical performance gait speed; Older Women Breast Cancer

INTRODUCTION

Functional decline, defined as increasing difficulty to independently complete Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs), is a significant and profound marker of morbidity and mortality.^{1, 2} Existing literature has shown that mortality progressively increases with increasing limitations in ADLs and IADLs, increasing from 15% for those with one limitation in IADLs, to 21% for those with two limitations in ADLs and to 37% for those with five or six limitations in ADLs.³ For this and many other reasons, the Centers for Medicare and Medicaid Services has declared mobility maintenance and functional independence among at risk older adults a priority for aging research.⁴

Cancer and related-treatment augment the disablement process, and accelerate the trajectory towards functional decline. Indeed, as many as forty percent of older women with breast cancer have functional disability at initial breast cancer diagnosis⁵ and about twenty percent develop functional decline within a year of initiating breast cancer treatment.

Given the likely adverse impact of functional decline on the overall health status of older cancer survivors¹, it is imperative to develop strategies and interventions to prevent and attenuate functional decline among cancer survivors. The first and critical step to developing any preventive strategies, is the early identification of those at increased risk for developing functional decline.

Although several self-report and performance-based measures for predicting functional decline have been developed and validated among older adults in general, a limited number have been tested among older adults with cancer. In particular, existing data on the ability of performance-based measures to predict functional decline among older adults with cancer is scant. Therefore, using data from a longitudinal study of older women with newly diagnosed breast cancer we sought to examine and compare the ability of three performance-based and one self-report measure to predict functional decline among older women with breast cancer. This information is clinically relevant for cancer treatment-decision making and for informing interventions aimed at preventing functional decline among older breast cancer survivors.

PATIENTS and METHODS

Study Design and Patient Population

A more detailed description of the study design and methods have been published already⁶ but in brief we used longitudinal data from a prospective cohort study of women with newly diagnosed stage I–III breast cancer who were 65 years of age and older. Patients were excluded from study participation if they had already received chemotherapy, hormonal or targeted therapy or breast irradiation for the current diagnosis of breast cancer prior to enrollment. Receipt of breast surgery before enrollment was allowed. Patient recruitment from ambulatory oncology clinics at an academic center begun in 2008. In September 2010, performance-based measures were included in study assessments. Therefore, for the current analyses we only included participants enrolled from September 2010 onward who had repeated measures of ADL and IADL at 12 months. The study was approved by the Institutional Review Board.

Study Procedures and Data Collection

Using weekly multi-disciplinary breast cancer conference list, potentially eligible patients were identified and approached for informed consent by a trained research assistant during patients' initial visit with a medical or radiation oncologist. A Comprehensive Geriatric Assessment (CGA) which included a functional assessment was completed by consenting patients at baseline and 12 months from study enrollment.

Functional Assessment Measures

Short Physical Performance Battery—The Short Physical Performance Battery (SPPB), which consists of three lower extremity physical performance measures had participants complete standing balance, five consecutive chair rises, and a 4-meter gait walk at usual pace. A 4-point scale was used for each task, and summary scores ranged from 0–12 with higher scores denoting higher physical performance. Best performance SPPB scores range from 10–12 and scores ≤ 9 have been found to be associated with increased mortality.^{7, 8}

Usual Gait Speed

We measured usual gait speed (as part of the SPPB) in a flat and unobstructed clinic hallway. The measuring area was demarcated by two strips of brightly colored tape placed 4 meters apart. Each participant performed the gait speed protocol twice with a 20–30 second break between trials. Each walk was performed with a one-meter rolling start, where the participant was already walking upon entering the measuring area. Canes and walkers were allowed if participants regularly used these assistive devices in their daily activities. Participants were instructed to “walk at a comfortable and normal pace” from one tape to the other. The time to walk 4 meters was measured with a manual stopwatch. A research assistant stood in the middle of the 4-meter course and started the stopwatch when the participant's first foot completely crossed into the timing area and stopped the stopwatch once the participant's first foot completely came out of the timing area. Pathological gait speed or slow gait speed is defined as walking $<0.8\text{m/sec}$.⁹

The Vulnerable Elders Survey

The VES-13 is a self-report measure which took participants approximately 4 minutes to complete. The survey asked participants to report their age by three categories (65–74, 75–84, 85 years); self-rated health (excellent, very good, good, fair, poor); functional limitations (1. stooping, crouching or kneeling; 2. lifting or carrying heavy objects; 3. writing or grasping small objects; 4. walking a quarter of a mile; 5. doing heavy housework); and functional disabilities (1. shopping for personal items; 2. managing money; 3. walking across a room; 4. doing light housework; 5. bathing or showering).^{10–12} The maximum score is 10 with increasing scores denoting increasing risk of functional decline. Scores of 3 denote increased vulnerability and has been found to be associated with an increased risk of functional decline.^{10, 11}

Grip Strength

Grip strength was measured with a Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, Illinois). While sitting and holding the dynamometer in their dominant hand, with the arm extended and the palm of their hand facing their leg, participants was instructed to squeeze the grip as hard as possible. The strongest of 3 attempts (in kilograms) was recorded, with higher values reflecting better performance.¹³ This was repeated for the other hand and the average of the highest measurement from the two hands was the final measurement. Normative data have been derived for community dwelling older adults and range from a mean of 25.3 kg (s.d =4.8) for women aged 60–69 years to 20.0kg (s.d. = 4.3) for those aged 80 years in the right hand with slightly lower strength in the left hand.¹⁴

Functional Status

The Katz Activities of Daily Living (ADLs), and the Lawton Instrumental Activities of Daily Living (IADLs) were used to evaluate self-reported functional status. ADLs are skills necessary to live independently at home such as bathing, transferring, and dressing¹⁵ and IADLs are skills required for living independently in the community such as using the telephone, managing medications, housekeeping, transportation, ability to manage finances, and preparing meals.¹⁶ The maximum score for ADLs and IADLs is 6 and 8 respectively, with increasing scores denoting better functional status.

Other Variables

Socio-demographic variables were captured at baseline using a self-administered questionnaire. Data on median household income was obtained from United States Census Bureau website¹⁷ using participants' zip codes from their place of residence at the time of enrollment. Height was measured to the nearest 0.1 cm and weight measured to the nearest 0.01kg to compute Body Mass Index (BMI). Medical records were abstracted to obtain data on tumor characteristics and cancer treatments received, medications and comorbidities. Using the list of comorbidities we derived the *Charlson Comorbidity Index* (CCI)¹⁸ score, based on the presence of eighteen medical conditions.

Analytic Variables

Primary outcome variable—The primary outcome was functional decline within 12 months of study enrollment. Functional decline was defined as a decrease in at least one point on the ADL and/or IADL scales from baseline to 12 months, *Yes or No*.^{19, 20}

Independent variables—The independent variables were the SPPB scores, usual gait speed, grip strength and VES-13 scores at baseline all analyzed as continuous variables.

Explanatory variables—Explanatory variables included the following baseline variables: age at enrollment (65–74, 75 years); race (AA, NHW); marital status (married, other); educational status (< high school, > high school); median household income (<\$35,000, \$35,000); living situation (alone, other); body mass index [BMI] (<25kg/m², 25kg/m²); physical activity level (<500-METs/minute/week, 500-METs/minute/week); stage (I–II, III); hormone receptor status (positive, negative); receipt of surgery (*Yes or No*); receipt of surgery before or after enrollment (*Yes or No*); receipt of axillary lymph node assessment (*Yes or No*); receipt of chemotherapy (*Yes or No*); receipt of hormone therapy (*Yes or No*); receipt of radiation therapy (*Yes or No*); geriatric syndromes [presence of dementia, depression, polypharmacy and/or malnutrition (0–1, 2)]; functional disability (*Yes or No*); and comorbidity [CCI score (0–1, 2)].

Data Analysis

We examined participants' baseline characteristics using descriptive analysis. Bivariate analysis was used to examine independent variables by primary outcome. We used univariate logistic regression with functional decline (Yes vs. No) as our outcome variable to identify explanatory variables that had a univariate associations with functional decline ($p < 0.10$), see Table 2.

We developed our multivariable model for each measure by using a stepwise multiple logistic regression approach that included functional decline as the outcome variable, scores of measure as the independent variable and explanatory variables that were associated with functional decline at p -value ≤ 0.10 . We did not include baseline functional status in our models because scores of the four measures were collinear with ADL/IADL scores. We also did not include receipt of surgery (Yes or No) in models because only 5 patients did not undergo surgery. Using this approach a final model was derived for each measure that adjusted for explanatory variables that remained significantly associated with functional decline at $p < 0.05$.

Using this strategy, comorbidity was the only explanatory variable that was found to be independently associated with functional decline in the models for SPPB, grip strength and VES-13 and therefore comorbidity was retained in final models for these measures. Lymph node assessment was independently associated with functional decline in the model for gait speed and therefore retained in the final model for gait speed.

We also conducted sensitivity analysis that adjusted for all variables found to be predictive of functional decline at the univariate level. In these full models, all four measures remained predictive of functional decline, see appendix B for full multivariable model for SPPB.

To compare the discriminatory power of the SPPB, gait speed, grip strength and VES-13 for identifying functional decline at 12 months, logistic regression Receiver Operating Characteristic curves (ROC) were calculated for functional decline, using estimated area under the ROC curve (AUC) with 95% confidence interval as an index of predictive accuracy. Adjustment covariates were the same as those used in multivariable regression models. ROC curve areas of different models were compared using the method of Delong and Delong.²¹ To reduce the Type 1 error rate associated with pair-wise comparisons p-value <0.01 were considered significant. AUCs were categorized into > 0.9, 0.8 to 0.9, 0.7 to <0.8 and <0.7 to represent outstanding, excellent, acceptable or poor instrument discriminating ability.²² Optimal cut-off scores for the instruments were determined as the cut-offs maximizing the Youden index $J = \text{SEc} + \text{SPc} - 1$, where SEc and SPc are sensitivity and specificity, respectively at a chosen cut-point when using only the performance measure alone as a classifier. All analyses were conducted using SAS version 9.4 (SAS institute, Cary, NC).

RESULTS

Details of patient flow into the parent study have already been described in a previous publication.⁶ In brief, we screened 614 patients, of whom 206 were enrolled into the parent study. Of these 206 participants, 63 were enrolled before September 2010 and did not complete performance-based measure, leaving 145 participant who completed performance based assessments and were potentially eligible for the current analysis. However, 22 patients (15%) did not complete follow-up assessments at 12 months, (withdrew N=7 and lost to follow-up N=15), and were excluded from these analyses, resulting in 123 evaluable patients. There were no statistically significant differences in baseline characteristics between participants who were excluded versus those who were not, see appendix A.

Participants' Baseline Characteristics

Participants' baseline characteristics are displayed in Table 1. The median duration from diagnosis to baseline assessment was 2.0 months, (interquartile range 1.3–2.8 months). The median duration of follow-up was 12.1 months, (interquartile range 11.8–12.6 months). The mean age of the cohort was 74.5 years, (range 65–93 years), 29% were AA, 39% had high school education and 35% had functional disability at baseline. The cohort had a mean SPPB score of 8.6, SD 3.3; mean usual gait speed of 5.1 seconds, SD 2.4; mean grip strength of 19.9 kg, SD 6.2; and mean VES-13 score of 1.8, SD 2.4 at baseline.

Measures According to Functional Decline

Of 123 evaluable participants, fifteen percent (18) developed functional decline. With regards to the trajectory of functional status 15%, 72% and 14% of participants declined, remained stable or improved in functional status, respectively, from baseline to 12 months. The mean baseline scores for the four measures for participants who developed versus those who did not develop functional decline were as follows; SPPB scores 4.1 (SD 2.6) vs. 9.3 (SD 2.8), $p < 0.0001$; gait speed 8.5 seconds (SD 3.7) vs. 4.6 seconds (SD 1.7), $p < 0.0001$; grip strength 15.4 kg (SD 8.3) vs. 20.7 kg (SD 5.4), $p = 0.0025$; and VES-13 scores 4.7 (SD 2.5) vs. 1.3 (SD 2.0), $p < 0.0001$, respectively.

Additionally, in comparison with participants who did not develop functional decline, participants who developed functional decline were more likely at baseline to be 75 years or older (21% vs. 9%, $p=0.05$); to be AA (25% vs. 10%, $p=0.04$); to have high school level or less education (24% vs. 9%, $p=0.02$); to have a median household income of $<\$35,000$ (33% vs. 10%, $p=0.008$); to have functional disability at baseline (26% vs. 9%, $p=0.01$), to have a comorbidity index ≥ 2 (36% vs. 9%, $p=0.0025$); to have ≥ 2 geriatric syndromes (30% vs. 11%, $p=0.01$); to be less physically active (25% vs. 3%, $p=0.0007$); to have undergone surgery after enrollment (27% vs. 10%, $p=0.02$); not to have completed axillary lymph node assessment (44% vs. 9%, $p<0.0001$); and not to have completed radiation therapy (22% vs. 7%, $p=0.02$). These results were consistent with univariate analysis which identified 12 potential predictors of functional decline, see Table 2

Discriminatory Abilities of the SPPB, Usual Gait Speed, Grip Strength and the VES-13

SPPB was predictive of functional decline, $AUC=0.93$ (95% CI: 0.89–0.98). With each one-unit decrease in SPPB scores, the odds of developing functional decline increased by 65% ($AOR=1.65$, 95% CI: 1.33–2.05), sensitivity=94.4%, specificity=80%, at cut-off ≥ 7 , (see Table 3 and Figure 1). Usual gait speed showed similar discriminatory powers, $AUC=0.93$ (95% CI: 0.88–0.99), sensitivity=86.7%, specificity=78.6%, at cut-off ≤ 4.98 seconds. With each one-second increase in usual walking time, the odds of developing functional decline increased by 76% ($AOR=1.76$, 95% CI: 1.29–2.41). Results for grip strength were as follows; $AUC=0.80$ (95% CI: 0.56–0.88), sensitivity of 66.7% and specificity of 76.9%, at cut-off ≤ 17.5 kg. With each one kg decrease in grip strength, the odds of developing functional decline increased by 18% ($AOR=1.18$, 95% CI: 1.06–1.30). Lastly VES-13 scores predicted functional decline; $AUC=0.87$ (95% CI: 0.76–0.96), sensitivity=83.3%, specificity=83.8%, at cut-off ≥ 3 . With each one-unit increase in VES-13 scores, the odds of developing functional decline increased by 64% ($AOR=1.64$, 95% CI: 1.31–2.05).

Pair-wise comparisons between SPPB vs. gait speed, SPPB vs. VES-13 and SPPB vs. grip strength showed no statistical significant difference between ROC curves, [difference=−0.009, p -value=0.72, (95% CI: −0.06 to 0.04); difference=−0.07, p -value=0.18, (95% CI: −0.17 to 0.03), and [difference=−0.21, p -value=0.03, (95% CI: −0.39 to −0.04)], respectively.

DISCUSSION

This study, conducted among older women with stage I–III newly diagnosed breast cancer, revealed a high prevalence of functional disability at diagnosis (35%) and subsequent development of functional decline (15%) within 12 months of treatment initiation for breast cancer. The SPPB, usual gait speed, grip strength and VES-13 were all useful instruments for predicting functional decline.

Among older adults in general, performance-based measures such as the SPPB has been found to be a robust and consistent predictor of functional decline, hospitalization, nursing home placement, and death.^{7, 23} The SPPB has been found to be easy to administer in both epidemiological⁷ and clinical settings²⁴, has excellent test–retest reliability and has demonstrated sensitivity to change²⁵ making it an ideal measure for use in intervention

studies. Gait speed has also been demonstrated among older adults in general to be a well-established, inexpensive and reliable measure of physical performance²⁶, with high inter-rater and test-retest reliability²⁴. Gait speed has well-documented predictive value for major health-related outcomes such as functional decline, hospitalizations, nursing home placements, mortality, poor quality of life and falls^{27, 28}, making it a useful screening measure to identify older persons at risk of such events²⁶. Grip strength, another performance-based measure with excellent reliability (ICC=.92)²⁹ is associated with functional disability.³⁰ The VES-13, the only self-reported measure evaluated in this study, also has a well-established track record as a robust and consistent measure for predicting functional decline and death, irrespective of patient population including older patients with cancer.^{6, 31}

Among older adults with cancer on the other hand, far fewer studies have evaluated the utility of physical performance measures for predicting functional decline, likely due to a concern that such measures may not be easy to administer in busy oncology practices. In a population-based study of 429 older adults with cancer, gait speed was found to be associated with functional decline and death among patients with non-metastatic breast cancer.³² There were no associations between grip strength and functional decline or death.³² In another secondary analysis of a population based study conducted among 413 cancer survivors with a median follow-up of 11.0 years each 1-unit increase in SPPB score and 0.1 m s(-1) increase in fast walk speed predicted a 12% reduction in mortality.³³ While these findings suggest that physical performance measures are useful for predicting and quantifying the health status of older cancer survivors, it will be very helpful and even more imperative for such assessments to be tested more proximal to diagnosis where early intervention is more likely to be impactful.

Moreover, and to the best of our knowledge no studies have compared performance-based to self-report measures among patients with cancer to identify the best predictive measures for functional decline³⁴ although one study has compared the utility of different self-report and physical performance measures to predict mortality, the most extreme manifestation of functional decline. Among 200 women 65 years of age and older with gynecological cancers, Cesari M, et al,³⁵ compared six measures which included the VES-13, usual gait speed, SPPB, grip strength, ECOG Performance Status Scale, Karnofsky Performance Status Scale, ADL and IADL on their abilities to predict one-year mortality. The SPPB, usual gait speed and IADL were the only predictive measures.³⁵ Our study results are somewhat consistent with these findings by demonstrating the SPPB and usual gait speed as the most robust predictors of functional decline. Our study therefore informs a gap in evaluating the functional health of older the adults with cancer given that very few to no studies have examined and compared the utility of self-report and performance-based measures to identify the best measures for identifying older patients with cancer at increased risk for functional decline.

Early identification of persons at increased risk for functional decline among older adults with cancer is critically important and clinically relevant. Our previous work demonstrated that among older women with stage I–III newly diagnosed breast cancer one in five developed functional decline and/or death within 12 months of initiating treatment for breast

cancer and that women of lower socioeconomic status were the most at risk.⁶ Hoppe, et al,³⁶ in their study of patients 70 years of age and older receiving first line chemotherapy, demonstrated that 17% of patients developed functional decline after just one cycle of chemotherapy. These two studies speak to the high likelihood of functional decline developing soon after a new diagnosis of cancer and initiation of treatment. Because functional status is a key component for consideration in cancer treatment decision-making and predicts treatment tolerance³⁷, and because of the adverse impact of functional decline on the overall health status of older cancer survivors including nursing home placement and increased mortality², it is imperative to identify those at increased risk for functional decline and implement early intervention to attenuate the disablement process. Feasible and robust measures such as the SPPB, usual gait speed, grip strength and VES-13 offer different options for early identification of those at increased risk of functional decline, particularly older AA and lower SES breast cancer survivors who are disproportionately affected by poor functional outcomes^{5, 6}.

Our study has some caveats. The sample size is small and the study population was recruited from a single academic institution raising a concern that results may not be generalizable. Patients grip strength may have been affected by the laterality of breast cancer surgery and/or lymph node assessment. We did not collect data on the dominant hand or on the laterality of breast surgery and therefore the grip strength model was not adjusted for these variable. This could have led to an underestimation of relation between grip strength and functional decline. On the other hand, study strengths include prospective data collection by staff trained to administer these functional measures and the availability data on four measures in one population.

In conclusion, this study examined the ability of three performance-based measures and one self-report measure to predict functional decline. All measures demonstrated excellent predictive abilities for predicting functional decline with the SPPB and gait speed showing the strongest predictive abilities. Larger studies are warranted to confirm these results. Oncologists should consider using performance-based measures such as the SPPB and usual gait speed for assessing for the risk of functional decline as these measures can be administered in busy ambulatory oncology settings and may enable oncologists better identify older patients with cancer at increased risk for functional decline who may then be targeted for studies to explore the effects of interventions to improve function.

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Appendix A: Baseline Characteristics of Participants who Completed Follow-up at 12 months versus Participants Who Did Not

	Completed Follow-up 123 (85%)	Did Not Complete Follow-up 22 (15%)	P-value
Age Group (Years)			
65 to 74	67 (54)	13 (59)	0.6882
>=75	56 (46)	9 (41)	
Race			
African-American	36 (29)	9 (41)	0.2770
Non-Hispanic Whites	87 (71)	13 (59)	
Educational Status			
High school or less	46 (37)	11 (52)	0.1944
More than high school	77 (63)	10 (48)	
Median Household Income*			
\$35,000	99 (80)	16 (73)	0.4079
<\$35,000	24 (20)	6 (27)	
Marital Status			
Married	50 (41)	5 (24)	0.2235
Other	73 (59)	16 (76)	
Living Situation			
Alone	51 (42)	9 (38)	0.7499
Other	71 (58)	13 (62)	
Body Mass Index			
<25 (Normal)	23 (24)	3 (14)	0.4077
25 (Overweight/Obese)	94 (76)	19 (86)	
Physical Activity			
<500-METs/minute/week	63 (52)	11 (50)	0.8584
500-METs/minute/week	58 (48)	11 (50)	
Stage			
Stage I-II	109 (90)	19 (86)	0.7034
Stage III	12 (10)	3 (14)	
Hormonal Status			
Positive	102 (83)	18 (82)	0.8991
Negative	21 (17)	4 (18)	
Primary Surgery			
Mastectomy	36 (30)	4 (19)	0.4670
Lumpectomy	80 (67)	16 (76)	
None	4 (3)	1 (5)	
Primary surgery prior to enrollment			
Yes	90 (73)	16 (73)	

	Completed Follow-up 123 (85%)	Did Not Complete Follow-up 22 (15%)	P-value
No	33 (27)	6 (27)	0.9655
Sentinel Node Biopsy/Axillary Node Dissection			
Yes	102 (85)	18 (86)	
No	18 (15)	3 (14)	0.9999
Radiation Therapy			
Yes	58 (50)	13 (62)	
No	59 (50)	8 (30)	0.2978
Chemotherapy			
Yes	31 (26)	4 (18)	
No	87 (74)	18 (82)	0.5931
Hormonal Therapy			
Yes	95 (81)	18 (82)	
No	23 (19)	4 (18)	0.9999
Functional Disability**			
Yes	43 (35)	10 (45)	
No	80 (65)	32 (55)	0.3465
Vulnerable Elders Survey Score			
Scores 0–2	91 (74)	12 (55)	
Scores 3–10	32 (26)	10 (45)	0.0641
Short Physical Performance Battery Score			
Scores 8–12	85 (69)	12 (55)	
Scores 0–7	38 (30)	10 (45)	0.1813
4 Meters Walk Time (seconds)			
6.2 secs	99 (80)	15 (68)	
>6.2 secs	24 (20)	7 (32)	0.1947
Grip Strength (Kg)			
≥21	53 (43)	7 (32)	
<21	69 (57)	15 (68)	0.3087
Charlson Comorbidity Index			
0–1	96 (79)	14 (63)	
2	25 (21)	8 (37)	0.1078
Geriatric Syndromes***			
0–1	94 (78)	18 (86)	
2	27 (22)	3 (14)	0.5660

* Median Household income is derived from information from the US Census Bureau using Zip codes

** Functional disability denotes self-reported ADL/IADL dependence

*** Geriatric syndromes include dementia, depression, polypharmacy, malnutrition, and falls

Appendix B: Multivariate Logistic Model of SPPB Scores Adjusted for All Explanatory Variables Predictive of Functional Decline on Univariate Analysis

	Odds Ratio	95% CI	P-value
Baseline Characteristics			
SPPB Score			
1-unit decrease in scores	1.78	1.21, 2.63	0.004
Age Group (Years)			
65 to 74	Referent		
>=75	1.56	0.25, 9.99	0.62
Race			
White	Referent		
African-American	5.00	0.62, 40.65	0.13
Educational Status			
More than high school	Referent		
High school or less	1.82	0.33, 10.03	0.49
Median Household Income *			
\$35,000	Referent		
<\$35,000 (Lowest Quartile)	1.42	0.20, 9.97	0.73
Physical Activity			
500-METs/minute/week	Referent		
<500-METs/minute/week	4.35	0.43, 44.22	0.21
Primary surgery prior to enrollment			
Yes	Referent		
No	2.43	0.35, 17.10	0.37
Sentinel Node Biopsy/Axillary Node Dissection			
Yes	Referent		
No	2.50	0.36, 17.45	0.35
Radiation Therapy			
Yes	Referent		
No	4.86	0.57, 2.78	0.15
Charlson Comorbidity Index			
0-1	Referent		
2	10.61	1.58, 71.25	0.02
Geriatric Syndromes **			
0-1	Referent		
2	2.06	0.24, 7.45	0.51

* Median Household income is derived from information from the US Census Bureau using Zip codes

** Geriatric syndromes include dementia, depression, polypharmacy, malnutrition, and falls

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Figure 1. Comparison of Receiver Operator Curves of Four Measures to Predict Functional Decline

Note: 4MWT denotes 4 minute Walk Test which is Usual Gait Speed

Table 1

Baseline Characteristics of Participants

Baseline Characteristics	N=123 (100%)
Age Group (Years)	
65 to 74	67 (54%)
>=75	56 (46%)
Race	
African-American	36 (29%)
Non-Hispanic White	87 (71%)
Educational Status	
High school or less	46 (37%)
More than high school	77 (63%)
Marital Status	
Married	50 (41%)
Other	73 (59%)
Median Household Income *	
\$35,000	99 (80%)
<\$35,000	24 (20%)
Living Situation	
Alone	51 (42%)
Other	71 (58%)
Missing/Unknown	1
Body Mass Index	
< 25	29 (24%)
25 to 30	41 (33%)
30	53 (43%)
Physical Activity	
<500-METs/minute/week	63 (52%)
500-METs/minute/week	58 (48%)
Missing	2
Stage	
Stage I-II	109 (90%)
Stage III	12 (10%)
Missing	2
Hormonal Status	
Positive	102 (83%)
Negative	21 (17%)
Primary Surgery	
Mastectomy	36 (30%)

Baseline Characteristics	N=123 (100%)
Lumpectomy	80 (67%)
None	4 (3%)
Missing	3
Primary Surgery Prior to Enrollment	
Yes	90 (73%)
No	33 (27%)
Lymph Node Assessment	
Yes	90 (73%)
No	33 (27%)
Radiation Therapy	
Yes	58 (50%)
No	59 (50%)
Missing/unknown	6
Chemotherapy	
Yes	31 (26%)
No	85 (74%)
Missing/unknown	5
Hormonal Therapy	
Yes	95 (81%)
No	23 (19%)
Missing/unknown	5
Functional Disability **	
No	80 (65%)
Yes	43 (35%)
Vulnerable Elders Survey Score	
Scores 0–2	91 (74%)
Scores 3–10	32 (26%)
Short Physical Performance Battery Score	
Scores 8–12	85 (69%)
Scores 0–7	38 (31%)
Gait Speed in Seconds (4-Meter Walk Time)	
6.2 secs	99 (80%)
>6.2 secs	24 (20%)
Grip Strength (Kg)	
21	53 (43%)
<21	69 (57%)
Charlson Comorbidity Index	
0–1	96 (79%)
2	25 (21%)

Baseline Characteristics	N=123 (100%)
Missing	2
Geriatric Syndromes ***	
0–1	94 (78%)
2	27 (22%)
Missing	2

* Median Household income is derived from information from the US Census Bureau using Zip codes

** Functional disability denotes self-reported ADL/IADL dependence

*** Geriatric syndromes include dementia, depression, polypharmacy, malnutrition, and falls

Table 2

Univariate Analysis Showing Explanatory Variables Associated with Functional Decline at 12 months among Older Women with Breast Cancer

	Odds Ratio	95% CI	P-value
Baseline Characteristics			
Age Group (Years)			
65 to 74	Referent		
>=75	2.77	0.97, 7.95	0.06
Race			
White	Referent		
African-American	2.89	1.04, 8.03	0.04
Educational Status			
More than high school	Referent		
High school or less	3.14	1.12, 8.81	0.03
Median Household Income			
\$35,000	Referent		
<\$35,000 (Lowest Quartile)	4.45	1.53, 12.99	0.006
Marital Status			
Married	Referent		
Other	1.95	0.65, 5.87	0.23
Living Situation			
Other	Referent		
Alone	1.48	0.54, 4.03	0.45
Body Mass Index			
<25 (Normal)	Referent		
25 (Overweight/Obese)	2.77	0.60, 12.83	0.19
Physical Activity			
500-METs/minute/week	Referent		
<500-METs/minute/week	9.53	2.08, 43.58	0.004
Stage			
Stage I-II	Referent		
Stage III	0.49	0.06, 4.06	0.51
Primary Surgery			
Yes	Referent		
No	6.73	0.88, 51.45	0.07
Primary surgery prior to enrollment			
Yes	Referent		
No	3.38	1.21, 9.46	0.02
Lymph Node Assessment			
Yes	Referent		

	Odds Ratio	95% CI	P-value
No	8.27	2.61, 26.22	0.0003
Radiation Therapy			
Yes	Referent		
No	3.82	1.16, 12.51	0.03
Chemotherapy			
Yes	Referent		
No	1.94	0.52, 7.23	0.32
Hormone			
Yes	Referent		
No	1.25	0.33, 4.74	0.74
Functional Disability			
Yes	Referent		
No	3.59	1.27, 10.09	0.02
Charlson Comorbidity Index			
0–1	Referent		
2	5.44	1.87, 15.80	0.002
Geriatric Syndromes			
0–1	Referent		
2	3.54	1.23, 10.15	0.02

Association Between Physical Function Measures and Functional Decline at 12 months: Unadjusted Models

Table 3

Physical Function Measures	Odds Ratio (95% CI)	P-Value	Sensitivity	Specificity	Cut-off	Area Under the Curve (95% CI)
Short Physical Performance Battery						
1-unit decrease in scores	1.63 (1.34, 1.98)	<0.0001	94.4	80.0	7.85	0.92 (0.87, 0.97)
Gait Speed in Seconds						
1-unit increase in usual walking time	1.76 (1.33, 2.32)	<0.0001	86.7	78.6	4.98	0.91 (0.85, 0.97)
Grip Strength (Kg)						
1-unit decrease in grip strength	1.16 (1.06, 1.26)	0.002	66.7	76.9	17.5	0.72 (0.56, 0.88)
Vulnerable Elders Survey Score (VES)						
1-unit increase in scores	1.61 (1.31, 1.97)	<0.0001	83.3	83.8	2.61	0.86 (0.77, 0.96)

Table 4

Association between Physical Function Measures and Functional Decline at 12 months: Adjusted Models

Physical Function Measures	Odds Ratio (95% CI) [*]	P-Value	Area Under the Curve (95% CI)
Short Physical Performance Battery			
1-unit decrease in scores	1.65 (1.33, 2.04)	<0.0001	0.93 (0.89, 0.98)
Gait Speed in Seconds			
1-unit increase in usual walking time	1.76 (1.29, 2.41) [†]	0.0004	0.93 (0.88, 0.99)
Grip Strength (Kg)			
1-unit decrease in grip strength	1.18 (1.06, 1.30)	0.001	0.80 (0.66, 0.94)
Vulnerable Elders Survey Score (VES)			
1-unit increase in scores	1.64 (1.31, 2.05)	<0.0001	0.87 (0.76, 0.96)

^{*} Adjusted for Charlson Comorbidity Index[†] Adjusted for lymph node assessment