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Association of falls with health-related quality of life (HRQOL) in older cancer survivors: A population based study

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ABSTRACT

Objective: To examine the association between falls and health-related quality of life (HRQOL) in older cancer survivors.
Materials and Methods: Using the 2006–2011 Surveillance, Epidemiology, and End Results cancer registry system and the Medicare Health Outcomes Survey (SEER-MHOS) linkage database, a cross-sectional analysis was performed including 17,958 older cancer survivors. Multivariable regression models were used to evaluate the association of falls with HRQOL measured by the physical component summary (PCS) and mental component summary (MCS) scores on the Veteran RAND 12-item health survey after controlling for demographic, health- and cancer-related factors. A longitudinal analysis using the analysis of covariance (ANCOVA) models was also conducted comparing changes in HRQOL of older cancer survivors who fell with HRQOL of older patients with cancer who did not fall.
Results: In the cross-sectional analysis, 4524 (25%) cancer survivors who fell reported a significantly lower PCS (−2.18; SE = 0.16) and MCS (2.00; SE = 0.17) scores compared to those who did not (N = 13,434). In the longitudinal analysis, after adjusting for baseline HRQOL scores and covariates, patients who fell reported a decline in mean HRQOL scores of both PCS (−1.54; SE = 0.26) and MCS (−1.71; SE = 0.27). Presence of depression, functional impairment and comorbidities was significantly associated with lower HRQOL scores.
Conclusion: Falls are associated with lower HRQOL scores and are associated with a significant prospective decline in HRQOL in older cancer survivors. Further research is necessary to determine if assessment and intervention programs can help improve HRQOL by reducing the likelihood of falls.

1. Introduction

Unintentional falls are the leading cause of non-fatal injuries in the United States, affecting 2.4 million older adults aged ≥65 years in 2012.[1] More than one third of community-dwelling adults older than 65 fall at least once per year; 30%–50% results in mild injuries while 5%–10% of falls leads to severe injuries like fractures and head injuries requiring immediate medical

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attention.[2,3] Between 2001 and 2008, there was a 50% increase in the absolute number of fall-related hospitalizations in older adults with fractures being the most frequent primary diagnosis at hospitalization.[4]

The rate of falls in community-dwelling older adults with cancer has been reported to be between 20% and 30% over time periods of 3–12 months and evidence suggests this rate is higher than in those without cancer.[5,6] Risk factors associated with falls in older patients with cancer are similar to those in the general older population, including age, gender, race/ethnicity, vision problems, comorbidities, medications and depression.[3,6] Cancer-specific variables could lead to functional impairments which may increase the likelihood of falls in this population.[7–11]

Falls have been shown to decrease health-related quality of life (HRQOL) in older adults.[12–15] Specifically, falls impact the physical component of HRQOL in the general older adult population, which may be a consequence of avoidance of activities and decline in self-confidence due to fear of falling.[16] Knowledge on the impact of falls on HRQOL in older patients with cancer is very limited.[17] To our knowledge, this study is the first investigating the association of falls with HRQOL in older cancer survivors using a population-based database. The overall hypothesis of this study is that falls are associated with lower HRQOL in older cancer survivors. In the cross-sectional model, we hypothesize that falls are associated with lower HRQOL in patients with cancer after controlling for demographic-, health- and cancer-related factors. In the longitudinal model, we hypothesize that relative to older patients with cancer who do not fall, those who fall report a decline in HRQOL.

2. Methods

2.1. Data Source

The study population consists of Medicare Advantage (MA) beneficiaries from participating managed care organizations in the SEER-MHOS database — a linkage dataset between Center for Medicare Medicaid Service (CMS)-administered Medicare Health Outcomes Survey (MHOS) and data from Surveillance Epidemiology and End Results Program (SEER) registry. The MHOS database is developed from survey responses of 1000 randomly selected MA plan enrollees annually, followed by a 2-year follow-up survey. The surveys are used to gather valid, reliable, and clinically meaningful health status data to assess the quality and performance of MA plans. The MHOS collects information on patient demographics, socio-economic status, life-style behavior such as smoking status, survey characteristics, chronic medical conditions and patient-reported outcomes (PROs) such as HRQOL, activities of daily living (ADLs) and clinical symptoms such as chest pain, shortness of breath, etc. The SEER program collects data on patients with cancer from 16 population-based cancer registries capturing approximately 26% of the US population. Out of these, 14 registries are represented in the SEER-MHOS database and include cancer-related information such as type, stage, time of diagnosis, cancer related treatment such as surgery and radiation, cancer histology and survival time. More detailed information on the variables captured in SEER-MHOS database can be obtained elsewhere.[18] This study was granted exempt status by the institutional review board at the University of Rochester.

2.2. Study Sample

The sample included participants of six SEER-MHOS cohorts from the 2006–2011 survey years capturing information on falls. Eligible individuals included those who were 65 years or older, enrolled in MA plans for the study period, and having at least one cancer diagnosis. Both cross-sectional and longitudinal analyses using the study sample were performed. For the cross-sectional analysis, data from the most recent survey after the cancer diagnosis was used. The study population included two groups of cancer survivors: those who, in the past 12 months, reported falling at least once and those who reported not falling. Individuals who did not meet eligibility criteria ($N = 834$), who did not respond to the falls survey question ($N = 2335$), or who did not have data on all the study covariates ($N = 1113$) were excluded from the study, resulting in a final cross-sectional sample of 17,958 older adults with a diagnosis of cancer (Fig. 1).

A longitudinal analysis was also performed. This analysis estimated the prospective change in HRQOL before and after reported falls among patients with cancer and compares the HRQOL changes to a comparison cohort of patients with cancer and no falls. The longitudinal analysis included cancer survivors who had at least two complete surveys after cancer diagnosis ($N = 10{,}715$): first survey capturing the baseline health status after cancer diagnosis and a subsequent survey capturing follow-up health status. Excluding the patients that had missing fall response on survey ($N = 1933$), age < 65 years ($N = 204$), history of falls on first survey ($N = 1919$) and missing covariates ($N = 346$) resulted in a total of 6313 eligible patients that were included in the final longitudinal analysis. The population was then dichotomized into those individuals who reported at least 1 fall in the 12 months prior to the follow-up survey and those patients who denied any interval falls (Fig. 1). The average time between the baseline and follow-up survey in the longitudinal group was 1.86 ± 0.54 years.

2.3. Study Variables

The primary health outcome of interest was HRQOL, measured using the Veteran RAND (VR)-12 item health survey, captured by the physical component summary (PCS) scores and mental component summary (MCS) scores.[19] HRQOL measured by VR-12 PCS scores and MCS scores ranges from zero (worst possible QOL) to 100 (the best possible QOL). These scores are standardized to have a mean of 50 and a standard deviation of 10 to allow comparability with the US general population. A minimally important difference estimate of 2 points on the HRQOL summary scores was used to compare the changes in the HRQOL scores between the initial and follow-up surveys.[20,21]

The primary independent variable of interest was self-reported history of falls in the 12 months prior to the survey date. Based on empirical research on HRQOL in patients with cancer[22] and falls in older adults,[3] covariates used in the study

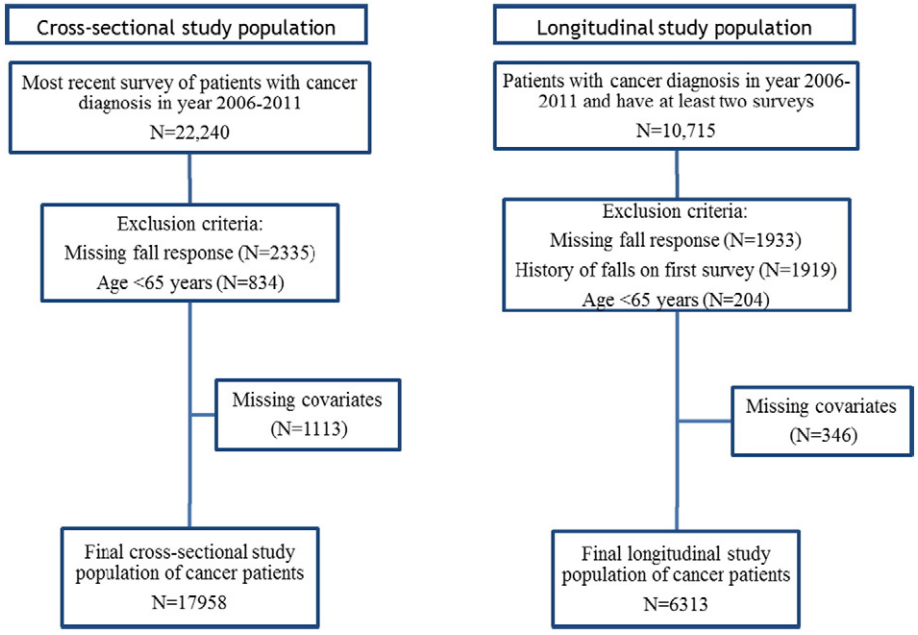

Fig. 1 – Flowchart of study population.

include demographic, general health-related and cancer-specific variables. Demographic variables include age (≥65–70, >70–75, >75–80, >80–85 and >85 years), gender (male and female), race (White and Non-White), marital status (single and divorced/separated/widow), education (<high school, = high school and >high school), and household income (missing, <$30k, $30–50k and >$50k).

General health-related variables included self-reported number of chronic non-cancer comorbidities, activities of daily living (ADL) and depression. Self-reported comorbidities (diabetes, arthritis of hip or knee, chronic obstructive pulmonary disease, high blood pressure, stroke, coronary artery disease, congestive heart failure, myocardial infarction, and other heart conditions) were categorized into 0, 1, 2–3 and 4+ comorbidities. ADLs, an important measure of functional status in older adults, were categorized into those having no difficulty versus having difficulty/inability in bathing, dressing, eating, transferring, walking, and using the toilet.[23] Depression was categorized into a "yes/no" variable based on patient's reporting of experiencing depression for much of the time in the one year prior to the baseline survey.

Cancer-specific variables included type of cancer, stage of cancer, cancer-related treatment and time since initial cancer diagnosis. Similar to other population-based studies,[5,21] the cancer diagnoses were classified based on their prevalence in the study population into four main categories- breast, colon, prostate and others (lung, bladder, gynecological, head and neck, kidney, pancreas, and stomach cancers). Given the variations across cancer types, cancer stage was classified into four categories: localized, advanced, un-staged and missing. Treatment was categorized into radiation, surgery, radiation and surgery, no radiation or surgery and missing. The SEER program does not capture chemotherapy related information and hence was not included in treatment categories. "Time since initial cancer diagnosis" measured the time from initial cancer diagnosis to the time of the baseline survey.

3. Analysis

Bivariate analyses were performed to determine the differences in the baseline characteristics of subjects who reported falls from no falls using chi-square tests. Differences in the mean scores of PCS and MCS between the comparison groups at baseline, follow-up and changes over time were tested using independent sample t-tests. Multivariable regression models were used to assess the association between falls and HRQOL scores (PCS and MCS) in the cross-sectional study group after controlling for covariates. For the longitudinal group, analysis of covariance (ANCOVA) models was used to examine changes in PCS and MCS scores in cancer survivors before and after falls after controlling for baseline HRQOL scores and above mentioned covariates. The PCS and MCS scores of the multivariable regression models were expressed by least squared means ± SE. The percentage of complete follow-up MHOS surveys that are linked to SEER data for the study cohorts is approximately 40% of the complete baseline MHOS surveys and hence it is expected that the longitudinal study population be smaller than the cross-sectional study population. Bivariate analyses were performed to explore any significant difference in the characteristics between longitudinal study population and those in the cross-sectional study group not included longitudinal analyses. All statistical tests were two-tailed and p-value of ≤ 0.05 was considered significant. The SAS 9.3 statistical software package (SAS Institute Inc., Cary, NC, USA) was used for all analyses.

4. Results

4.1. *Sample Characteristics*

Table 1 summarizes the characteristics of cancer survivors in the cross-sectional (N = 17,958) and longitudinal (N = 6313)

Table 1 – Sample characteristics for cross-sectional and longitudinal study population.

	Cross-sectional group (N = 17,958)			Longitudinal group (N = 6313)		
	Falls N (%)	No falls N (%)	p-value	Falls N (%)	No falls N (%)	p-value
Cancer	4524 (25.2)	13,434 (74.8)		1021 (16.2)	5292 (83.8)	
Gender						
Male	2073 (45.8)	6940 (51.7)	<0.001	472 (46.2)	2758 (52.1)	<0.001
Female	2451 (54.2)	6494 (48.3)		549 (53.8)	2534 (47.9)	
Age						
≥65–70 years	462 (10.2)	1856 (13.8)	<0.001	92 (9.0)	555 (10.5)	<0.001
>70–75 years	879 (19.4)	3562 (26.5)		200 (19.6)	1424 (26.9)	
>75–80 years	997 (22.0)	3465 (25.8)		247 (24.2)	1484 (28.0)	
>80–85 years	1056 (23.4)	2649 (19.7)		258 (25.3)	1116 (21.1)	
>85 years	1130 (25.0)	1902 (14.2)		224 (21.9)	713 (13.5)	
Race						
White	3344 (73.9)	9473 (70.5)	<0.001	764 (74.8)	3848 (72.7)	0.163
Non-White	1180 (26.1)	3961 (29.5)		257 (25.2)	1444 (27.3)	
Education						
<High school	1222 (27.0)	3349 (24.9)	0.002	217 (21.3)	1198 (22.6)	0.049
High school	1387 (30.7)	4448 (33.1)		321 (31.4)	1810 (34.2)	
>High school	1915 (42.3)	5637 (42.0)		483 (47.3)	2284 (43.2)	
Income						
Missing	866 (19.2)	2557 (19.0)	<0.001	179 (17.5)	909 (17.2)	0.769
<30k	2241 (49.5)	5996 (44.6)		451 (44.2)	2273 (42.9)	
30–50k	837 (18.5)	2779 (20.7)		228 (22.3)	1202 (22.7)	
>50k	580 (12.8)	2102 (15.7)		163 (16.0)	908 (17.2)	
Marital status						
Married	2180 (48.2)	7743 (57.6)	<0.001	530 (51.9)	3099 (58.6)	<0.001
Single/Divorced/Widowed	2344 (51.8)	5691 (42.4)		491 (48.1)	2193 (41.4)	
Activities of daily living[a]						
None	1549 (34.2)	8996 (67.0)	<0.001	435 (42.6)	3792 (71.7)	<0.001
Atleast 1 ADL	2975 (65.8)	4438 (33.0)		586 (57.4)	1500 (28.3)	
Comorbidities						
0	366 (8.1)	1964 (14.6)	<0.001	99 (9.7)	811 (15.4)	<0.001
1	879 (19.4)	3681 (27.4)		231 (22.6)	1530 (28.9)	
2–3	2019 (44.6)	5709 (42.5)		463 (45.4)	2229 (42.1)	
4+	1260 (27.9)	2080 (15.5)		228 (22.3)	722 (13.6)	
Depression						
No	3365 (74.4)	11,937 (88.9)	<0.001	843 (82.6)	4834 (91.3)	<0.001
Yes	1159 (25.6)	1497 (11.1)		178 (17.4)	458 (8.7)	
Cancer type[b]						
Breast	1315 (29.1)	3447 (25.7)	<0.001	314 (30.8)	1409 (26.6)	0.015
Colon	642 (14.2)	1926 (14.3)		131 (12.8)	756 (14.3)	
Prostate	1321 (29.2)	4558 (33.9)		320 (31.3)	1855 (35.1)	
Others	1246 (27.5)	3503 (26.1)		256 (25.1)	1272 (24.0)	
Cancer stage[c]						
Localized	1808 (40.0)	5144 (38.3)	0.022	426 (41.7)	2024 (38.3)	0.0127
Advanced	994 (22.0)	3248 (24.2)		192 (18.8)	1182 (22.3)	
Unstaged	928 (20.5)	2721 (20.3)		197 (19.3)	1122 (21.2)	
Missing	794 (17.6)	2321 (17.3)		206 (20.2)	964 (18.2)	
Time since cancer diagnosis						
0–3 years	848 (18.7)	2708 (20.2)	<0.001	61 (6.0)	562 (10.6)	<0.001
>3–5 years	534 (11.8)	1569 (11.7)		138 (13.5)	676 (12.8)	
>5–10 years	1146 (25.3)	3794 (28.2)		283 (27.7)	1624 (30.7)	
>10 years	1996 (44.1)	5363 (39.9)		539 (52.8)	2430 (45.9)	
Cancer treatment[d]						
No radiation/surgery	1654 (36.6)	4406 (32.9)	<0.001	356 (34.9)	1737 (32.9)	0.075
Radiation	860 (19.0)	2730 (20.4)		198 (19.4)	1082 (20.5)	

Table 1 (*continued*)

	Cross-sectional group (N = 17,958)			Longitudinal group (N = 6313)		
	Falls N (%)	No falls N (%)	p-value	Falls N (%)	No falls N (%)	p-value
Cancer treatment[d]						
Surgery	1428 (31.6)	4575 (34.0)		311 (30.5)	1786 (33.8)	
Both radiation & surgery	481 (10.7)	1452 (10.8)		131 (12.8)	581 (11.0)	
Missing	94 (2.1)	248 (1.9)		25 (2.4)	98 (1.8)	
Health related quality of life						
Physical Component Summary Score	31.69 ± 11.72	39.48 ± 11.74	<0.001	37.51 ± 11.62	41.43 ± 11.28	<0.001
Mental Component Summary Score	46.59 ± 12.98	52.45 ± 10.54	<0.001	51.63 ± 10.63	54.02 ± 9.41	<0.001

[a] Activities of daily living scale assess difficulty or inability to perform six tasks: bathing, dressing, eating, getting in/out of chair, walking and using toilet. We defined patients as having an ADL impairment if they reported "a lot of difficulty" or "unable to do" any of the aforementioned six tasks.
[b] Other cancer types include lung, bladder, gynecological, head and neck, kidney, pancreas, and stomach cancers.
[c] The staging system was based on that of American Joint Committee on Cancer (AJCC); AJCC 3rd edition (1998–2003) and 6th edition (2004–2007). Stage 0 and I cancers were classified as localized cancer and stage I–IV cancers were classified as advanced cancer. Stage Unknown was classified as Unknown while those with missing values were coded as missing stage.
[d] Cancer treatment is classified based on the treatment administered as a part of their initial work up or first course of therapy into those who underwent surgery only, radiation only, both surgery and radiation, no surgery/radiation and missing treatment.

group with and without falls. In the cross-sectional group, statistically significant differences ($p < 0.05$) in the characteristics were observed between the two comparison groups with history of falls being more prevalent in females, older age group (>80 years), white race, having less than high school education, having a low income (<30k), being single/divorced/widowed, having at least 1 ADL impairment, having more than one comorbidities, depression, breast and other cancer types, localized cancer stage, longer time since cancer diagnosis (>10 years) and no history of radiation/surgery treatment. A logistic regression model implemented (results table not included) to explore the association of falls with the above mentioned patient factors showed that older age group (>80 years), white race, less than high school education, at least 1 ADL impairment, more than one comorbidities and depression were more likely to fall ($p < 0.05$). No statistically significant difference in prevalence of falls was detected among cancer-specific variables in logistic model after controlling for covariates. Similar associations between falls and baseline patient characteristics were observed in the longitudinal group with the exception of race, income, and cancer treatment categories. Comparing the cross-sectional and longitudinal study population using missing data analysis, we found that the longitudinal study population were more likely to be white, married, had higher education, higher income, lower comorbidities, lower rates of depression, lower ADL limitations, higher prevalence of breast and prostate cancer, more missing stage of cancer diagnosis and higher mean HRQOL scores (p-value < 0.05) compared to cross-sectional study population.

4.2. Cross-sectional Analysis

In the cross-sectional study sample, the unadjusted mean HRQOL scores (±standard deviation) for PCS was 31.69 ± 11.72 in the fall group (N = 4524) compared to 39.48 ± 11.74 in the no-fall group (N = 13,434) ($p < 0.001$) while the scores for MCS were 46.59 ± 12.98 and 52.45 ± 10.54 in fall and no-fall groups, respectively ($p < 0.001$) (Table 1). Results from the multivariable regression models used to estimate the effect of falls on HRQOL in the cross-sectional cancer population are shown in Table 2. Cancer survivors with a history of falls in past 12 months reported statistically significant lower adjusted mean scores than the comparison group who reported no falls with PCS scores lower by 2.18 ± 0.16 points and MCS scores by 2.00 ± 0.17 points ($p < 0.001$). Cancer-specific variables associated with lower PCS scores in the adjusted model include a more recent cancer diagnosis, advanced and un-staged cancer stages, and those with colon and other cancer diagnoses ($p < 0.05$). Prostate cancer was associated with a lower MCS score.

4.3. Longitudinal Analysis

In the longitudinal sample, the fall group (N = 1021) had unadjusted baseline PCS and MCS scores of 37.51 ± 11.62 and 51.63 ± 10.63, respectively compared to no-fall group (N = 5292) reporting PCS and MCS scores of 41.43 ± 11.28 and 54.02 ± 9.41, respectively suggesting that fallers had lower baseline HRQOL compared to non-fallers ($p < 0.001$). The follow-up PCS score in the fall group was 34.12 ± 11.88 which was 6.4 points lower than that of no-fall group with mean score of 40.54 ± 11.47 ($p < 0.001$). Also, the follow-up MCS score in fall group was 48.95 ± 11.92 which was 4.6 points lower than that of the no-fall group ($p < 0.001$) (Table 1).

Table 3 shows the results of adjusted model used to estimate the effect of falls on HRQOL in longitudinal group of cancer survivors after controlling for their baseline scores. Falls were significantly associated with lower mean scores of both PCS (−1.54 ± 0.26) and MCS (−1.71 ± 0.27) ($p < 0.001$) in this sample of patient with cancer. In the longitudinal analyses, a statistically significant association between falls and cancer-specific variables was not observed.

4.4. Covariates and HRQOL

Covariates included in the cross-sectional analyses that were significantly associated with lower PCS included female gender, older age (>75 years), white race, married marital status, low education level, low income level, presence of at least one ADL

Table 2 – Multivariable regression model for cross-sectional study population.

	Parameter	PCS12 estimate	SE	Pr > |t|	MCS12 estimate	SE	Pr > |t|
	Intercept	49.61	0.39	<0.001	42.19	0.44	<0.001
Falls in past 12 months	**Yes**	**−2.18**	**0.16**	**<0.001**	**−2.00**	**0.17**	**<0.001**
	No	**Ref.**					
Gender	Male	1.07	0.22	<0.001	−0.68	0.22	0.002
	Female	Ref					
Age categories	≥65–70 years	Ref					
	>70–75 years	0.29	0.23	0.20	0.41	0.23	0.077
	>75–80 years	−0.49	0.23	0.03	0.27	0.23	0.249
	>80–85 years	−1.23	0.24	<0.001	0.09	0.24	0.702
	>85 years	−2.18	0.26	<0.001	−0.31	0.26	0.238
Race/Ethnicity	White	−0.31	0.15	0.056	1.03	0.16	<0.001
	Non-White	Ref.					
Marital status	Married	−0.43	0.15	0.004	−0.18	0.15	0.241
	Single/Divorced/Widowed	Ref.					
Education	<High school	−1.54	0.18	<0.001	−2.16	0.19	<0.001
	High school	−0.74	0.16	<0.001	−0.94	0.16	<0.001
	>High school	Ref.					
Income	Missing	−1.75	0.24	<0.001	−0.89	0.24	<0.001
	<30k	−1.87	0.22	<0.001	−1.54	0.22	<0.001
	30–50k	−1.12	0.23	<0.001	−0.48	0.23	0.041
	>50k	Ref.					
Activities of daily living	None	Ref.					
	At least 1 ADL	**−12.33**	**0.15**	**<0.001**	**−4.57**	**0.16**	**<0.001**
Comorbidities	0	Ref.					
	1	**−2.22**	**0.23**	**<0.001**	−0.13	0.23	0.581
	2–3	**−4.98**	**0.21**	**<0.001**	−0.21	0.22	0.333
	4+	**−8.43**	**0.25**	**<0.001**	**−1.06**	**0.26**	**<0.001**
Depression	No	Ref.					
	Yes	**−1.28**	**0.20**	**<0.001**	**−14.86**	**0.20**	**<0.001**
Year since cancer dx	0–3 years	−0.72	0.22	<0.001	−0.08	0.22	0.72
	>3–5 years	−0.42	0.24	0.08	−0.18	0.24	0.45
	>5–10 years	−0.39	0.17	0.02	−0.01	0.18	0.96
	>10 years	Ref.	.	.			
Cancer stage	Localized	Ref.					
	Advanced	−1.28	0.21	<0.001	−0.37	0.21	0.08
	Unstaged	−0.85	0.22	<0.001	−0.04	0.22	0.87
	Missing	0.03	0.21	0.903	−0.34	0.21	0.12
Cancer type	Breast	Ref.					
	Colon	0.10	0.24	0.674	0.03	0.25	0.897
	Prostate	1.06	0.30	<0.001	−0.44	0.21	0.035
	Others	−1.04	0.21	<0.001	0.24	0.30	0.419

Notes:

a. Activities of daily living scale assesses difficulty or inability to perform six tasks: bathing, dressing, eating, getting in/out of chair, walking and using toilet. We defined patients as having an ADL impairment if they reported "a lot of difficulty" or "unable to do" any of the aforementioned six tasks.

b. Other cancer types include lung, bladder, gynecological, head and neck, kidney, pancreas, and stomach cancers.

c. The staging system was based on that of American Joint Committee on Cancer (AJCC); AJCC 3rd edition (1998–2003) and 6th edition (2004–2007). Stage 0 and I cancers were classified as localized cancer and stage II–IV cancers were classified as advanced cancer. Stage Unknown was classified as Unknown while those with missing values were coded as missing stage.

d. Statistically significant (p-value < 0.05) results are bolded.

impairment, having any comorbidities and depression. Most of the above mentioned covariates were also statistically significantly associated with PCS in the longitudinal analysis with the exception of gender, race, and marital status ($p > 0.05$). Patients with low education, low income, at least one ADL impairment, having any comorbidities and depression had significantly lower MCS scores ($p < 0.05$) in the cross-sectional analysis. Similar associations between MCS and covariates were also observed in the longitudinal analyses, with the exception of comorbidities.

5. Discussion

This population-based study is the first to examine the association of falls with HRQOL in older Medicare managed care beneficiaries with a history of cancer diagnosis. Older cancer survivors who had a history of falls in the last year had significantly lower HRQOL, as assessed by their PCS and MCS scores (−7.8 and −6.0 points, respectively), compared with older cancer survivors with no history of falls ($p < 0.001$). After

Table 3 – Change in HRQOL scores of longitudinal patients with cancer.

	Parameter	PCS12 estimate	SE	Pr > |t|	MCS12 estimate	SE	Pr > |t|
	Intercept	23.86	0.77	<0.001	23.62	0.82	<0.001
	Baseline HRQOL scores	0.49	0.01	<0.001	0.42	0.01	<0.001
Falls in past 12 months	**Yes**	**−1.54**	**0.26**	**<0.001**	**−1.71**	**0.27**	**<0.001**
	No	**Ref.**					
Gender	Male	0.57	0.31	0.07	−0.33	0.32	0.313
	Female	Ref.					
Age categories	≥65–70 years	Ref.					
	>70–75 years	−0.31	0.34	0.373	0.23	0.36	0.519
	>75–80 years	−0.81	0.34	0.018	−0.02	0.36	0.944
	>80–85 years	−1.15	0.36	0.001	−0.61	0.37	0.102
	>85 years	−1.36	0.39	<0.001	−0.88	0.41	0.03
Race/Ethnicity	White	−0.11	0.22	0.607	0.41	0.23	0.073
	Non-White	Ref.					
Marital status	Married	−0.10	0.21	0.644	−0.63	0.22	0.004
	Single/Divorced/Widowed	Ref.					
Education	<High school	−0.56	0.27	0.035	−1.30	0.28	<0.001
	High school	−0.20	0.22	0.361	−0.28	0.23	0.223
	>High school	Ref.					
Income	Missing	−0.86	0.33	0.01	−0.34	0.35	0.318
	<30k	−0.39	0.30	0.181	−0.94	0.31	0.002
	30–50k	−0.65	0.30	0.032	−0.24	0.31	0.449
	>50k	Ref.					
Activities of daily living	None	Ref.					
	At least 1 ADL	**−7.87**	**0.24**	**<0.001**	**−2.75**	**0.23**	**<0.001**
Comorbidities	0	Ref.					
	1	**−2.22**	**0.23**	**<0.001**	0.31	0.31	0.317
	2–3	**−4.98**	**0.21**	**<0.001**	−0.10	0.30	0.747
	>3	**−8.43**	**0.25**	**<0.001**	−0.33	0.37	0.367
Depression	No	Ref.					
	Yes	**−1.23**	**0.32**	**<0.001**	**−10.94**	**0.35**	**<0.001**
Year since cancer dx	0–3 years	0.06	0.36	0.871	0.51	0.38	0.178
	>3–5 years	−0.21	0.32	0.521	0.38	0.34	0.257
	>5–10 years	−0.39	0.23	0.09	0.04	0.24	0.881
	>10 years	Ref.					
Cancer stage	Localized	Ref.					
	Advanced	−0.38	0.30	0.212	−0.17	0.32	0.599
	Unstaged	0.49	0.31	0.111	0.25	0.32	0.438
	Missing	0.00	0.29	0.986	0.24	0.30	0.415
Cancer type	Breast	Ref.					
	Colon	−0.48	0.35	0.166	0.18	0.36	0.608
	Prostate	−0.11	0.42	0.794	0.14	0.44	0.751
	Others	−0.61	0.29	0.037	−0.31	0.30	0.303

Notes:

a. Activities of daily living scale assess difficulty or inability to perform six tasks: bathing, dressing, eating, getting in/out of chair, walking and using toilet. We defined patients as having an ADL impairment if they reported "a lot of difficulty" or "unable to do" any of the aforementioned six tasks.

b. Other cancer types include lung, bladder, gynecological, head and neck, kidney, pancreas, and stomach cancers.

c. The staging system was based on that of American Joint Committee on Cancer (AJCC); AJCC 3rd edition (1998–2003) and 6th edition (2004–2007). Stage 0 and I cancers were classified as localized cancer and stage II–IV cancers were classified as advanced cancer. Stage Unknown was classified as Unknown while those with missing values were coded as missing stage.

d. Statistically significant (p-value < 0.05) results are bolded.

controlling for relevant covariates and potential confounders, a history of falls was associated with lower mean adjusted-HRQOL scores for both PCS (2.18 ± 0.16 points) and MCS (2.00 ± 0.17 points). In this analysis, the presence of comorbidity was also associated with a lower PCS score of approximately two points which suggests that falls may have an equivalent clinically meaningful impact on the HRQOL on older cancer survivors.

Longitudinal analysis further demonstrated that a preceding fall episode predicts a significant subsequent decline in HRQOL, affecting both PCS and MCS, after controlling for baseline HRQOL scores. The prospective decline in the adjusted HRQOL scores, both PCS and MCS by 1.54 and 1.71 respectively, just fall short of the minimally important differences (MIDs) threshold of 2-point difference in the summary scores. Moreover, the mean baseline HRQOL scores for individuals that subsequently fall are significantly lower compared to those who do not fall. These results suggest that cancer-related factors associated with low HRQOL may also increase the likelihood of falling in

older cancer survivors. Although this is the first large study evaluating the impact of falls on quality of life in older cancer survivors, the results follow a similar pattern demonstrated in prior studies in the general elderly population.[14,15,24] A recent study of community-dwelling Medicare beneficiaries without cancer reported a negative impact of falls on the PCS (−5.57 points) as well as the MCS (−3.08 points) of the VR-12 health survey.[15] Moreover, the longitudinal decline in the HRQOL scores following falls is also similar to those reported in a prospective study in the general elderly population which showed a decline in follow-up SF-12 PCS and MCS scores suggesting that falls have negative physical as well as psychological impact. These findings are also consistent with a prior longitudinal study in community-dwelling older adults without cancer where a group who previously fell reported significantly lower HRQOL and life satisfaction scores at the baseline assessment compared to those who did not.[16]

Wildes et al. in a systematic review of the literature on falls in older patients with cancer,[25] found that most studies of older adults of cancer reported a fall rate between 20% and 30%, which is similar to the 25% of older cancer survivors that reported falls in this study population. In the review, the risk factors for falls in patients with cancer included age, race, and dependence on ADLs. Cancer-specific factors such as chemotherapy type (neuropathic),[7] symptoms (such as pain) and advanced cancer stage were also associated with falls.[25] In the general population, cognitive deficits have been shown to be significantly associated with increased risk of falling.[26,27] In this study, patients with low education, low income, one or more ADL deficits or comorbidities, and depression had lower HRQOL, and it would be important to collect these variables in future research that evaluates the impact of treatments or interventions on HRQOL. As noted, even after controlling for functional impairment (ADLs) and comorbidities, falls were independently associated with lower HRQOL.

Prior studies that have evaluated falls in older patients with cancer have utilized self-report and objective physical performance testing through geriatric assessment (GA). GA is a standardized approach that could be incorporated into clinical care and survivorship plans to identify those older patients who are falling or who are at risk of falls.[28] A large study (n = 500) of older adults with a variety of cancer types illustrated that falls were a significant risk factor for grade 3–5 toxicity from chemotherapy.[29] Our finding that falls also independently decrease HRQOL in the study population adds to the importance of assessing falls and physical performance of older cancer survivors.

In this study, changes in HRQOL suggest that falls may have a clinically meaningful impact on older cancer survivors. In addition to the multifactorial assessment and intervention programs which have been shown to reduce the rate of falls, group and home-based exercise programs and home safety interventions should be recommended to high risk groups of older cancer survivors, which reduce risks as well as rate of falling.[30] Moreover, most of the studies evaluating fall prevention interventions have used the rate and risk of falling as primary outcomes while using HRQOL as secondary outcome measure and have been inconclusive on their potential to improve quality of life.[30] The adverse impact of falls on the HRQOL in this study warrants further research to implement and evaluate fall-prevention interventions to improve quality of life, as one of the primary outcomes of interest, in this patient population.

There are some limitations to the study. The study population may not be generalizable to the entire population. Studies evaluating differences in health status between managed care enrollees and fee-for-service enrollees are mixed and inconclusive.[31–33] Self-reported recall of falls may result in bias resulting from underreporting of incidence of falls. However 12 months, the time frame used in this study, is considered to be one of the optimal time-frame for eliciting self-reported falls.[34] The survey does not capture number of falls experienced by patients. Previous studies in older populations without cancer have shown a “dose–response” relationship between number of falls and HRQOL in which two or more falls are associated with greater decline compared to one fall.[24] Categories of cancer-specific variables available in this database such as cancer type, stage, time since diagnosis may not have enough detail to fully capture the impact of cancer on HRQOL. More detailed staging and treatment history (including chemotherapy type) should be included in future research evaluating association of falls with outcomes of older patients with cancer. The results of longitudinal analyses should be interpreted in light of the missing data analysis which suggests that the longitudinal study population had demographic, general-health and cancer-specific characteristics that are associated with better HRQOL scores compared to the remainder of the cross-sectional study population that had only one survey following fall episode. The selection bias due to missing data may lead to under estimation of true measure of effect of falls on HRQOL in this patient population.

Despite these limitations, large population-based and prospective design of this study highlights the clinical significance of falls in older cancer survivors. Falls are common in older patients with cancer and negatively impact their HRQOL. Routine falls monitoring by oncology health care providers taking care of older patients with cancer is warranted. A more frequent and individualized assessment of patients with cancer utilizing GA to identify those at highest risk for falling for referral to interventions is appropriate. Future studies should evaluate if post-fall interventions such as physical therapy, home safety evaluation and fall precaution counseling can modify the impact that the fall experience has on HRQOL for older patients with cancer.

6. Conclusion

Falls are associated with significantly lower scores on both the physical and the mental component of HRQOL in older cancer survivors. Moreover, falls predict a significant prospective decline in the physical and mental HRQOL in this population. Clinical and survivorship care plans should address the needs of older adults with cancer by identifying and intervening on falls risk in order to prevent a decline in HRQOL.

Disclosures and Conflict of Interest Statements

The authors had no conflicts of interest to report.

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Data acquisition: S Mohile.
Quality control of data and algorithms: S Mohile and C Pandya.
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