"Katz activities of daily living disability in older cancer survivors by age, stage, and cancer type"

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Jennifer Blackwood[1] · Hannah Karczewski[1] · Min H. Huang[1] · Lucinda Pfalzer[1]

Abstract

Purpose/objective The purpose of this study was to describe ADL impairments using the Katz ADL Index by cancer type, stage, and age in older cancer survivors.

Methods Cross-sectional data from cohorts 9-14 (year 2006-2013) of the Surveillance, Epidemiology and End Results national cancer registry and Medicare Health Outcomes Survey linkage were used to describe ADL performance using the Katz ADL Index. Mean Katz scores and frequency of ADL disability were reported across cancer types for all eight cancers (colon, lung, breast, prostate, bladder, kidney, non-Hodgkin's lymphoma, uterine) and by stage and age for the four large cancers (colon, lung, breast, prostate).

Results In this sample of 6,973 cancer survivors, ADL deficits were the greatest in uterine cancer survivors ($\mu = 4.72$, SD = 1.44). When considering age, Katz scores were most impaired in breast ($\mu = 3.90$, SD = 1.93) and prostate survivors ($\mu = 4.35$, SD = 1.84) age ≥ 85 years. When considering stage, Katz scores were most impaired in stage four survivors of prostate ($\mu = 4.14$, SD = 1.82) or breast ($\mu = 4.43$, SD = 2.05) cancer. Across all cancer types and age groups, with the exception of stage 4 prostate cancer, ADL deficits were consistently impaired in the same order, from most impaired to least: continence, transfers, bathing, dressing, toileting, and, lastly, feeding.

Conclusions Screening for ADL impairments is needed for older cancer survivors as Katz ADL disability differs by cancer type, stage, and age with greater impairment with advanced age and stage.

Implications for cancer survivors Interventions to address ADL limitations should be considered for older cancer survivors.

Keywords Cancer · Geriatrics · Activities of daily living · Katz ADL Index

Introduction

The population of cancer survivors is increasing [1] and 87% of all cancers are diagnosed in people age 50 years and older [2, 3]. A cancer survivor is defined as a person who has survived from the time of diagnosis until death [4]. Cancer survivors age 65 years and older in the USA are projected to reach nineteen million by 2024 [3, 5, 6]. Eight cancer types accounted for 63% new cancers diagnosed in 2016 which include breast, lung, prostate, colorectal, bladder, kidney, non-Hodgkin's lymphoma, and uterine with the top four being prostate, breast, colorectal, and lung [3, 7].

In cancer survivors, impairments in the ability to complete activities of daily living (ADL) have been reported with up to one-third reporting difficulty in performing basic ADL [8, 9]. In comparison, non-cancer specific data from the United States National Health Interview Survey (2018) indicate that ADL impairments are found in 3.9% of those 65 to 74 years old and in 11.6% of those 75 years and older [12,13]. In cancer survivors, the most frequently impaired ADL include deficits in personal hygiene, walking, and transfers [9]. In older cancer survivors, the greatest degree of ADL disability is found in those related to physical function, which limits their ability to work [3, 10, 11]. Additionally, the impact of cancer on ADL performance is important, as one-third of cancer survivors reported that cancer caused deficits in their ability to perform either basic ADL, Instrumental Activities of Daily Living (I-ADL), or other functional tasks [12].

Impaired ADL performance is associated with lower health related quality of life [14]. The impact of age-related ADL limitations influences multiple domains in health and wellness. Older cancer survivors with increased comorbidity have

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reported significantly more ADL limitations than those without comorbidity [10, 11]. In older survivors of breast, prostate, lung, or colorectal cancer ADL impairment was identified as a significant contributor to balance impairment and falls [15]. The presence of ADL impairments also influences treatment decision making, as survivors of colorectal cancer with two or more ADL limitations were 35% to 40% less likely to receive chemotherapy [6, 15–17]. Additionally, higher mortality rates have been reported in older colorectal cancer survivors with two or more functional limitations [16, 18]. The ability to perform ADL safely influences a person's independence, mortality, health, and quality of life [14, 31].

Oncologic studies which have identified impairments in ADL performance have done so using a heterogeneous mix of adult cancer survivors in a variety of testing locations (inpatient, outpatient, community) resulting in a mixed grouping of ADL disability in cancer survivors [9–12]. In addition, although some studies have used valid ADL measures, a portion of the cancer literature has described ADL performance using ADL categories gathered by questionnaires or chart review or a modified version of a standardized ADL tool [8, 9]. The lack of congruency between measurements makes comparisons across studies difficult.

As cancer stage is associated with changes in function, the degree of ADL disability likely differs by stage within a cancer type. However, data describing the differences in ADL performance by cancer stage is not available. Furthermore, age may also contribute to ADL disability in older cancer survivors, yet these data have not been reported. Older cancer survivors may be experiencing ADL disability; however, it is unknown whether these deficits are consistent across all cancer types or if they vary by cancer stage or age of the survivor. Therefore, the primary aim of this study was to describe ADL performance using a standardized ADL index in older cancer survivors across eight cancer diagnoses. Additionally, we sought to describe Katz ADL performance by cancer stage and age in older survivors of the top four cancers: breast, prostate, colorectal, or lung.

Methods

Design

Data from cohorts 9 to 14 (2006-2013) of the Surveillance, Epidemiology and End Results–Medicare Health Outcomes Survey (SEER-MHOS) linkage was used for this study [19, 20]. SEER collects information related to cancer diagnosis, stage, time of diagnosis, histology, and treatment, except for chemotherapy and hormonal therapy [19]. MHOS gathers demographics and information about health problems, chronic conditions, function, symptoms, and health-related quality of life from Medicare Advantage plan beneficiaries [19]. Each

cohort of SEER-MHOS was comprised of beneficiaries who were randomly sampled to complete MHOS at baseline, and resurveyed 2 years later [19–21]. This study was approved by the Institutional Review Board at the University of Michigan–Flint.

This cross-sectional study examined national, population-based data on ADL performance in older survivors of first, primary prostate, breast, colorectal, lung, bladder, non-Hodgkin's lymphoma, uterine, and kidney cancer without metastasis or recurrence. Figure 1 shows the inclusion of the study sample. Inclusion criteria were age ≥ 65 years at time of cancer diagnosis, cancer staging information available, and completion of baseline MHOS 2- to 3-year post-cancer diagnosis. Data from the first MHOS completed by each individual were extracted for analysis.
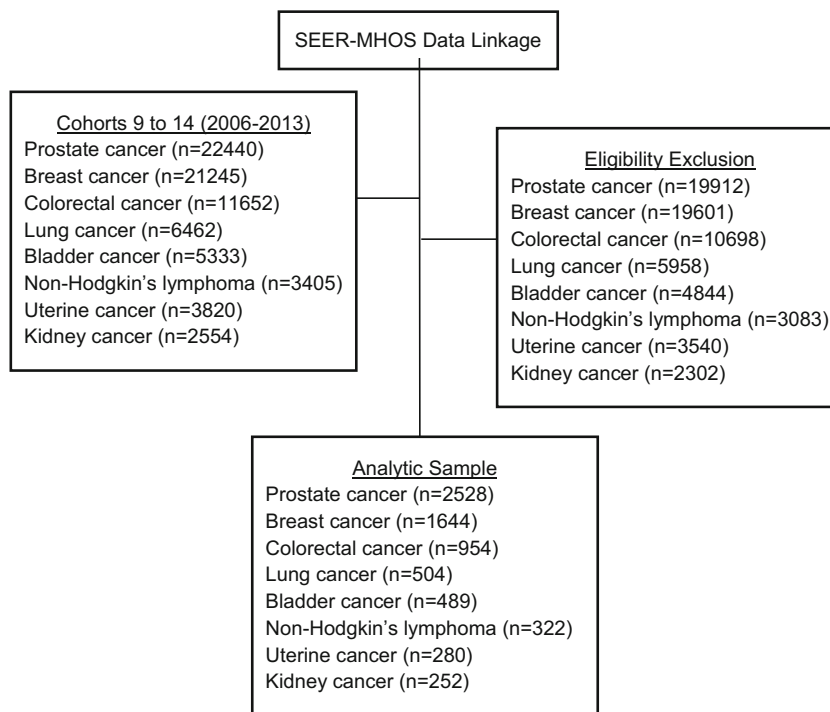
Measurements

Demographic information extracted included age (years), gender, race, marital status, and body mass index (kg/m^2). The Katz ADL Index was selected because it assesses basic ADL, is sensitive to changes in declining health status, and for its ease of use in quantifying ADL impairment based on a six-item dichotomous scale [22–24]. The six different ADL categories of Katz include: bathing, dressing, toileting, transferring, continence, and feeding [22–25]. In the SEER-MHOS, participants were asked the following question concerning their self-reported difficulty for each of the six ADL categories: "Because of a health or physical problem, do you have difficulty doing the following activities without special equipment or help from another person?" Based on their responses to this question, the Katz ADL Index scoring system was applied, and each ADL category was scored as dependent (0 points) or independent (1 point). During the survey, if the participant reported, "no, I do not have difficulty" in an activity, the participant was given a score of one (1), meaning independent, for that Katz ADL category. If the participant reported, "yes, I have difficulty" or "I am unable to do this activity," the participant was rated as a zero (0), indicating ADL impairment. Scores for each of the six ADL categories were summed for each cancer diagnosis and the total Katz score was created. Scores on the Katz ADL Index range from zero (0) to six (6) with higher scores indicating ADL independence.

Statistical analysis

Descriptive statistics in mean/standard deviation were used for continuous variables and frequencies were reported for categorical variables. Katz scores and the frequency of ADL impairment for each ADL category were reported for the eight cancer types (breast, prostate, lung, colorectal, kidney, non-Hodgkin's lymphoma, uterine, bladder). For the top four

Fig. 1 Flowchart of study sample. The sample comprised of individuals age ≥ 65 years from the cohort 9 to 14 (year 2006 to 2014) of the Surveillance, Epidemiology and End Results Program and the Medicare Health Outcomes Survey (SEER-MHOS) linkage. Inclusion criteria were cancer survivors that were first, primary cancer (breast, prostate, colorectal, lung, bladder, kidney, non-Hodgkin's lymphoma, or uterine), no metastasis or recurrence, cancer staging information available, age ≥ 65 years at time of cancer diagnosis, and completion of MHOS during years 2–3 years post-cancer diagnosis. Data from the first MHOS completed by each individual were extracted

SEER-MHOS Data Linkage

Cohorts 9 to 14 (2006-2013)
Prostate cancer (n=22440)
Breast cancer (n=21245)
Colorectal cancer (n=11652)
Lung cancer (n=6462)
Bladder cancer (n=5333)
Non-Hodgkin's lymphoma (n=3405)
Uterine cancer (n=3820)
Kidney cancer (n=2554)

Eligibility Exclusion
Prostate cancer (n=19912)
Breast cancer (n=19601)
Colorectal cancer (n=10698)
Lung cancer (n=5958)
Bladder cancer (n=4844)
Non-Hodgkin's lymphoma (n=3083)
Uterine cancer (n=3540)
Kidney cancer (n=2302)

Analytic Sample
Prostate cancer (n=2528)
Breast cancer (n=1644)
Colorectal cancer (n=954)
Lung cancer (n=504)
Bladder cancer (n=489)
Non-Hodgkin's lymphoma (n=322)
Uterine cancer (n=280)
Kidney cancer (n=252)

cancers, mean Katz scores and frequency of ADL impairment are presented by cancer stage and age groupings. The three age groupings were as follows: 65–74 years, 75–84 years, and 85 years or older. Cancer stages from the SEER-MHOS data were categorized as follows: stage one (in situ), stage two (local), stage three (regional), and stage four (distant) for the top four cancers except lung and prostate which only has three categories: local, regional, and distant [15, 16].

Results

Sample characteristics

The study sample was composed of 6,973 older cancer survivors: prostate (36.2%), breast (23.6%), colorectal (13.7%), lung (7.2%), bladder (7.0%), non-Hodgkin's lymphoma (4.6%), uterine (4.0%), and kidney (3.6%). Table 1 describes the characteristics of survivors. The average age at cancer diagnosis was 72.97 (6.52) years. The average length of time from cancer diagnosis to the current SEER survey was 28.98 (9.89) months ranging from the shortest time, 26.54 (9.54) months in lung cancer, to the longest duration found in kidney cancer survivors, 29.83 (9.95) months. The average age at the time of the SEER survey was 76.18 years and the oldest respondents were bladder cancer survivors (μ = 77.89, SD = 6.67) and the youngest were prostate cancer survivors (μ = 74.94, SD = 5.91). The majority were female: uterine (100%), breast (99.1%), non-Hodgkin's lymphoma (50.6%), lung (54.1%), and colorectal (51%). Over 70% identified as white

within all eight cancer diagnoses. Over 50% of breast cancer survivors were unmarried while over 70% of prostate cancer survivors were married. Body mass index, in kg/m^2, was the highest in uterine (μ = 30.39, SD = 7.23) and the lowest in lung (μ = 25.57, SD = 5.25) cancer survivors. When examined by age, BMI was the highest in the youngest (age 65-74 years) group across all four cancer types, and when cancer stage was considered, BMI was the highest in the earliest stage within all cancer types.

Activities of daily living impairment by cancer type

ADL scores by cancer type are found in Table 1. Uterine cancer survivors (n = 280) had the most impaired overall Katz scores (μ = 4.72, SD = 1.44) followed by lung (μ = 4.74, SD = 1.64) and kidney (μ = 4.77, SD = 1.62). Katz ADL scores were the highest in non-Hodgkin's Lymphoma and prostate cancer survivors. When ADL impairment was examined categorically, lung cancer survivors had the greatest impairments in five ADL categories: transferring (28.0%), bathing (26.7%), dressing (19.4%), toileting (12.0%), and feeding (9.9%). Of all the ADL measurements, continence was the most impaired across all cancer diagnosis with impairments ranging from 34.4 to 55.6%, of which uterine cancer survivors had the most impairment. A consistent pattern of impaired ADL performance was found within all cancers and presented in following order from most impaired ADL to least: continence, transferring, bathing, dressing, toileting, and lastly, feeding.

Table 1 ADL impairment by cancer type in older survivors of prostate, breast, colorectal, lung, bladder, non-Hodgkin's lymphoma, uterine, and kidney cancer

Variables	Prostate (n = 2528)		Breast (n = 1644)		Colorectal (n = 954)		Lung (n = 504)		Bladder (n = 489)		Non-Hodgkin's lymphoma (n = 322)		Uterine (n = 280)		Kidney (n = 252)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Age at survey, y	2528	74.94 (5.91)	1644	75.80 (6.58)	954	77.47 (7.08)	504	76.01 (6.11)	489	77.89 (6.67)	322	76.36 (6.56)	280	75.50 (6.68)	252	75.49 (6.36)
Age at cancer diagnosis, y	2528	71.98 (5.96)	1644	72.89 (6.60)	954	74.57 (7.15)	504	73.29 (6.23)	489	74.96 (6.80)	322	73.59 (6.85)	280	72.56 (6.70)	252	72.56 (6.49)
Time since cancer diagnosis, m	2528	29.58 (9.96)	1644	28.94 (9.88)	954	28.87 (9.85)	504	26.54 (9.54)	489	29.04 (9.60)	322	27.88 (10.11)	280	29.07 (9.60)	252	29.83 (9.95)
Female gender	-		1644	99.1	541	51.0	300	54.1	118	24.1	163	50.6	280	100	120	47.6
White race	1939	72.4	1327	74.0	765	72.1	438	78.9	431	88.1	270	83.9	224	80.0	187	74.2
Married	1902	72.4	724	41.4	528	51.1	313	57.6	287	59.7	175	55.0	106	39.0	151	60.9
BMI, kg/m^2	2528	27.58 (4.67)	1644	27.80 (6.20)	954	26.90 (5.25)	504	25.57 (5.25)	482	26.93 (4.94)	313	27.00 (5.10)	267	30.39 (7.23)	245	28.76 (6.59)
Katz ADL total	2528	4.98 (1.40)	1644	4.84 (1.47)	954	4.95 (1.55)	504	4.74 (1.64)	489	4.91 (1.520)	308	4.99 (1.45)	261	4.72 (1.44)	239	4.77 (1.62)
ADL dependence in																
Bathing	345	13.1	313	17.7	185	17.8	146	26.7	85	17.7	53	16.7	52	18.8	53	21.5
Dressing	323	12.2	218	12.3	146	14.1	106	19.4	65	13.5	36	11.4	21	12.3	39	15.8
Toileting	250	9.5	173	9.8	111	10.7	66	12.0	53	11.1	26	8.2	28	10.1	31	12.6
Transfers	533	20.2	451	25.6	242	23.4	153	28.0	117	24.3	77	24.4	77	27.5	67	27.3
Continence	1146	44.1	840	48.1	364	35.6	183	34.4	173	36.9	114	36.3	148	55.6	96	39.3
Feeding	123	4.7	96	5.4	72	6.9	54	9.9	26	5.4	17	5.4	12	4.3	18	7.3

Values shown are mean (SD) or number

ADL activities of daily living, *BMI* body mass index, *m* months, *y* years

Table 2 ADL impairment by cancer type and age in older survivors of prostate, breast, colorectal, and lung cancer

Variables / Age group, years	Prostate (n = 2528) 65–74 n	%	75–84 n	%	85 + n	%	Breast (n = 1644) 65–74 n	%	75–84 n	%	85 + n	%	Colorectal (n = 954) 65–74 n	%	75–84 n	%	85 + n	%	Lung (n = 504) 65–74 n	%	75–84 n	%	85 + n	%
Age, y	1312	70.07 (2.27)	966	78.7	182	87.96 (2.65)	819	70.02 (2.23)	640	79.09 (2.59)	185	88.41 (2.88)	384	70.06 (2.32)	416	79.25 (2.55)	182	88.49 (3.07)	233	70.20 (2.39)	237	79.12 (2.61)	47	87.69 (2.36)
Female gender	-	-			-	-	807	98.5	638	99.7	184	99.5	174	45.3	219	52.6	101	55.5	133	57.1	127	53.6	24	51.1
White race			104	10.8	135	74.2	602	73.5	474	74.1	133	71.9	264	68.8	305	73.3	142	78.0	176	75.5	193	81.4	38	80.9
Married	941	72.8	707	74.4	46	27.5	392	49.1	235	38.0	55	30.4	226	60.1	205	50.7	62	35.6	136	59.9	136	57.9	19	44.2
BMI, kg/m₂	1285	28.18 (4.77)	941	27.10 (4.42)	166	25.06 (3.88)	794	28.81 (6.43)	616	27.28 (5.92)	181	24.97 (4.87)	376	28.48 (5.30)	398	26.58 (4.92)	174	24.62 (4.04)	223	26.30 (5.42)	231	24.92 (5.09)	44	25.52 (4.86)
Katz total	1249	5.10 (1.27)	906	4.94 (1.45)	172	4.35 (1.84)	782	5.09 (1.67)	598	4.81 (1.42)	169	3.90 (1.93)	366	5.22 (1.29)	384	4.92 (1.54)	159	4.43 (1.98)	220	4.70 (1.74)	221	4.76 (1.54)	43	4.60 (1.47)
ADL dependence in																								
Bathing	127	9.8	149	15.7	38	21.0	98	12.2	116	18.4	69	37.9	49	12.9	73	17.9	46	26.4	62	26.7	64	27.7	13	28.3
Dressing	127	9.8	125	13.1	43	23.9	69	8.5	76	12.1	52	28.6	35	9.3	61	15.0	39	22.3	46	19.8	45	19.6	a	-
Toileting	93	7.2	114	12.1	38	21.1	54	6.7	54	8.6	48	25.9	25	6.7	46	11.3	29	16.6	31	13.3	24	10.4	a	-
Transfers	207	16.0	208	21.9	72	39.8	157	19.5	168	27.0	85	45.9	61	16.1	97	23.9	62	35.8	63	27.0	66	28.8	16	34.0
Continence	578	45.0	394	42.3	86	49.1	355	44.3	305	49.0	107	60.1	115	30.3	149	37.4	74	43.5	71	32.1	87	37.8	17	37.8
Feeding	46	3.6	51	5.4	17	9.4	29	3.6	28	4.5	29	15.9	19	5.0	28	6.9	20	11.4	23	9.9	23	10.0	a	-

Values shown are mean (SD) or number

ADL activities of daily living, BMI body mass index, y years

a indicates cell number < 11

Activities of daily living impairment by age

When ADL impairment was examined by age in survivors of breast, prostate, colorectal, or lung cancers, those 85 years and older had the most ADL deficits across all cancers. Overall Katz scores were most impaired in the 85 + age group for breast (μ = 3.90, SD = 1.93) followed by prostate (μ = 4.35, SD = 1.84) cancer survivors. Prostate cancer survivors between the ages 75 to 84 years old reported the greatest difficulty with toileting (89.3%). Breast cancer survivors aged 85 years and older had the greatest difficulty with bathing (37.4%), dressing (28.1%), transferring (45.9%), continence (60.1%), and feeding (15.9%) than any other age group (Table 2). With the exception of the oldest prostate group, the order from most impaired ADL to least across all age groupings was as follows: continence (32.1%-60.1%), transferring (16.1%-45.9%), bathing (12.2%-37.9%), dressing (8.5%-28.6%), toileting (6.7%-25.9%), and feeding (3.6%-15.9%).

Activities of daily living impairment by cancer stage

Data for cancer impairment by stage for each of the top four cancer types can be found in Tables 3, 4, 5 and 6. When ADL disability was examined by cancer stage, stage four cancer survivors had the most ADL deficits (prostate [μ = 4.14, SD = 1.82], breast [μ = 4.43, SD = 2.04], colorectal [μ = 4.48, SD = 1.78], lung [μ = 4.63, SD = 1.85]). As shown in Table 6, stage four prostate cancer survivors reported the most deficits in four ADL categories: transferring (49.1%), bathing (41.1%), dressing (31.8%), and feeding (18.2%). Stage four colorectal survivors had the greatest deficits in continence (50%). Toileting was equally impaired (20%) in stage four breast and colorectal survivors. With the exception of stage 4 prostate, colorectal, and lung groups, ADL were impaired consistently in the same order as previously noted from most impaired ADL to least: continence, transferring, bathing, dressing, toileting, and feeding.

Discussion

This study of 6,973 older cancer survivors describes ADL deficits by cancer type, stage, and age using a validated ADL index measure. Similar to the geriatric literature, ADL were most impaired in the oldest age group (85 years +) within all cancer diagnoses [8]. Additionally, those in the advanced stages of cancer had the lowest Katz scores, likely the result of advanced disease [8, 9].

Across all cancer types and within the majority of age groupings and stages, the order of ADL impairment from most to least impaired was consistent. Continence was the most impaired ADL with frequencies of 34.3 to 48.1% while feeding was the least impaired (4.3–9.9%). This order differs from

Table 3 Katz ADL impairment in older survivors of breast cancer by stage

| Variables | Breast (n = 1644) | | | | | | | |
| | Stage 1: in situ (n = 305) | | Stage 2: local (n = 963) | | Stage 3: regional (n = 355) | | Stage 4: distant (n = 30) | |
	n	%	n	%	n	%	n	%
Age, y	305	74.45 (3.05)	963	76.30 (6.54)	355	75.68 (6.80)	30	74.83 (6.80)
Female gender	305	100.0	963	100.0	355	100.0	30	100.0
White race	213	66.8	788	76.9	272	72.5	22	73.3
Married	137	43.5	404	40.0	161	43.5	11	36.7
BMI, kg/m^2	305	28.73 (6.54)	963	27.42 (5.84)	355	28.01 (6.83)	28	27.95 (5.68)
Katz ADL Index	305	4.92 (1.38)	963	4.88 (1.42)	355	4.68 (1.60)	30	4.43 (2.05)
ADL dependence in								
Bathing	51	16.0	169	16.8	76	21.1	a	-
Dressing	36	11.4	116	11.5	52	14.1	a	-
Toileting	28	8.9	90	9.0	43	11.6	a	-
Transfers	72	22.8	250	24.9	107	29.4	a	-
Continence	152	48.7	489	49.0	176	47.7	11	36.7
Feeding	14	4.5	44	4.4	30	8.1	a	-

Values shown are mean (SD) or number

ADL activities of daily living, *BMI* body mass index, *y* years

a indicates cell number < 11

what was reported in 13,113 older adults (mean age = 84 years) living in a nursing home where the order of impairment from most impaired to least was deficits in bathing, dressing, toileting, transferring, continence, and eating [26]. In a systematic review of ADL disability in a variety cancer survivors across different settings, the most impaired ADL reported in

Table 4 Katz ADL impairment in older survivors of colorectal cancer by stage

| Variables | Colorectal (n = 954) | | | | | | | |
| | Stage 1: in situ (n = 60) | | Stage 2: local (n = 511) | | Stage 3: regional (n = 371) | | Stage 4: distant (n = 42) | |
	n	%	n	%	n	%	n	%
Age, y	60	75.94 (6.34)	511	77.44 (7.08)	371	78.00 (7.12)	42	75.40 (7.07)
Female gender	28	43.1	214	53.4	187	46.6	24	50.0
White race	42	64.6	401	73.3	289	72.1	33	68.8
Married	34	55.7	280	52.4	192	49.9	22	46.8
BMI, kg/m^2	60	27.40 (4.53)	511	27.14 (5.31)	371	26.60 (5.13)	42	26.50 (6.22)
Katz total	60	4.85 (1.62)	511	4.99 (1.50)	371	4.95 (1.58)	42	4.48 (1.79)
ADL dependence in								
Bathing	15	23.8	83	15.5	72	18.2	15	32.6
Dressing	a	-	69	12.8	55	14.0	12	26.1
Toileting	a	-	61	11.4	34	8.7	a	-
Transfers	18	28.6	118	22.0	94	24.0	12	26.7
Continence	21	33.9	188	35.7	132	33.9	23	50.0
Feeding	a	-	36	6.7	31	7.9	a	-

Values shown are mean (SD) or number

ADL activities of daily living, *BMI* body mass index, *y* years

a indicates cell number < 11

Table 5 Katz ADL impairment in older survivors of lung cancer by stage

Variables	Lung cancer (n = 504)					
	Stage 2: local (n = 223)		Stage 3: regional (n = 198)		Stage 4: distant (n = 98)	
	n	%	n	%	n	%
Age, y	223	76.39 (6.29)	198	75.68 (5.88)	98	75.75 (6.13)
Female gender	133	54.3	63	59.4	43	40.6
White race	198	80.8	164	80.4	76	71.7
Married	128	53.3	125	62.8	60	57.7
BMI, kg/m^2	223	26.05 (5.54)	198	25.56 (4.90)	98	24.50 (5.06)
Katz total	223	4.74 (1.59)	198	4.78 (1.59)	98	4.63 (1.85)
ADL dependence in						
Bathing	63	26.1	55	27.1	28	27.5
Dressing	47	19.4	35	17.3	24	23.5
Toileting	26	10.7	23	11.4	17	16.3
Transfers	68	28.2	55	27.2	30	28.8
Continence	88	38.4	66	33.0	29	28.2
Feeding	22	9.1	18	8.9	14	13.7

Values shown are mean (SD) or number

ADL activities of daily living, *BMI* body mass index, *y* years

participants from all included studies were deficits in personal hygiene (grooming or brushing teeth), followed by disability related to walking, transfers, and bathing [9]. Within our sample, differences in the degree of ADL impairment were found in some late stage cancers (lung, prostate, colorectal) or with advanced age (prostate group 75–84 years) indicating that slight differences in ADL impairment may be present across the aging spectrum in cancer survivors. Collectively, these data indicate the need for further study to determine whether there is a consistent order or hierarchy of ADL disability in older cancer survivors. Additionally, determining how the timing of ADL disability contributes to other deficits in functional mobility, like balance impairment or falls, is needed.

Table 6 Katz ADL impairment in older survivors of prostate cancer by stage

Variables	Prostate (n = 2528)					
	Stage 2: local (n = 2242)		Stage 3: regional (n = 235)		Stage 4: distant (n = 57)	
	n	%	n	%	n	%
Age, y	2242	75.14 (5.82)	235	72.44 (5.00)	57	76.90 (6.37)
Male gender	2242	100.0	235	100.0	57	100.0
White race	1710	72.0	185	75.5	43	75.4
Married	1691	72.6	178	73.6	33	28.9
BMI, kg/m^2	2242	27.62 (4.66)	235	27.29 (4.75)	55	26.89 (4.71)
Katz total	2242	5.01 (1.40)	235	4.95 (1.30)	51	4.14 (1.82)
ADL dependence in						
Bathing	296	12.6	26	10.7	23	41.1
Dressing	283	12.1	22	9.1	15	31.8
Toileting	222	9.5	17	7.0	a	-
Transfers	462	19.8	43	17.7	28	49.1
Continence	994	43.1	131	55.0	21	38.9
Feeding	103	4.4	a	-	a	-

Values shown are mean (SD) or number

ADL Activities of daily living, *BMI* body mass index, *y* years

a indicates cell number < 11

This study measured ADL impairment using the six item Katz ADL Index, which has excellent sensitivity (98.5%) in identifying ADL impairments [9]. In comparison, other studies which have described ADL disability in older cancer survivors have used non-validated ways of measuring ADL including summing the number of ADL which require assistance [9]. Using Katz allows for the comparison of ADL disability in cancer survivors with those without cancer. An additional benefit of using Katz is in the categorization of participants being either independent or dependent thus providing a clear-cut distinction of ADL performance. However, a limitation to this dichotomous scale is that it does not quantify the severity of disability (e.g., minimal or moderate) in completing ADL which can be detected through the use of qualitative descriptions of ADL performance. Therefore, further study assessing the degree of dependence of ADL is necessary in older cancer survivors.

Although colorectal and bladder survivors were the oldest groups at cancer diagnosis, Katz scores for both groups were found in the top half of overall scores. However, uterine and lung cancer survivors who had the lowest ADL scores, 4.74 (1.44) and 4.74 (1.64) respectively, were diagnosed at a younger age. Additionally, the time from cancer diagnosis to completion of the SEER survey was the shortest in lung cancer survivors (26.54 months) indicating that for patients with this cancer type, although they may be diagnosed at a younger age, their level of potential ADL disability is greater than other older cancer survivors. Similarly, although older adults diagnosed with uterine cancer may be younger, their level of ADL comorbidity may be greater. Further study is needed to examine ADL disability by cancer type relative to age at diagnosis and the onset of disability over the trajectory of survivorship.

The oldest age group had the most impaired ADL performance across the top four diagnoses: lung ($\mu = 4.60$, SD = 1.47), colorectal ($\mu = 4.43$, SD = 1.98), prostate ($\mu = 4.35$, SD = 1.84), and breast cancer survivors ($\mu = 3.90$, SD = 1.93). This finding is consistent with increased ADL impairments with advanced age reported in a nationally represented sample of older adults; however, our results indicate that ADL impairment in cancer survivors may be higher than in those without comorbidity [13]. Early intervention for cancer survivors age 85 years and older is important for treatment decision making. Since this is the first study to report ADL disability by cancer type, stage, and age, there is a lack of literature supporting increased ADL deficits in cancer survivors 85 years and older.

The ADL category most impaired across all diagnoses was continence with impairments ranging from 33 to 55%. Issues with incontinence are not new as studies describing interventions for continence management for prostate and colorectal cancer survivors have been completed [27–29]. Incontinence is identified as a risk factor for falls in breast, prostate, and lung cancer and also a risk factor for balance/walking difficulty in older breast or prostate cancer survivors [16]. Given the prevalence of this ADL impairment and its association with deficits in functional mobility and injury, further attention is indicated in clinical settings to manage incontinence in older cancer survivors including screening and referral.

Stage four cancer survivors had the lowest ADL scores across all diagnosis. Given the probable high degree of comorbidity as a result of the disease, this result was not surprising. To further quantify the impact of comorbidity on ADL disability, future studies should consider the use of a comorbidity index to describe relationships between ADL performance and disability to direct healthcare practitioners in the provision of care.

Changes in ADL performance have been previously reported to be associated with change in comorbidity and also increased likelihood of injury such as falls [30]. In addition, in older breast cancer survivors, decline in function 3-27 months after diagnosis result in an increased mortality rate [31]. This cross-sectional study is limited in that data describing ADL impairment prior to cancer diagnosis was not available, and since the timing of the survey was not related to the course of any particular health condition, it was not known if a person may have had a recent injury, hospitalization, or treatment which would have influenced their responses. Nevertheless, on average, the sample was approximately 2.4 years (28.98 months) since cancer diagnosis indicating the presence of ADL impairment at this timepoint post diagnosis. However, the timing of ADL decline as it relates to cancer diagnosis, treatment, and survivorship needs to be examined further.

The strengths of this study include having a sample of older cancer survivors from a large population-based dataset and the use of a standardized ADL index to describe ADL impairment across cancer stage, age, and diagnosis. This study has several limitations. First, as ADL performance was assessed via a question to the participant, recall bias cannot be ruled out. Beyond the heterogeneity of demographics, a general limitation of the SEER-MHOS database is that participants in Medical Advantage plans have more risk factors for disease and poorer function [32]. Future research should examine the impact of age and stage-related ADL limitations on functional mobility and quality of life in older cancer survivors across cancer types. Lastly, more data is needed to describe ADL impairments in other cancer types beyond those reported in this study and in those where our data cells were too small to report.

Results of this cross-sectional study indicate that: ADL impairments are prevalent in older cancer survivors; the degree of impairment differs by type of cancer, stage, and age; and using an ADL measure, like the Katz ADL Index, may be

clinically useful tool to detect ADL impairment as a part of routine cancer care. As ADL impairment is associated with falls and balance problems, screening for ADL disability in clinical settings as a part of an oncologic comprehensive geriatric assessment to determine functional limitations is indicated [16, 33].

Conclusions

ADL disability differs by cancer type, age, and stage. Health care providers should consider referral of the older cancer survivor to address the underlying functional limitations that influence ADL performance.

Compliance with ethical standards

Conflict of interest   The author(s) declare that they have no conflict of interest

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