The Well-Being of Long-Term Cancer Survivors

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Cancer care is changing rapidly. Over the past 60 years in the United States, population aging and declining mortality from heart disease have led to an increase in the total number of deaths from cancer.[1] However, this increase in the total number of deaths masks substantial improvement in the cancer mortality risk faced by individuals. Adjusting for population aging, cancer mortality rates in the United States have declined by 23% from 1990 to 2012, from 214.95 to 166.40 per 100,000 individuals.[2] Reasons for this decline include advances in early detection and treatment and decreased smoking.[3] Although the debate continues about the efficacy of the "war on cancer" and further progress is needed,[4-7] the trend of improving mortality is clear. Studies examining many tumor types have found that advances in care have led to significant mortality declines in recent decades.[8-10] These reductions in mortality have increased the number of cancer survivors.

However, surviving cancer does not guarantee a high quality of life. Adverse effects of cancer treatment are well documented. Cardiac toxicities are a known complication of specific chemotherapeutics used in breast and other solid tumors, leaving many cancer survivors with degrees of heart failure.[11] Radiotherapy in patients with breast cancer has been linked to an increased risk of coronary events.[12] Impairment of renal function is a complication of certain cancer treatment regimens, often resulting in acute damage and chronic kidney disease.[13-16]

Patients with cancer also face an increased risk of second primary malignancies.[17-22] For example, a meta-analysis found that patients treated for Hodgkin lymphoma are at increased risk of developing second primary lung cancer.[17] A study of testicular cancer survivors found that, compared with surgery only, radiotherapy below the diaphragm significantly increased the risk of second primary cancers or cardiovascular diseases.[18]

Because long-term cancer survivors face the risk of second primary malignancies and may live with complications from treatment toxicities, one might expect that they would experience a low quality of life. However, research to date has tended to

ABSTRACT

OBJECTIVES: To compare the well-being of long-term cancer survivors with that of US residents of similar age and demographic characteristics, patients recently diagnosed with cancer, and individuals with chronic illness.

STUDY DESIGN: Retrospective observational study.

METHODS: Using the Health and Retirement Study, a survey of US residents older than 50 years, we defined 4 cohorts: long-term cancer survivors (>4 years post diagnosis), individuals recently diagnosed with cancer (≤4 years post diagnosis), individuals with chronic illness, and US residents older than 50 years ("nationally representative cohort"). Well-being measures included self-reported health, utility, happiness, medical utilization and spending, employment, and earnings, and these measures were compared across cohorts, adjusting for survey year, demographic characteristics, smoking, and number of comorbidities. We imputed medical spending using the Medical Expenditure Panel Survey and the Medicare Current Beneficiary Survey.

RESULTS: Long-term cancer survivors fared significantly better than those recently diagnosed with cancer, those with chronic illness, and individuals in the nationally representative cohort in the majority of well-being measures (*P* <.05), including fewer doctor visits, hospitalizations, and hospital nights; better utility and self-reported health; and greater likelihood of employment. Long-term cancer survivors had lower healthcare spending than those recently diagnosed with cancer (*P* <.01) and significantly greater happiness than the nationally representative cohort and those with chronic illness (*P* <.05).

CONCLUSIONS: Although patients with cancer experience diminished well-being in the short term across a variety of measures, in the long term, cancer survivors do as well as or better than US residents of similar age and demographic characteristics. This finding is striking given that one might expect long-term cancer survivors to do worse than similar individuals without a history of cancer.

focus on clinical and short-term outcomes, while comparatively little is known about the well-being of long-term cancer survivors. As improvements in treatment have made long-term survival a possibility for some patients with advanced cancers, understanding the well-being of long-term survivors is of increasing importance.

In this study, we measured the well-being of long-term cancer survivors and compared their well-being with that of individuals recently diagnosed with cancer, individuals with chronic illness, and US residents of similar age and demographic characteristics. According to the CDC, "There is no consensus around a single definition of well-being."[23] Therefore, we studied a variety of well-being measures encompassing patients' health, life satisfaction, and productivity.

METHODS

This study compared well-being outcomes across 4 cohorts: 1) long-term cancer survivors, 2) patients recently diagnosed with cancer, 3) individuals with at least 1 nonterminal chronic illness, and 4) a nationally representative sample of US residents older than 50 years. Regression analysis was used to compare outcomes across the cohorts, adjusting for survey year, demographic characteristics,

TAKEAWAY POINTS

▶ Although patients with cancer experience diminished well-being in the short term across a variety of measures, in the long term, cancer survivors do as well as or better than US residents of similar age and demographic characteristics.

▶ We found that long-term cancer survival has an effect on well-being comparable with that of many chronic conditions. This is notable given that 70% of US residents older than 50 years have at least 1 comorbidity.

▶ Advances in cancer care that offer a chance of long-term survival may enable patients to experience a high quality of life.

smoking, and number of comorbidities. A study schematic is presented in **Figure 1**.
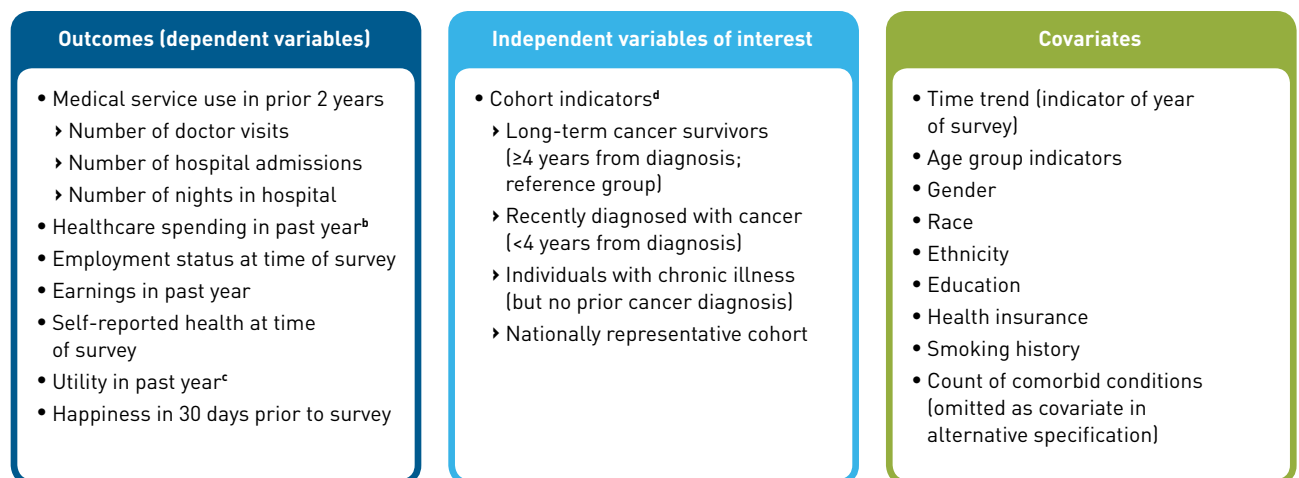
Cohort Selection and Data Sources

We used the Health and Retirement Study (HRS), a nationally representative biannual survey of US residents older than 50 years, to construct the 4 cohorts and follow their well-being outcomes over time. The HRS was designed to illuminate various aspects of US residents' lives, including health, finances, and employment, as they approach and move into retirement.[24]

The common definition of long-term survival in individuals who have had a cancer diagnosis is 5 years post diagnosis.[25-31] Because the HRS data are only collected every 2 years, we chose 4 years as the threshold for separating short- from long-term cancer survivors

FIGURE 1. Study Schematic[a]

Outcomes (dependent variables)	Independent variables of interest	Covariates

• Medical service use in prior 2 years
  ‣ Number of doctor visits
  ‣ Number of hospital admissions
  ‣ Number of nights in hospital
• Healthcare spending in past year[b]
• Employment status at time of survey
• Earnings in past year
• Self-reported health at time of survey
• Utility in past year[c]
• Happiness in 30 days prior to survey
	• Cohort indicators[d]
	  ‣ Long-term cancer survivors (≥4 years from diagnosis; reference group)
	  ‣ Recently diagnosed with cancer (<4 years from diagnosis)
	  ‣ Individuals with chronic illness (but no prior cancer diagnosis)
	  ‣ Nationally representative cohort
		• Time trend (indicator of year of survey)
		• Age group indicators
		• Gender
		• Race
		• Ethnicity
		• Education
		• Health insurance
		• Smoking history
		• Count of comorbid conditions (omitted as covariate in alternative specification)

HRS indicates Health and Retirement Study; MEPS, Medical Expenditure Panel Survey.

[a]Unless indicated otherwise, all variables were obtained from the 2004-2012 HRS.

[b]Healthcare spending was imputed in the HRS using the 1992-2010 Medicare Current Beneficiary Survey for individuals older than 65 years and the 2000-2010 MEPS for individuals aged 50 to 64 years.

[c]Utility was imputed in the HRS using the 2000-2010 MEPS data for individuals 50 years and older.

[d]Although the study analysis used the HRS from 2004 to 2012, to identify the cohorts, we included earlier survey waves (through 1992). This enabled us to accurately capture past diagnoses of cancer and chronic conditions disclosed in the prior waves.

(ie, long-term survivors were diagnosed at least 4 years ago, whereas short-term survivors were diagnosed less than 4 years ago). This definition enabled us to focus on long-term survivors beyond the acute treatment phase. Taking a long-term perspective was important because research suggests that the transition from patient to long-term survivor can be challenging,[32] and we sought to understand survivors' well-being after that transition has been undertaken.

The chronic illness cohort included individuals with a diagnosis of diabetes, hypertension, heart disease, lung disease, or prior stroke, but with no prior cancer diagnosis. The nationally representative cohort consisted of all individuals older than 50 years in the 2010 HRS data, as this was the most recent nationally representative wave in the HRS. The cohorts were analyzed over 2004 through 2012 at the person-year level, although we used HRS data from as far back as 1992 to identify whether patients were short-term or long-term cancer survivors. A patient could appear in multiple cohorts.

Because most outcomes in the HRS data are self-reported, these data are not ideally suited for tracking medical expenditures. Therefore, we developed an algorithm to impute total medical expenditures, including medical and pharmacy costs, in the HRS based on 2 data sets: the Medicare Current Beneficiary Survey (MCBS) for those older than 65 years and the Medical Expenditure Panel Survey (MEPS) for those between ages 50 and 64 years.

Specifically, we used the MCBS Cost and Use files, which combine results of a nationally representative survey of Medicare beneficiaries with administrative data to obtain accurate estimates of Medicare program spending.[33] Health conditions were identified using the Health Status and Functioning (Community) data file from the Cost and Use files. We used the MCBS and the HRS from 1992 to 2010 to develop this imputation and applied it to our 2004-2012 HRS sample.

To estimate the medical expenditures of individuals aged between 50 and 64 years, we used the MEPS years 2000 through 2010. Although MEPS is based on survey data, it is designed to measure healthcare cost and utilization.[34] In addition, the MEPS data were used to estimate utility for everyone older than 50 years based on the EQ-5D-3L measure, a utility measure introduced by the EuroQol Group in 1990. All health conditions were identified via self-reports from the MEPS condition files and household consolidated files.

Variables

Because there is no single consensus definition of well-being,[23] we selected a wide range of well-being outcomes, including medical service use, healthcare spending, employment status, earnings, self-reported health, utility, and happiness.

Medical service use measures included the numbers of doctor visits, hospital admissions, and hospital nights over the 2 years prior to the survey. Healthcare spending (medical and pharmacy) was measured annually in the year of the survey and inflated to 2014 dollars using the medical Consumer Price Index (CPI). We constructed a binary variable for whether an individual was working

at the time of the survey. We identified individuals as working if they were working full-time, they were working part-time, or they were working part-time in retirement. Earnings were measured annually in the year of the survey, conditional on the individual working, and inflated using the CPI for all urban consumers. Earnings summarized the market value of an individual's effort in the labor force and served as a proxy for productivity.

For self-reported health, we constructed a binary variable: poor or fair health versus good, very good, or excellent health. Self-reported health was measured at the time of the survey.

Utility was measured using a regression of EQ-5D-3L score on health, demographics, and functional status over the year prior to the survey.[35] For happiness, we constructed a binary variable: not at all, a little, or moderately happy versus quite a bit or very much happy. Happiness was measured over the 30 days prior to the survey.

We looked at the differences in these well-being outcomes across the 4 cohorts controlling for the year of the survey (2004-2012), age group (51-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, ≥85 years), gender, race (white/Caucasian, black/African American, other), ethnicity (Hispanic, non-Hispanic), education (less than high school, general educational development certificate, high school graduate, some college, college and above), health insurance (insured, not insured), smoking history (ever smoked, never smoked), and comorbidity count. The latter included any prior diagnoses of cancer, diabetes, heart disease, hypertension, lung disease, or stroke. Prior diagnosis was determined by whether an individual indicated ever being diagnosed with any of the mentioned diseases, as determined in the year of eligibility for the cohort in question.

Statistical Analysis

Descriptive analysis. We performed a descriptive analysis on the HRS data using standard weights to compare outcomes across cohorts at the person-year level. Simple 2-way *t* tests were conducted to assess the significance of the differences in means across cohorts.

Multivariable analysis. We ran multivariable analyses for all outcomes to compare the well-being of long-term cancer survivors with that of the other 3 cohorts, adjusting for survey year, demographic characteristics, smoking, and number of comorbidities. Because cancer could plausibly affect the subsequent development of comorbidities,[11-16,36-38] we also ran an alternative specification omitting number of comorbidities as a covariate. Models were selected to be appropriate for the given outcome. We used a Poisson model for medical service use, an ordinary least squares model for annual earnings conditional on being employed, a Tobit model for utility, and a generalized least squares model with a gamma distribution and log link for healthcare spending. Additionally, we used logistic models for the binary outcomes: self-reported health, happiness, and employment status. After conducting the analyses, we estimated the predicted values of all outcomes using the mean values of the covariates for the nationally representative cohort in 2010.

TABLE 1. Counts and Characteristics of Long-Term Cancer Survivors, Individuals Recently Diagnosed With Cancer, Individuals With Chronic Illness, and Nationally Representative Cohort

	Long-Term Cancer Survivors		Individuals Recently Diagnosed With Cancer		Individuals With Chronic Illness		Nationally Representative Sample in 2010	
	n	%	n	%	n	%	n	%
Cohort counts	8817		3374		57,108		22,034	
Age, years, mean (SD)	73.1 (9.7)		70.6 (9.3)		67.1 (10.3)		65.0 (10.6)	
Gender								
Male	3524	41.8	1700	52.7	24,988	46.7	9377	46.1
Female	4903	58.2	1526	47.3	28,547	53.3	10,960	53.9
Education								
Less than HS	1524	18.1	590	18.3	10,030	18.7	2927	14.4
GED	340	4.0	180	5.6	2631	4.9	946	4.7
HS graduate	2501	29.7	919	28.5	16,435	30.7	5653	27.8
Some college	1892	22.5	709	22.0	12,923	24.1	5213	25.6
College and above	2170	25.8	827	25.6	11,501	21.5	5594	27.5
Race								
White	7599	90.2	2888	89.5	43,899	82.1	16,901	83.3
Black/African American	568	6.7	261	8.1	6401	12.0	2081	10.3
Other	260	3.1	77	2.4	3181	5.9	1307	6.4
Ethnicity								
Not Hispanic	8078	95.9	3078	95.4	48,962	91.5	18,592	91.5
Hispanic	349	4.1	148	4.6	4541	8.5	1721	8.5
Smoked ever								
No	3405	40.6	1236	38.6	22,085	41.5	8845	43.7
Yes	4978	59.4	1965	61.4	31,177	58.5	11,408	56.3
Health insurance								
No insurance	196	2.3	87	2.7	3632	6.8	1654	8.2
Insurance	8212	97.7	3125	97.3	49,614	93.2	18,411	91.8
Comorbidity count (including cancer)								
0	0	0.0	0	0.0	0	0.0	6253	30.7
1	2029	24.1	818	25.4	28,751	53.7	6798	33.4
2	2893	34.3	1114	34.5	16,572	31.0	4431	21.8
3	2128	25.2	777	24.1	6347	11.9	2010	9.9
4	973	11.5	378	11.7	1631	3.0	678	3.3
5	359	4.3	121	3.7	233	0.4	154	0.8
6	46	0.5	19	0.6	0	0.0	13	0.1

GED indicates General Educational Development; HS, high school.

RESULTS

In 2010, there were 1184 long-term cancer survivors; 676 individuals recently diagnosed with cancer; 12,583 individuals with chronic illness; and 22,034 US residents older than 50 years ("the nationally representative cohort"). Over the biennial survey waves from 2004 to 2012, there were 8817; 3374; 57,108; and 22,034 person-years in the cohorts, respectively. Cohort characteristics are shown in **Table 1**.

Long-term cancer survivors were, on average, older compared with the other cohorts and more likely to be female, white, and non-Hispanic and to have health insurance. **Table 2** presents the results of the descriptive analysis. The means of medical service use, employment, and medical spending for individuals recently diagnosed with cancer, the chronic illness cohort, and the nationally representative cohort were all significantly different from those

TABLE 2. Comparison of Well-Being Outcomes Across Cohorts

Continuous outcomes	Long-Term Cancer Survivors		Individuals Recently Diagnosed With Cancer		Individuals With Chronic Illness		Nationally Representative Sample in 2010	
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Doctor visits in previous 2 years	7929	12.86 (19.35)	2955	20.83 (37.82)**	50,794	11.20 (21.67)**	19,263	10.53 (21.20)**
Hospital visits in previous 2 years	8379	0.64 (1.62)	3204	1.07 (1.68)**	53,119	0.52 (1.39)**	20,029	0.48 (1.60)**
Hospital nights in previous 2 years	8348	2.78 (9.20)	3177	5.76 (15.77)**	52,928	2.37 (9.37)**	19,959	2.04 (8.75)**
Annual earnings[a] (2014 US$)	1733	36,825 (61,456)	727	40,646 (48,826)	17,150	44,411 (85,010)**	8020	49,204 (68,725)**
Utility in previous year	8318	0.77 (0.09)	3180	0.77 (0.09)	52,933	0.77 (0.08)**	19,995	0.79 (0.08)**
Employment status[a]	8427	0.25 (0.43)	3226	0.27 (0.45)**	53,535	0.39 (0.49)**	20,337	0.46 (0.50)**
Annual medical expenditures (2014 US$)	6970	15,760 (7524)	2609	18,871 (11,057)**	44,081	11,050 (6939)**	16,751	9559 (7256)**
Ordinal outcomes	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Self-reported health[b]	8417	100.0	3221	100.0	53,490	100.0	20,328	100.0
Excellent	539	6.4	164	5.1	3110	5.8	2372	11.7
Very good	2300	27.3	710	22.0	14,620	27.3	6660	32.8
Good	2771	32.9	1042	32.4	18,482	34.6	6206	30.5
Fair	1903	22.6	772	24.0	12,298	23.0	3646	17.9
Poor	904	10.7	533	16.6	4980	9.3	1445	7.1
Happiness[c]	2206	100.0	772	100.0	12,630	100.0	7752	100.0
Very much	672	30.5	252	32.6	3905	30.9	2375	30.6
Quite a bit	870	39.4	284	36.8	4493	35.6	2927	37.8
Moderately	436	19.8	151	19.6	2718	21.5	1584	20.4
A little	191	8.7	62	8.0	1142	9.1	684	8.8
Not at all	36	1.7	23	3.0	372	2.9	181	2.3

*$P <.05$; **$P <.01$ for a mean that is statistically different from that of long-term cancer survivors.
[a]Includes employed full-time, employed part-time, and partly retired. Earnings are conditional on being employed.
[b]Self-reported health was converted to a binary variable (1 = excellent, very good, good; 0 = fair, poor). The means of individuals recently diagnosed with cancer and the nationally representative sample in 2010 were statistically different at $P <.01$ compared with the long-term cancer survivors.
[c]Happiness was measured in the 30 days prior to the survey. This measure was converted to a binary variable (1 = very much, quite a bit; 0 = moderately, a little, not at all). The means of chronically ill individuals were statistically different at $P <.01$ compared with the long-term cancer survivors.

of long-term cancer survivors ($P <.01$). The means of utility and earnings conditional on being employed for the chronic illness and nationally representative cohorts were significantly different from those of long-term cancer survivors ($P <.01$), whereas those of the recently diagnosed cohort were not statistically different from those of long-term cancer survivors. Grouping self-reported health as excellent, very good, or good versus fair or poor, the recently diagnosed cohort had a significantly lower likelihood of being excellent/very good/good, and the nationally representative cohort had a significantly higher likelihood, than long-term cancer survivors ($P <.01$). Grouping happiness as very much or quite a bit versus moderately, a little, or not at all, the chronic illness cohort was significantly less likely to be very much/quite a bit than long-term cancer survivors ($P <.01$).

The results of the multivariable analyses are presented in **Table 3**, which shows the predicted values of the different well-being measures in each cohort. Long-term cancer survivors fared better than the recently diagnosed cohort in terms of healthcare utilization, utility, healthcare spending, self-reported health, and employment (all $P <.01$). Differences in other outcomes were not significant. Similarly, long-term cancer survivors fared better than individuals with chronic illness in terms of healthcare utilization, utility, self-reported health (all $P <.01$), happiness, and employment status (both $P <.05$). Differences in other outcomes were not significant. Compared with the nationally representative sample, long-term cancer survivors fared better in terms of healthcare utilization, utility, employment status (all $P <.01$), self-reported health, and happiness (both $P <.05$). Other outcomes were not significantly different.
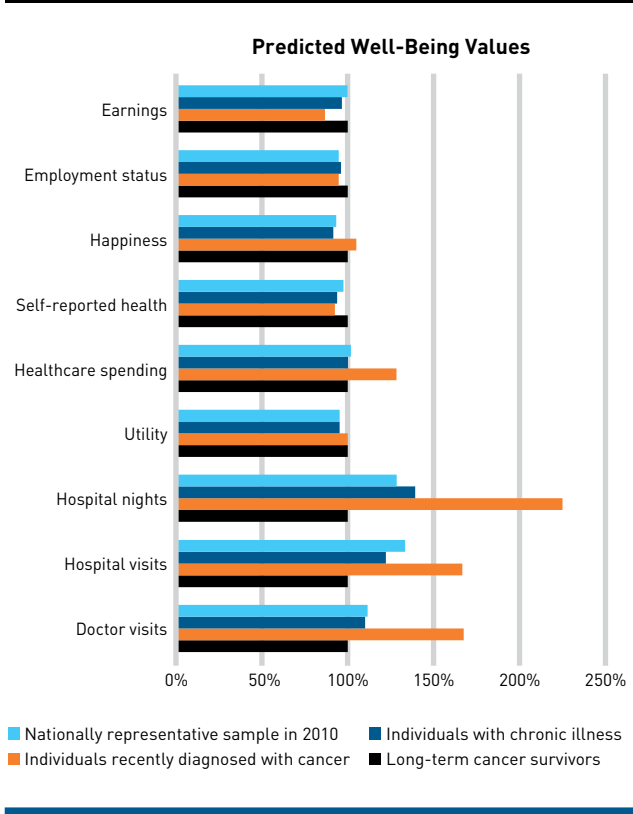
TABLE 3. Predicted Values of Well-Being Measures

Outcome/ Cohort	Predicted Values[a]								
	Doctor Visits	Hospital Visits	Hospital Nights	Utility	Healthcare Spending (2014 US$)	Self-Reported Health[b]	Happiness[c]	Employment Status[d]	Earnings[e] (2014 US$)
Long-term cancer survivors	2.95	0.09	0.28	0.86	3026	0.81	0.60	0.76	22,498
Individuals recently diagnosed with cancer	4.94**	0.15**	0.63**	0.86**	3886**	0.75**	0.63	0.72**	19,510
Individuals with chronic illness	3.25**	0.11**	0.39**	0.82**	3028	0.76**	0.55*	0.73*	21,731
Nationally representative sample[f]	3.29**	0.12**	0.36**	0.82**	3082	0.79*	0.56*	0.72**	22,478

*P <.05; **P <.01 for whether an outcome was significantly different from the long-term cancer survivors in the multivariable analyses.

[a]Predicted values were estimated using the results of the multivariable analyses, holding covariates for all cohorts fixed at the mean values of the nationally representative cohort in 2010. Specifically, we used a Poisson model for the medical service use outcomes, an ordinary least squares model for annual earnings conditional on being employed, a Tobit model for utility, and a generalized least square model with a gamma distribution and log link for healthcare spending. We used logistic models for the binary well-being outcomes: self-reported health, happiness, and employment status. The key explanatory variables were the cohort indicators. Covariates included the survey year, age group indicators, gender, race, ethnicity, education, health insurance, smoking history, and comorbidity count. An alternative specification was run omitting the comorbidity count as a covariate; it is reported in the **eAppendix**.

[b]Expressed as the probability of reporting excellent, very good, or good health rather than fair or poor.

[c]Expressed as the probability of reporting having felt happy very much or quite a bit rather than moderately, a little, or not at all.

[d]Expressed as the probability of being employed.

[e]Includes employed full-time, employed part-time, and partly retired. Earnings are conditional on being employed.

[f]The nationally representative sample is from 2010, the most recent available year that the Health and Retirement Study was nationally representative.

The multivariable results are presented graphically in **Figure 2**, which shows how the well-being measures compared across the 4 cohorts. To display all outcomes on a common scale, well-being measures were normalized so that the value of the long-term cancer survivors cohort is 100%.

The results of the alternative specification in which number of comorbidities was omitted as a covariate are presented in the **eAppendix** (available at **ajmc.com**). As in the base case, long-term cancer survivors fared better than the recently diagnosed cohort in the majority of well-being outcomes, with the exceptions of utility, happiness, and earnings, which were not significantly different. Compared with individuals with chronic illness, long-term cancer survivors had moderately higher healthcare utilization and spending and lower self-reported health but greater utility. There were no significant differences in hospital nights, happiness, employment, and earnings between long-term cancer survivors and individuals with chronic illness. Compared with the nationally representative cohort, long-term cancer survivors had greater healthcare utilization and spending and lower self-reported health and employment. Differences between long-term cancer survivors and the nationally representative cohort in terms of utility, happiness, and earnings were not significant.

DISCUSSION

Our study results show a marked improvement in cancer survivors' well-being in the long term compared with the first 4 years after

FIGURE 2. Across a Variety of Outcomes, Long-Term Cancer Survivors Had Similar or Better Outcomes Compared With Other, Demographically Similar Cohorts

Predicted Well-Being Values

Legend: Nationally representative sample in 2010 — Individuals with chronic illness — Individuals recently diagnosed with cancer — Long-term cancer survivors

diagnosis. Moreover, long-term cancer survivors fared at least as well as average US residents across a variety of well-being measures, controlling for demographics and the number of comorbidities. When comorbidities were not controlled for, long-term cancer survivors had modestly higher healthcare utilization and spending and modestly lower self-reported health and employment compared with average US residents. Taken together, these results suggest that when long-term cancer survivors fare worse than individuals without cancer, it is due to their comorbidity burden. These differences tended to be modest in size (eg, 1 extra doctor visit over 2 years). Moreover, even without controlling for comorbidity burden, there were no differences in happiness, utility, or earnings between long-term cancer survivors and average US residents.

Our analysis indicated that 70% of US residents older than 50 years have at least 1 comorbidity. Therefore, the fact that long-term cancer survivors fare comparably with others their age, many of whom are also dealing with health conditions, suggests that in the long term, cancer has an effect on well-being comparable with that of many chronic conditions.

Previous literature has compared the well-being of cancer survivors with that of individuals with chronic illness.[39,40] Steel et al studied the difference in health-related quality of life (HRQoL) of individuals with hepatocellular carcinoma (HCC), individuals with chronic liver disease (CLD), and the general population.[39] Those with HCC had statistically significantly poorer HRQoL than those with CLD and the general population. Those with HCC and CLD had better social and family well-being than the general population.

In a similar study, Elliot et al compared the well-being of cancer survivors without other chronic conditions, cancer survivors with chronic conditions, and individuals with chronic conditions other than cancer with that of healthy individuals.[40] They found that, generally, the well-being outcomes of cancer survivors without chronic conditions did not statistically differ from those of individuals with 1 chronic condition.

Other studies have compared the well-being of cancer survivors with that of the general population. Using data from the American Cancer Society's Study of Cancer Survivors, Zhou et al showed that ovarian cancer survivors had an HRQoL similar to that of the general population 1 year post diagnosis.[41] Kunitake et al found that long-term colorectal cancer survivors had better overall physical and mental health compared with the general population.[30] Similarly, Greenwald et al found that cervical cancer does not reduce the quality of life of long-term survivors,[42] and Schmidt et al found that breast cancer survivors may experience long-term quality of life comparable with that of the general population.[43] Finally, Thong et al found that although disease progression reduces cancer survivors' quality of life, the effect diminishes over time.[31]

Our study echoes the existing literature in finding that long-term cancer survivors fared as well as or sometimes better than the general population. The main contribution of our study is that it investigates short- and long-term cancer survivors' well-being across a variety of measures in a large, nationally representative sample.

Our findings are important given that recent breakthroughs in cancer treatment have raised the prospect of long-term survival for increased numbers of cancer patients. For example, new immuno-oncology agents, including ipilimumab, pembrolizumab, and nivolumab, have offered significant survival gains to patients,[44-48] and preliminary data suggest the prospect of long-term survival for some metastatic cancer patients.[49]

Limitations

Our study does have limitations. First, the HRS data do not distinguish between cancer types and, therefore, we were unable to perform separate analyses by tumor type. As such, our results represent the experience of the "average" cancer survivor and will overrepresent those with particularly common or less deadly cancers.

Second, the most recent nationally representative cohort in the HRS was in 2010, which was a recession year. Because the nationally representative cohort was constructed from the 2010 survey year and all other cohorts were constructed from the 2004-2012 survey years, secular trends could affect the well-being outcomes. However, we controlled for this by including survey year indicators in our analysis.

Third, in studying the well-being of cancer survivors, we necessarily limited the analysis to those who survived. Thus, we cannot definitively determine whether the observed changes in cancer survivors' well-being between the short- and long-term time horizons are due to cancer survivorship itself or to characteristics potentially common to individuals more likely to survive cancer.

Finally, we focused mainly on objective measures of well-being rather than subjective measures. However, focusing on objective measures does come with the advantage that, in doing so, we avoided any biases that can result from the way that subjective well-being outcomes are measured, as these outcomes can be subject to self-reporting or measurement bias.[50]

CONCLUSIONS

Our study results are striking, given concerns that patients with cancer may experience a low quality of life.[51] Although we do find that quality of life is reduced in the short term, we find that it solidly rebounds in the years after diagnosis, becoming comparable with or even better than that of others of similar age and demographic characteristics. The high quality of life experienced by long-term cancer survivors is relevant in the midst of debate about the cost and value of cancer care. Although cost and other up-front considerations are important, it is also important to keep the patient's perspective in mind. Prior research has shown that patients value therapies that give them a chance of long-term survival.[52] Our study shows that the well-being

of long-term cancer survivors eventually recovers, becoming similar to or even better than that of the general population. To the extent that long-term survivors enjoy a high quality of life, it makes interventions offering patients with cancer a chance of long-term survival more valuable. ∎

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eAppendix Table. Predicted Values of Well-Being Measures Using the Alternative Model Which Omits Number of Comorbid Conditions as a Covariate

Outcome/ Cohort	Predicted Values[a]								
	Doctor Visits	**Hospital Visits**	**Hospital Nights**	**Utility**	**Healthcare Spending (2014 US$)**	**Self-Reported Health[b]**	**Happiness[c]**	**Employment Status[d]**	**Earnings[e] (2014 US$)**
Long-term cancer survivors	5.58	0.30	0.95	0.78	5616	0.51	0.54	0.62	19,500
Individuals recently diagnosed with cancer	9.34**	0.52**	2.12**	0.78	7093**	0.43**	0.57	0.57**	16,567
Individuals with chronic illness	5.08**	0.26*	0.90	0.77**	4537**	0.55**	0.53	0.64	19,703
Nationally representative sample[f]	4.78**	0.26*	0.79*	0.78	4359**	0.63**	0.54	0.66**	21,284

*P <.05; **P <.01 for whether an outcome was significantly different from the long-term cancer survivors in the multivariable analyses.

[a]Predicted values were estimated using the results of the multivariable analyses, holding covariates for all cohorts fixed at the mean values of the nationally representative cohort in 2010. Specifically, we used a Poisson model for the medical service use outcomes, an ordinary least squares model for annual earnings conditional on being employed, a Tobit model for utility, and a generalized least square model with a gamma distribution and log link for healthcare spending. We used logistic models for the binary well-being outcomes: self-reported health, happiness, and employment status. The key explanatory variables were the cohort indicators. Covariates included the survey year, age group indicators, gender, race, ethnicity, education, health insurance, and smoking history.

[b]Expressed as the probability of reporting excellent, very good, or good health, rather than fair or poor.

[c]Expressed as the probability of reporting having felt happy very much or quite a bit, rather than moderately, a little, or not at all.

[d]Expressed as the probability of being employed.

[e]Includes employed full-time, employed part-time, and partly retired. Earnings are conditional on being employed.

[f]The nationally representative sample is from 2010, the most recent available year that the Health and Retirement Survey was nationally representative.