Cancer and Aging: Challenges and Opportunities across the Cancer Control Continuum

Cancer Survivorship and Aging

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Cancer is primarily a disease of the elderly. Greater than 60% of new cancers occur in people aged >65 years, and 60% of the current 10 million cancer survivors are aged >65 years. Given these large numbers and the potential vulnerability of older adults, older cancer survivors have become an especially important group to study. This article discusses published research on the physical and mental functioning of older cancer survivors. In the first part, the authors reviewed studies of those who are newly diagnosed at the age of ≥65 years. The second part reviewed the research regarding long-term (>5 years) cancer survivors who are aged >65 years, but may have been diagnosed at a younger age. Older survivors are likely to be more affected by cancer in terms of physical than psychologic function. However, comparisons with individuals without a history of cancer suggest that older cancer survivors may be faring worse physically and psychologically than noncancer comparison groups. For older cancer survivors, cancer occurs against a background of other chronic conditions and normal aging, and comorbidities and symptoms are important factors to consider. Limitations of the research were discussed, and recommendations for future research were provided. In particular, prospective studies with measures of functioning before cancer diagnosis and treatment, comparisons with age-matched noncancer populations, and interventions to reduce the impact of cancer on functioning are needed. Cancer 2008;113(12 suppl):3519–29. © 2008 American Cancer Society.

KEYWORDS: aging, elderly, oncology, cancer survivors, quality of life.

Cancer is primarily a disease of the elderly. Greater than 60% of new cancers occur in people aged >65 years. The incidence rate for all sites triples in persons ages 60 years to 70 years, compared with individuals aged 40 to 59 years. Moreover, as the proportion of the US population aged ≥65 years increases, even greater numbers of older individuals will be diagnosed with cancer. Improved early detection and treatment have also increased the number of people who have cancer for an extended period of time. Of the current 10 million cancer survivors, 60% are aged ≥65 years, and >16% of US adults aged ≥65 years are cancer survivors. Given these large numbers and the potential vulnerability of older adults, older cancer survivors have become an especially important group to study.

Survivorship represents a relatively new way of thinking about cancer as it is experienced by those who are diagnosed and treated for this disease. In the past, poor survival rates for the majority of cancers resulted in thinking of cancer as a “death sentence.” However, improved survival rates have made a survivorship orientation...
more realistic. This, along with the perspective of cancer as a chronic disease, has resulted in survivorship becoming a new focus for both the clinicians who treat cancer patients and the scientists who study them.

The term “survivor” now refers not only to those who have lived for an extended period of time after treatment, but also includes newly diagnosed individuals as well as those who are in treatment, have completed treatment, or are in remission. This change in orientation and language has been adopted and promoted by the American Cancer Society and the National Coalition of Cancer Survivors. In fact, the National Cancer Institute’s Office of Cancer Survivorship defines a survivor as anyone who has been diagnosed with cancer. Taken together, the definition of a cancer survivor now includes a range of individuals beginning with those newly diagnosed to those who have been free of cancer for decades.

This article discusses the physical and mental functioning of older cancer survivors across a temporal continuum. The first part reviewed research on survivors age ≥65 years who are relatively newly diagnosed (≥3 years) with cancer. The second part reviewed research on older survivors who represent long-term survivors. In reviewing the research, we focused on published research based on samples of cancer survivors aged >60 years only or research that specifically compared survivors of different age categories. We began our search with recently published articles identified through PubMed and added articles cited in these publications. This article did not attempt to provide an exhaustive review of all published research on older cancer survivors, but rather to present a sense of what is currently known regarding older cancer survivors, the limitations of this research, and directions for future research.

We should mention several factors that make comparisons across studies particularly challenging. One challenge is differing age distributions and cutpoints across studies. The most common cutpoint for older survivors is 65 years of age, but this is not used uniformly. Second, samples differ in their time since diagnosis. Some smaller studies have samples comprised of survivors with very explicit time intervals from diagnosis (eg, 3 months, 1 year), whereas other large cohort studies may have wider ranges (eg, any cancer survivor). Third, some studies control for important covariates, and others do not. As seen in this review, these covariates (particularly comorbidities and symptoms) are important considerations in studying older survivors. Fourth, studies involve different cancer sites. The majority of studies focus on breast cancer survivors, but others include survivors of multiple cancer sites. As seen in these studies, quality of life (QOL) issues vary by cancer site. Despite these challenges, there are some consistent patterns to the findings, and those patterns are the focus of this article.

Studies of Newly Diagnosed Older Patients

Although many studies have examined the physical and mental status of newly diagnosed cancer patients, to our knowledge few have focused specifically on older patients or on age-related comparisons. Even fewer provide comparisons with a general population. We classified these studies into 2 categories: 1) those that include older cancer survivors only or compare older and younger survivors, and 2) those that provide a comparison between older cancer patients with the general population.

**Newly diagnosed older survivors (no comparison group)**

Given et al and Ganz et al have conducted what to our knowledge are the largest studies published to date focusing specifically on older cancer survivors during the first year after diagnosis (Table 1). The primary aim of these studies was to examine the trajectory of functioning in the year after diagnosis and factors related to better functioning. Both studies assessed functioning with the Medical Outcomes Study 36-item Short Form (MOS SF-36), but found somewhat different results in terms of the trajectory of functioning over time.

Given et al studied 907 newly diagnosed breast, colon, lung, and prostate cancer patients aged ≥65 years and found that physical functioning improved over 1 year and that symptoms of depression decreased over 1 year. Ganz et al followed 691 newly diagnosed breast cancer patients aged ≥65 years for 15 months and found that both physical functioning and mental health on the SF-36 declined over time. It is difficult to determine why these studies found different patterns of functioning using the same instrument and similar timeframes. Differences cannot be explained by cancer site, because Given et al found improvement among all cancer sites.

Interestingly, Ganz et al found improvement over time on a cancer-specific psychosocial instrument (Cancer Rehabilitation Evaluation System). Both studies, however, found that the number of comorbid conditions was a significant predictor of changes in physical and mental health. Given et al also found that improvement in physical function was correlated with cancer site, being female, and having fewer symptoms; a decrease in depressive symptomatology was found to be correlated with cancer site,
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<tr>
<td>Given et al 2000</td>
<td>Newly diagnosed breast, colon, lung, and prostate cancer; N=907; all aged ≥65 y</td>
<td>6-8, 12-16, 26-30, and 52 wk after diagnosis</td>
<td>SF-36 physical function subscale</td>
<td>No. of comorbid conditions, cancer site, and sex</td>
<td>Physical function improved over time; predictors of worse physical function: site, age, female sex, comorbidity, and symptoms.</td>
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<tr>
<td>Stommel et al 2004</td>
<td>Same sample as Given et al 2000</td>
<td>Depressive symptomatology (CESD)</td>
<td>Sex, marital status, education, race/ ethnicity, cancer site, stage, comorbidities, physical function, and symptoms</td>
<td>Depressive symptomatology declined over time; predictors: cancer site, stage, comorbidities, education, physical functioning, and symptom severity; age was NS.</td>
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<tr>
<td>Ganz et al 2003</td>
<td>Newly diagnosed breast cancer; N=691; aged 65-69 y, 70-74 y, and ≥80 y</td>
<td>3, 6, and 15 months after surgery</td>
<td>SF-36 physical function and mental health; CARES-SF cancer-specific psychosocial summary, medical interaction, and self-rated health</td>
<td>Baseline QOL, social support, marital status, education, no. of comorbid conditions, type of surgery, treatment, ethnicity, Medicaid, and disease stage</td>
<td>Physical function declined over time; predictors: no. of comorbid conditions, chemotherapy, Medicaid, BCS without radiation. Mental health declined over time (small amount); predictors: no. of comorbid conditions, Medicaid, and married. CARES psychosocial score improved over time; predictors: social support and better interaction with healthcare providers. Perceived health at 15 mo; predictors: baseline physical function, mental health, and social support. Age not related to any outcome. Note: low response rate (50%).</td>
</tr>
<tr>
<td>Vinokur et al 1990</td>
<td>Breast cancer; N=274; stages I and II; aged &lt;60 y and ≥60 y</td>
<td>4 mo and 10 mo after diagnosis</td>
<td>Mental health (many measures) physical function</td>
<td>Younger patients reported significantly worse emotional well-being, breast cancer concerns, global QOL, and depression. No age difference noted in physical or functional well-being, sexual functioning.</td>
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<tr>
<td>Wenzel et al 1999</td>
<td>Breast cancer; stages I, II, and IIIA; aged ≤50 y (n=161), aged &gt;50 y (n=143); N=304</td>
<td>&lt;2 mo after treatment</td>
<td>FACT, CESD, sexual functioning</td>
<td>Younger patients reported lower emotional well-being. Other predictors: ≤high school education, symptoms, and lower social support.</td>
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<tr>
<td>Mor et al 1994</td>
<td>Newly diagnosed breast cancer patients; aged 24-54 y (n=143), aged &gt;55 y (n=119)</td>
<td>Beginning chemotherapy or radiation</td>
<td>SF-36 MHI-5</td>
<td>Younger patients reported lower emotional well-being. Other predictors: ≤high school education, symptoms, and lower social support.</td>
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<tr>
<td>King et al 2000</td>
<td>Early-stage breast cancer; aged 25-39 y (n=29), aged 40-49 y (n=86), aged 50-59 y (n=93), aged 60-81 y (n=95)</td>
<td>3 mo and 12 mo after surgery</td>
<td>EORTC QLQ-C30</td>
<td>Older patients reported better social, emotional functioning, less pain, fewer symptoms, but worse physical functioning.</td>
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</table>

SF-36 indicates Medical Outcomes Study 36-item Short Form; CESD, Center for Epidemiological Studies-Depression Scale; NS, not significant; CARES-SF, Cancer Rehabilitation Evaluation System, Short Form; QOL, quality of life; BCS, breast conservation surgery; FACT, Functional Assessment of Cancer Therapy; MHI-5, Mental Health Inventory; EORTC QLQ-C30, European Organization for Research and Treatment of Cancer quality of life questionnaire.
stage, physical functioning, and symptom severity. Age was found to be related to worse physical function in the study by Given et al., but was unrelated to outcomes in the report by Ganz et al.

Several studies have compared older and younger cancer survivors (Table 1). By using various outcome measures, these studies consistently found greater psychologic morbidity among younger cancer patients compared with older survivors. Possible explanations for this include cancer being an off-time event for younger women (most of these studies focused on breast cancer patients) and younger women having more family responsibilities, greater interference with work, more concerns about the impact of treatment on fertility, and fewer coping or financial resources. Although older cancer patients may experience less psychologic effects of cancer than younger survivors, older patients report worse physical functioning. Despite the consistency of findings, these studies were limited by the lack of adjustment for age-related differences in treatment. It is well established that younger cancer patients receive more aggressive cancer treatments, which could have a negative impact on their functioning.

**Cancer Patients Compared With the General Population**

The studies reviewed above all lacked a comparison group of similarly aged individuals who had not been diagnosed with cancer and were unable to distinguish between age-linked effects resulting from the impact of cancer and those that are the result of aging. This distinction is especially important given that older patients are likely to have several comorbidities and other functional limitations. Two studies addressed this limitation by providing explicit comparisons of older cancer survivors with the general population (Table 2). In a study conducted in Germany, Arndt et al. compared scores on the European Organization for Research and Treatment of Cancer QOL questionnaire (QLQ-C30) of cancer survivors who were 1 year after diagnosis with scores from a general adult population. They found differences between cancer patients and the general population among a younger cohort of patients, but not the older age group. Consistent with other studies, they found that among cancer survivors, age was correlated with better emotional and social functioning, but also poorer physical functioning.

Kroenke et al. used data from the Nurses’ Health Study (NHS) and NHS 2 to analyze change in function among women diagnosed with breast cancer within a 4-year period compared with an age-matched group of women who remained healthy over the same time period. A strength of this study

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TABLE 2

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<thead>
<tr>
<th>Study</th>
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<tr>
<td>Arndt et al 2004</td>
<td>Breast cancer patients; mean age: 57 y; aged 30-49 y (n = 88), aged 50-59 y (n = 85), aged 60-69 y (n = 87), aged 70-80 y (n = 54)</td>
<td>German female adult population ages 16-92 y; N = 1139</td>
<td>1 y after diagnosis</td>
<td>EORTC QLQ-C30</td>
<td>Age, smoking, alcohol, physical activity, BMI, comorbidities, menopausal status, hormone use</td>
<td>Age related to lower physical function and global QOL. Older patients reported better emotional, cognitive, and social functioning. Differences between cancer patients and reference group was largest for younger patients, older patients did not differ significantly from general population.</td>
</tr>
<tr>
<td>Kroenke et al 2004</td>
<td>Nurse’s Health Study and Nurse’s Health Study 2; women diagnosed with breast cancer (N = 1082); aged ≤40 y, aged 41-64 y, and aged &gt;65 y</td>
<td>Age-matched women without breast cancer</td>
<td>Prediagnosis and up to 4 y after diagnosis</td>
<td>SF-36</td>
<td>Baseline functional status, smoking, alcohol, physical activity, BMI, comorbidities, menopausal status, hormone use</td>
<td>All women with breast cancer showed greater functional declines compared with controls, but the difference was greater in younger women.</td>
</tr>
</tbody>
</table>

EORTC QLQ-C30 indicates European Organization for Research and Treatment of Cancer QOL questionnaire; QOL, quality of life; SF-36, Medical Outcomes Study 36-item Short Form; BMI, body mass index.
was the availability of SF-36 scores before diagnosis, which enabled researchers to compare change in SF-36 scores from before to after diagnosis. Controlling for baseline functional status, smoking, alcohol, physical activity, body mass index, comorbidities, menopausal status, and hormone use, they found that all women with breast cancer demonstrated greater functional declines than the controls. However, young women who developed breast cancer demonstrated greater absolute and relative functional losses in physical role function, bodily pain, social function, and mental health compared with middle-aged or older women with breast cancer. Results showed substantial physical declines in older women both with and without breast cancer, suggesting that much of this decline is related to age, rather than disease or treatment. This research highlights the importance of obtaining functional measures before treatment.

**Summary**

Taken as a whole, research on newly diagnosed older cancer patients suggests that for older cancer survivors, cancer affects physical functioning more than psychologic functioning. Whereas older cancer patients may demonstrate some psychologic impact of cancer, this tends to be relatively short-lived and less detrimental than for younger patients. Although several hypotheses have been put forward as to why younger cancer survivors have greater psychologic morbidity, these hypotheses need to be explored further and tested. Conversely, older cancer patients may be more affected by cancer in terms of physical function. The presence of comorbidities is especially important and needs to be considered in any study of older cancer survivors.

**Studies of Long-term Cancer Survivors**

This section focuses specifically on the physical and psychosocial QOL of older-adult long-term survivors of cancer (≥5 years). The diversity of older adults included in these studies in terms of age at diagnosis, current age, and length of survivorship makes this literature difficult to synthesize. Studies often include individuals who range from ages 60 years to 90 years at the time of the study, but may have survived cancer for ≥25 years. This results in the inclusion of very different survivor subgroups. As in the previous section, studies of long-term cancer survivors can be categorized as: 1) those that include only cancer survivors and 2) those that compare cancer survivors to those without cancer. We reviewed each category separately.

**Older adult long-term survivors only (no comparison group)**

Many of the long-term survivorship studies that included older adults did not include a comparison group of similarly aged individuals without a history of cancer. As with other studies of survivors, the majority focused on breast cancer survivors. Our review (Table 3) reflects this pattern.

In a study of 316 breast cancer survivors aged >65 years who were followed for 5 years after diagnosis, Clough-Gorr et al reported that mental health did not change for the majority of survivors. Those survivors who did demonstrate a decline in mental health had poorer physical function at baseline. Ganz et al found that age was positively related to general health, and that older breast cancer survivors reported less of an impact of cancer on their lives, a finding also reported by Stava et al.21 Cimprich et al compared long-term (≥5 years) breast cancer survivors diagnosed at different ages (<45 years, 45 to 64 years, and ≥65 years) and found that survivors diagnosed at an older age (aged ≥65 years) reported significantly poorer QOL in the physical domain, whereas those diagnosed at a younger age (aged <45 years) demonstrated worse QOL in the social domain.

Two groups of researchers have conducted studies focusing on long-term survivors of multiple types of cancers. Avis et al studied 242 long-term (≥5 years) survivors of breast, bladder, prostate, colorectal, head and neck, or gynecologic cancer. Approximately Eighty-five percent of this sample was aged >60 years, and 65% was aged >70 years. The mean time since diagnosis was 12.6 years. This study was conducted in the context of developing a QOL instrument specific to adult cancer survivors, the Quality of Life in Adult Cancer Survivors (QLACS) scale. The biggest problems cited by survivors were sexual problems, fatigue, and family-related concerns surrounding disease recurrence.23 QOL varied by cancer site, with prostate and colorectal cancer survivors reporting the best QOL and head and neck and bladder cancer survivors the worst QOL.

Deimling et al also conducted a study of long-term breast, colorectal, and prostate survivors that specifically examined QOL issues. They studied 321 survivors aged >60 years who were at least 5 years after diagnosis. Their results demonstrated that nearly 40% of older survivors had at least 1 continuing symptom attributed to cancer or its treatment. Survivors who had chemotherapy and/or more types of treatment reported significantly more symptoms both during treatment and currently. Being African American or female was found to be significantly associated with more current symptoms and greater
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<tbody>
<tr>
<td>Cimprich et al 2002</td>
<td>Breast cancer; N=105; aged &lt;45 y (n=42), aged 45-65 y (n=35), aged &gt;65 y (n=28); mean age: 64.5 y</td>
<td>≥5 y after diagnosis; range, 5-50 y; mean, 11.5 y</td>
<td>QOL-CS: domains: physical well-being, psychologic well-being, social well-being, and spiritual well-being.</td>
<td>y since diagnosis, marital status, education, type of surgery, chemotherapy, radiation, and antiestrogen therapy.</td>
<td>Women diagnosed at an older age reported lower physical well-being; women diagnosed at a younger age reported lower social well-being.</td>
</tr>
<tr>
<td>Ganz et al 2002</td>
<td>Mean age: 55.6 y at baseline; follow-up occurred 4 y later</td>
<td>5-9.5 y after diagnosis; mean, 6.3 y</td>
<td>SF-36 General Health; Ladder of Life Scale</td>
<td>Demographics (age, ethnicity, education, income, and partnership status), time since diagnosis, type of surgery, chemotherapy (tamoxifen), social support, comorbidities, general well-being, and physical functioning</td>
<td>Age was found to be positively related to general health; age was found to be unrelated to the Ladder of Life Scale; older survivors reported less impact of cancer.</td>
</tr>
<tr>
<td>Clough-Gorr et al 2007</td>
<td>Breast cancer, aged ≥ 65 y; aged 65-69 y (n=172), aged 70-79 y (n=372), aged ≥80 y (n=116)</td>
<td>Follow-up to 5 y after diagnosis</td>
<td>MHI-5, CARES SF breast cancer-specific emotional health</td>
<td>Education, adequate finances, physical function, comorbidity, and social support</td>
<td>Mental health for majority of survivors did not change; decline in mental health related to less education and poorer physical function. Did not analyze by age group.</td>
</tr>
<tr>
<td>Deimling et al 2007</td>
<td>Breast, colorectal, and prostate cancer; aged 60-64 y (n=30), aged 65-74 y (n=76), aged ≥75 y (n=74)</td>
<td>5 y after diagnosis</td>
<td>POMS anxiety, hostility, depression; (CES-D); PTSD</td>
<td>Age, race, sex, comorbidities, stage, cancer type, treatment type, and cancer-related symptoms</td>
<td>25% reported clinical levels of depression, current cancer-related symptoms related to depression and hyperanxious; younger patients reported greater anxiety; hostility; age was found to be unrelated to depression or PTSD.</td>
</tr>
<tr>
<td>Deimling et al 2007</td>
<td>Breast, colorectal, and prostate cancer; N=180; ages 60-64 y (n=30), aged 65-74 y (n=76), aged ≥75 y (n=74)</td>
<td>5 y after diagnosis</td>
<td>Burden of disability, subjective health, health worries, functioning (Nagi), and comorbidities</td>
<td>Age, race, sex, cancer type, years since diagnosis, and treatment type</td>
<td>African Americans reported poorer functioning, but this was not related to cancer, but rather to comorbidities.</td>
</tr>
<tr>
<td>Deimling et al 2007</td>
<td>Breast, colorectal, and prostate cancer; N=321; aged 60-64 y (n=50), aged 65-74 y (n=145), aged ≥75 y (n=126)</td>
<td>5 y after diagnosis</td>
<td>Symptoms during cancer, current symptoms, functioning (Nagi), comorbidities, and self-rated health</td>
<td>Age, race, sex, cancer type, and treatment type</td>
<td>40% continue to have 1 or more cancer-related symptom. Pain was most commonly reported symptom; chemotherapy related to more symptoms during treatment and currently; did not examine age differences.</td>
</tr>
<tr>
<td>Deimling et al 2007</td>
<td>Breast, colorectal, and prostate cancer; aged 60-64 y (n=30), aged 65-74 y (n=145), aged ≥75 y (n=126)</td>
<td>5 y after diagnosis</td>
<td>Current cancer symptoms, comorbidities, functional difficulties (Nagi), and restrictions on participation in social activities</td>
<td>Age, race, sex, cancer stage and type, y since diagnosis, current cancer-related symptoms, and comorbidities</td>
<td>Comorbidities were found to be the best predictor of functional difficulties and significant predictor of restriction. Continuing cancer symptoms were found to be a significant predictor of functional difficulties.</td>
</tr>
<tr>
<td>Deimling et al 2007</td>
<td>Breast, colorectal, and prostate cancer; aged 60-64 y (n=50), aged 65-74 y (n=145), aged ≥75 y (n=126)</td>
<td>5 y after diagnosis</td>
<td>Pain, energy, weakness, and functional difficulties</td>
<td>Age, race, sex, cancer stage and type, y since diagnosis, current cancer-related symptoms, and comorbidities</td>
<td>Current cancer symptoms correlated to pain, energy, and weakness. Noncancer symptoms and comorbidities were found to be the best predictors of pain, energy, and weakness.</td>
</tr>
</tbody>
</table>

QOL-CS indicates Quality of Life Cancer Survivors scale; SF-36, Medical Outcomes Study 36-item Short Form; MHI-5, Mental Health Inventory; CARES-SF, Cancer Rehabilitation Evaluation System, Short Form; POMS, Profile of Mood States; CES-D, Center for Epidemiologic Studies Depression Scale; PTSD, post-traumatic stress disorder.
functional difficulty, but this was related to having more comorbidities and not to cancer-related factors such as cancer stage at diagnosis or treatment complexity.

In terms of specific symptoms, pain was the most commonly reported symptom, with 21% attributing this current symptom to their past cancer or its treatment. Although cancer-related factors were significant correlates of pain, comorbidities and non-cancer symptoms were stronger correlates. Greater than 40% of breast cancer survivors and nearly 20% of prostate cancer survivors reported pain, with breast cancer survivors reporting the highest levels of pain. Race was also a significant correlate of pain, with African-American women having the highest scores.

Greater than 40% of survivors reported feeling weakness or lack of energy within the past week, with approximately 25% attributing it to cancer. However, as with other symptoms, the lack of energy and weakness reported by these older adult survivors was found to be more strongly related to age-related factors such as the number of other health problems rather than cancer.

This study also found important psychosocial outcomes of cancer. Nearly half of the older adult long-term survivors reported a range of cancer-related worries such as fears of disease recurrence, fears of a new cancer, and fears that symptoms they experience may represent cancer. Furthermore, these fears were correlated with the number of cancer-related symptoms experienced during treatment as well as current cancer-related or treatment-related symptoms. Importantly, cancer-related worries were found to be significant predictors of more general levels of distress such as anxiety and depression.

**Comparison of long-term survivors to those without a cancer history**

Most of the long-term physical and mental effects of cancer reported above are from studies that included only cancer survivors. To fully understand the impact of cancer on older persons, it is important to compare long-term survivors with individuals who have never had cancer. These studies are presented in Table 4.

In a study focusing specifically on older adult, long-term survivors from the Health and Retirement study, Keating et al compared cancer survivors with a population-based noncancer comparison group from this same study. Cancer survivors had higher rates of specific comorbidities such as lung disease, heart disease, arthritis, incontinence, frequent pain, and obesity compared with controls. Controlling for these comorbidities, survivors were still less likely to report being in excellent health and had more mobility and activity limitations than those without a history of cancer. Older long-term cancer survivors did not exhibit more psychiatric disease or depression, nor did they exhibit poorer cognitive functioning compared with those who never had cancer.

Robb et al compared SF-36 scores and measures of psychologic well-being from a sample of older adult breast cancer survivors aged ≥70 years with the scores of women who had never had cancer. Their analysis found that cancer survivors reported poorer physical functioning, bodily pain, more days per week with fatigue, and worse psychologic well-being than the comparison group. However, the comparison group was a sample of women enrolled in a longitudinal study of healthy aging, and therefore may have been particularly healthy.

Using data from the large Health Outcomes Study, Baker et al compared SF-36 scores between those participants who had a history of cancer with age-matched participants who did not. They found that cancer survivors had poorer QOL on all subscales of the SF-36, but the effect sizes were small. Those who were currently in treatment for lung cancer or had >1 cancer were worse off. Comorbidities were found to be significantly related to health-related QOL. In what to our knowledge was 1 of the few studies that further broke down the group of patients aged >65 years, they found that the patients ages 65 years to 74 years reported better QOL than those who were aged >75 years.

Hewitt et al used data from the National Health Interview Survey to compare participants with a history of cancer with those without such a history. Analyses included survivors ranging from <2 years to those who had survived >20 years. Cancer survivors had more comorbidities and were more likely to report poorer overall health and limitations in activities of daily living. Survivors reported greater use of mental health services in general; this was noted particularly for younger women, who also reported greater psychologic problems. Although these analyses include both short-term and long-term survivors, 83% of the sample had been diagnosed >2 years previously.

Two studies were able to take advantage of existing large cohorts in which data were available before a cancer diagnosis. Sweeney et al compared the functional limitations of female older-adult cancer survivors (ages 66 years-79 years) from the Iowa Women's Health Study with study participants who had never had cancer. Controlling for baseline characteristics (obesity, smoking, and diabetes) and comorbidities, they found that 5-year survivors, compared with those without a cancer history, were sig-
### TABLE 4
Studies Comparing Long-term Survivors With Controls

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<tr>
<td>Arndt et al 2004&lt;sup&gt;11&lt;/sup&gt;</td>
<td>Aged 30-49 y (n = 67), aged 50-59 y (n = 66), aged 60-69 y (n = 75), aged ≥70 y (n = 43)</td>
<td>German general population that was age-standardized</td>
<td>3 y after diagnosis</td>
<td>EORTC QLQ-C30</td>
<td>None reported</td>
<td>Differences between cancer patients and general population were greatest for younger patients.</td>
</tr>
<tr>
<td>Robb et al 2007&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Breast cancer; N = 127; aged ≥70 y; mean age, 78 y</td>
<td>Women in epidemiologic study of aging; N = 119; mean age, 77.6 y</td>
<td>&gt;1 y after diagnosis; mean, 5.1 y</td>
<td>SF-36 psychologic well-being</td>
<td>Did not adjust</td>
<td>Breast cancer survivors reported worse QOL and some psychologic well-being (comparison group may have been particularly healthy); survivors had more comorbidities.</td>
</tr>
<tr>
<td>Baker et al 2003&lt;sup&gt;13&lt;/sup&gt;</td>
<td>Health Care Financing Administration’s Health Outcome Survey; N = 22,747; aged 65-74 y (n = 10,969), aged ≥75 y (n = 10,716)</td>
<td>Age-matched noncancer patients</td>
<td>Anytime postdiagnosis</td>
<td>SF-36</td>
<td>Age, sex, race, Hispanic, income, marital status, education, medical condition, treatment status, cancer site</td>
<td>Cancer survivors had poorer QOL than comparison group on all subscales, but effect sizes were small; those in treatment for lung cancer or &gt;1 cancer were worse; comorbidities also significantly related to HRQOL; 65-74 group had higher scores.</td>
</tr>
<tr>
<td>Sweeney et al 2006&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Iowa Women’s Health Study; aged 55-69 y in 1996; aged 66-79 y in 1997; mean age, 72 y; cancer survivors; N = 2218</td>
<td>Study participants without cancer; N = 23,601</td>
<td>&gt;2 y after diagnosis, 2-5 y after diagnosis, ≥5 y after diagnosis</td>
<td>Functional limitations</td>
<td>Smoking, BMI, comorbidities, physical activity, and education</td>
<td>Cancer survivors reported more functional limitations; difference greatest for patients surviving ≤2 y.</td>
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<td>Garman et al 2003&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Duke established populations for epidemiologic studies of the elderly cancer patients; N = 578; all aged ≥65 y; mean age, 73.6 y</td>
<td>Participants never diagnosed with cancer; N = 3784</td>
<td>Patients diagnosed 0-4 y previously (n = 132), diagnosed 5-15 y previously (n = 117), and diagnosed &gt;15 y previously (n = 127)</td>
<td>Katz activities of daily living, Rosow-Breslau Nagi scale, instrumental activities of daily living</td>
<td>Comorbidity score of 0 or 1 vs ≥2 predictors were age, sex, race, marital status, education, depression, and cognitive status</td>
<td>Cancer survivors reported greater use of mental health services and were more likely to report poorer health; HRQOL was worse among those aged ≥65 y and diagnosed at younger age, and more comorbidities, formerly married.</td>
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<td>Keating et al 2005&lt;sup&gt;16&lt;/sup&gt;</td>
<td>Health and Retirement Study cancer survivors; N = 964; all aged ≥55 y; mean age, 68.3 y</td>
<td>Participants who did not report having cancer; N = 14,333</td>
<td>≥4 y after diagnosis</td>
<td>Self-assessed health, ADLs, and depression</td>
<td>Comorbidities</td>
<td>Survivors had worse physical health; no difference noted with regard to mental health. Comment: Analysis used propensity score weights.</td>
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<td>Hewitt and Rowland 2002&lt;sup&gt;17&lt;/sup&gt;</td>
<td>National Health Interview Survey; aged 18-44 y; aged 45-64 y; aged ≥65 y; cancer survivors; N = 4878</td>
<td>Participants without a history of cancer; N = 90,737</td>
<td>Anytime after diagnosis; 83% of sample was ≥2 y after diagnosis</td>
<td>Use of mental health services</td>
<td>Sociodemographics and health characteristics</td>
<td>Cancer survivors reported greater use of mental health services; mental health service use greater among those aged &lt;65 y and diagnosed at younger age, and more comorbidities, formerly married.</td>
</tr>
<tr>
<td>Hewitt et al 2003&lt;sup&gt;18&lt;/sup&gt;</td>
<td>National Health Interview Survey; aged 18-44 y; aged 45-64 y; aged ≥65 y; cancer survivors, N = 4878</td>
<td>Participants without a history of cancer; N = 90,737</td>
<td>Anytime after diagnosis; 83% of sample was ≥2 y after diagnosis</td>
<td>General health status, psychologic disability, limitations in ADLs and IADLs, physical functioning</td>
<td>Sociodemographics, comorbidities, cancer site, age, and age at diagnosis</td>
<td>Cancer survivors had more comorbidities and were more likely to report poorer health, psychologic problems, limitations of ADLs and IADLs, and functional limitations. Among cancer survivors, younger survivors reported greater psychologic problems.</td>
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</table>

EORTC QLQ-C30 indicates European Organization for Research and Treatment of Cancer quality of life questionnaire; SF-36, Medical Outcomes Study 36-item Short Form QOL, quality of life; HRQOL, health-related quality of life; BMI, body mass index; ADLs, activities of daily living; IADLs, instrumental activities of daily living.
nificantly more likely to report functional limitations such as an inability to do housework, walk a half mile, or walk up/down stairs. Using data from the Duke Established Populations for Epidemiologic studies of the Elderly, Garman et al found that function decline was significantly correlated with the presence of comorbidities rather than cancer per se among participants aged ≥65 years.

Summary
The research regarding long-term cancer survivors is noteworthy for the consistency of findings that cancer survivors have more comorbidities and poorer functioning (independent of comorbidities) than noncancer survivors. The consistency of this research is in contrast to that of newly diagnosed older patients, in whom the effects of cancer due to age are not as apparent. It thus appears that age-related differences may arise over time. This may be the result of the late effects of cancer and its treatment, consequences of underlying risk factors for cancer (eg, smoking and diet), or the interaction of cancer and aging. This highlights the importance of studying the late effects of cancer and developing interventions to prevent loss of functioning with age.

Summary and Future Research Directions
The literature suggests that older cancer survivors are likely to be more affected by cancer in terms of physical compared with psychologic function. Physical domains also may be more important to older persons, for whom impairments in mobility may mean the difference between independent and assisted living. The literature has consistently shown that older breast cancer survivors are less likely to have psychologic morbidity than younger survivors. However, comparisons with noncancer patients in some studies suggest that older cancer survivors may be faring worse psychologically than noncancer survivors. In the context of older cancer survivors, it is important to consider the impact of an acute cancer episode on a background of other chronic conditions and deterioration in physical functioning that is part of normal aging. To our knowledge, very few studies to date have measures of functioning before a cancer diagnosis and treatment, thus making it difficult to determine the direct impact of cancer.

Limitations of Research
The majority of studies reviewed herein focused on breast cancer survivors. This is largely a result of the large numbers of long-term breast cancer survivors. However, the extent to which these findings can be generalized to men, cancers that progress more quickly, and cancers with different patterns of treatment is unknown. Another limitation is that most studies do not report effect sizes, which is particularly important for some of the studies that determined statistical significance with large sample sizes.

Studies comparing older and younger cancer survivors do not take treatment characteristics beyond type of surgery or adjuvant therapy into account. This is an important consideration because older persons tend to receive less aggressive treatment because of the greater likelihood of estrogen receptor–positive tumors, the presence of comorbid conditions, and lower functional status, and more aggressive treatment may impact QOL. To truly understand the impact of age on cancer survivorship, it is important to control for type of treatment received.

Although many studies control for comorbidities, others do not. The long-term effects of cancers that are common among older adults often coexist along with other health problems associated with aging. Thus, older adults may experience this dual vulnerability. Over a decade ago, Havlik et al identified comorbidities as a significant issue among cancer survivors and found them to increase with advancing age. Recently, others have also identified the presence of comorbidities among older survivors as 1 of the key issues to be addressed by research on cancer and aging.

Finally, it should be noted that few articles report effect sizes, but in those that do, the effect size is often modest. This is noted especially in studies with large sample sizes, in which small effects can be statistically significant.

The following approaches to future research are suggested:

- Any study of older cancer survivors needs to consider comorbidities and their interaction with a cancer diagnosis. As observed in the studies described herein, comorbidities are important determinants of QOL.
- Comparisons with age-matched noncancer populations are critical for understanding the impact of cancer on older persons. These comparisons are particularly important in the context of other functional declines that occur with aging and are not attributable to cancer.
- Prospective studies that measure physical and mental health functioning before treatment are needed to assess changes in functioning resulting from treatment.
- Age groupings of older survivors need to be broken down further into young-old and old-old. To our
knowledge, the majority of research published to date combined all survivors aged >65 years. However, some research has shown age differences even among those aged ≥60 years. The general gerontologic literature would recommend separating the young-old from the old-old, because research has shown that there are important health, functioning, and psychosocial differences among age groupings of older adults.

- It is important to identify subgroups of older survivors at greatest risk. This may include those who have poor functioning at the time of diagnosis, low social support, or comorbidities. Cancer site and type of treatment may also be important.

- Greater emphasis is needed on recruiting older persons into clinical trials. Relatively few elderly persons are accrued to clinical trials because of concerns that older patients cannot tolerate or will not benefit from treatment or restrictive inclusion/exclusion criteria. These criteria need to be carefully evaluated to ensure that older persons are not excluded unnecessarily.

- Interventions are needed to reduce the impact of cancer on functioning. Existing behavioral interventions that have shown benefits among cancer survivors in general need to be applied to older patients. In some instances, this may mean adjusting the modality or specific of the intervention (eg, exercise).

A more detailed discussion of the implications for future research is provided in the article by Bellizzi et al in this issue.

REFERENCES


