

Treatment and Lifestyle Profiles of Healthy Aging Survivors: A Report from the Childhood Cancer Survivor Study

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Background: Survivors of childhood cancer are at elevated risk for adverse health outcomes, but many maintain excellent health throughout adulthood. We sought to characterize the trajectories of, and examine factors associated with, healthy aging across the lifespan.

Methods: We longitudinally surveyed ≥ 5 y cancer survivors (18-64 y) and sibling controls enrolled in the Childhood Cancer Survivor Study. "Healthy aging" was defined by 1) having a cumulative number of severe or life-threatening (i.e., grade 3+) chronic health conditions (CHCs) less than or equal to the mean of same age, same sex sibling controls; and 2) having no functional impairment or activity limitations. We then examined prevalences of healthy aging and its 2 component domains across survivor age groups (<30, 30-39, 40-49, ≥ 50 y). Multivariable logistic regression models adjusted for demographic, treatment, and lifestyle factors at cohort entry were used to estimate risk factors for healthy aging among survivors.

Results: We analyzed 17,263 survivors (median age 39 y, IQR 32-46) and 3,378 siblings. Among all sibling age/sex groups, mean grade 3+ CHC counts were <1. Of survivors, 53.4% (95% CI 52.7-54.2) had no Grade 3+ CHC, and 71.4% (95% CI 70.7-72.1) reported no functional impairment. Overall, 45.0% (95% CI 44.2-45.7) of survivors met criteria for healthy aging, but this prevalence decreased with age (Table). In multivariable analysis, treatment factors associated with lower odds of healthy aging included anthracycline dose (≥ 250 mg/m² vs none: OR 0.60, 95% CI 0.52-0.69), alkylator dose (4-7.9 g/m² vs none: OR 0.78, 95% CI 0.66-0.91; ≥ 8 g/m² vs none: OR 0.76, 95% CI 0.67-0.86), and stem cell transplant (OR 0.60, 95% CI 0.41-0.89). High doses of radiation to any site were also associated with less healthy aging (e.g., ≥ 30 Gy to brain vs none: OR 0.22, 95% CI 0.19-0.26; ≥ 35 Gy to chest vs none: OR 0.62, 95% CI 0.47-0.83; ≥ 20 Gy to abdomen vs none: OR 0.56, 95% CI 0.43-0.71). Baseline physical activity >180 min/week was associated with healthy aging (vs <180 min: OR 1.23, 95% CI 1.11-1.37). Underweight, overweight, and obese baseline BMIs had lower odds of healthy aging compared with normal BMI (ORs 0.54 to 0.82, each $p < 0.05$). Survivors treated in more recent decades were more likely to experience healthy aging (1990s vs 1970s: OR 1.26, 95% CI 1.06-1.50) even after adjusting for attained age.

Conclusions: Among childhood cancer survivors, the prevalence of healthy aging declines with age but has improved in more recent treatment eras. Higher levels of exercise and normal BMI at baseline were associated with subsequent healthy aging, suggesting that the trajectory of aging could be improved through targeted interventions.

Table: Prevalence (%) of outcomes across survivor age groups (95% CI)

	<30 y	30-39 y	40-49 y	≥50 y
CHC count ≤ sibling mean for age/sex	67.4 (65.8, 69.0)	59.3 (58.1, 60.5)	47.5 (46.2-48.9)	34.4 (32.6-36.2)
No functional impairment or activity limitations	76.0 (74.6, 77.5)	73.9 (72.8, 74.9)	69.4 (68.2-70.7)	64.1 (62.3-65.9)
Healthy aging*	58.0 (56.3, 59.7)	50.8 (49.5, 52.0)	39.2 (37.8-40.5)	27.2 (25.5-28.9)

*Defined as having both a low CHC count for age/sex as well as no functional impairment/activity limitations.