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Cancer Epidemiology, Biomarkers & Prevention

Research Article

Prevalence and Correlates of Smoking and Cessation-Related Behavior among Survivors of Ten Cancers: Findings from a Nationwide Survey Nine Years after Diagnosis

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Abstract

Background: Smoking is detrimental to recovery and survival from cancer, but many cancer survivors continue to smoke. Information is lacking on smoking patterns of survivors many years after diagnosis and correlates of smoking status and patterns, likelihood of quitting, and intentions to quit.

Methods: Cross-sectional analyses were conducted among survivors of 10 cancers recruited by stratified random sampling from cancer registries in a nationwide, longitudinal, quality-of-life study ($n = 2{,}938$).

Results: Approximately 9 years after diagnosis, 9.3% of all survivors were current (past 30-day) smokers. Smoking prevalence was highest among survivors of bladder (17.2%), lung (14.9%), and ovarian (11.6%) cancers. Most current smokers (83%) smoked daily, averaging 14.7 cigarettes per day (cpd). Forty percent of daily smokers smoked more than 15 cpd. Nondaily smokers smoked a mean of 10.9 days in the last 30 days and averaged 5.7 cpd on smoking days. Current smoking was associated with younger age, lower education and income, and greater alcohol consumption. Quitting after diagnosis was associated with having a smoking-related cancer. Roughly, a third of current smokers intended to quit, 40% within the next month. The odds of intending to quit were lower if survivors were married, older, or smoked more.

Conclusions: This population-based study indicated that smoking can persist long after initial diagnosis and at high levels and identified characteristics associated with quitting and intentions to quit.

Impact: Findings can be used to identify survivors most at risk for continued smoking and to inform tailoring of cessation treatments for survivors. *Cancer Epidemiol Biomarkers Prev; 23(9); 1783–92. ©2014 AACR.*

Introduction

Prevalence and patterns of smoking in survivors

Cigarette smoking decreases the effectiveness of cancer treatments, increases the probability of recurrence, and reduces survival time (1, 2). Yet a significant proportion of cancer survivors continue to smoke tobacco post-diagnosis (3–7). Population-based, cross-sectional surveys estimate that between 15% and 18% of cancer survivors currently smoke (8–11), but prevalence varies by type of cancer diagnosis (9, 10) and is higher among younger survivors (8, 10) and those diagnosed with smoking-related cancers (11). There is a lack of information on smoking prevalence and cessation interventions for survivors many years after diagnosis, however. High smoking rates would suggest the need for interventions at points well after recovery, and knowledge of factors associated with smoking behavior could inform clinical practice and, potentially, the tailoring of interventions—an important aspect of effective treatment for this population (12).

There is also a lack of data on patterns of smoking, such as daily versus nondaily smoking, or heaviness of smoking (i.e., cigarettes per day), among cancer survivors long after treatment for initial diagnoses has ended. Recently, research has pointed to significant increases in the prevalence of nondaily smoking in the general population (13, 14). Evidence of a high prevalence of nondaily smoking among long-term survivors who smoke has implications for cessation interventions; for example, the dangers of nondaily smoking would need to be addressed in treatment. Moreover, the dearth of evidence-based treatments for nondaily smokers suggests a gap in our capacity to successfully treat survivors who are also chronic nondaily smokers.

Predictors of quitting among survivors

A number of studies have examined sociodemographic and other factors associated with subsequent quitting among those who smoked at the time of diagnosis. For example, in a study of 566 individuals from the National

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Health and Nutrition Examination Survey (NHANES; ref. 7), cross-sectional analyses found that the likelihood of (self-reported) smoking post-diagnosis was associated with being female, younger, Hispanic, underweight or normal weight, and not having a smoking-related cancer. Other studies have corroborated findings regarding female gender (15) and younger age (15) and also documented lower income and/or education (16) and type of cancer (17) as predictors of quitting smoking post-diagnosis. These studies have been limited by small samples frequently from a single institution, a focus on single or smoking-related cancers, and on survivors relatively soon after their diagnosis (16–19). Thus, more research is needed to corroborate these findings and to explore other variables that may be associated with continued smoking versus quitting among cancer survivors years after diagnosis. For example, medical conditions or physical limitations of which smoking may be a cause (e.g., comorbid conditions such as heart disease) or that could conceivably influence smokers' motivation to quit or their smoking status (e.g., an additional cancer diagnosis) have not been included in prior studies of risk factors for continued smoking. Given associations of smoking with mental health conditions such as depression, and with alcohol abuse (20, 21), examining these variables' relationships with smoking status among survivors also seems particularly important.

Some survivors who currently smoke years after diagnosis may also still have intentions of quitting, but the prevalence of intentions to quit has not been examined or reported for longer term survivors. Investigating the prevalence of intentions to quit, and their predictors, however, would help to identify those who may be more receptive to smoking cessation interventions years after recovery.

To address the aforementioned research and gaps in the literature, we used cross-sectional data from the last wave of a longitudinal study (when smoking status was assessed) of long-term survivors of 10 cancers identified from cancer registries in 11 states (22). Specifically, we examined (i) prevalence and correlates of current smoking and smoking patterns among cancer survivors, (ii) correlates of cessation versus current smoking after cancer diagnosis, and (iii) correlates of planning to quit smoking (and when) among current smokers.

Materials and Methods

Study design and setting

Analyses for the current cross-sectional study used data on smoking status assessed at the third wave of the American Cancer Society's Study of Cancer Survivors-I (SCS-I), which is a longitudinal nationwide study of adult cancer survivors. Participants were initially selected through stratified random sampling from 11 state cancer registries covering all 4 census regions (West, Midwest, Northeast, and South). Smoking status questions were included in the third wave of data collection to maximize the amount of time since cancer diagnosis (i.e., several years post-diagnosis).

Samples for SCS-I were stratified on the basis of age, race/ethnicity, and cancer type. Survivors who were younger than 55 years and belonged to racial and ethnic minorities were oversampled. Study eligibility criteria included: (i) being at least 18 years of age at the time of diagnosis, (ii) diagnosed with 1 of the 10 most highly incident cancers at the time of participant recruitment (i.e., breast, prostate, bladder, uterine, skin melanoma, colorectal, kidney, non–Hodgkin lymphoma, ovarian, and lung), (iii) diagnosed with a local, regional, or distant Surveillance, Epidemiology, and End Results (SEER; ref. 23) summary stage (except inclusion of *in situ* cases for bladder cancer), (iv) diagnosed between January 2000 and September 2003, and (v) fluent in English or Spanish. For initial recruitment, physician consent for surveying participants was obtained (physician consent rate of 93.0%). The case recruitment rate for the first survey (after refusals, ineligibility, deceased status, and unlocatability) was 42.1% ($n = 6{,}309$). In all, 3 waves of surveys were administered by either mail or telephone between July 2000 and December 2011. Retention rates for the second and third surveys were 80% and 70%, respectively (relative to enrollment in the first survey). The third survey was completed by 3,138 individuals between January 2010 and December 2011, approximately 9 years after diagnosis. Of these, 2,938 (93.6%) answered questions on smoking status and comprised the total sample for the cross-sectional analyses reported herein. The Institutional Review Board of Emory University (Atlanta, GA) approved SCS-I, and additional approvals were obtained for each state, including the Connecticut Department of Public Health Human Investigation Committee. A detailed discussion of recruitment and methodology is available elsewhere (22).

Measures

Sociodemographic variables. Gender was recorded from cancer registries, and survey questions asked participants their age, marital status, household income, race/ethnicity, and education. The latter 4 variables were recoded to fewer categories (see tables) to attain adequate cell sizes in statistical analyses.

Cancer-related variables. SEER stage and cancer type were recorded on the basis of cancer registry data and confirmed by self-report of cancer diagnosis in the baseline survey. Among self-reported diagnoses ($n = 2{,}694$), agreement with registry data was high (97.9%), with registry diagnoses used for the remaining cases. Colorectal, bladder, kidney, lung, and mucinous ovarian cancers were classified as smoking-related cancers (24). Among the cases of ovarian cancer ($n = 121$), only 3 were mucinous ovarian. These 3 cases were excluded in analyses of relationships between smoking-related cancers and smoking behavior.

The survey also asked if in the past 5 years "the same cancer came back (recurrence)?," "the cancer spread to another part of your body (metastasis)?," and "you were

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diagnosed with another type of cancer?" ("yes" or "no" response). In addition, participants were asked if they had received cancer treatments in the past 5 years from a list that included surgery to remove the cancer, chemotherapy, radiation treatment, bone marrow or stem cell transplantation, immunotherapy, and targeted therapy ("yes" or "no" response). A dichotomous variable was created to indicate whether or not any of the above treatments was received in the past 5 years. Years since diagnosis was calculated on the basis of age at diagnosis and at survey completion.

Other health-related variables. Participants indicated if they had been treated in the past 5 years ("yes" or "no" response) for any of 26 medical conditions [Alzheimer's disease, dementia, high cholesterol, gastrointestinal problems, diabetes, high blood pressure, heart attack, heart disease, other heart conditions, stroke, neuropathy, circulatory problems, anemia, lymphedema, thyroid disorders, arthritis, pulmonary/breathing problems, hearing loss, osteoporosis, anxiety, depression, mental health problems (other than anxiety or depression), alcohol abuse, liver disease, kidney problems, urinary tract problems]. After excluding responses for anxiety, depression, mental health problems other than depression or anxiety, and alcohol abuse, conditions were summed to create a final comorbidity index. Responses to the anxiety, depression, and other mental health problems were used to create a dichotomous variable representing having received any mental health treatment (or not) in the past 5 years. Treatment for alcohol abuse was examined separately.

Two variables assessed alcohol frequency and quantity [adapted from the 2007 Behavioral Risk Factor Surveillance System (BRFSS) survey; ref. 25)] Respondents were asked "on average, how frequently did you drink any alcoholic beverage (beer, wine, or liquor) in the past month?" Response options were "never or less than 1 day per month," 1–4 days per month," "2–5 days per week," and "6–7 days per week." From these responses, a dichotomous variable was created to indicate drinking frequency of 1 d/wk or less or 2 d/wk or more. Respondents were also asked "on days that you do drink, how many drinks of alcohol (beer, wine, or liquor) do you have on average?". Responses were "I don't drink alcohol," "1 drink per day," "2 drinks per day," and "3 or more drinks per day." A 3-category variable was created to indicate no drinking, 1 drink per day, or 2 or more drinks per day. Physical functioning was assessed using the physical functioning subscale of the 12-item Medical Outcomes Study-Short Form (MOS SF-12; ref. 26). Current body mass index (BMI) was calculated on the basis of self-reported weight and height.

Smoking behavior. Standard questions for classifying smoking status were used. Respondents were asked whether they smoked at least 100 cigarettes in their entire life and whether they "never smoked cigarettes" or now smoked cigarettes "every day," "some days," or "not at all." Never smokers had not smoked at least 100 cigarettes and indicated never having smoked. Former smokers had smoked at least 100 cigarettes and were not currently smoking. Current smokers had smoked at least 100 cigarettes and currently smoked every day or some days; someday, smokers were asked the number of days smoked in the past 30 days and number of cigarettes smoked on those days. Using responses to a question asking at what age they had quit for good, former smokers were further subdivided into 2 groups: those who had quit at or after diagnosis and those who had quit before diagnosis.

To capture differences in intensity of smoking between daily and nondaily smokers using a common metric, we calculated a measure of average cigarettes smoked per day (cpd) over the past 30 days for nondaily smokers by multiplying the number of smoking days in the last 30-day period by cigarettes smoked per day on those days and divided the result by 30. This was incorporated with daily smokers' cpd to create a final measure of cpd for all current smokers.

Current smokers were also asked whether they planned to quit smoking. Response options were "yes," "no," and "not sure." Because of low frequencies of survivors not planning to quit (see results), the latter 2 categories were combined to create a dichotomous variable representing intentions of quitting versus not sure (or not). Those who answered "yes" were further asked when they planned to quit. Options were "less than a month from now," "in the next 3 months," "in the next 6 months," and "after 6 or more months." Because of low frequencies for the last 3 categories, they were merged to create a dichotomous variable representing smokers who planned to quit in less than a month versus in the next 3 months or later.

Analysis plan

Participant characteristics were examined using descriptive statistics. We examined bivariate associations of sociodemographic factors, cancer-related factors, and other health factors with (i) smoking status (never/former/current smoker), (ii) smoking pattern (i.e., daily vs. nondaily), (iii) having quit after diagnosis versus currently smoking, and (iv) planning to quit smoking in the future (and when) among current smokers. Multivariate logistic regression analyses were conducted in which statistically significant factors from bivariate analyses were the independent variables in predicting smoking status, quitting pattern, quitting after diagnosis versus currently smoking, and intentions to quit smoking (and when) among current smokers. Because smoking status was a 3-category variable, a multinomial logistic regression rather than binary logistic regression was used (with current smokers as the reference group). Final regression models were built using a backward stepwise method. Analyses were conducted using SPSS 20; alpha was set at 0.05 for all analyses.

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Results

Sample characteristics

Sixty percent ($n = 1{,}763$) of the sample was female, participants' mean age was 65.5 years (SD = 11.1), the majority (91.9%; $n = 2{,}700$) of the sample was Caucasian, and approximately one third (30.3%) had an annual household income of $39,999 or less (Table 1). The average time since first diagnosis was 8.9 years (SD = 0.7). In the past 5 years, 7.3% ($n = 214$) had experienced a recurrence of their cancer, the cancer had metastasized for 3.3% ($n = 98$), and for 8% ($n = 236$), a new cancer was diagnosed. Almost 19% ($n = 551$) reported having received some form of cancer treatment in the last 5 years. The proportion of the total sample with smoking-related cancers was 28.3% ($n = 830$). Twenty-one percent of the sample ($n = 624$) had received mental health treatment in the past 5 years but less than 1% ($n = 8$) for alcohol abuse.

Prevalence and correlates of current smoking

Of the entire sample, 9.3% ($n = 272$) were current smokers, 41.2% ($n = 1{,}209$) were former smokers, and 49.6% ($n = 1{,}457$) were never smokers (as assessed at the final wave). Of the 1,209 former smokers, 88.6% ($n = 1{,}072$) had quit before their diagnosis.

Bivariate analyses indicated that sociodemographic variables significantly associated with current smoking status were younger age, female gender, lower education, and lower income (see Table 1 for proportions and test statistics). Cancer-related variables associated with current smoking (vs. never smoking) were *in situ* diagnosis of the initial cancer and recurrence of the initial cancer in the past 5 years. Current and former smoking were associated with receiving cancer treatment in the last 5 years and with diagnosis of a smoking-related cancer. The prevalence of current smoking differed by cancer type [$\chi^2(27) = 223.4$, $P = 0.0001$] and was highest among bladder (17.2%), lung (14.9%), and ovarian (11.6%) survivors and lowest among survivors of colorectal (6.8%), kidney (7.3%), and skin melanoma (7.6%) cancers.

Health-related variables associated with current smoking status were having received mental health treatment in the past 5 years and greater consumption of alcohol (both frequency and quantity; Table 1). Only 8 individuals reported having received treatment for alcohol abuse in the past 5 years, so this variable was dropped from further analyses. Current smokers' physical functioning and BMI were lower than that of former smokers' and never smokers'. Current smokers' number of comorbid conditions did not differ from that of former smokers or never smokers, although former and never smokers differed significantly (Table 1).

The final multinomial logistic regression model indicated that compared with the odds of being a current smoker, the odds of being a never or former smoker were greater for survivors who were older (ORs > 1.04) and had higher income (ORs > 1.71), physical functioning (ORs > 1.02), and BMI (ORs > 1.08; Table 2). The odds of being a never or former smoker were lower for survivors who drank 2 or more drinks per day (ORs < 0.59). Compared with being a current smoker, the odds of being a never smoker were lower for males (OR, 0.60), higher for survivors with more than a high school education (OR, 1.54), and lower for survivors who had received mental health treatment in the past 5 years (OR, 0.56).

Prevalence and correlates of daily versus nondaily smoking

Among the sample's 272 current smokers, 83.1% smoked every day ($n = 226$) and 16.9% smoked some days ($n = 46$). Daily smokers smoked a mean of 14.7 cpd (SD = 8.0; range = 1–50 cpd). Nondaily smokers smoked an average of 10.8 days in the last 30 days (SD = 6.9) and on those days smoked an average of 5.7 cpd (SD = 5.2; range = 1–20 cpd).

Bivariate analyses indicated that only education was associated with whether current smokers smoked daily versus nondaily [$\chi^2(8) = 4.28$, $P = 0.039$; which obviated multivariate analyses]. Specifically, while 55% of daily smokers had more than a high school education, an even greater proportion of nondaily smokers did (72%).

Prevalence and correlates of quitting after diagnosis versus current smoking

Of the 1,209 former smokers, 11% ($n = 137$) were smokers at the time of diagnosis but had quit since then. Assuming that the 272 current smokers in the overall sample had also been smoking at the time of their diagnosis, the number of smokers who smoked at the time of diagnosis was 409 (272 + 137), and the proportion of these individuals who had subsequently quit was 33.5% (137 of 409).

In bivariate analyses, quitting after diagnosis was associated with having had a smoking-related cancer, more comorbid conditions, and higher BMI (Supplementary Table S1). The multivariate analysis [$\chi^2(3) = 23.03$, $P = 0.0001$] indicated that the odds of having quit after diagnosis were greater for survivors whose cancer was smoking-related [OR, 1.73; confidence interval (CI), 1.11–2.68; $P = 0.01$], who had higher BMI (OR, 1.06; CI, 1.03–1.10; $P = 0.001$), and marginally more current comorbid medical conditions (OR, 1.10; CI, 1.00–1.21; $P = 0.06$).

Prevalence and correlates of intention to quit among current smokers

Of the 272 current smokers in the sample, 268 (98.5%) responded to the question about intentions of quitting; 46.6% ($n = 125$) indicated planning to quit, 10.1% ($n = 27$) did not plan to quit, and 43.3% ($n = 116$) were "not sure."

Bivariate analyses indicated that sociodemographic variables associated with intending to quit (vs. not sure or not) were being *not* married and of younger age (Supplementary Table S2). No cancer-related variables were associated with intending to quit. Health-related variables associated with intentions of quitting were higher BMI,

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Table 1. Sample characteristics as a function of wave 3 smoking status in SCS-I

	Total $N = 2{,}938$	Never smokers $n = 1{,}457$ (49.6%)	Former smokers $n = 1{,}209$ (41.2%)	Current smokers $n = 272$ (9.3%)		
	n(%)/M(SD)	*n*(%)/M(SD)	*n*(%)/M(SD)	*n*(%)/M(SD)	χ^2/*F test*	*P*
Sociodemographic variables						
Race						
Caucasian/White	2,700 (91.9)	1,326 (91.0)	1,125 (93.1)	249 (91.5)	$\chi^2(4, 2{,}937) = 8.5$	0.075
African-American/Black	175 (6.0)	91 (6.2)	63 (5.2)	21 (7.7)		
Other	62 (2.1)	39 (2.7)	21 (1.7)	2 (0.7)		
Gender						
Male	1,175 (40.0)	438 (30.1)	626 (51.8)	111 (40.8)	$\chi^2(2, 2{,}938) = 129.9$	0.000
Female	1,763 (60.0)	1,019 (69.9)	583 (48.2)	161 (59.2)		
Education						
High school or less	973 (33.1)	440 (30.2)	421 (34.8)	112 (41.2)	$\chi^2(2, 2{,}928) = 16.3$	0.000
Post-secondary	1,955 (66.5)	1,013 (69.5)	787 (65.1)	155 (57.0)		
Marital status						
Not married	848 (28.9)	408 (28.0)	345 (28.5)	95 (34.9)	$\chi^2(2, 2{,}935) = 5.4$	0.067
Married	2,087 (71.0)	1,047 (71.9)	863 (71.4)	177 (65.1)		
Income						
Less than $19,999	331 (11.3)	154 (10.6)	121 (10.0)	56 (20.6)	$\chi^2(6, 2{,}492) = 38.0$	0.000
$20,000–$39,999	559 (19.0)	253 (17.4)	248 (20.5)	58 (21.3)		
$40,000–$74,999	842 (28.7)	399 (27.4)	363 (30.0)	80 (29.4)		
$75,000 or more	760 (25.9)	412 (28.3)	300 (24.8)	48 (17.6)		
Age	65.5 (11.1)	64.4_a (11.7)	67.7_b (10.9)	61.8_c (8.8)	$F(2, 2{,}937) = 45.8$	0.000
Cancer-related variables						
SEER stage						
In situ	77 (2.6)	24 (1.6)	39 (3.2)	14 (5.1)	$\chi^2(6, 2{,}938) = 15.9$	0.014
Localized	1,990 (67.7)	988 (67.8)	829 (68.6)	173 (63.6)		
Regional	697 (23.7)	356 (24.4)	273 (22.6)	68 (25.0)		
Distant	174 (5.9)	89 (6.1)	68 (5.6)	17 (6.2)		
Cancer recurrence in the past 5 years						
Yes	214 (7.3)	90 (6.2)	96 (7.9)	28 (10.3)	$\chi^2(2, 2{,}938) = 7.1$	0.029
No	2,724 (92.7)	1,367 (93.8)	1,113 (92.1)	244 (89.7)		
Cancer metastasized in the past 5 years						
Yes	98 (3.3)	47 (3.2)	37 (3.1)	14 (5.1)	$\chi^2(2, 2{,}938) = 3.1$	0.212
No	2,840 (96.7)	1,410 (96.8)	1,172 (96.9)	258 (94.9)		
New cancer diagnosis in the past 5 years						
Yes	236 (8.0)	104 (7.1)	111 (9.2)	21 (7.7)	$\chi^2(2, 2{,}938) = 3.8$	0.152
No	2,702 (92.0)	1,353 (92.9)	1,098 (90.8)	251 (92.3)		
Cancer treatment in the past 5 years						
Yes	551 (18.8)	243 (16.7)	253 (20.9)	55 (20.2)	$\chi^2(2, 2{,}938) = 8.2$	0.016
No	2,387 (81.2)	1,214 (83.3)	956 (79.1)	217 (79.8)		
Cancer smoking related						
Yes	830 (28.3)	344 (23.6)	404 (33.4)	82 (30.1)	$\chi^2(2, 2{,}938) = 31.9$	0.000
No	2,108 (71.7)	1,113 (76.4)	805 (66.6)	190 (69.9)		
Years since diagnosis	8.9 (0.7)	8.9 (0.7)	8.9 (0.7)	9.0 (0.7)	$F(2, 2{,}937) = 1.9$	0.094
Other health-related variables						
Mental health treatment in the past 5 years						
Yes	624 (21.2)	276 (18.9)	264 (21.8)	84 (30.9)	$\chi^2(2, 2{,}938) = 20.0$	0.000
No	2,314 (78.8)	1,181 (81.1)	945 (79.2)	188 (69.1)		
Alcohol abuse treatment in the past 5 years						
Yes	8 (0.3)	2 (0.1)	3 (0.2)	3 (1.1)	$\chi^2(2, 2{,}938) = 7.9$	0.019

(Continued on the following page)

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Table 1. Sample characteristics as a function of wave 3 smoking status in SCS-I (Cont'd)

	Total $N = 2,938$	Never smokers $n = 1,457$ (49.6%)	Former smokers $n = 1,209$ (41.2%)	Current smokers $n = 272$ (9.3%)		
	n(%)/M(SD)	*n*(%)/M(SD)	*n*(%)/M(SD)	*n*(%)/M(SD)	χ^2/*F test*	*P*
No	2,930 (99.7)	1,455 (99.9)	1,206 (99.8)	269 (98.9)		
Alcohol frequency						
1 d/wk or less	2,138 (72.7)	1,163 (79.8)	790 (65.3)	185 (68.0)	$\chi^2(2, 2,915) = 72.3$	0.000
2 d/wk or more	777 (26.4)	285 (19.6)	407 (33.7)	85 (31.3)		
Alcohol quantity						
None	1,210 (41.2)	700 (48.0)	417 (34.5)	93 (34.2)	$\chi^2(4, 2,887) = 117.0$	0.000
1 drink/d	980 (33.4)	495 (34.0)	418 (34.6)	67 (24.6)		
2 or more drinks/d	697 (23.7)	238 (16.3)	351 (29.0)	108 (39.7)		
Physical functioning	46.4 (10.4)	47.5_a (10.1)	45.6_b (10.2)	43.9_c (11.6)	$F(2, 2,937) = 20.71$	0.000
Comorbid conditions	2.5 (2.1)	2.4_a (2.1)	2.7_b (2.1)	$2.4_{a,b}$ (2.1)	$F(2, 2,937) = 8.84$	0.000
BMI	28.7 (6.1)	28.8_a (6.6)	28.8_a (5.7)	27.3_b (5.5)	$F(2, 2,893) = 7.56$	0.001

NOTE: Means with different subscripts differ significantly at $P = 0.05$ with Bonferroni correction (and means sharing a subscript do not differ significantly). Subtotals may not equal actual totals due to exclusion of respondents missing data on a particular characteristic.

smoking fewer cpd, being a nondaily smoker, and drinking 1 d/wk or less (vs. 2 d/wk or more).

Multivariate analyses indicated that the odds of intending to quit smoking were lower for married (vs. unmarried) survivors (OR, 0.57; CI, 0.33–0.98, $P = 0.04$), for older survivors (OR, 0.96; CI, 0.93–0.99; $P = 0.01$), for those who smoked more cpd on average (OR, 0.96, CI, 0.93–0.99; $P = 0.01$), and marginally for those who drank 2 or more drinks per day (OR, 0.59; CI, 0.33–1.03; $P = 0.06$).

Prevalence and correlates of immediacy of intentions to quit

Of the 125 smokers who indicated planning to quit, 124 responded to the question of when; 39.5% ($n = 49$) planned to quit "less than a month from now," with the remainder ($n = 75$) planning to quit in the next 3 months or later.

Bivariate analyses indicated that none of the sociodemographic variables were significantly associated with planning to quit in a month or less (Supplementary Table S3). Planning to quit within a month was significantly associated with an initial cancer that was smoking-related and marginally ($P = 0.07$) with having had cancer treatment in the past 5 years. Variables assessing cancer recurrence, metastasis, and new cancer diagnoses were dropped from further analyses because of low frequencies (<5 cases per cell). Planning to quit within a month was also associated with smoking fewer cpd and being a nondaily smoker. Multivariate analyses [$\chi^2(2) = 16.13$, $P = 0.0001$] indicated that the odds of planning to quit in less than a month were greater for survivors who had been diagnosed with a smoking-related cancer (OR, 2.32; CI, 1.03–5.24; $P = 0.043$), and for survivors who were nondaily (vs. daily) smokers (OR, 4.78; CI, 1.85–12.39; $P = 0.001$).

Discussion

The current study aimed to address gaps in research regarding long-term cancer survivors' smoking behavior and their predictors. Compared with other studies (10, 11), this cross-sectional sample of survivors 9 years after diagnosis documented a lower smoking prevalence of 9.3%. A plausible explanation is mortality from cancer (particularly lung cancer, which has a low survival rate) in the 9 years since being diagnosed. Declining smoking prevalence in the general population more recently may also play a role.

Similar to prior studies (8–10), current smokers in the sample were of younger age compared with never and former smokers. Lower household income among survivors was also associated with increased odds of being a current smoker. Compared with former and never smokers, current smokers also had lower scores on physical functioning and slightly lower BMI. Survivors who still smoked were also more likely to drink more frequently (compared with never smokers) and to drink more on the days they drank (compared with former and never smokers). They were also more likely to have received treatment for mental health in the previous 5 years. These results suggest that alcohol consumption and mood management may need to be addressed or incorporated in interventions for survivors who smoke many years after diagnosis.

Overall, results indicated that survivors who smoked daily smoked at relatively high levels and would likely have a difficult time quitting because of their tobacco dependence (27). Moreover, a sizeable minority smoked nondaily, which was associated with higher education. Although it would need to be confirmed in future research, nondaily smoking may represent an attempt by some survivors to reduce their risk of negative health

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Table 2. Multinomial logistic regression model comparing current smokers with never and former smokers

	Never smokers (vs. current smokers) OR (95% CI)	Former smokers (vs. current smokers) OR (95% CI)
Age	1.04[a] (1.02–1.05)	1.06[a] (1.05–1.08)
Gender		
Female (Ref)	1.0	1.0
Male	0.60[b] (0.43–0.82)	1.23 (0.85–1.57)
Education		
≤High school (Ref)	1.0	1.0
>High school	1.54[c] (1.10–2.14)	1.19 (0.85–1.62)
Income		
<$19,999 (Ref)	1.0	1.0
$20,000–$39,999	1.71[c] (1.08–2.72)	2.03[b] (1.27–3.24)
$40,000–$74,999	1.95[b] (1.25–3.05)	2.36[a] (1.50–3.71)
≥$75,000	4.17[a] (2.48–7.01)	4.13[a] (2.43–7.01)
Mental health treatment		
None (Ref)	1.0	1.0
Treatment in last 5 years	0.56[d]	0.83 (0.59–1.17)
Alcohol quantity		
None (Ref)	1.0	1.0
1 drink/d	0.66[c] (0.45–0.97)	1.05 (0.71–1.55)
2 or more drinks/d	0.23[a] (0.15–0.33)	0.59[b] (0.41–0.87)
Physical functioning	1.04[a] (1.02–1.05)	1.02[b] (1.01–1.04)
BMI	1.09[a] (1.06–1.12)	1.08[a] (1.05–1.11)

NOTE: Model $\chi^2(22) = 374.8$, $P < 0.0001$.
[a]$P < 0.0001$.
[b]$P < 0.01$.
[c]$P < 0.05$.
[d]$P < 0.001$.

consequences, given prior research showing that some survivors believe that reducing their smoking is beneficial for their recovery (28). The findings that smoking fewer cpd was associated with greater odds of intending to quit, and nondaily smoking (vs. daily smoking) with intending to quit sooner rather than later, suggests that lighter or nondaily smokers may be receptive to, and thus a prime target for, cessation treatments, even many years after diagnosis. Cessation treatments for these survivors should of course incorporate information about the hazards of any amount of smoking (even nondaily) for cancer-free survival and of its effects on other non-cancer outcomes (e.g., heart disease). This information is standard for cessation treatments in the general population but should hold particular significance for survivors who could potentially experience late effects of treatments that result in decreased physical health (29).

Increasing all survivors' access to cessation support from oncologists, however, will be necessary to translate motivation to actual success in quitting. Prior research indicates that while oncologists do ask about smoking and quitting and are supportive of providing cessation assistance to patients with cancer who smoke, in practice their provision of cessation assistance and follow-up of smoking status is much lower (30, 31). Whatever the reasons (e.g., reluctance to address tobacco use in older patients, time constraints), this could be ameliorated by automated systems that screen for tobacco use and provide referrals to available treatments (32), regardless of smoking level or age. While minimal treatment could offer significant benefits, heavier smoking survivors may require more comprehensive care to address their unique treatment needs (e.g., psychiatric comorbidity; ref. 33). On the basis of the smoking patterns observed in the current study, follow-up of survivors about their smoking habits well after initial treatment and recovery is warranted, which in conjunction with improving access to appropriate cessation treatment could potentially reduce smoking prevalence in survivors.

Smoking prevalence also varied considerably by cancer type. The highest rates were found among survivors of bladder, lung, and ovarian cancers, the first 2 of which are smoking-related cancers. The inclusion of *in situ* cases for bladder cancer, and the longer progression from *in situ* to

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invasive disease, may have inflated the smoking prevalence in this sample. In any event, almost a fifth of patients with bladder cancer were still smoking 9 years after diagnosis, which is comparable to smoking prevalence in the general population. A smaller proportion of patients with lung cancer (15%) still smoked.

The finding of these levels of smoking among survivors with bladder and lung cancer is reason for concern. *Post hoc* analyses indicated that most bladder and lung cancer survivors were daily smokers (90% and 85%, respectively) who smoked a median of 10 or more cpd (median of 14 cpd for bladder cancer survivors). In addition to their tobacco dependence, which makes quitting more difficult, a possibility is that these survivors are less motivated to quit because they have survived this long after their initial diagnosis. Moreover, survivors of bladder cancer, which has relatively high survivability, may believe that because their cancer is relatively curable or has a longer predicted survival, they can continue smoking without great fear that they will suffer severe negative cancer- or other health-related consequences—and indeed current smokers' comorbidity did not differ from that of never and former smokers. Future research could examine support for this proposition and its implications for treatment. It is likely that soon after diagnosis is the most advantageous time to encourage quitting [i.e., a "teachable moment" (refs. 34, 35)] and that with the passage of time, survivors may become less motivated if additional comorbid conditions do not appear.

Results also indicated that the odds of having quit after diagnosis (vs. current smoking) were higher among survivors whose cancer was smoking-related. This result may partly be an artifact of greater mortality among those who continued smoking past their diagnosis. Post-diagnosis smoking is associated with increased all-cause mortality, decreased overall survival, and increased cancer mortality compared with never smoking, according to a summary of this research in the 2014 Surgeon General's Report (1). Thus, in the 9 years after diagnosis, a significant number of continuing smokers may have died. It is also possible that oncologists or health care providers in contact with survivors of a tobacco-related malignancy may be more likely to address their tobacco use, both at the time of diagnosis and subsequently. This may also explain why among current smokers who planned to quit, diagnosis of a smoking-related cancer was associated with more immediate plans to quit. Whatever the reason, these results indicate that long after diagnosis some survivors are motivated to quit and should be offered treatment.

Results also indicated that older smokers in the current study were less likely to plan to quit. While the effect was not strong, it suggests the possibility that older longer term survivors who smoke may feel that the effort or difficulties in quitting (e.g., withdrawal symptoms) may not be worth the possible gain in greater life expectancy and/or reduced morbidity. Studies that assess older survivors' perceptions of the benefits and costs of quitting would help determine the plausibility of this hypothesis.

Although previous research found that being widowed or divorced, compared with being married, is associated with increased smoking prevalence (9), the current study found that married smokers had lower intentions of quitting. This was unexpected and to our knowledge has not been previously reported. Future prospective research with large samples should seek to understand why being married is associated with lower motivation to quit among long-term survivors who smoke (e.g., having a spouse who smokes). It may be that marriage initially decreases the risk of smoking among survivors (assuming the partner does not smoke) but that this beneficial effect may disappear many years after diagnosis.

Limitations

In spite of attrition across waves, sociodemographic characteristics of the final sample were comparable to other population-based studies such as the National Health Information Survey (NHIS; ref. 36) and BRFSS (11). Nevertheless, data suggest that older, male, and non-white individuals are less likely to respond to surveys (37, 38), which may translate to a conservative estimate of smoking prevalence in the current study.

An advantage of the current study was its use of registry-reported cancer diagnosis which reduces the likelihood of misclassification of cancer diagnosis compared with self-report. Similar to other large population-based surveys of cancer survivors, a limitation is self-report of smoking status and other health-related variables. Self-report of smoking in this study may not be a significant source of bias, however, as a study of newly diagnosed patients with cancer found that self-report of current and never smoking corresponded 100% with cotinine validation (39). In contrast, it was those who self-reported recent quitting within a year for whom there were discrepancies between self-report and biochemical validation; in the current study, however, only 1.2% of respondents reported quitting within a year of our assessment of smoking status. Still, smoking prevalence observed may be conservative as some current smokers may have died in the 9 years since diagnosis or declined participation because of poorer health. Finally, although we assessed and interpreted results for intentions to quit, other conditions may need to be present for intentions to translate to actions (27). Nevertheless, intentions have been shown to be predictors of health behavior change among survivors (40).

Conclusions

In sum, this study identified smoking patterns and correlates of current smoking, quitting after diagnosis, and quitting intentions 9 years after cancer diagnosis. Some survivors' daily levels of smoking suggest a dependence on tobacco, and there was a significant frequency of nondaily smoking among those who smoked. Prior

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research suggests that many survivors are interested in quitting following their diagnosis (28, 41). Those who smoke heavily long after their diagnosis may require more intense treatment addressing specific psychosocial characteristics such as perceptions of risk, beliefs of fatalism, etc., that may influence motivation to quit. Effective cessation treatment for cancer survivors exists (12, 42), but future population-based studies examining the importance of psychosocial variables, and their relationships to other health-related variables in predicting current smoking or motivation to quit, will further contribute to enhancing cessation strategies for all survivors who smoke. For example, we propose that the relatively high survivability of a cancer, in the absence of comorbid conditions long after diagnosis, may contribute to reduced perceptions of risk or severity that lower interest in quitting among some long-term survivors who smoked at the time of diagnosis. If supported by evidence, this would be important to address in treatment for long-term survivors. Attention to patient–provider communication, and feelings of stigma and guilt by survivors with smoking-related cancers, is also warranted (43). Any intervention, however, will need to address the unique disease- and treatment-related complexities of cancer survivors (34) to be maximally effective.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: J.L. Westmaas, K.D. Stein
Development of methodology: J.L. Westmaas, K.I. Alcaraz, K.D. Stein
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): K.D. Stein
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): J.L. Westmaas, K.I. Alcaraz, C.J. Berg, K.D. Stein
Writing, review, and/or revision of the manuscript: J.L. Westmaas, K.I. Alcaraz, C.J. Berg, K.D. Stein
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): J.L. Westmaas
Study supervision: K.D. Stein

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