



Smoking and Smoking Cessation Among Persons with Tobacco- and Non-tobacco-Associated Cancers

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Published online: 14 February 2019
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Abstract

Purpose To examine smoking and use of smoking cessation aids among tobacco-associated cancer (TAC) or non-tobacco-associated cancer (nTAC) survivors. Understanding when and if specific types of cessation resources are used can help with planning interventions to more effectively decrease smoking among all cancer survivors, but there is a lack of research on smoking cessation modalities used among cancer survivors.

Methods Kentucky Cancer Registry data on incident lung, colorectal, pancreatic, breast, ovarian, and prostate cancer cases diagnosed 2007–2011, were linked with health administrative claims data (Medicaid, Medicare, private insurers) to examine the prevalence of smoking and use of smoking cessation aids 1 year prior and 1 year following the cancer diagnosis. TACs included colorectal, pancreatic, and lung cancers; nTAC included breast, ovarian, and prostate cancers.

Results There were 10,033 TAC and 13,670 nTAC survivors. Smoking before diagnosis was significantly higher among TAC survivors ($p < 0.0001$). Among TAC survivors, smoking before diagnosis was significantly higher among persons who: were males (83%), aged 45–64 (83%), of unknown marital status (84%), had very low education (78%), had public insurance (89%), Medicaid (85%) or were uninsured (84%). Smoking cessation counseling and pharmacotherapy were more common among TAC than nTAC survivors ($p < 0.01$ and $p = 0.05$, respectively).

Discussion While smoking cessation counseling and pharmacotherapy were higher among TAC survivors, reducing smoking among all cancer survivors remains a priority, given cancer survivors are at increased risk for subsequent chronic diseases, including cancer. Tobacco cessation among all cancer survivors (not just those with TAC) can help improve prognosis, quality of life and reduce the risk of further disease. Health care providers can recommend for individual, group and telephone counseling and/or pharmacotherapy recommendations. These could also be included in survivorship care plans.

Keywords Smoking · Smoking cessation · Tobacco-associated cancers · Health administrative claims · Linkage · Registry

Introduction

Tobacco use is the leading preventable cause of cancer and cancer deaths [51]. Cigarette smoking is causally linked to 12 cancers, including: oral cavity and pharynx; larynx; esophagus; lung, bronchus, and trachea; stomach; kidney and renal pelvis; pancreas; liver; urinary bladder; uterine cervix; colon and rectum; and acute myeloid leukemia [51]. While not conclusive, research also suggests a possible causal relationship between cigarette smoking and breast and prostate cancer mortality [9, 51]. Each year in the United States, approximately 660,000 people are diagnosed with a cancer associated with tobacco use [26]. In 2016, there were more than 15 million cancer survivors in the United States [36]. Despite evidence that continued smoking places all

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cancer survivors (regardless of whether their initial cancer was associated with tobacco) at increased risk for a new or recurrent cancer diagnosis, many continue to smoke [30]. Previous studies have shown that the prevalence of smoking among cancer survivors is similar to that of the general population [12, 19, 20, 49, 53].

Cigarette smoking is harmful for all people, including those previously diagnosed with cancers [30, 33, 34, 39] and continued smoking negatively affects cancer treatment [6, 15, 24, 35]. Screening for tobacco use at the time of a cancer diagnosis is important for assessing risks of multiple cancers and developing treatment and survivor care plans to enhance the length and health-related quality of life. Patient smoking history can also help to link patients with cessation resources.

Tobacco cessation treatments are effective among smokers with cancer [21, 29, 48]. The Centers for Disease Control and Prevention's (CDC) National Comprehensive Cancer Control Program (NCCCP) supports increasing knowledge and availability of evidence-based tobacco cessation services among cancer survivors [11, 16]. Individual, group, and telephone cessation counseling and seven FDA-approved cessation medications have been found to be safe and effective when used as directed [7, 27, 31, 43–46, 51]. Cessation counseling and pharmacotherapy are even more effective when they are combined than when either is used alone [44]. Understanding when and if specific types of cessation resources are used can help with planning interventions to more effectively decrease smoking among all cancer survivors, but there is a lack of research on smoking cessation modalities used among cancer survivors [53].

The purpose of this study was to examine the prevalence of smoking and the use of cessation aids among persons diagnosed with what have been causally deemed tobacco-associated cancers (TAC) and non-tobacco-associated cancers (nTAC) [51] using data from the Kentucky Cancer Registry (KCR).

Methods

Data

The Kentucky Cancer Registry (KCR) conducted a data linkage to augment its cancer incidence data with health claims data. The intent was to improve data quality of the registry data and inform the quality of care and outcomes research, while also providing an empirical basis to assess adherence to evidence-based quality-of-life measures and patterns of care among cancer survivors in Kentucky. Probabilistic data linkage combined with a manual review process were used to conduct the data linkage between the KCR data for lung, colorectal, pancreatic, breast, ovarian, and prostate cancer

patients diagnosed in 2007–2011 and health administrative claims including: Medicare [Surveillance, Epidemiology and End Results (SEER)-Medicare, 2000–2013], Medicaid (Kentucky Family Health Service, 2000–2015), Humana and State Employee Insurance (Humana-Comprehensive Health Insights, 2007–2015), and Anthem (HealthCore, 2006–2015).

Only the most common cancers were linked to ensure proper linkage, completeness of data, and limit errors. The six cancers included account for the majority of cancer deaths in Kentucky and the United States [50]. To reduce biases introduced from data linkage, only the first primary invasive cancer cases diagnosed in 2007–2011 were included. Only cases with continuous enrollment coverage in health administrative claims data for 12 months before and 12 months after date of diagnosis were included. Registry cases captured through autopsy or death certificate only were excluded. We categorized the six included cancers according to the U.S. Surgeon General's report on smoking [51]: TACs included those with sufficient evidence to infer a causal relationship with smoking (i.e., lung, colorectal, and pancreatic cancers). NTACs included those with suggestive, inadequate or no causal evidence with smoking (i.e., breast, prostate cancers).

Smoking Status

Smoking cessation (counseling (individual or group) or pharmacotherapy) were based on claims within 1 year before or 1 year after cancer diagnosis. Cases were classified with a history of smoking before the cancer diagnosis if documentation of personal history of tobacco use (ICD-9 V15.82) or tobacco use disorder (ICD-9 305.1) was identified in linked records for the 12 months before the cancer diagnosis. Cases were classified with use of smoking cessation treatments before and after the cancer diagnosis if documentation of smoking cessation counseling (health-care common procedure coding system [HCPCS]: 99406, 99407, G0375, G0376) or pharmacotherapy (i.e., nicotine replacement therapy, bupropion, varenicline) was identified in linked records for the 12 months before, or 12 months after diagnosis (or during the month of diagnosis). Smoking status was initially pulled from KCR records and augmented with health administrative claims data. If smoking status in the KCR data was either "Non Smoker" or "Unknown," but it was "Yes" for history of smoking or smoking cessation treatment information in the claims data, then the final smoking status was classified as "Smoker."

Demographic Variables

Stratified by TAC and nTAC, the following demographic characteristics were examined: sex, age, race/ethnicity

(white non-Hispanic, black non-Hispanic, Hispanic, other), education (percentage with high school education at county level, categorized by quantiles: very low, low, moderate, high), marital status [married (or living with a partner), previously married (divorced, separated, widowed), never married, unknown], poverty (percentage below poverty line at county level, categorized by quantiles: low, moderate, high, very high), Appalachian status (included or not included based upon Appalachian Region Commission https://www.arc.gov/appalachian_region/CountiesinAppalachia.asp), and insurance (uninsured, private, Medicaid, Medicare, other public, unknown).

Statistical Analysis

The prevalence of smoking at the time of cancer diagnosis and the use of smoking cessation aids (before and after cancer diagnosis) were estimated for TAC and nTAC survivors. Chi square test statistics were conducted with a threshold of $p < 0.05$ used as a measure of significant difference across relevant strata for cancer cases with a valid smoking status. All analyses were completed using SAS 9.4 (SAS Institute, Cary, NC).

Results

Cancer Survivor Characteristics

From 2007 to 2011, there were 10,033 TAC and 13,670 nTAC cancer survivors identified from the KCR and included in the dataset. Sixty-four percent of TAC and

40% of nTAC survivors smoked in the 12 months before their cancer diagnosis (Table 1). A history of smoking was most common among TAC survivors (lung [84%], pancreas [48%], colorectal [44%]). Among nTAC survivors, those with prostate cancer had the highest prevalence of a history of smoking (43%). Smoking history was unknown for 15% of TAC and 28% of nTAC survivors.

A history of smoking in the 12 months prior to a cancer diagnosis was significantly higher among TAC survivors compared to nTAC survivors ($p < 0.0001$, not shown). Significant between groups differences were observed. Among TAC survivors, pre-diagnosis smoking was significantly higher among males (83%, Table 2). It was also higher among those aged 45–64 (83%), with unknown marital status (84%), with very low education (78%), with Medicaid (85%), with public insurance (other than Medicaid or Medicare, 89%), and uninsured (84%). Among nTAC survivors, pre-diagnosis smoking was significantly higher among males (66%), and those: who were aged 45–64 (60%), had unknown marital status (77%), were non-Hispanic black (62%) or other (63%) race/ethnicity, had very low education (58%), had low (57%) or very high (58%) poverty level, and those who had an unknown insurance (84%).

Use of Smoking Cessation Aids Among Cancer Survivors

Smoking cessation counseling before and/or after a cancer diagnosis was significantly more common among TAC survivors (4.8%) compared to nTAC survivors (2.2%) ($p < 0.01$, Table 3). Among TAC survivors, lung cancer survivors were most likely to have documentation of any smoking cessation

Table 1 Smoking history among tobacco- and non-tobacco-associated cancer survivors

	Total n	Smoking history ^a					
		Yes		No		Unknown	
		n	%	n	%	n	%
Tobacco-associated cancers ^b	10,033	6453 ^c	64.3	2030	20.2	1550	15.4
Lung	5096	4287	84.1	242	4.7	567	11.1
Colorectal	4563	1986	43.5	1697	37.2	880	19.3
Pancreas	374	180	48.1	91	24.3	103	27.5
Non-tobacco-associated cancers	13,670	5468	40.0	4437	32.5	3765	27.5
Prostate	7342	3188	43.4	1631	22.2	2523	34.4
Breast	5916	2148	36.3	2625	44.4	1143	19.3
Ovary	412	132	32.0	181	43.9	99	24.0

^aPersonal history of tobacco use (ICD-9 V15.82) or tobacco use disorder (ICD-9 305.1) identified in linked records for the 12 months before the cancer diagnosis

^bTobacco-associated cancer for this study is defined as those cancers causally linked to tobacco and for which complete registry and claims data were available. Non-tobacco-associated cancers are defined for this study as those for which complete registry and claims data were available. The six cancers listed account for the majority of cancer deaths in the United States

^cSignificant within-group difference between tobacco- and non-tobacco-associated cancer groups

Table 2 Smoking history (prior to cancer diagnosis)^a and demographic characteristics for tobacco- and non-tobacco-associated cancer survivors

	Tobacco-associated cancer (TAC)					Non-tobacco-associated cancer (nTAC)				
	History of smoking					History of smoking				
	No		Yes		p	No		Yes		p
	n	%	n	%		n	%	n	%	
Overall	2030	23.9	6453	76.1		4437	44.8	5468	55.2	
Sex					<0.001					<0.001
Male	716	17.0	3507	83.0		1631	33.8	3188	66.2	
Female	1314	30.8	2946	69.2		2806	55.2	2280	44.8	
Age					<0.001					<0.001
<25		^b		^b		13	92.9		^b	
25–44	48	34.0	93	66.0		135	53.4	118	46.6	
45–64	355	17.2	1709	82.8		981	40.5	1439	59.5	
65+	1625	25.9	4647	74.1		3308	45.8	3910	54.2	
Marital status					0.003					<0.001
Married	1058	23.1	3530	76.9		2727	45.5	3260	54.5	
Previously married	769	25.1	2295	74.9		1282	45.5	1533	54.5	
Never married	170	27.0	459	73.0		330	48.2	355	0.0	
Unknown	33	16.3	169	83.7		98	23.4	320	76.6	
Race/ethnicity					0.254					<0.001
White, non-hispanic	1881	24.0	5967	76.0		4071	45.4	4892	54.6	
Black, non-hispanic	97	21.4	357	78.6		255	38.5	407	61.5	
Hispanic	7	31.8	15	68.2		20	54.1	17	45.9	
Other	45	28.3	114	71.7		91	37.4	152	62.6	
Education					0.044					<0.001
Very Low	461	21.7	1663	78.3		1024	42.3	1397	57.7	
Low	492	24.2	1537	75.8		1124	45.6	1339	54.4	
Moderate	857	25.0	2576	75.0		1663	43.9	2124	56.1	
High	220	24.5	677	75.5		626	50.7	608	49.3	
Poverty					0.161					<0.001
Low	499	22.8	1692	77.2		1039	43.5	1348	56.5	
Moderate	605	24.9	1824	75.1		1159	43.9	1481	56.1	
High	461	25.1	1379	74.9		1240	49.4	1271	50.6	
Very high	465	23.0	1558	77.0		999	42.2	1368	57.8	
Appalachian status					0.465					0.166
Appalachian	618	23.4	2020	76.6		1195	43.7	1541	56.3	
Non-appalachian	1412	24.2	4433	75.8		3242	45.2	3927	54.8	
Insurance					<0.001					<0.001
Uninsured	5	15.6	27	84.4		10	45.5	12	54.5	
Private	329	28.4	828	71.6		1016	51.1	971	48.9	
Medicaid	79	14.6	463	85.4		133	28.7	330	71.3	
Medicare	1600	24.1	5032	75.9		3223	44.9	3949	55.1	
Other public	9	11.4	70	88.6		25	33.8	49	66.2	
Unknown	8	19.5	33	80.5		30	16.3	154	83.7	

^aPersonal history of tobacco use (ICD-9 V15.82) or tobacco use disorder (ICD-9 305.1) identified in linked records for the 12 months before the cancer diagnosis

^bCell count suppressed due to insufficient sample size (n < 5), per Kentucky Cancer Registry guidelines

counseling (not shown). Among nTAC survivors, breast cancer survivors were most likely to have documentation of any smoking cessation counseling (not shown). Smoking

cessation counseling differed significantly between TAC and nTAC survivors by insurance status (p = 0.01, Table 4).

Smoking cessation pharmacotherapy before and/or after a cancer diagnosis was significantly more common among

Table 3 Use of smoking cessation counseling or pharmacotherapy (before and/or after diagnosis) among tobacco- and non-tobacco-associated cancer survivors with a history of smoking

Smoking cessation ^a	Tobacco-associated cancer (TAC)		Non-tobacco-associated cancer (nTAC)	
	n	%	n	%
Counseling				
None	6146	95.2	5348	97.8
Any	307	4.8 ^d	120	2.2
Pre-diagnosis ^b	146	2.3 ^d	49	0.9
Post-diagnosis ^c	197	3.1 ^d	81	1.5
Pre + post-diagnosis	36	0.6	10	0.2
Pharmacotherapy				
None	6241	96.7	5322	97.3
Any	212	3.3 ^d	146	2.7
Pre-diagnosis ^b	104	1.6	103	1.9
Post-diagnosis ^c	156	2.4 ^d	103	1.9
Pre + post-diagnosis	48	0.7	60	1.1

^aDocumentation of smoking cessation counseling (HCPS: 99406, 99407, G0375, G0376)

^bTwelve months before cancer diagnosis

^cTwelve months after diagnosis (or during the month of diagnosis)

^dSignificant within-group difference between tobacco- and non-tobacco-associated cancer groups

TAC survivors (3.3%) compared to nTAC survivors (2.7%) ($p=0.05$, Table 3). Among TAC survivors, those with lung and pancreas cancers were most likely to have documentation of any smoking cessation pharmacotherapy (not shown). Among nTAC survivors, those with breast cancer were most likely to have documentation of any smoking cessation pharmacotherapy (not shown). Use of smoking cessation pharmacology differed significantly between TAC and nTAC survivors by age ($p=0.001$) and insurance status ($p=0.02$, Table 4).

Discussion

We found that the prevalence of smoking cessation counseling or pharmacotherapy used before and/or after a cancer diagnosis was more common among TAC survivors compared to nTAC survivors. In general, the prevalence of smoking has been shown to decline after a cancer diagnosis [56], but longer-term cancer survivors who have quit smoking may relapse [2, 3, 53]. In this study, we also found the use of smoking cessation counseling or pharmacotherapy differed significantly by insurance status, and less than 1% of uninsured survivors reported using either of these. Patients who receive advice about cessation from their health care providers are more likely to quit tobacco use. However,

previous research has demonstrated that health professionals may miss opportunities to advise cancer survivors about smoking cessation and/or assist them with cessation [17, 40, 52, 55], or may not consider tobacco cessation treatment delivery as a core health care service [23]. Smoking cessation is beneficial for prognosis and quality of life among all cancer survivors, regardless of whether they were diagnosed with a TAC or nTAC [30, 33, 34, 39]. In 2015, less than half of current and former cancer survivor smokers (participating in the National Health Interview Survey [NHIS]) reported using cessation counseling and/or medication when trying to quit [22]. Previous population studies have found that the majority of quit attempts tend to be unassisted [1, 8, 18]. Health care providers can assist all cancer survivors by providing them with local counseling and/or pharmacotherapy resources.

The prevalence of smoking in the year before a cancer diagnosis was significantly higher among TAC survivors compared to nTAC survivors. This was largely driven by the pre-diagnosis prevalence of smoking among lung cancer survivors. The prevalence of smoking in this study was similar to the prevalence reported in previous studies [4, 5, 15, 37, 38, 41, 42, 54]. Current smoking status at the time of a cancer diagnosis has been shown to increase mortality for a number of cancer sites [54]. As has been observed in this study and others [4, 5, 15, 37, 38, 41, 42, 54] the prevalence of smoking status can vary widely among persons diagnosed with different cancers. Approximately one-third of cancer deaths are attributable to cigarette smoking in the United States, but even higher rates have been reported in the South where nearly 40% of cancer deaths in men are caused by smoking [32]. States with a high prevalence of smokers also have a high prevalence of TAC cases [47]. However, information about smoking status is not always available in cancer registry data, making a direct inference of this association in population-based data challenging. In this study, using the KCR linked with medical claims data, we were able to determine that the prevalence of smoking in the year prior to a diagnosis was significantly higher among TAC cases compared to nTAC cases. Several central cancer registries have linked with health administrative claims data, but were mostly limited to single claims sources, such as Medicaid, Medicare or private insurance groups, and most linkages are not done to augment smoking information collected from medical records. The KCR was able to link over 80% of cases with claims from Medicaid, Medicare and private insurers. The substantial coverage of linked cancer cases provided the unique opportunity to augment smoking information collected from medical records and investigate smoking cessation counseling or pharmacotherapy at the population level.

A history of smoking was significantly more common among TAC survivors who were middle- to retirement-aged

Table 4 Any use of smoking cessation counseling or pharmacology (prior to or after diagnosis) among tobacco-associated cancer (TAC) and non-tobacco-associated cancer (nTAC) survivors with a history of smoking

	Smoking cessation (before or after diagnosis) ^a									
	Counseling					Pharmacotherapy				
	TAC		nTAC		p	TAC		nTAC		p
	n	%	n	%		n	%	n	%	
Overall	307	100	120	100		212	100	146	100	
Sex					0.333					0.226
Male	135	44.0	59	49.2		89	42.0	52	35.6	
Female	172	56.0	61	50.8		123	58.0	94	64.4	
Age					0.505					0.001
< 25	b		b			b		b		
25–44	b		b			b		17	11.6	
45–64	111	36.2	35	29.2		108	50.9	73	50.0	
65+	190	61.9	83	69.2		99	46.7	56	38.4	
Marital status					0.136					0.089
Married	149	48.5	53	44.2		98	46.2	78	53.4	
Previously married	120	39.1	43	35.8		88	41.5	46	31.5	
Never married	26	8.5	13	10.8		21	9.9	13	8.9	
Unknown	12	3.9	11	9.2		5	2.4	9	6.2	
Race/ethnicity					0.551					0.736
White, non-hispanic	291	94.8	111	92.5		201	94.8	136	93.2	
Black, non-hispanic	12	3.9	6	5.0		7	3.3	8	5.5	
Hispanic	b		b			b		b		
Other	b		b			b		b		
Education					0.951					0.117
Very low	102	33.2	37	30.8		59	27.8	45	30.8	
Low	71	23.1	27	22.5		62	29.2	32	21.9	
Moderate	107	34.9	45	37.5		81	38.2	54	37.0	
High	27	8.8	11	9.2		10	4.7	15	10.3	
Poverty					0.245					0.377
Low	67	21.8	32	26.7		53	25.0	31	21.2	
Moderate	76	24.8	26	21.7		46	21.7	40	27.4	
High	79	25.7	22	18.3		64	30.2	36	24.7	
Very high	85	27.7	40	33.3		49	23.1	39	26.7	
Appalachian status					0.500					0.956
Appalachian	107	34.9	46	38.3		72	34.0	50	34.2	
Non-appalachian	200	65.1	74	61.7		140	66.0	96	65.8	
Insurance					0.009					0.019
Uninsured	b		b			b		b		
Private	28	9.1	22	18.3		32	15.1	34	23.3	
Medicaid	17	5.5	4	3.3		31	14.6	27	18.5	
Medicare	257	83.7	89	74.2		145	68.4	78	53.4	
Other public	b		b			b		b		
Unknown	b		5	4.2		b		6	4.1	

^aDocumentation of smoking cessation counseling (HCPS: 99406, 99407, G0375, G0376)

^bCell count suppressed due to insufficient sample size (n < 5), per Kentucky Cancer Registry guidelines

males with public or no insurance. A similar pattern was observed among nTAC survivors. Though few comparable studies have reported demographic characteristics specifically for smokers diagnosed with TACs, smoking continues

to be more prevalent among poor and less educated populations [28]. This is consistent with the patterns observed in our dataset. In a study that specifically assessed the prevalence of persistent smoking after a TAC diagnosis [53], there

was evidence of increased smoking among TAC survivors who were poor, uninsured, and less educated following their cancer diagnosis. Increasing the availability and use of tobacco cessation services for cancer survivors is of paramount importance in reducing TAC deaths. A TAC diagnosis can be a valuable teachable moment to facilitate quitting [25]. Providers can ask survivors whether they use tobacco products, encourage those who do to quit, and assess their willingness to quit. They could also talk with survivors about the risks of tobacco use after a cancer diagnosis. Cessation counseling could occur during active cancer treatment and/or after treatment has been completed. Patients who receive advice about cessation from their health care providers are more likely to quit tobacco use. Health care providers can recommend individual, group and telephone counseling, or one of seven FDA-approved cessation medications found to be safe and effective [44, 51]. Recommended tobacco cessation counseling services and medications would be beneficial if included in survivorship care plans, and would provide patients a written record of services available that they can access any time following a diagnosis. Community-based programs such as CDC's Tobacco Control Program and National Comprehensive Cancer Control Program (NCCCP) can assist healthcare providers in this area (Centers for Disease Control and Prevention & Office of Smoking and Health [[10]; Comprehensive Cancer Control National Partnership, [11, 16]). Specifically the NCCCP helps identify the prevalence of cancer survivors who are current smokers, assists providers with completion and distribution of survivorship care plans, and educates providers and community health workers about counseling patients to live healthy lifestyles following a cancer diagnosis [14].

This study is subject to at least five limitations. First, augmenting the KCR with medical claims enabled positively identifying smoking status for the majority of the population; however, smoking status was unknown for 22% of survivors. Second, the medical claims data on smoking cessation counseling or pharmacotherapy may be not be a complete representation of the true number of quit attempts or use of cessation aids. We could not account for the majority of smoking quit attempts that are unassisted (i.e., no counseling or pharmacotherapy) [8]. Third, the small sample size of survivors with documented smoking cessation aids limited analyses of disparities in use of these products among specific populations. Fourth, the KCR claims-linked data consists of only six cancer sites, thus limiting the extent to which we could explore smoking and smoking-related characteristics among other cancers caused by smoking. Finally, approximating smoking history and smoking cessation using medical claims data has inherent limitations. The use of ICD-9 codes to identify smoking status has been shown to be reliable [57], but the absence of an ICD-9 code may not equate to a lack of smoking history. Similarly, the

existence of relevant smoking cessation counseling and pharmacotherapy codes may not accurately reflect whether a survivor adhered to a treatment or filled a prescription [13].

Reducing smoking among all cancer survivors remains a priority, given that cancer survivors are at increased risk for subsequent chronic diseases, including cancer. Tobacco cessation among all cancer survivors can help improve prognosis, quality of life, and reduce the risk of further disease.

Acknowledgements None.

Author Contributions MSG, ET: Conceptualization, methodology, formal analysis, investigation, writing original-draft, writing-review and editing, project administration. BH: Methodology, writing original-draft, writing-review and editing, resources, project administration. QC: Data analysis, writing original-draft, writing-review and editing. TCT, JKM, ED, SLS: Conceptualization, methodology, writing-review and editing, resources, project administration.

Funding Funds to support this work were received from the Centers for Disease Control and Prevention [National Center for Chronic Disease Prevention and Health Promotion (U48DP0085014-01 SIP = 14-017)], and Markey Cancer Center Support Grant [Division of Cancer Prevention, National Cancer Institute (NCI P30 CA177558)].

Compliance with Ethical Standards

Conflict of Interest None.

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