

Systematic Review of Tobacco Use after Lung or Head/Neck Cancer Diagnosis: Results and Recommendations for Future Research

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Abstract

Tobacco use after cancer diagnosis is associated with adverse cancer outcomes, yet reliable prevalence estimates for this behavior are lacking. We conducted a systematic literature review of the prevalence of current tobacco use among individuals with a history of lung or head/neck cancer (CRD #42012002625). An extensive search of electronic databases (MEDLINE, EMBASE, Cochrane Library, CINAHL, PsycINFO, and Web of Science) identified 7,777 potentially relevant articles published between 1980 and 2014 and 131 of these yielded pertinent information. Aggregating results across heterogeneous study designs and diverse patient samples, the overall mean prevalence rate of

current tobacco use (mostly cigarette smoking) was 33.0% (median, 31.0%). Among current tobacco users at cancer diagnosis, the mean prevalence rate of current tobacco use (mostly cigarette smoking) was 53.8% (median, 50.3%). In many cases, an operational definition of "current" tobacco use was absent, and biochemical verification of self-reported smoking status was infrequent. These and other observed methodologic limitations in the assessment and reporting of cancer patients' tobacco use underscore the necessity of uniform tobacco use assessment in future clinical research and cancer care. *Cancer Epidemiol Biomarkers Prev*; 24(10); 1450–61. ©2015 AACR.

Introduction

Tobacco use is well established as a leading cause of cancer (1, 2). In addition to its etiologic role, tobacco use carries substantial clinical significance after cancer diagnosis. Tobacco use following cancer diagnosis is causally related to second primary cancer and both all-cause and cancer-specific mortality, and it is a risk factor for cancer recurrence, poorer treatment response, and treatment-related toxicity (2). Tobacco use is also correlated with poor quality-of-life outcomes, including symptoms of depression and indicators of stress (3–6). Consequently, the American Association for Cancer Research, American Society of Clinical Oncology, and International Society of Nurses in Cancer Care all advocate for systematic assessment and routine treatment of tobacco use among patients with cancer (6–8).

Despite the objective importance of tobacco use after cancer diagnosis, methodologic limitations in the assessment and reporting of tobacco use make it difficult to determine the true scope of the problem. Studies on the prevalence of persistent smoking after cancer diagnosis often yield highly divergent results. In head and neck (head/neck) cancer studies, for example,

Lin and colleagues (9) found an 18% prevalence rate of current cigarette smoking, whereas Duffy and colleagues (10) found a 30% prevalence rate. Reasons for such variation include heterogeneity in study design, outcome measurement, and sample characteristics.

While the relevant literature has grown recently, to our knowledge, no systematic review addresses the prevalence of tobacco use after cancer diagnosis. With ever-increasing demands on oncologists' time and limited resources in most cancer centers, resource allocation toward tobacco use treatment must be firmly grounded in scientific evidence. Consequently, we conducted a systematic literature review (i) to determine the prevalence of tobacco use after lung or head/neck cancer diagnosis and (ii) to identify the methodologic characteristics of existing studies to provide recommendations for future work. While the number of cancers attributable to tobacco use continues to expand, we focus on lung and head/neck cancers because they are the most widely known "tobacco-related malignances" (1, 2).

Materials and Methods

Search strategy and data sources

Following best practices for systematic reviews (11), we registered our study with PROSPERO International (Centre for Reviews and Dissemination #42012002625, http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42012002625) and then conducted an extensive electronic search to identify pertinent published articles. Searches were conducted by a reference librarian (A.P. DeRosa) in the following databases with publication dates ranging from January 1, 1980, to December 31, 2011: CINAHL, Cochrane Library, EMBASE, MEDLINE (via PubMed), PsycINFO, and Web of Science. Both controlled vocabulary and text word searches were conducted, as appropriate. Search terms included, but were not limited to, head and neck neoplasm; lung neoplasm;

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smoking; snuff; tobacco; tobacco, smokeless; cessation; quit; smoking cessation; and tobacco use cessation products. A complete description of our Medical Subject Headings (MeSH) and keyword terms, as well as our exact MEDLINE search strategy, is available upon request. After the aforementioned search, but before data synthesis, several relevant studies were published. Consequently, we performed another MEDLINE search for publication dates ranging from January 1, 2012, to June 31, 2014.

Inclusion–exclusion criteria

For inclusion in this systematic review, articles needed to meet these criteria: (i) include a sample of at least 25% lung and/or head/neck cancer patients, (ii) measure the prevalence of current tobacco use after cancer diagnosis, and (iii) be written in English. Case studies, commentaries, editorials, abstracts, dissertations, and review articles were excluded. In addition, we excluded 14 articles that described clinical trials to promote tobacco cessation (12–25), as we intended to provide valid estimates of the natural history of tobacco use after cancer diagnosis. Readers interested in such interventions may see a recently published meta-analysis on the subject (26).

Search results and data extraction

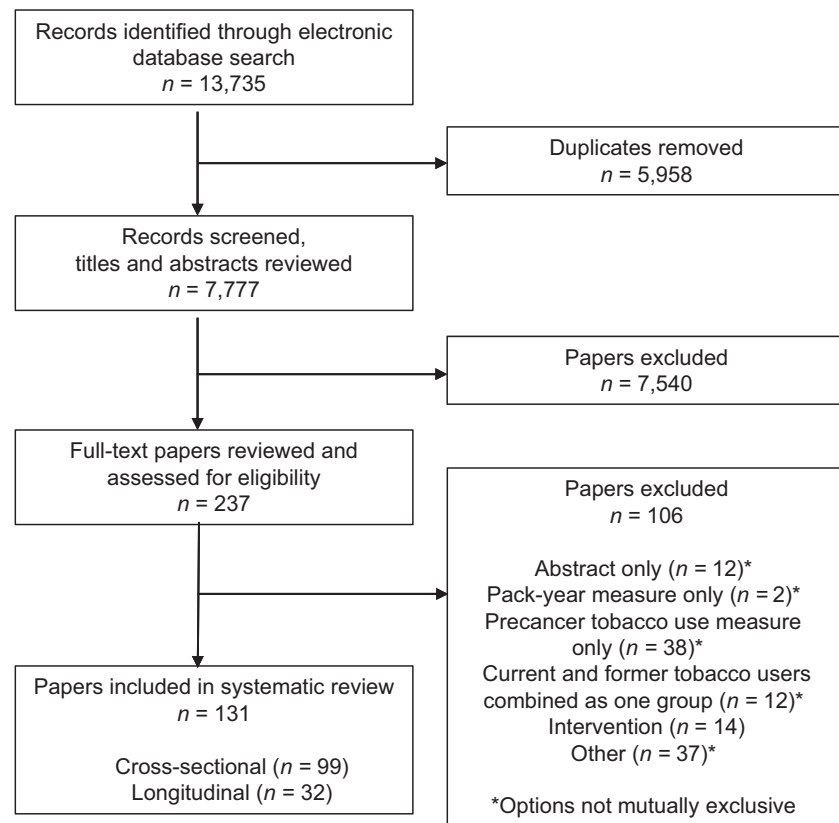
Search results were combined in a bibliographic reference management tool (EndNote X7). After elimination of duplicates, our search strategy yielded 7,777 citations. The titles and abstracts of these articles were reviewed to identify those that addressed plausibly relevant topics. Articles judged by at least one of 3

reviewers (J.L. Burris, J.L. Studts, and J.S. Ostroff) to be worthy of further consideration advanced to the next stage of review. The second step involved reviewing full-length articles. Data were extracted and entered into a Research Electronic Data Capture (REDCap; ref. 27) database. We extracted data on the sample, methods, and results of each article, and we coded data as "missing" whenever appropriate. In addition to those variables that were easily identifiable in a given article (e.g., gender composition), we computed some variables on the basis of available information in text or tables (see "Measurement of Select Variables"). The first author (J.L. Burris) independently coded each full-length article using a detailed manual. Half of the articles were *a priori* randomly selected for independent double coding by another author (J.L. Studts or J.S. Ostroff) to ensure the first author's strict adherence to the coding manual. Discussions among the authors were used to resolve disagreements and achieve consensus. Figure 1 shows our search results.

Measurement of select variables

We coded 2 variables on the basis of where participants were along the cancer trajectory. First, we coded "phase of survivorship" on the basis of participants' number of months since cancer diagnosis at the time current tobacco use was assessed (e.g., 0–3 months). Second, we coded "phase of treatment" on the basis of participants' treatment phase at the time current tobacco use was assessed (e.g., during treatment). For both phase of survivorship and treatment, data were coded at the sample level. In the case of longitudinal studies, coding for these variables was

Figure 1. Flow diagram for article identification, retrieval, and inclusion in systematic review.



based on baseline data. In addition, we classified participants in longitudinal studies as falling into 1 of 4 categories on the basis of their smoking status at each time point: (i) persistent smoker: smoker at every assessment, (ii) relapser: nonsmoker at an earlier assessment but smoker at the final assessment, (iii) late quitter: smoker at an earlier assessment but nonsmoker at the final assessment, or (iv) persistent abstainer: nonsmoker at every assessment.

Results

Summary of studies

We identified 131 articles that reported the prevalence of tobacco use after lung or head/neck cancer diagnosis (4, 5, 9, 10, 28–154), with the earliest study published in 1980 (83). Most studies were conducted in the United States (60.3%, $n = 79$; e.g., refs. 74, 99, 101, 114, 134), with the next most common study locations being in Canada (7.6%, $n = 10$; refs. 30, 38, 39, 44, 65, 84, 97, 104, 147, 148) and France (4.6%, $n = 6$; refs. 32, 37, 100, 108, 113, 146). Most articles described cross-sectional studies (75.6%, $n = 99$) but some described longitudinal studies (24.4%, $n = 32$; refs. 10, 35, 38, 42, 45, 46, 52–54, 56, 62, 65, 69, 73, 75, 76, 80, 84, 89, 90, 98, 100, 103, 104, 118, 121, 123, 126, 129, 135, 149, 152). For the longitudinal studies, the number of tobacco use assessments ranged from 2 (e.g., refs. 42, 100, 123) to ≥ 5 (e.g., refs. 69, 103, 121); the number of assessments was sometimes unclear (e.g., refs. 35, 118, 152). Participant recruitment usually involved clinics or hospitals (88.5%, $n = 116$; e.g., refs. 50, 101, 139), although some studies recruited through cancer registries (6.1%, $n = 8$; refs. 31, 56, 66, 100, 128, 138, 142, 150) or relied on population-based survey data (1.5%, $n = 2$; refs. 85, 153); only a handful of studies used multiple recruitment strategies (3.8%, $n = 5$; refs. 52, 53, 73, 103, 125).

Characteristics of participants

Sample sizes ranged from 13 (105) to 7,990 (102) with a mean of 384.4 (SD, 805.4; median, 176.0) participants. Most studies consisted exclusively of patients with either lung (48.1%, $n = 63$; e.g., refs. 53, 85, 86, 116, 121, 146) or head/neck (42.7%, $n = 56$; e.g., refs. 38, 49, 59, 72, 79) cancer. Other clinical characteristics are summarized in Table 1. Given the clinical population, the predominance of older, male samples was not unexpected. Indeed, participants' mean age at study enrollment was 61.8 years [SD, 3.6; median, 61.6; range, 55.0; (ref. 9)–71.0 (refs. 67, 128)] and in 85.0% ($n = 102$ of 120) of articles, women made up fewer than half of the sample. Participants' racial and ethnic background was infrequently reported (missing, 59.5%; $n = 78$), as was their educational attainment (missing, 76.3%; $n = 100$) and relationship status (missing, 71.0%; $n = 93$). In cases where such information was available, participants could typically be described as predominantly White, non-Hispanic individuals with at least a high school education or equivalent. Marital status was more varied, with several studies including a fair number of single or unmarried participants. Lifetime history of tobacco use was the most frequently measured tobacco use history variable (e.g., compared with pack-years), with 80.1% ($n = 105$) of studies reporting such data. We found 51.3% (48) to 100.0% (31, 36, 42, 44, 51, 54, 72, 73, 76, 80, 84, 117, 129–132, 135, 145, 147–149) of participants had a positive lifetime history, with nearly half of all relevant studies (47.6%, $n = 50$ of 105) classifying $\geq 90.0\%$ of participants as current or former smokers.

Table 1. Participants' clinical characteristics and tobacco use measurement ($n = 131$ studies)

Clinical variable	Percent (n) of studies ^a	M, SD across studies
Cancer diagnosis		
Lung only	48.1 (63)	
Head/neck only	42.7 (56)	
Mixed	9.2 (12)	
Cancer stage		
Early or local only	13.7 (18)	
Regional only	1.5 (2)	
Late or advanced only	7.6 (10)	
Mixed	65.6 (86)	
Missing or unclear	11.5 (15)	
Treatment phase ^b		
Pretreatment only	23.7 (31)	
In treatment only	19.1 (25)	
Posttreatment only	21.4 (28)	
Mixed	29.0 (38)	
Missing or unclear	6.9 (9)	
Treatment type ^c		
Surgery only	11.5 (15)	
Radiation only	9.9 (13)	
Chemotherapy only	2.3 (3)	
Mixed	61.1 (80)	
Missing or unclear	15.3 (20)	
Months since cancer diagnosis, mean ^d		21.4, 19.0
Tobacco use variable	Percent (n) of studies^a	
Cigarette smoking		
1 y	12.2 (16)	
30 days	13.0 (17)	
7 days	9.9 (13)	
24 hours	2.3 (3)	
Missing or unclear ^e	61.1 (80)	
Other tobacco use		
1 y	0.0 (0)	
30 days	16.7 (1)	
7 days	0.0 (0)	
24 hours	16.7 (1)	
Missing or unclear ^e	66.7 (4)	

^aColumn percentages may not add up to 100.0 due to rounding.

^bThis variable refers to what was occurring at the time of tobacco use assessment. In the case of longitudinal studies, this variable corresponds to baseline.

^cThis variable includes treatment that may have occurred after the time of tobacco use assessment.

^dThis variable was missing or unclear in 89.3% ($n = 117$) of studies, although some articles reported a median value and others reported time since treatment initiation or completion.

^eThis includes studies that reported the point prevalence of "current" tobacco users, without explicit mention of how "current" was operationalized.

Measurement of tobacco use after cancer diagnosis

In 13.7% ($n = 18$) of articles, the method used to measure tobacco use was unspecified (28, 29, 37, 58, 77, 102, 105, 107, 109, 116, 117, 119, 124, 134, 139, 140, 148, 154). When this information was reported, data were typically collected directly from participants (57.3%, $n = 75$; e.g., refs. 59, 65, 86, 110, 136). When chart reviews were used to measure tobacco use (14.5%, $n = 19$; refs. 9, 31, 33, 43, 48, 50, 66, 68, 79, 91, 93, 94, 98, 108, 118, 142, 146, 147, 150), it was often unclear whether the data arose from patient report and/or clinician ratings. Biochemical analysis was occasionally used to validate self-report data (14.5%, $n = 19$; refs. 39, 42, 52–54, 67, 73, 75, 76, 88, 89, 96, 101, 106, 122, 126, 128, 135, 149), with cotinine as the

most frequent assay (89.5%, $n = 17$ of 19). In no study employing biochemical validation was there 100% agreement between self-report and biochemical analysis. As examples, Browning and colleagues found a misreporting rate of 7% (42), Hay and colleagues found a rate of 3% (76), and Landi and colleagues found a rate less than 1% (96). Regardless of how tobacco use was ascertained, the specific definition used to calculate the prevalence of current tobacco use was often unavailable (61.1%, $n = 80$); see Table 1. Finally, nicotine dependence measures like the Fagerström Test of Nicotine Dependence (155) and Heaviness of Smoking Index (156) were rarely used (9.2%, $n = 12$; refs. 36, 51–53, 65, 73, 75, 76, 106, 129, 135, 149).

Prevalence of tobacco use after cancer diagnosis

Cross-sectional data. On the basis of the cross-sectional studies and the baseline assessments from longitudinal studies ($n = 117$), the overall prevalence of tobacco use after lung or head/neck cancer diagnosis ranged from 0.0% (105) to 100.0% (42); the mean prevalence rate was 33.0% (SD, 18.8; median, 31.0%). Whether these prevalence data are analyzed by publication dates split into 5- or 10-year increments, no temporal trends emerged (data not shown). Notably, this prevalence rate varied between samples of exclusively lung (29.6%; SD, 18.5) versus head/neck (36.8%; SD, 19.6) cancer patients. The aforementioned prevalence rates refer almost entirely to cigarette smoking, as very few papers (4.6%, $n = 6$) addressed other tobacco products (e.g., snus, cigar; refs. 63, 73, 75, 77, 87, 103). Consequently, in the text that follows, we limit our discussion to cigarette smoking.

In 27.5% ($n = 36$) of studies, there was sufficient information to determine the prevalence of current smoking among participants who were current smokers at cancer diagnosis (4, 5, 34–36, 39, 40, 44, 46, 56, 60, 65, 76, 80–84, 87, 97, 110, 112, 115, 117, 123, 125, 128, 129, 136–138, 142–144, 149, 153). In many cases, the definition used to classify current smokers at cancer diagnosis was unreported (38.9%; $n = 14$ of 36; e.g., refs. 4, 31, 87, 110, 128). When it was reported, the most common definition corresponded to a 1-year point prevalence rate (54.5%; $n = 12$ of 22; e.g., refs. 60, 101, 136, 138, 144), which reflects smoking in the year prior to cancer diagnosis. Collapsing data across all point prevalence measures, this modified prevalence rate of persistent smoking ranged from 13.8% (76) to 100.0% (65, 84, 149), with a mean of 53.8% (SD, 24.3; median, 50.3%). Again, no temporal trends emerged from the data, but the prevalence rate did appear to differ between exclusively lung (50.3%; SD, 27.8) versus head/neck (57.3%; SD, 18.3) cancer samples.

The prevalence of current smoking after lung or head/neck cancer diagnosis can also be calculated on the basis of where participants were along the cancer trajectory (see Fig. 2A and B). Results of both the survivorship- and treatment-specific analysis suggest the overall prevalence of smoking may be greatest near the time of cancer diagnosis, declining sharply in the months immediately thereafter (coinciding with the onset of treatment), with a risk of increasing as individuals get further out from cancer diagnosis and treatment. (The second decrease in the prevalence rate of smoking shown in Fig. 2A, we believe, is probably due to low representation of smokers in studies of "long-term cancer survivors" as opposed to a high rate of smoking cessation at this time.) While the aforementioned behavioral pattern is possible, the results shown in Fig. 2 are based on cross-sectional data, which precludes any definitive remarks about within-person change.

Longitudinal data. As stated above, 32 articles included ≥ 1 assessment of participants' tobacco use following cancer diagnosis. However, half ($n = 16$) of these articles reported data such that participants were either continuing smokers or not (35, 38, 45, 46, 56, 69, 75, 89, 90, 98, 100, 103, 118, 123, 126, 152). For this subgroup of longitudinal studies, the prevalence of smoking after lung or head/neck cancer diagnosis ranged from 8.2% (126) to 60.0% (75), with a mean of 30.5% (SD, 15.0; median, 26.8%). Among those participants who were current smokers at cancer diagnosis, the prevalence of persistent smoking ranged from 25.6% (46) to 57.3% (56), with a mean of 42.2% (SD, 14.4; median, 42.9%).

For the 16 studies that made full use of longitudinal data (10, 42, 52–54, 62, 65, 73, 76, 80, 84, 104, 121, 129, 135, 149), the prevalence of current smoking after lung or head/neck cancer diagnosis can be described in 2 ways. In 10 studies, there was sufficient information to create the 4-group categorical variable that captured change in smoking status over time (52, 53, 62, 65, 73, 76, 80, 84, 121, 129). As shown in Table 2, the largest category corresponds to persistent abstainers, although patients with lung and head/neck cancer demonstrate some fluidity in their smoking behavior, as there is fair representation in the relapser and late quitter groups. In 11 studies, it was possible to calculate the prevalence of current smoking at distinct assessment time-points (10, 42, 52–54, 76, 80, 84, 129, 135, 149); 2 additional studies provided multiple prevalence estimates, but the length of time between assessments was unclear (65, 104). In an attempt to combine data across studies with major methodological differences, baseline was coded as "Month 0," and follow-ups were coded as baseline + X number of months. The prevalence of smoking at each assessment from months 0 to 24 (the longest observation period was 24.5 months; ref. 84) is shown in Fig. 3. In regard to change over time, no clear pattern of increasing or decreasing prevalence emerged.

Other tobacco use outcomes

Participants' amount of smoking (e.g., cigarettes per day) was reported in fewer than 10% ($n = 10$) of studies (49, 61, 72, 73, 76, 84, 121, 135, 144, 157). Likewise, information on post-cancer diagnosis quit attempts, continuous abstinence, and/or tobacco cessation treatment use was omitted from all but a handful of articles (35, 39, 42, 44, 51–54, 56, 60, 73, 75, 80, 82, 83, 87, 90, 97, 103, 112, 129). Given limited data, we chose not to aggregate findings across studies.

Discussion

On the basis of our systematic review of 131 articles, we estimate that the overall prevalence of current smoking after lung or head/neck cancer diagnosis is about 30%. Thus, at any given time, about one third of individuals with a history of lung or head/neck cancer can be classified as current smokers. This prevalence rate far exceeds what is now typically found in population-based studies of adults in the United States [18.1% in 2012 (ref. 158); 33.2% in 1980 (ref. 159)], the most common location for the studies reviewed herein. If one only considers individuals who were current smokers at cancer diagnosis, the prevalence rate we found (roughly 50%) is sufficiently high to classify smokers at cancer diagnosis as "high risk" for persistent smoking in the ensuing weeks, months, and years. Regardless of whether one considers the overall prevalence rate or the modified prevalence

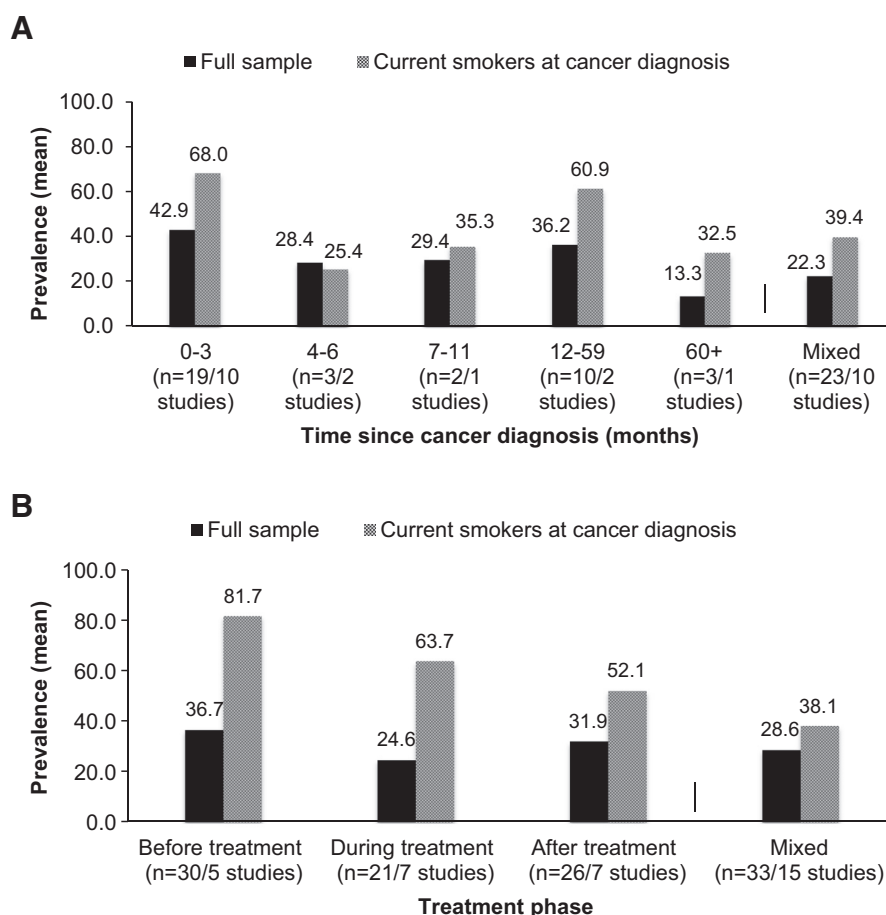


Figure 2. A, prevalence of current smoking after lung or head/neck cancer diagnosis by phase of survivorship. Ns, number of studies in the analysis for full sample/current smokers at cancer diagnosis. Full sample: 0–3 includes data from refs. 4, 10, 34, 40, 42, 54, 63, 73, 80, 84, 110, 127, 132, 134, 135, 143, 145, 147, 154; 4–6 includes data from refs. 51, 131, 153; 7–11 includes data from refs. 49, 133; 12–59 includes data from refs. 59, 79, 85, 86, 88, 91, 97, 100, 141, 152; 60+ includes data from refs. 67, 70, 128; and Mixed includes data from refs. 5, 29–31, 46, 52, 56, 62, 69, 90, 94, 95, 98, 103, 112, 115, 120–122, 125, 126, 130, 138. Current smokers at cancer diagnosis: 0–3 includes data from refs. 4, 34, 39, 40, 80, 82, 84, 110, 143, 149; 4–6 includes data from refs. 76, 153; 7–11 includes data from ref. 123; 12–59 includes data from refs. 36, 97; 60+ includes data from ref. 128; and Mixed includes data from refs. 5, 35, 44, 46, 56, 112, 115, 125, 129, 138. B, prevalence of current smoking after lung or head/neck cancer diagnosis by phase of treatment. Ns, number of studies in the analysis for full sample/current smokers at cancer diagnosis. Full sample: before treatment includes data from refs. 4, 10, 28, 32, 43, 45, 57, 59, 63–65, 68, 73, 74, 84, 99, 101, 102, 106, 108, 109, 111, 114, 127, 132, 134, 143, 148, 151, 154; during treatment includes data from refs. 33, 34, 37, 38, 40, 50, 75, 78, 104, 107, 110, 118, 121, 124, 133, 139, 145–147, 150, 152; after treatment includes data from refs. 29, 30, 49, 53, 58–60, 67, 69, 70, 79, 85–87, 89, 92, 97, 98, 100, 103, 105, 119, 122, 128, 138, 141; and Mixed includes data from refs. 5, 41, 42, 46, 47, 52, 55, 61, 62, 73, 77, 80, 83, 90, 91, 93, 94, 96, 115, 126, 130, 131, 133, 140, 144, 153. Current smokers at cancer diagnosis: before treatment includes data from refs. 4, 65, 82, 84, 143; during treatment includes data from refs. 34, 39, 40, 110, 117, 142, 149; after treatment includes data from refs. 44, 60, 87, 97, 128, 136, 138; and Mixed includes data from refs. 5, 35, 36, 46, 56, 76, 80, 83, 112, 115, 123, 125, 129, 144, 153.

rate based on the current smoker subgroup analysis, our findings are striking, given the clear, negative implications that persistent smoking has on cancer outcomes (2, 6, 160). The observed rate of current smoking underscores the clinical necessity of a "paradigm shift" that would bring assessment and treatment of tobacco use to the forefront of cancer care (161). Recent cancer provider (162, 163) and patient (52, 53) report surveys highlight critical gaps between recommended evidence-based guidelines (164–166) and actual delivery of tobacco cessation treatment in the cancer setting, which indicates there is much room for improvement for this aspect of quality cancer care.

This article represents the first systematic review of a growing empirical literature on tobacco use after lung or head/neck cancer diagnosis. However, there remains an incomplete picture of this

clinical problem, partly due to methodologic limitations in the measurement and reporting of cancer patients' tobacco use. At minimum, accurate classification of patients with cancer as "current," "former," or "never" tobacco users requires an operational definition for each category. Current tobacco users could be defined by 1-year, 30-day, 7-day, or 24-hour point prevalence (167), so specificity is necessary. Given that a larger window of observation allows greater heterogeneity in smoking behavior at both the individual and sample levels and relapse curves for smoking differ based on time since quit attempt (53, 149, 168, 169), there is strong need to standardize tobacco use assessment (6). Reliable and valid measurement of tobacco use should be required for clinical trials so as to advance the scientific knowledge on the risks of persistent tobacco use on

Table 2. Longitudinal classification of smoking status after lung or head/neck cancer diagnosis

Study	Sample size	Percentage of participants in each category ^a			
		Persistent smoker	Relapser	Late quitter	Persistent abstainer
Cooley et al. (52)	230	6.7	1.2	0.6	91.5
Cooley et al. (53)	94	13.1	40.5	0.0	46.4
Do et al. (62)	1190	16.6	12.3	3.3	67.7
Eng et al. (65)	721	14.7	0.7	18.9	65.7
Gritz et al. (73)	840	6.8	21.5	8.2	63.5
Hay et al. (76)	188	11.9	8.4	4.2	75.5
Hopenhayn et al. (80)	142	11.9	13.4	4.9	69.7
Kashigar et al. (84)	295	24.4	0.0	24.7	50.8
Sanderson et al. (121)	226	66.7	30.0	3.3	0.0
Schnoll et al. (129)	74	31.4	13.7	9.8	45.1

^aRow percentages may not add up to 100.0 due to rounding.

clinical outcomes (170, 171). In addition, for clinical practice, proper assessment is essential to identify current tobacco users and provide evidence-based treatment (7, 8). Although we recognize the pitfalls of a "one size fits all" approach, we recommend adoption of a 30-day point prevalence definition of current tobacco user, consistent with the National Cancer Institute—American Association for Cancer Research Cancer Patient Tobacco Use Assessment Taskforce (172) and National Comprehensive Cancer Network Clinical Practice Guidelines for Smoking Cessation (173). Furthermore, in some research and clinical settings, we believe it necessary to employ biochemical verification of tobacco use status since nicotine may affect the course of cancer treatment (174–176) and misreporting is a well-documented problem in the context of cancer care (e.g., refs. 42, 177).

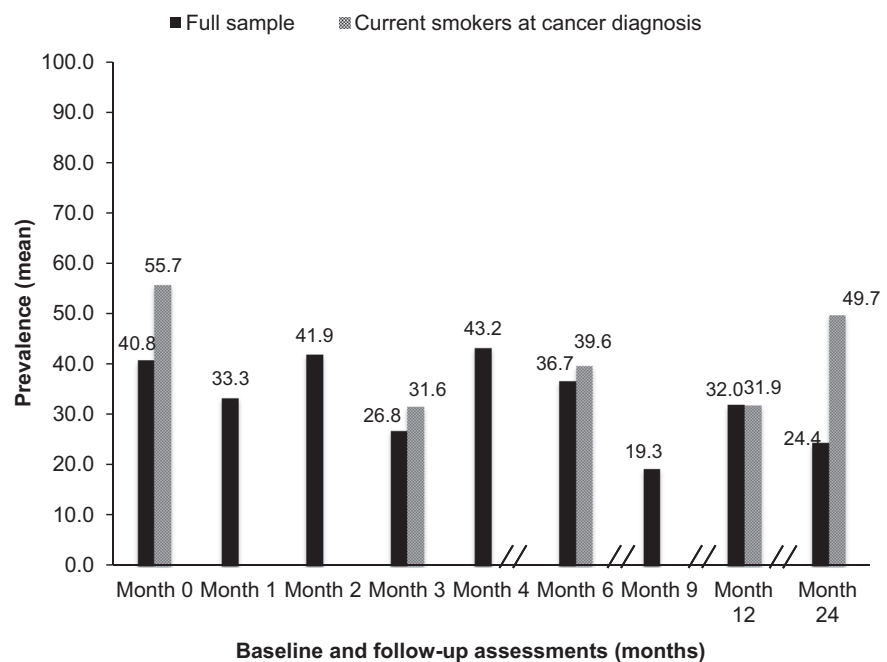
Because of the changing landscape of tobacco products, we suggest cigarette smoking not be measured in isolation. With the advent of potentially reduced exposure products (178), patients with cancer—like smokers in the general population (179–183)—might consider use of noncombustible tobacco products. Motivation for snus use, in particular, might arise due to (i) the

perception that it is less harmful than cigarette smoking, (ii) the desire to reduce or quit smoking, and/or (iii) the ability to circumvent smoking restrictions and mitigate nicotine withdrawal when smoking is prohibited (184–188). Similarly, patients with cancer may be motivated to use electronic cigarettes as a substitute or complement to smoking or perhaps as an aid to smoking cessation (182, 189). A paucity of the articles we reviewed provide information about non-cigarette tobacco products, so the prevalence of non-cigarette tobacco use among lung and head/neck cancer patients is unclear. However, if one generalizes from the general population (179, 190–192), dual or poly tobacco use may be increasing among patients with cancer.

A final comment about methodology pertains to the need to collect data on post-cancer diagnosis quit attempts (e.g., time to relapse) and tobacco cessation treatment use (e.g., nicotine replacement therapy). Some data suggest that patients with cancer attempt tobacco cessation without formal assistance (166), which decreases the likelihood of long-term abstinence (165, 169). Given the potential value of designing interventions that capitalize on the "teachable moment" of cancer diagnosis (20, 193, 194), there is dire need to better understand the naturalistic process of

Figure 3.

Variation in the prevalence of current smoking after lung or head/neck cancer diagnosis across time. Baseline was centered at month 0 for every study. Full sample: Month 0 includes data from refs. 10, 42, 52–54, 80, 84, 135; Month 1 includes data from ref. 53; Month 2 includes data from refs. 10, 52–54, 80; Month 3 includes data from refs. 10, 52–54, 80; Month 4 includes data from ref. 135; Month 6 includes data from refs. 10, 42, 52, 54, 80, 135; Month 9 includes data from ref. 10; Month 12 includes data from refs. 10, 135; and Month 24 includes data from ref. 84. Current smokers at cancer diagnosis: Month 0 includes data from refs. 76, 80, 84, 129, 149; Month 3 includes data from refs. 76, 80, 129, 149; Month 6 includes data from refs. 80, 149; Month 12 includes data from refs. 76, 149; and Month 24 includes data from ref. 84.



smoking cessation after cancer diagnosis (e.g., the nature of the relapse curve, the amount of time that passes between quit attempts), as there currently exist only a handful of longitudinal studies on the subject (53, 73, 149). Similarly, further research identifying demographic, clinical, and psychosocial factors associated with persistent smoking is needed for targeting and tailoring tobacco cessation treatment.

Limitations of this systematic review deserve comment. First, the decision to focus on lung and head/neck cancer limits the generalizability of our findings. It is quite possible the prevalence rates we found may be higher or lower than what would be observed in other samples. Thus, as the literature matures, it will be important to consider tobacco use patterns in cancer patients with other diagnoses. Second, there is selection bias, as we did not include the "grey literature" nor did we include papers published in languages other than English. Third, we did not formally rate the quality of each article, instead judging the overall methodological strengths and weaknesses of the extant body of published literature. Finally, because of the wide heterogeneity of studies, we did not conduct a meta-analysis.

Conclusions

This systematic review found roughly one third of lung and head/neck cancer patients continue to smoke after cancer diagnosis. The rate of current smoking is even higher (approximately half) among those individuals who were current smokers at cancer diagnosis. Generally, low rates of misreporting smoking status were observed in the studies reviewed here, but failures to biochemically validate self-reported tobacco use data are known to occur in some cancer settings. Estimates of the overall prevalence of smoking seem to increase and decrease at different points across the cancer trajectory. Similarly, within any given patient with cancer, smoking status may fluctuate due to the chronic nature of nicotine dependence and the stressors of living with

cancer. Because of the methodologic limitations of prior studies and great heterogeneity in the extant body of literature, however, we are not yet in a position to provide details about the process of smoking cessation after cancer diagnosis. As is, our findings only begin to document the magnitude of the problem of tobacco use after cancer diagnosis. To advance the field of cancer prevention and control, we strongly support greater uniformity in tobacco use assessment and firm requirements to integrate tobacco cessation treatment into routine cancer care (6).

Disclosure of Potential Conflicts of Interest

J.S. Ostroff reports receiving a commercial research grant from Pfizer. No potential conflicts of interest were disclosed by the other authors.

Disclaimer

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