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Research Article

Differences in Active and Passive Smoking Exposures and Lung Cancer Incidence Between Veterans and Non-Veterans in the Women's Health Initiative

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Abstract

Introduction: Women Veterans may have higher rates of both active and passive tobacco exposure than their civilian counterparts, thereby increasing their risk for lung cancer.
Purpose of the Study: To compare differences in active and passive smoking exposure and lung cancer incidence among women Veterans and non-Veterans using prospective data from the Women's Health Initiative (WHI).
Design and Methods: We used data from the WHI, which collected longitudinal demographic, clinical, and laboratory data on 161,808 postmenopausal women. We employed linear and multinomial regression and generalized linear models to compare active and passive smoking exposure between Veterans and non-Veterans and Cox proportional hazards models to estimate differences in lung cancer incidence rates.
Results: After adjustment, Veterans had 2.54 additional pack years of smoking compared with non-Veterans (95% confidence interval [CI] 1.68, 3.40). Veterans also had a 1% increase in risk of any passive smoking exposure (95% CI 1.00, 1.02) and a 9% increase in risk of any workplace exposure (95% CI 1.07, 1.11) compared with non-Veterans. After adjustment for age and smoking exposures, Veterans did not have a higher risk of lung cancer compared with non-Veterans (relative risk = 1.06 95% CI 0.86, 1.30).
Implications: Women Veterans had higher rates of tobacco use and exposure to passive smoking, which were associated with a higher risk for lung cancer compared with non-Veterans. Clinicians who care for Veterans need to be aware that older women Veterans have more exposures to risk factors for lung cancer.

Key Words: Lung cancer, Smoking, Tobacco, Women Veterans

Lung cancer is the second most common cancer in women, accounting for 13% of all new cancers, and is by far the leading cause of cancer deaths among women (American Cancer Society, 2015). The American Cancer Society estimates 105,590 new cases of lung cancer and 71,660 deaths among U.S. women in 2015, or 27% of all cancer deaths (American Cancer Society, 2015). Lung cancer predominately affects aging adults, with the majority of diagnoses occurring after age 65. Overall, a woman has a 1 in 16 chance of developing lung cancer in her lifetime (American Cancer Society, 2015).

Smoking is by far the major risk factor for lung cancer. Other risk factors for lung cancer among women include passive smoke exposures, air pollution, residential radon, occupational hazards, lung diseases, hormonal factors, prior cancer treatments, and family history of cancer (Kreuzer et al., 2002). All of these factors have been suggested to contribute to lung cancer incidence but to a much lesser extent than smoking.

Military service and combat exposure are risk factors for smoking in both men and women (Brown, 2010; Klevens et al., 1995; Lehavot, Hoerster, Nelson, Jakupcak, & Simpson, 2012; Whitlock, Ferry, Burchette, & Abbey, 1995). Smoking is highly prevalent among active duty service members compared with civilians, and women Veterans may also have experienced unique workplace exposures (e.g., passive smoke exposure) compared with civilians that increase their risk of lung cancer (Kang et al., 2014). Among a survey of women Veterans, more than one third of smokers began smoking in the military (Whitlock et al., 1995). Despite these important environmental exposures associated with military service, studies have not examined passive smoke exposure in women Veterans.

Studies of lung cancer in women Veterans have found variable results. Evidence among Vietnam Veterans suggests that they are less likely to die from lung cancer than their non-Veteran peers, which has been attributed to the "healthy solider effect" that individuals who served in the military are healthier than their peers due to enlistment standards of physical health (Dalager, Kang, & Thomas, 1995; Kang et al., 2014). Contrary to these findings, some subgroups of Veterans, such as nondeployed Vietnam nurses, were found to have increased lung cancer mortality compared with the U.S. population (Dalager et al., 1995). There is a growing body of research that the "healthy soldier effect" may wane due to time from service (Monson, 1986; Waller & McGuire, 2011); however, these studies often contained limited smoking behavior data clouding our understanding of the effect on lung cancer.

Conceptual Framework

The differences in smoking behaviors between military and civilian populations are likely influenced by factors at multiple levels based on the ecological model of health behaviors (McLeroy, Bibeau, Steckler, & Glanz, 1988). This conceptual framework describes the influence of factors at different levels such as intrapersonal (demographics of women joining the military and region of the country where they live), interpersonal (relationships/positions in the military), institutional (exposures unique to military service), and community (active and passive smoking exposures). Differences in one or more of these constructs between Veterans and non-Veterans may lead to disparities in both smoking behaviors and lung cancer. Therefore, we examined links between military service and incidence of lung cancer, as well as the influence of smoking on this relationship. Specifically, we predicted that women Veterans would have greater exposure to both active and passive smoking and a higher incidence of lung cancer than non-Veterans.

The Women's Health Initiative (WHI) represents a unique opportunity to explore the patterns and correlates of smoking and lung cancer among a large, prospective, multiethnic cohort of postmenopausal women Veterans and non-Veterans. Therefore, we aim to (i) compare cumulative exposure of active smoking and sources of passive smoking between Veterans and non-Veterans and (ii) examine whether women Veterans have higher lung cancer incidence after adjustment for potential risk factors, such as active smoking exposures.

Methods

Study Population

The study population for the analyses included women enrolled in the WHI Clinical Trial (CT) and Observational Study (OS), in which postmenopausal women 50–79 years of age were recruited from 40 clinical centers across the United States (Anderson et al., 2003; Hays et al., 2003; The Women's Health Initiative Study Group, 1998). WHI enrolled a total of 161,808 (CT: 68,132, OS: 93,676) racially and ethnically diverse women between 1993 and 1998, who were followed until 2005 for the main study. The WHI CT involved three overlapping components: Dietary Modification (DM) Trial, Hormone Therapy (HT) Trials, and Calcium and Vitamin D (CaD) Trial. The HT included two separate trials—one using estrogen plus progestin (E+P) for women with an intact uterus and the other using estrogen alone (E-alone) for women without an intact uterus. Women who were not willing or eligible to join the CT were invited to join the OS. Consenting participants from the main study were followed in the first Extension Study (ES) from 2005 to 2010, and consenting participants from the first ES were followed from 2010 to 2015 in the second ES. Data for all participants were collected using self-administered forms, in person or phone interviews, and clinical measurements. Institutional Review Board approved the study at all participating sites, and all participants provided written informed consent.

Study Variables

Veteran Status

At baseline, participants responded to the question, "Have you served in the US armed forces on active duty for a period of 180 days or more," a standard question in national Centers for Disease Control and Prevention studies (Hoerster et al., 2012; Koepsell, Reiber, & Simmons, 2002; Lehavot et al., 2014). Participants responding affirmatively were classified as Veterans and those responding negatively as non-Veterans; participants with missing information were excluded from all analyses.

Demographic Variables

Variables of interest included baseline self-reported age; region of the country where residing; education; marital status; race/ethnicity; occupation (current or former); and income. We also included study assignment of the participant (OS, E+P intervention, E+P control, E-alone intervention, E-alone control, DM intervention, DM control).

Active Smoke Exposure

Extensive information on smoking was collected at baseline in the WHI OS and CT, including whether the participant had ever smoked ≥100 cigarettes (no/yes), whether she currently smoked (no/yes), average cigarettes smoked per day (categorical), ages at initiation and cessation (categorical), and years as a regular smoker (categorical). From these data, WHI computed the smoking status (never, former, and current) and the pack years of smoking, for which never smokers were assigned a value of zero. WHI also categorized pack years of smoking as 0, >0 to <5, 5 to <20, and 20+ years. We collapsed age at initiation among current or former smokers as <15, 15–19, 20–24, and 25+ years and age at cessation among former smokers as <25, 25–34, 35–44, 45–54, and 55+ years.

Passive Smoke Exposure

At baseline, WHI collected information on passive smoking among the OS women only. Information included whether the participant had lived with a smoker as a child, as an adult (since age 18); whether she currently lived with a smoker; whether the current smoker was a child, partner, or other (multiple selections allowed); whether she had worked with a smoker; and whether she currently worked with a smoker (all responses no/yes). From these data, we also created a variable reflecting any passive smoke exposure (child, adult, and/or workplace). Finally, we created a variable reflecting mutually exclusive sources of passive smoke exposure, which included no passive smoke exposure, childhood exposure only, adult home exposure only, adult work exposure only, any two exposures, and all three exposures (Luo et al., 2011). Additional information on duration of exposure in years was collected for each of the sources (categorical). We collapsed years living with a smoker as a child as never, <5, 5–9, and 10–18 years; and collapsed years living

with a smoker as an adult and years working with a smoker as never, <5, 5–9, 10–19, 20–29, and 30+ years.

Lung Cancer

Lung cancer was determined based on physician-adjudicated report for all WHI participants (OS and CT). Participants initially reported any incident diagnoses of cancer through annual mailed follow-up contacts, which were then verified centrally through medical records and death certificates (Curb et al., 2003). Adjudicated outcomes are available through August 2014. A history of physician-diagnosed lung cancer was self-reported at baseline, and those reporting a diagnosis were excluded (N = 240) from analyses where incident lung cancer was an outcome. When pathology reports were available, tumors were histologically classified according to International Classification of Disease for Oncology, second edition. Cases were classified as non-small-cell lung cancer (NSCLC, subtypes: adenocarcinoma, squamous cell carcinoma, and other/unspecified), small-cell lung cancer (SCLC), and other (carcinoid), according to SEER, AJCC Cancer Staging Handbook, and WHO (Edge & Compton, 2010; Wang et al., 2015).

Data Analyses

We first examined the baseline characteristics and health behaviors of Veterans and non-Veterans separately in WHI overall and in the WHI OS.

Analyses in OS Participants

Active smoke exposure

To examine differences between Veterans and non-Veterans in pack years of smoking, we employed linear regression to obtain mean differences and 95% confidence intervals (CIs), using robust standard error estimates. The analysis included women who never smoked, who were assigned a value of zero for pack years. We also re-ran analyses excluding women who had never smoked. To evaluate differences in smoking status, categorical pack years of smoking, age at initiation, and age at cessation, we fit multinomial logistic regression models to estimate odds ratios (ORs) and 95% CIs. To facilitate interpretation, we also calculated adjusted differences in the probability of being in each particular category comparing Veterans with non-Veterans (marginal effects) in these multinomial models. Marginal effects are presented in main tables and ORs in Supplementary Tables. Age at initiation models included only current or former smokers, and age at cessation models included only former smokers. We adjusted all models for age (continuous); region (nominal; Northeast, South, Midwest, West); years living with a smoker as a child (nominal); years living with a smoker as an adult (nominal); and years working with a smoker (nominal). We restricted analyses to women in the OS because passive smoke exposure data were not available for those in the CT. We also performed sensitivity analyses adjusting additionally for race

(White, non-White); education (ordinal; no school, 1–4 years, 5–8 years, 9–11 years, high school diploma or Graduate Education Development, vocational or training school, some college or Associate Degree, college graduate, some postgraduate or professional, Master's Degree, Doctoral Degree); and income (ordinal; <$10,000, $10,000–$19,999, $20,000–$34,999, $35,000–$49,999, $50,000–$74,999, $75,000–$99,999, $100,000–$149,000, $150,000+).

Passive smoke exposure
We examined differences between Veterans and non-Veterans in the OS in any passive smoke exposure, child exposure, adult home exposure, and workplace exposure using generalized linear models with a log link, Poisson distribution, and robust standard error estimates. Because these outcomes were common, and thus ORs from logistic regression models would have overestimated the relative risks (RRs), we used this technique to directly calculate RRs and 95% CIs (Lumley et al., 2006; Zou, 2004). To examine differences in sources of passive smoke exposure and duration of exposure to the various sources, we used multinomial logistic regression to estimate ORs and 95% CIs. We also calculated marginal effects, as described earlier. We adjusted the models for age and region, as defined earlier, as well as pack years of smoking (continuous). In sensitivity analyses we additionally adjusted for race, education, and income.

Analyses in OS and CT Participants
Lung cancer incidence and case fatality
To determine whether the incidence of lung cancer differed between Veterans and non-Veterans in the WHI overall, we used Cox proportional hazards models to estimate hazard ratios (HRs) and 95% CIs. We excluded those with a self-reported history of lung cancer at baseline. For participants with lung cancer, follow-up time was defined as days from enrollment to lung cancer diagnosis or death; and for those without lung cancer, the days from enrollment to loss to follow-up or end of follow-up. We sequentially adjusted the models as follows: (i) age, (ii) age, pack years of smoking, (iii) age, pack years of smoking, and region, (iv) age, pack years of smoking, region, race, income, and education, and study assignment (nominal). In a sensitivity analysis, we adjusted for workplace passive smoke exposure (no/yes), which limited analyses to participants in the OS. The limited number of lung cancer cases in Veterans precluded adjustment for additional potential confounders. We tested the proportional hazards assumption of these models using Schoenfeld residuals (Grambsch, 1994). Because we found evidence that the proportional hazards assumption was violated for age, we also fit each of the adjusted models stratified by age group (<60, 60–69, and 70+ years), for which we present the results.

We also examined the distribution of histologic types between Veterans and non-Veterans and made comparisons using Pearson's chi-squared test among those diagnosed

with lung cancer (Wang et al., 2015). We estimated standardized case fatality rates utilizing the distribution of smoking status (never, former, and current) and age (<60, 60–69, and 70+ years) among the WHI study population as the reference in order to account for differences between Veterans and non-Veterans in these confounding variables.

Results

Out of 161,808 total WHI participants, 16,287 did not have information on Veteran status (10.07%) and were excluded from analyses. Overall, 3,719 women Veterans and 141,802 non-Veterans were included in the WHI CT and OS (Table 1). Women Veterans were older and more likely to live in the West, to be White, never married, and college graduates than non-Veterans. In the OS, there were 2,302 Veterans and 85,609 non-Veterans whose characteristics were similar to that of WHI participants overall (Table 1).

Results in OS Participants

Active Smoking Exposure
The mean pack years of smoking among Veterans was 13.10 (*SD* = 21.53), whereas it was 9.88 (*SD* = 18.54) in non-Veterans (Table 2). In adjusted linear regression, Veterans smoked 2.54 years longer than non-Veterans on average (95% CI 1.68, 3.40). Among former or current smokers, Veteran women smoked 2.12 years longer than non-Veterans (95% CI 0.78, 3.46). When examining pack years in categories, Veterans were more likely to have a higher smoking exposure, particularly 20+ pack years (see Supplementary Table 1 for ORs). The probability of smoking 20+ years was nearly 5 percentage points larger for Veterans than non-Veterans (difference [diff] = 4.67, 95% CI 3.22, 6.11). Veterans were also more likely than non-Veterans to be former (diff = 4.26, 95% CI 2.24, 6.27) or current smokers (diff = 1.90, 95% CI 0.99, 2.81). There was no consistent pattern with age at initiating smoking; Veterans were less likely to initiate between ages 15 and 19 (diff = –5.38, 95% CI –8.30, –2.45) and 25+ years (diff = –2.51, 95% CI –4.42, –0.61) and more likely to initiate between 20 and 24 years of age (diff = 6.94, 95% CI 4.42, 9.47). Among former smokers, there were no differences in the age at quitting. Results were essentially unchanged with additional adjustments for race, income, and education (data not shown).

Passive Smoking Exposure
There were only small differences between Veterans and non-Veterans in passive smoke exposure from some sources (Table 3). In adjusted analyses, Veterans had a 1% increase in risk of any passive smoking exposure (95% CI 1.00, 1.02) and a 9% increase in risk of any workplace exposure (95% CI 1.07, 1.11). There were no differences in childhood or adult home exposure (RRs = 1.00). For sources of passive smoke exposure, compared with non-Veterans, Veterans

Table 1. Baseline Characteristics of Veterans and Non-Veterans in the Women's Health Initiative Overall and in the Observational Study

	Overall[a]				Observational Study[a]			
	Non-Veterans		Veterans		Non-Veterans		Veterans	
	N	%	N	%	N	%	N	%
Total	1,41,802	100.0	3,719	100.0	85,609	100.0	2,302	100.0
Age (years)								
<50–59	46,367	32.7	785	21.1	27,308	31.9	455	19.8
60–69	64,643	45.6	1,081	29.1	38,131	44.5	627	27.2
70+	30,792	21.7	1,853	49.8	20,170	23.6	1,220	53.0
Region								
Northeast	31,594	22.3	579	15.6	19,020	22.2	359	15.6
South	36,616	25.8	1,011	27.2	22,392	26.2	635	27.6
Midwest	31,842	22.5	666	17.9	19,342	22.6	407	17.7
West	41,750	29.4	1,463	39.3	24,855	29.0	901	39.1
Race								
American Indian/Alaskan Native	606	0.4	25	0.7	361	0.4	19	0.8
Asian/Pacific Islander	3,986	2.8	46	1.2	2,562	3.0	29	1.3
Black/African American	12,874	9.1	263	7.1	6,989	8.2	159	6.9
Hispanic/Latino	5,671	4.0	86	2.3	3,251	3.8	56	2.4
White	1,16,617	82.2	3,239	87.1	71,230	83.2	2,004	87.1
Other	1,675	1.2	47	1.3	975	1.1	26	1.1
Marital status								
Never married	6,063	4.3	381	10.2	3,869	4.5	259	11.3
Divorced/separated	22,709	16.0	686	18.4	13,456	15.7	422	18.3
Widowed	24,358	17.2	835	22.5	14,756	17.2	527	22.9
Married/marriage-like	88,189	62.2	1,807	48.6	53,244	62.2	1,089	47.3
Education								
Less than high school	7,483	5.3	64	1.7	4,369	5.1	42	1.8
High school diploma/GED	24,225	17.1	379	10.2	13,814	16.1	232	10.1
Some college or vocational/training school	53,197	37.5	1,522	40.9	31,022	36.2	877	38.1
College graduate or more	55,975	39.5	1,740	46.8	35,822	41.8	1,142	49.6
Occupation								
Managerial/Professional	58,280	41.1	1,828	49.2	36,219	42.3	1,175	51.0
Technical/Sales/Administration	41,346	29.2	939	25.2	24,022	28.1	544	23.6
Service/Labor	24,778	17.5	551	14.8	14,524	17.0	332	14.4
Homemaker	14,365	10.1	313	8.4	9,003	10.5	196	8.5
Income								
<20,000	21,823	15.4	629	16.9	12,494	14.6	399	17.3
20,000 to <50,000	58,778	41.5	1,728	46.5	34,300	40.1	1,055	45.8
50,000 to <75,000	26,489	18.7	630	16.9	16,185	18.9	360	15.6
75,000+	25,310	17.8	527	14.2	16,496	19.3	351	15.2

Note: GED = Graduate Education Development. [a]Numbers may not add to totals and percents may not add to 100 due to missing data.

had a lower probability of never being exposed to passive smoke (diff = –1.12, 95% CI –2.22, –0.02) and adult home only (diff = –2.37, 95% CI –3.48, –1.26). However, Veterans had a higher probability of being exposed to all three sources than non-Veterans (diff = 2.92, 95% CI 0.85, 4.99) (Table 3; see Supplementary Table 2 for ORs).

When comparing categories of duration of exposure, there were no differences between Veterans and non-Veterans in the probability of being exposed for any childhood duration. For adult home exposure, Veterans had a higher probability of being exposed for less than 5 years

(diff = 2.78, 95% CI 1.43, 4.13) and lower probability of being exposed for 30+ years (diff = –3.27, 95% CI –4.90, –1.64). Differences in workplace exposure showed a more clear and consistent pattern: The probability of never being exposed in the workplace was nearly 7 percentage points lower for Veterans than for non-Veterans (95% CI –8.94, –4.86); for all other durations of exposure, Veterans had higher probability than non-Veterans, which was significant for the 10–19 years, 20–29 years, and 30+ years exposure durations. Results were unchanged with additional adjustments for race, income, and education (data not shown).

Table 2. Differences in Active Smoke Exposure Between Veterans and Non-Veterans in the Women's Health Initiative Observational Study

	Non-Veteran		Veteran		Diff[a]	95% CI		*p* Value
	N	Mean (*SD*)	*N*	Mean (*SD*)		LB	UB	
Pack years of smoking								
Among all women	79,767	9.88 (18.54)	2,126	13.10 (21.53)	2.54	1.68	3.40	<.001
Among former or current smokers	38,135	20.67 (22.26)	1,143	24.36 (24.25)	2.12	0.78	3.46	.002

	N	%	*N*	%	Difference in probability (percentage points)			
					Diff[a]	95% CI		*p* Value
						LB	UB	
Smoking status								
Never	41,632	51.0	983	45.1	–6.15	–8.17	–4.14	<.001
Former	34,986	42.9	1,029	47.2	4.26	2.24	6.27	<.001
Current	4,994	6.1	167	7.7	1.90	0.99	2.81	<.001
Pack years								
Never	41,632	52.2	983	46.2	–6.12	–8.17	–4.07	<.001
<5	11,876	14.9	293	13.8	0.227	–1.35	1.81	.78
5 to <20	11,445	14.3	319	15.0	1.23	–0.24	2.69	.10
20+	14,814	18.6	531	25.0	4.67	3.22	6.11	<.001
Initiating age (years)								
<15	2,615	6.6	75	6.3	0.95	–0.50	2.40	.20
15–19	20,049	50.3	493	41.3	–5.38	–8.30	–2.45	<.001
20–24	12,325	30.9	486	40.7	6.94	4.42	9.47	<.001
25+	4,856	12.2	140	11.7	–2.51	–4.42	–0.61	.01
Cessation age (years)								
<25	3,436	10.5	76	8.0	–0.14	–2.28	1.99	.90
25–34	7,987	24.5	199	20.9	–0.02	–2.87	2.83	.99
35–44	8,051	24.7	219	23.0	–0.21	–3.05	2.62	.88
45–54	7,742	23.8	249	26.1	2.30	–0.33	4.94	.09
55+	5,354	16.4h8	211	22.1	–1.92	–3.90	0.05	.06

Notes: CI = confidence interval; diff = difference; LB = lower bound; SD = standard deviation; UB = upper bound.

[a]Adjusted for age (continuous), region (nominal), years living with a smoker as a child (nominal), years living with a smoker as an adult (nominal), years working with a smoker (nominal); Veterans compared with non-Veterans.

Results in OS and CT Participants

Lung Cancer Incidence and Fatality

Among non-Veterans, there were 2,766 lung cancer diagnoses, leading to an incidence rate of 14.5 per 10,000 person-years (data not shown). For Veterans, there were 98 diagnoses for an incidence rate of 20.5 per 10,000 person-years. In Cox proportional hazards models with stratification by age categories and adjustment for age and pack years of smoking, Veterans did not have a higher incidence of lung cancer compared with non-Veterans (HR = 1.06 95% CI 0.86, 1.30; Table 4). Results were unchanged with subsequent adjustments for (i) region and (ii) region, race, income, education, and study assignment. When limiting to OS participants and adjusting for workplace exposure to passive smoke in addition to age and pack years of smoking, there were no significant differences between Veterans and non-Veterans in risk for lung cancer (data not shown).

The majority of lung cancer cases were NSCLC in both Veterans and non-Veterans (71.4% vs 74.9%) (Table 5). Although not statistically significant, women Veterans had more SCLC and the squamous cell carcinoma subtype of NSCLC compared with non-Veterans (SCLC: 11.2% vs 8.1%; squamous cell: 15.3% vs 11.4%, respectively), which is consistent with their smoking exposure (Table 5).

Among non-Veterans, the case fatality was 61.8% (1,708 deaths from lung cancer), and for Veterans it was slightly higher at 70.4% (69 deaths). When standardized to baseline smoking status and age categories of the WHI population, estimated fatality rates remained slightly higher for Veterans (63.4, 95% CI 53.1–73.7) compared with non-Veterans (61.7, 95% CI 59.9–63.5); however, there was not enough evidence to conclude that Veterans and non-Veterans differed in case fatality.

Table 3. Differences in Passive Smoke Exposure Between Veterans and Non-Veterans in the Women's Health Initiative Observational Study

	Non-Veterans		Veterans		RR[a]	95% CI		p Value
	N	%	N	%		LB	UB	
Any exposure								
Any passive exposure	77,149	94.2	2,077	95.3	1.01	1.00	1.02	.01
Childhood exposure	51,609	63.9	1,318	61.1	1.00	0.97	1.04	.82
Adult home exposure	59,964	73.3	1,651	75.9	1.00	0.98	1.03	.70
Workplace exposure	60,906	74.4	1,760	80.9	1.09	1.07	1.11	<.001

	N	%	N	%	Difference in probability (percentage points)			
					Diff[a]	95% CI		p Value
						LB	UB	
Exposure sources								
None	4,718	5.9	102	4.8	–1.12	–2.22	–0.02	.05
Childhood only	3,065	3.8	56	2.6	–0.57	–1.54	0.40	.25
Adult home only	4,535	5.6	93	4.3	–2.37	–3.48	–1.26	<.001
Adult workplace only	7,280	9.1	211	9.9	0.94	–0.25	2.14	.12
Two sources	27,106	33.7	736	34.4	0.20	–1.83	2.23	.85
Three sources	33,683	41.9	944	44.1	2.92	0.85	4.99	.01
Duration								
Childhood exposure								
Never	29,187	36.2	838	38.9	–0.40	–2.41	1.62	.70
<5 years	2,997	3.7	84	3.9	0.24	–0.56	1.03	.56
5–9 years	4,681	5.8	109	5.1	–0.54	–1.61	0.53	.32
10–18 years	43,768	54.3	1,121	52.1	0.70	–1.42	2.82	.52
Adult home exposure								
Never	21,810	26.7	523	24.1	–0.08	–1.99	1.84	.94
<5 years	9,893	12.1	284	13.1	2.78	1.43	4.13	<.001
5–9 years	7,585	9.3	185	8.5	0.40	–0.89	1.68	.55
10–19 years	12,872	15.8	343	15.8	0.85	–0.71	2.40	.29
20–29 years	12,123	14.9	330	15.2	–0.68	–2.19	0.82	.38
30+ years	17,325	21.2	506	23.3	–3.27	–4.90	–1.64	<.001
Workplace exposure								
Never	20,921	25.7	415	19.2	–6.90	–8.94	–4.86	<.001
<5 years	15,790	19.4	390	18.0	0.82	–0.92	2.56	.36
5–9 years	12,577	15.4	328	15.2	1.28	–0.28	2.84	.11
10–19 years	15,265	18.7	429	19.8	1.58	–0.07	3.22	.06
20–29 years	10,227	12.6	340	15.7	1.98	0.69	3.28	.00
30+ years	6,709	8.2	263	12.1	1.24	0.25	2.23	.01

Notes: CI = confidence interval, LB = lower bound; RR = relative risk; UB = upper bound.
[a]Adjusted for age (continuous), region (nominal), and pack years of smoking (continuous); Veterans compared with non-Veterans.

Discussion

To our knowledge, this is the first report to evaluate whether military service affects risk of lung cancer in women Veterans. Although women Veterans had higher tobacco use and exposures to passive smoking, they did not have a higher adjusted risk for lung cancer compared with non-Veterans. These findings may have important implications for caring for older women Veterans. Both Department of Veterans Affairs (VA) and non-VA clinicians who care for Veterans need to be aware that older women Veterans have more exposures to risk factors for lung cancer.

Higher rates of smoking exposure among older women Veterans may have been influenced by military service. Women Veterans in the WHI likely served during WWII (1939–1945), Korean War (1950–1953), and Vietnam War (1965–1973). Additionally, our findings show that there were few smoke-free households or work places in our cohort. Although smoking is a major risk factor for lung cancer, 20% or more of lung cancers arise in women who have never smoked (Samet et al., 2009; Thun et al., 2008; Wakelee et al., 2007).

During this time period, smoking cessation efforts were in their infancy, as the cigarette smoking–lung cancer link was recently discovered, with the U.S. Surgeon General

Table 4. Difference in Lung Cancer Rates Between Veterans and Non-Veterans in the Women's Health Initiative

Model[a]	Non-Veterans		Veterans		HR[a]	95% CI		p Value
	Total N	Lung cancer	Total N	Lung cancer		LB	UB	
Age adjusted	140,952	2,766	3,695	98	1.24	1.01	1.52	.04
Age and smoking adjusted[b]	136,045	2,657	3,525	95	1.06	0.86	1.30	.59
Age, smoking, and region adjusted[b,c]	136,045	2,657	3,525	95	1.05	0.86	1.29	.63
Age, smoking, region, race, income, education, and study arm adjusted[d]	126,027	2,472	3,308	91	1.07	0.87	1.33	.51

Notes: CI = confidence interval; HR = hazard ratio; LB = lower bound; UB = upper bound.
[a]All analyses stratified by age categories (<59, 60–69, 70+) because of evidence of violation of the proportional hazards assumption for age.
[b]Pack years of smoking, continuous.
[c]Pack years of smoking, continuous; region, nominal.
[d]Pack years of smoking, continuous; region, nominal; race, nominal; income, ordinal; education, ordinal; study arm, nominal; among Observational Study participants only.

Table 5. Lung Cancer Histology Among Veterans and Non-Veterans

	Non-Veterans[a]		Veterans[a]		p Value
	N	%	N	%	
Total	2,766	100.0	98	100.0	
Small cell	222	8.0	11	11.2	.50[b]
Other	66	2.4	2	2.0	
Non-small cell	2,072	74.9	70	71.4	.36[c]
Adenocarcinoma	1,202	43.5	37	37.8	
Squamous	315	11.4	15	15.3	
Other/Unspecified	555	19.9	18	18.3	

Notes: [a]Numbers may not add to totals and percents to 100 because of missing data; 385 non-Veterans and 14 Veterans were missing data.
[b]Chi-square test for differences in cell type between Veterans and non-Veterans.
[c]Chi-square test for differences in cell subtype (among non-small cell cancer) between Veterans and non-Veterans.

officially declaring cigarette smoking a health hazard in 1964. Interestingly from 1955–1965, smoking prevalence among women increased in contrast to the declining rates among men (Centers for Disease Control and Prevention, 1999). Furthermore, smoking initiation was deeply ingrained in military culture. Prepared combat rations, Type C and K rations, contained cigarettes until 1975 (Smith & Malone, 2009) and the military did not actively engage in anti-smoking efforts until the Health Promotion Directive 1010.10 in 1986 (Department of Defense, 1986). Moreover, the prosmoking culture may have also reduced the likelihood of quitting smoking while in the military (Whitlock et al., 1995). The combination of changing social norms for women (with more women entering the workforce and it becoming socially acceptable for women to smoke cigarettes), as well as military service, most likely facilitated these increased smoking rates among women Veterans. In line with these findings, women Veterans were more likely to have a higher smoking exposure in pack years and to be former or current smokers.

Available occupational choices for women in the military service may have led to increased workplace passive smoking exposures and smoking rates. Common occupations for military women during this period were nursing in both combat and noncombat zones and noncombat administrative/clerical positions (Department of Veterans Affairs, 1985; Holm, 1982). During the Vietnam era, 83% of women serving in Vietnam were nurses (Colonial Williamsburg Foundation, 2008; Holm, 1982). Nurses were shown to have higher smoking prevalence than the general female population around that time (Garfinkel & Stellman, 1986). Available military positions may have placed women at greater risk for smoking habits and exposure compared with civilian women occupations such as education professions at that time (Holm, 1982).

Although combat exposure is a known risk factor for lung cancer, the cohort of women Veterans included in the WHI study were more likely to have served in noncombat positions (Colonial Williamsburg Foundation, 2008). Women Veterans in the WHI were more likely to belong to a higher socioeconomic status (SES) and more likely to be White and to live in the Western region of the United States compared with non-Veterans in the WHI. Previous studies among the general population have found higher SES and being of White race/ethnicity to be inversely associated with lung cancer mortality (Krieger, Chen, Kosheleva, & Waterman, 2012). In national studies, lung cancer incidence and death rates among women were higher in both Midwestern and Southern states where the prevalence of smoking is also higher (Jemal et al., 2008, 2011).

There are some limitations to consider in evaluating the results of this study. First, this was a secondary analysis of data and there were a small number of cancer cases among women Veterans enrolled in the WHI. These women were young in an era of rapidly changing social norms, and it is difficult to estimate the effect of these factors on them. Very limited occupational (hazardous) exposure data are available for this cohort of women. The small differences in passive smoke exposure may be explained by the ubiquity of smoking in U.S. culture at this time or the inaccuracy of our measuring techniques. Passive smoking years were collected as opposed to the more accurately used pack years. Smoking variables and many

covariates relied on participant self-report, which potentially could lead to recall bias. However, because this bias was likely nondifferential (e.g., did not differ between Veterans and non-Veterans), it would likely only have attenuated the observed associations. Finally, the population included in the WHI was a select group that is not necessarily representative of the general population or the current population of women Veterans, thus potentially limiting the generalizability of our findings.

In conclusion, our findings highlight increased smoking exposures (both active and passive) among older women Veterans enrolled in the WHI which was associated with higher incidence of lung cancer. Given the data and resources available through the VA system, we are uniquely set up to continue to study the women Veteran population and perhaps consider additional unique exposures that may be determinants of lung cancer in this population.

Supplementary Material

Supplementary material can be found at: http://gerontologist.oxfordjournals.org

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