Women's knowledge of the leading causes of cancer death

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This paper describes adult women's knowledge of the leading causes of cancer mortality among women. Exposure to antismoking advertisements or media messages also is examined as a potentially effective mechanism for changing inaccurate beliefs. We used data from the 2002 and 2003 American Smoking and Health Survey (ASHES), a national telephone survey of adults, to measure women's knowledge about cancer mortality. Logistic regression models were used to estimate the likelihoods of women indicating either breast or lung cancer as the leading cause of cancer mortality among women. The independent influence of individual characteristics such as race, smoking status, education, and awareness of antismoking messages or advertising on women's knowledge of cancer mortality was assessed. Overall, 66.7% of women inaccurately indicated breast cancer as the leading cause of cancer death among women, whereas 29.7% of women correctly indicated lung cancer. Black women were 43% less likely than White women to indicate lung cancer as the leading cause of cancer mortality among women. Current smokers were 35% less likely than noncurrent smokers to state that lung cancer is the leading cause of cancer mortality among women. Awareness of antismoking messages or advertisements was associated with a higher probability of correctly indicating lung cancer as the leading cause of cancer mortality among women. Our evidence suggests that antismoking media messages may help to correct inaccurate beliefs about the leading causes of cancer death among women.

Introduction

Cancer is the second leading cause of death among women overall in the United States. Estimates indicate that more than 273,000 women will die from cancer in 2006, with large proportions of these deaths attributed solely to lung and breast cancer (26% and 15%, respectively; Jemal et al., 2006). Although lung cancer has been the leading cause of cancer death since 1987 and currently has a substantially higher mortality rate than breast cancer (40.9 per 100,000 vs. 26.4 per 100,000, respectively; Jemal et al., 2006), research has shown repeatedly that large proportions of women inaccurately believe that breast cancer kills more women each year than either heart disease or lung cancer, the actual leading causes of death among women overall (American Legacy Foundation, 2003; Covello & Peters, 2002; Mosca, Ferris, Fabunmi, & Robertson, 2004; Wilcox & Stefanick, 1999). None of these studies, however, specifically compared the subpopulations with inaccurate cancer mortality knowledge to those with accurate knowledge in terms of detailed demographic characteristics or further examination via multivariate analyses. A descriptive assessment of American women's knowledge of the causes of cancer mortality and how they obtain this information may provide much needed information about what is missing from our cancer-related public health messages and campaigns.

The general public, the media, and the government have traditionally regarded breast cancer and lung cancer quite differently in terms of media coverage, research funding, and advocacy (Blanchard, Erblich, Montgomery, & Bobbjerg, 2002; Gottlieb, 2001; Moffett, 2003; National Institutes of Health, 2005;

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Warner, Goldenhar, & McLaughlin, 1992), which may contribute in part to the discrepancy between most American women's knowledge of cancer mortality and actual fact. Because breast cancer is considered to be a predominantly "female" disease and the breast is often portrayed as a symbol of sexuality, the breast cancer issue has been embraced readily by feminist groups and the women's health movement. The high incidence and survival rates associated with breast cancer have contributed to the large number of activists, survivors, and their families, who have lobbied successfully for increased funding and education to the public (Moffett, 2003). Since the early 1990s, the pink ribbon has become a well-known symbol of breast cancer and, along with a widespread corporate cause-marketing campaign, it has helped to increase public visibility of the disease. The use of mammography has increased dramatically during the course of the breast cancer campaign. Between 1987 and 1998, recent mammograms, defined as having a mammogram in the past 2 years, among women aged 40 years or older increased from 30% to 67%, increasing the rate of early detection (American Cancer Society, 2005; Breen, Wagener, Brown, Davis, & Ballard-Barbash, 2001).

Despite the lauded successes of the breast cancer campaign, it has been argued that its effectiveness to serve a broad range of women is limited by goals and approaches that often benefit a White, middle-class target population (Moffett, 2003). In addition, research indicating that significantly more women list breast cancer as their most feared health risk compared with other conditions, and that large proportions of women are unaware that the risk of breast cancer differs by age group, suggests that breast cancer campaign messages may have unintended consequences (Covello & Peters, 2002).

Lung cancer often has been viewed as the sentinel disease of cigarette smoking—approximately 90% of all lung cancer deaths among women are attributed to smoking (U.S. Department of Health and Human Services, 2001). Many observers have argued that lung cancer should be considered a women's issue because of the tobacco industry's targeted marketing practices toward young women, but the disease has not been readily embraced and promoted as such (Gritz, 1993). The stigma associated with lung cancer as a self-imposed condition, as well as the powerful political and financial influence of tobacco companies, has led to disproportionate inattention from media outlets and political entities with regard to the toll of the disease (Frost, Frank, & Maibach, 1997; Gritz, 1993; Warner et al., 1992). In contrast to breast cancer activism, grassroots movements to support lung cancer are hindered by a lack of guidelines for systematic early detection screenings, a 5-year case-fatality rate of greater than 85%

(Surveillance, Epidemiology, and End Results (SEER) Program, 2003), the political and economic influence of the tobacco companies, and the perception of blame on smokers from the public at large (Gritz, 1993).

Research has shown that women obtain most of their health-related information from the general media, including television, newspapers, and magazines (Covello & Peters, 2002). Studies of cognition suggest that people often estimate the likelihood of an event happening based on their ability to recall related memories or knowledge, a bias known as the availability heuristic (Tversky & Kahneman, 1974). Therefore, the media's disproportionate coverage of breast cancer, compared with lung cancer, may account in part for some of the inaccurate knowledge and misperceptions held by significant proportions of the population. Thus women may assume that more females succumb to breast cancer than lung cancer because of the disparate media reporting of these two health issues. Moreover, the use of the media as the main source of health-related information suggests that media messages also may be a useful tool to promote accurate cancer-related knowledge.

The present study describes adult women's knowledge of the leading causes of cancer mortality among women. Our analyses include direct comparisons between self-reported knowledge of the causes of cancer mortality among women and actual rates of specific types of cancer deaths. This study sheds new light on the overall magnitude of inaccurate knowledge about the causes of cancer mortality among women as well as factors associated with these inaccuracies. In particular, we offer new evidence on how mass media campaigns can be potentially useful tools for increasing knowledge that lung cancer is the most significant cause of cancer death among women.

Method

Data

The present study used data from the American Smoking and Health Survey (ASHES), a national random-digit-dialed survey of adults aged 18 years or older. ASHES was conducted in two cross-sectional waves during the summers of 2002 and 2003. The survey, funded by the American Legacy Foundation, was designed to assess a broad range of tobacco-related topics among adults in the United States, including tobacco use, smoking cessation, knowledge and attitudes about smoking, exposure to second-hand smoke, and awareness of antismoking media messages and advertising.

The ASHES sample supports separate analyses by race/ethnicity. To ensure adequate representation of minority populations, Hispanics were oversampled from listed households with Hispanic surnames, and

Blacks were oversampled from geographic areas with high proportions of Blacks. In addition to racial/ethnic oversampling, adult women were oversampled in ASHES. Data from the 2002 and 2003 surveys were based on a combined 6,977 adults; overall response rates were 30.4% and 27.8%, respectively. Response rates were based on the RR4 formula, presented in the American Association of Public Opinion Research (1998) standard definitions handbook. All analyses in the present study are limited to adult women ($N=4,477$). See Table 1 for detailed data on sample sizes by wave.

To adjust for unequal probabilities of selection (related to oversampling) and nonresponse, we applied individual weighting factors to all estimates presented in this study. Analysis weights were constructed in a series of steps, beginning with the calculation of a household sampling weight that was adjusted for nonresponse within each sampling stratum. This adjusted weight was then multiplied by the number of persons in the household to obtain a person sampling weight, which was then post-stratified to the most current U.S. Census population estimates by census region, age category (18–24, 25–34, 35–64, 65+), gender, and racial/ethnic group.

Measures

The primary outcomes measured in the present study include knowledge of the leading causes of cancer mortality among women, with a particular focus on breast and lung cancer. Data were derived from a standardized ASHES multiple-choice item that asks, "Which of the following is the leading cause of cancer death among women?" Survey participants were given the following options from which to choose: Skin cancer, liver cancer, breast cancer, and lung cancer. The root question was asked of each participant in an identical manner. To eliminate the potential for sequencing bias, we read these four response options to each respondent in random order. Using this question, we constructed four mutually exclusive indicator variables for each type of cancer to serve as the primary outcome variables of this study.

Descriptive analysis

To provide an overall description of knowledge patterns of the leading causes of cancer death among women, we calculated proportions for each of the knowledge indicator variables by several demographic characteristics, including age, race, and smoking status. Smoking status was defined as never-smokers, former smokers, and current smokers. Individuals who reported smoking at least 100 cigarettes in their lifetime (five packs) but did not currently smoke at the time of the survey were categorized as former smokers. Current smokers were defined as having smoked at least 100 cigarettes in their lifetime and currently smoking

Table 1. ASHES unweighted sample characteristics for adult females (number of subjects and percentages).

	ASHES wave		
	Summer 2002	Summer 2003	Total
Demographic group	($n=2,628$)	($n=1,849$)	($N=4,477$)
Age (years)			
18–34	881 (33.5%)	584 (31.6%)	1,465 (32.7%)
35–54	1055 (40.1%)	744 (40.2%)	1,799 (40.2%)
55+	634 (24.1%)	492 (26.6%)	1,126 (25.2%)
Unspecified	58 (2.2%)	29 (1.6%)	87 (1.9%)
Race			
Black	557 (21.2%)	527 (28.5%)	1,084 (24.2%)
Hispanic	874 (33.3%)	533 (28.8%)	1,407 (31.4%)
White	969 (36.9%)	695 (37.6%)	1,664 (37.2%)
Other or unspecified	228 (8.7%)	94 (5.1%)	322 (7.2%)
Educational attainment			
Less than high school	490 (18.6%)	298 (16.1%)	788 (17.6%)
High school graduate	791 (30.1%)	560 (30.3%)	1,351 (30.2%)
Some college	736 (28%)	501 (27.1%)	1,237 (27.6%)
College degree	569 (21.7%)	487 (26.3%)	1,056 (23.6%)
Unspecified	42 (1.6%)	3 (0.2%)	45 (1%)
Smoking status			
Never smoke	1,692 (64.4%)	1,125 (60.8%)	2,817 (62.9%)
Former smoker[a]	472 (18%)	360 (19.5%)	832 (18.6%)
Current smoker[b]	451 (17.2%)	364 (19.7%)	815 (18.2%)
Unspecified Smoking	13 (0.5%)	0 (0%)	13 (0.3%)
Exposure to second-hand smoke			
At least once, past 7 days	575 (21.9%)	419 (22.7%)	994 (22.2%)

Note. [a]Has smoked 100 cigarettes lifetime, does not currently smoke, and has not smoked for at least 24 h. [b]Has smoked 100 cigarettes lifetime and now smokes either every day or some days.

either every day or some days. Daily cigarette consumption in the past 30 days among all current smokers was used to conduct a more detailed analysis of light current smokers ($\leqslant$20 cigarettes/day) and heavy current smokers (>20 cigarettes/day).

Multivariate analysis

The combined waves of ASHES were used to estimate a series of multivariate regression models that include several independent factors that may be associated with beliefs about cancer mortality. Logistic regressions were used to estimate the probabilities of identifying breast or lung cancer as the leading causes of cancer mortality among women, controlling for individual characteristics (e.g., race, smoking status, and education) and awareness of anti-tobacco media messages or advertising. To facilitate the interpretation of the findings, all logistic regression coefficients were transformed into odds ratios.

Awareness of anti-tobacco media messages and advertising was assessed with a self-reported measure in ASHES that prompts respondents to indicate whether they have seen or heard any advertisement in the past 30 days about the number of women who die from smoking each year. Awareness of these messages may have occurred through exposure to various media sources such as public service announcements on television, such as the American Legacy Foundation "Letters" campaign. This analysis also considered the potential influence of cigarette advertising and promotion on knowledge of the causes of cancer mortality among women. To estimate the effects of exposure to cigarette advertising or promotions, our models included an indicator variable for whether the respondent has seen any advertising or promotions for cigarettes or other tobacco products within the 30 days prior to the interview.

All models included control variables such as age, current smoking, yearly income, total years of education, marital status, exposure to second-hand smoke, and whether the respondent reports being pregnant. To control for the possibility that there was a national secular increase or decline in the primary outcome variables between the two waves of ASHES, our models also included an indicator variable for the 2003 wave of ASHES. Models included state-specific indicator variables to adjust for the potential influence of unobserved state characteristics that might be associated with knowledge of the leading causes of cancer death among women. Unless noted otherwise, all results discussed were statistically significant at the .05 level.

Results

Demographic patterns

Findings suggest that a broad lack of knowledge exists in relation to lung cancer as the leading cause of cancer death among women. Two-thirds of women (66.7%) identified breast cancer as the leading cause of cancer death among women, as opposed to lung cancer (29.7%; Table 2). The findings shown in Table 2 also suggest that this gap in knowledge about the leading cause of cancer death among women may be greatest among Black women. Compared with all other races, Black women were significantly more likely to identify breast cancer as the leading cause of cancer death (76.4%) and significantly less likely than White and Hispanic women to indicate lung cancer as the leading cause (21.2%).

Accurate identification of lung cancer as the primary cause of cancer death among women also varied significantly by age and smoking status. Women aged 55 or over were significantly more likely (35.1%) than women aged 54 and younger to indicate that lung cancer is the leading cause of cancer mortality among women. Not surprisingly, current smokers also were significantly less likely (24.4%) than noncurrent smokers to identify lung cancer as the leading cause of cancer mortality among women.

Multivariate results

Results from the multivariate models were generally consistent with the descriptive findings in Table 2, indicating that knowledge of the leading cause of cancer mortality among women was associated with race, smoking status, and other individual characteristics. Black women were 43% less likely than White women to identify lung cancer as the leading cause of cancer mortality among women (Table 3). Black women also were estimated to be 82% more likely to identify breast cancer as the leading cause of cancer mortality among women (Table 3). We found no statistically significant differences in knowledge about cancer mortality between White, Hispanic, and other races.

Consistent with the descriptive results, we found that beliefs about the causes of cancer mortality were significantly associated with smoking status after controlling for other factors in the multivariate analysis (Table 3). For example, current smokers were 35% less likely than noncurrent smokers to state that lung cancer is the leading cause of cancer mortality among women. Overall, we did not find a significant relationship between cancer beliefs and total years of education. However, we did find differences, specifically between high school

Table 2. Percentage of adult females who indicate breast, lung, skin, and liver cancers as the leading causes of cancer death among women (95% *CI*).

Demographic group	Cancer type			
	Breast	Lung	Skin	Liver
Age (years)				
All ages	66.7% (64.1–69.2)	29.7% (27.2–32.2)	2.8% (1.9–3.7)	0.8% (0.4–1.2)
18–34	68.0% (63.4–72.5)	28.8% (24.3–33.2)	2.8% (1.2–4.4)	0.5% (0.2–1.4)
35–54	68.9% (64.9–72.8)	27.0% (23.2–30.8)	3.4% (1.9–5.0)	0.8% (0.1–1.4)
55+	61.8% (56.8–66.8)	35.1% (30.2–40.0)	1.7% (0.5–3.0)	1.3% (0.4–2.3)
Race				
Black	76.4% (70.3–82.6)	21.2% (15.1–27.2)	1.2% (0.4–3.3)	1.3% (0.4–2.1)
Hispanic	63.3% (57.5–69.1)	32.5% (26.8–38.2)	3.1% (0.8–5.4)	1.1% (0.3–1.9)
White	66.5% (63.2–69.7)	30.5% (27.3–33.6)	2.5% (1.5–3.6)	0.5% (0.1–0.9)
Other	60.2% (51.3–69.0)	31.5% (23–40)	6.2% (1.8–10.6)	2.2% (0.7–6.5)
Educational attainment				
Less than high school	59.2% (51.6–66.8)	37.5% (30.1–45.0)	2.7% (0.9–7.8)	0.6% (0.1–1.1)
High school graduate	67.0% (62.4–71.6)	28.5% (24.0–32.9)	3.7% (1.9–5.5)	0.8% (0.2–1.5)
Some college	70.3% (65.7–74.9)	26.4% (21.9–30.8)	2.7% (1.1–4.4)	0.6% (0.2–1.6)
College degree	65.6% (60.7–70.5)	31.3% (26.5–36.2)	2.0% (0.8–3.2)	1.1% (0.1–2.1)
Smoking status				
Current smoker	70.5% (64.9–76.1)	24.4% (19.1–29.7)	4.4% (1.8–6.9)	0.7% (0.2–2.3)
Former smoker	63.3% (57.7–69.0)	34.3% (28.7–39.9)	2.0% (0.5–3.4)	0.4% (0.1–1.3)
Never smoker	66.4% (63.1–69.8)	29.9% (26.6–33.1)	2.7% (1.5–3.8)	1.0% (0.6–1.8)
Exposure to second-hand smoke				
At least once, past 7 days	65.6% (59.9–71.2)	28.8% (23.4–34.2)	4.8% (2.3–7.2)	1.0% (0.0–1.7)

dropouts and women with at least a high school diploma. In separate regressions, we estimated our models with alternative measures of education using dummy variables to identify women as high school dropouts, high school graduates, having some college, or having at least a college degree. These models showed that women with a high school diploma or some college education were less likely to indicate lung cancer as the leading cause of cancer mortality among women (data available on request).

Although older age was associated with a greater likelihood of accurately identifying lung cancer as the leading cause of cancer mortality among women in the descriptive findings presented in Table 2, this association was not significant (*p*<.10) when control variables were introduced in the multivariate analyses presented in Table 3. However, educational attainment may partially confound the association between age and beliefs about the causes of cancer mortality. When educational attainment was excluded from the models presented in Table 3, age was significantly associated (*p*<.05) with a greater likelihood of indicating lung cancer as the leading cause of cancer mortality and a lower likelihood of indicating breast cancer as the leading cause of cancer mortality among women.

Table 3. Logistic regression models showing the association between individual characteristics and the odds of stating that breast and lung cancer are the leading causes of cancer mortality among women (95% *CI*).

Explanatory variable	Breast cancer	Lung cancer
Race		
White	1.00	1.00
Black	1.82 (1.24–2.67)**	0.57 (0.38–0.86)**
Hispanic	0.92 (0.64–1.31)	0.96 (0.66–1.39)
Other race	0.71 (0.46–1.11)	1.10 (0.69–1.75)
Exposure to anti- and pro-tobacco messages		
Has seen or heard messages about the number of women who die from smoking each year	0.71 (0.54–0.91)**	1.45 (1.11–1.89)**
Aware of pro-tobacco advertising	0.93 (0.72–1.19)	1.16 (0.89–1.52)
Educational attainment		
Total years of education	1.04 (0.99–1.09)	0.96 (0.91–1.01)
Other individual characteristics		
Current smoker	1.46 (1.02–2.09)*	0.65 (0.44–0.95)*
Age	0.99 (0.99–1.00)	1.01 (1.00–1.01)
Yearly income (US$10,000s)	0.98 (0.93–1.04)	1.02 (0.97–1.08)
Married	1.21 (0.94–1.56)	0.85 (0.65–1.11)
Pregnant	1.39 (0.59–3.28)	0.84 (0.36–2.00)
Summer 2003	1.18 (0.92–1.50)	0.80 (0.62–1.03)
Exposure to second-hand smoke		
at least once, past 7 days	0.81 (0.58–1.13)	1.09 (0.77–1.56)

Note. Each model includes state-specific indicator variables to control for time-invariant state characteristics. *p<.05; **p<.01.

Our findings also suggest that exposure to antismoking media messages may play a role in reducing misperceptions about the leading causes of cancer mortality among women. Overall, 31% of women in the ASHES sample reported having seen or heard media messages about the number of women who die from smoking each year, whereas 62% of women reported awareness of pro-tobacco messages. Awareness of antismoking messages was higher among nonsmoking women (32%) compared with smokers (26%), although this difference was only marginally significant ($p<.06$). Women who reported awareness of messages or advertisements about the number of women who die each year from smoking were estimated to be 45% more likely to correctly identify lung cancer as the leading cause of cancer death among women, compared with women who did not report awareness (Table 3). Moreover, women who reported awareness of anti-tobacco messages were 29% less likely to indicate that breast cancer is the leading cause of cancer death among women (Table 3).

Given these findings, we estimated an additional set of models to assess whether these media messages had differential impacts by race, smoking status, and educational attainment (data available on request). These models were identical to those shown in Table 3 but included variables for the interaction between race and awareness of media messages about the number of women who die from smoking each year as well as terms for the interactions between media awareness, current smoking, and educational attainment. In these models, there were no statistically significant interaction effects, suggesting that the potential effects of media advertising about smoking-related mortality among women do not differ by race, smoking status, or education.

Among the overall adult female population, exposure to cigarette advertising or promotions for cigarettes were not found to be significantly associated with beliefs about the leading causes of cancer mortality. However, exposure to cigarette advertising and holding the belief that breast cancer is the leading cause of cancer death among women may be significantly greater among light smokers, compared with heavy smokers and nonsmokers. To assess this differential effect, we estimated additional models to test for interactions between exposure to cigarette advertising and smoking intensity (data available on request). These models suggested that a marginal association may exist between exposure to tobacco advertising and beliefs about the causes of cancer mortality among light smokers. Light current smokers who reported awareness of tobacco advertising or promotions within the 30 days prior to their interview were 90.3% more likely than other females to state that breast cancer is the leading cause of cancer death among women. This association was significant only at the .10 level, however. Given the size of the estimated odds ratio, the sample size may not be sufficient to detect a significant association at the .05 level. Finally, we did not find any evidence of differential associations by smoking status between exposure to tobacco advertising promotions and identifying lung cancer as the leading cause of cancer mortality among women.

Discussion

The results of the present study suggest a significant knowledge gap among adult women about the leading cause of cancer mortality. A majority of adult women in the United States identified breast cancer as the leading cause of cancer mortality among women, rather than lung cancer. Lung cancer, unlike breast cancer, is in theory almost entirely preventable. Findings also indicated that this knowledge gap may be greatest among Black women, in that they were significantly more likely to report breast cancer as the leading cause of cancer mortality among women. However, according to statistics from the American Cancer Society, breast cancer mortality rates are significantly higher among Black women (34.7 per 100,000) relative to White women (25.9 per 100,000), whereas lung cancer mortality is slightly lower (39.9 per 100,000 and 41.8 per 100,000, respectively; Jemal et al., 2006). Black women may be more likely than White women to identify breast cancer as the leading cause of cancer death among women because of this disparity. However, even though Black women smoke at lower rates than White women, and have a relatively lower lung cancer mortality rate, the Black community, as a whole, is largely affected by the high lung cancer mortality rate among Black men (101.3 per 100,000; Centers for Disease Control and Prevention, 2005; Jemal et al., 2006; Haiman et al., 2006). Furthermore, the toll of lung cancer among Black women should not be discounted, given that it still represents the leading cause of cancer death in this population (Jemal et al., 2006).

Although we found no significant relationship between overall years of education and cancer beliefs, women with less than a high school diploma appeared to be more likely to state that lung cancer is the leading cause of cancer mortality among women. Although this finding seems counterintuitive, it may partially reflect a higher prevalence of smoking among those who did not complete high school, among whom lung cancer may be a more salient or foreseeable cause of cancer death. However, our analyses also indicated that current smokers were less likely than non-current smokers to report lung cancer as the leading cause of death among women.

This suggests that actual lung cancer risk does not fully account for accurate knowledge, and other factors may be driving the apparent education related discrepancy. The broad-based efforts of the breast cancer awareness campaign may be one possible explanation, as it heavily targets women of higher socio-economic status (SES) (Moffett, 2003). Women with less educational attainment, but not necessarily smokers, may be exposed to fewer breast cancer campaign messages and thus less likely to have an inflated perception of the number of women who die of breast cancer relative to lung cancer.

The present study further suggest that anti-tobacco advertising and media messages may be an effective strategy for changing knowledge related to the leading causes of cancer mortality. Women who reported exposure to these types of messages were significantly more likely to correctly identify lung cancer as the leading cause of cancer mortality among women and less likely to identify breast cancer as the leading cause. In further analyses, exposure to media advertising about smoking-related mortality among women did not differ by race, smoking status, or educational attainment and we found no statistically significant effects of interactions between these groups and media awareness on the primary outcomes. This would suggest that the effects of advertising about smoking-related mortality among women did not differ substantially across these groups. However, the specific tone and content of media messages should be examined further across demographic groups to determine how these factors may influence receptivity and the underlying mechanisms contributing to the effectiveness of the messaging.

Studies have already indicated that women inaccurately believe breast cancer kills more women per year than does lung cancer (American Legacy Foundation, 2003; Covello & Peters, 2002; Mosca et al., 2004; Wilcox & Stefanick, 1999). Comparisons of our study with previous findings are limited because of the various methodologies and samples used in past studies. However, standardized data collection on the knowledge of cancer mortality using nationally representative data can strengthen the evaluation of future public health education campaigns and measure progress over time.

Our analyses are not without limitations, however. Specifically, the ASHES data do not allow us to account for the potential influence of mammography screening. The availability of a technology for early detection and treatment of breast cancer, in combination with general primary care emphasis on mammography screening, may contribute to the misconception that breast cancer is the leading cause of cancer mortality among women. Furthermore, we did not have data on respondents' family history of breast cancer or other comorbidities that may play a role in women's perceptions of breast and lung cancer. However, data on mammography screening may suggest that these concerns are minimal. Mammography screening has been associated with higher levels of education among American women. Among women aged 40 years or older, over 80% of those with 16 or more years of education received a mammogram within the past 2 years, compared with only 56.8% of those with 11 or fewer years of education (American Cancer Society, 2005). Given this association, our multivariate models may adequately account for the potential influence of mammography screening by controlling for age and education.

Another potential limitation of the present study is the relatively low response rates for each of the ASHES questionnaires. The increased use of cell phones, caller identification, and awareness and use of the national do-not-call list has presented challenges to traditional methods of telephone data collection (Keeter, Miller, Kohut, Groves, & Presser, 2000; Lynn, Clarke, Martin, & Sturgis, 2002). The changing landscape of the telecommunications environment has likely contributed to general declines in response rates for telephone surveys. However, the evidence is unclear as to whether lower response rates bias the measurement of smoking-related outcomes and, in particular, responses to questions about the causes of cancer death among women. An unpublished experimental study was included in the data collection of the 2003 ASHES to examine whether respondents in low- and high-response rate areas differed in terms of demographics, smoking status, and a number of other measures. This study showed no evidence of differential responses between low- and high-response rate samples. Furthermore, the weighted ASHES sample closely tracked the U.S. Census, and sample demographics remained virtually identical across each wave of the survey.

The ASHES dataset also contains self-reported smoking-related behavioral outcomes data, which may contain biases stemming from social desirability or other mechanisms that result in inaccurate reporting. However, the primary outcome variables in our analysis measured knowledge about cancer mortality, which have not been shown to be affected by recall biases. Although respondents may be reluctant to report their smoking status because of social desirability factors, self-reported measures have been found to be reliable estimates of smoking status in the general public and adults in particular (Patrick et al., 1994). Therefore, we do not believe the use of this dataset led to significant systematic biases related to the self-reported responses.

The gender-specific nature of breast cancer also may limit our findings indirectly. The ASHES

questionnaire asks women to indicate whether breast, lung, liver, or skin cancers are the leading cause of cancer death among women. Women may have a bias to view breast cancer as the leading cause of cancer death among women simply because it occurs predominately in women.

Finally, although the estimated associations between awareness of media messages about smoking-related mortality and knowledge of lung cancer as the leading cause of cancer death were very strong, the cross-sectional nature of the ASHES data limits causal inference. Because the data are cross-sectional, the results may reflect selective attention to these media messages rather than a causal relationship. For example, women who have a preexisting likelihood to identify lung cancer as the leading cause of cancer mortality among women also might be more likely to recall anti-tobacco media messages and advertising. Although our findings on the effectiveness of anti-tobacco messages are encouraging, further research is needed. Specifically, the use of longitudinal data can better assess whether exposure to media messages about smoking-related mortality is causally related to changes in knowledge of lung cancer as the leading cause of cancer death. Furthermore, given the real-world lack of messages that promote accurate perceptions about cancer mortality, this area of research may benefit from in-depth efficacy studies on the potential effects of newer messages that specifically emphasize the leading causes of cancer mortality.

Acknowledgments

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