ORIGINAL INVESTIGATION

# Smoking Status, Physical Health–Related Quality of Life, and Mortality in Middle-Aged and Older Women

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## ABSTRACT

**Introduction:** Women who smoke, particularly older women, have been relatively neglected in smoking research. There is a lack of knowledge concerning the relation of level of smoking to quality of life and mortality among middle-aged and older women smokers.

**Methods:** This study examined the relation of smoking status to physical health–related quality of life (PHRQL) and total mortality in women in the Women's Health Initiative (WHI) Observational Study. Participants were 90,849 postmenopausal women, who were an average age of 63.6 years at baseline. Analyses used multiple linear and Cox proportional hazards regression and controlled for age, educational level, and ethnicity. Never-smokers were the reference group.

**Results:** We found that smoking status was significantly related to PHRQL cross-sectionally at baseline and prospectively at a 3-year follow-up, with those who smoked having lower PHRQL. Heavier smokers showed large, clinically meaningful associations with PHRQL and light smokers showed small associations. In addition, we found that the smoking status at baseline was significantly related to 10-year total mortality. Both light and heavier smoking at baseline significantly correlated with higher mortality risk; however, the relationship of smoking to mortality was dose dependent. Among former smokers, those who had smoked longer showed significantly lower PHRQL and significantly increased mortality risk.

**Conclusions:** Findings suggest that the risks of smoking may not be evident to light smokers and that educational interventions targeted to middle-aged and older women stressing the consequences of light smoking may be particularly beneficial.

## INTRODUCTION

Smoking prevalence has decreased dramatically in the last 40 years through sustained public health efforts (Cummings, 2002); nevertheless, many people continue to smoke (Centers for Disease Control and Prevention [CDC], 2011). Contrary to earlier expectations, adult smokers are not increasingly hardened heavy smokers (Burns, Major, & Shanks, 2003; O'Connor et al., 2006). Rather, as overall smoking prevalence has declined, the proportion of light smoking has increased (CDC, 2011). Yet, all levels of smoking are unsafe (Bjartveit & Tverdal, 2005; Coggins, Murrelle, Carchman, & Heidbreder, 2009), and light smoking is a growing public health concern (Schane, Ling, & Glantz, 2010).

Women who smoke, particularly older women, have been relatively neglected in smoking research (Brown et al, 2004; Donze, Ruffieux, & Cornuz, 2007). There is a lack of knowledge concerning the relation of level of smoking to quality of life and mortality among middle-aged and older women smokers. Yet, middle-aged and older women may be especially likely to engage in light smoking (Donze et al., 2007; Holahan et al., 2011). The purpose of the present study is to examine the relation of smoking status to physical health–related quality of life (PHRQL) and total mortality in women in the Women's Health Initiative (WHI) Observational Study, a large study of middle-aged and older women.

Cigarette smoking is associated with increased morbidity and mortality in women, especially from cancer, cardiovascular disease, and pulmonary disease (CDC, 2008; Kenfield, Stampfer, Rosner, & Colditz, 2008; U.S. Department of Health and Human Services [U.S. DHHS], 2001, 2004). Smoking also takes a considerable toll on self-perceived quality of life (Heikkinen, Jallinoja, Saarni, & Patja, 2008; Nusselder, Looman, Marang-van de Mheen, van de Mheen, & Mackenbach, 2000; Ostbye, Taylor, & Jung, 2002; Strandberg et al., 2008). Smokers, as compared with individuals who have

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never smoked or former smokers, particularly longer term former smokers, have scored lower on measures of physical quality of life (Arday et al., 2003; Hays et al., 2008; Lyons, Lo, & Littlepage, 1994; Sarna, Bialous, Cooley, Jun, & Feskanich, 2008; Wilson, Parsons, & Wakefield, 1999). When level of smoking has been assessed, the inverse association of smoking with health-related quality of life has tended to be dose dependent with stronger results for heavier smokers than for light smokers (Ostbye et al., 2002; Sarna et al., 2008; Wilson et al., 1999) and for nicotine-dependent smokers compared with nonnicotine-dependent smokers (Schmitz, Kruse, & Kugler, 2003).

However, smoking and quality-of-life studies often do not report results separately for men and women (e.g., Lyons et al., 1994; Mody & Smith, 2006; Schmitz et al., 2003; Wilson et al., 1999; Woolf, Rothemich, Johnson, & Marsland, 1999). Moreover, when gender differences in smoking and quality of life have been addressed, results have been conflicting. For example, Heikkinen et al. (2008) found negative associations with physical functioning and everyday activities for both women and men. In contrast, Wilson, Chittleborough, Kirke, Grant, and Ruffin (2004) found stronger relationships between smoking and health-related quality of life for female heavy smokers, while Laaksonen, Rahkonen, Martikainen, Karvonen, and Lahelma (2006) found that, compared with nonsmokers, only male current smokers reported worse physical functioning and general health. In a large study of women smokers ranging in age from 29 to 71 years in the Nurses' Health Study (Sarna et al., 2008), it was found that current smokers reported lower PHRQL than never-smokers and former smokers. Among current smokers, number of cigarettes per day was related to lower PHRQL, and, among former smokers, longer smoking duration and shorter time since quitting was associated with lower physical quality of life.

The present study investigated the link of smoking status (defined as never-, former, light, and heavier smoker) with (a) PHRQL at baseline and 3 years and with (b) 10-year total mortality risk among women in the WHI Observational Study. The WHI was conducted to investigate the role of lifestyle factors in the prevention of heart disease, cancer, and osteoporosis in postmenopausal women (Hays et al., 2003). The sample ranged in age from 50 to 79 years at baseline. PHRQL was measured by the Short-Form Health Survey (SF-36; Ware, 2000; Ware & Sherbourne, 1992). It was expected that smoking status would be related in a dose-dependent manner to (a) PHRQL cross-sectionally at baseline, (b) PHRQL prospectively at 3 years, and (c) 10-year total mortality. In addition, among former smokers, it was expected that years of regular smoking would be inversely related to PHRQL at baseline and positively related to 10-year total mortality.

## METHODS

### Sample Selection and Characteristics

The WHI Observational Study included 93,676 women between the ages of 50 and 79 who were postmenopausal at enrollment in the study. Inclusion criteria included the ability and willingness to provide written informed consent and plans to stay in the same area for at least 3 years. Exclusion criteria included having medical conditions that predicted survival of less than 3 years, or conditions such as alcohol or drug dependency, or mental illness, including severe depression or dementia, which might affect retention. The WHI Observational Study is an observational study tracking a large sample of postmenopausal women and is not part of the WHI clinical trials. There was a concerted effort to enroll participants from racial/minority groups proportionate to their age-group representation in the U.S. population (Hays et al., 2003).

The present sample includes the 90,849 (97%) of baseline participants who provided sufficient data on the measures used here. At baseline, the participants in the present sample were an average age of 63.6 years (*SD* = 7.36). The sample was predominantly White, not of Hispanic origin (83.9%), with the remainder of the sample being American Indian/Alaskan Native (0.4%), Asian/Pacific Islander (2.9%), Black (8.0%), Hispanic (3.7%), and unknown (1.1%). Five percent of participants had less than a high school education, 16% had a high school education, 37% had some education beyond high school but had not completed college, and 42% had completed college.

### Measures

Smoking status, history of smoking, and sociodemographic factors were assessed at baseline. Quality of life was assessed at baseline and at a 3-year follow-up. Mortality was assessed across an approximately 10-year follow-up period.

#### *Sociodemographic Factors*

Sociodemographic factors used as control variables included age (in years), educational level, and ethnic group membership. Educational level was operationalized as less than a high school (or vocational school) education, high school (or vocational school) education, some education beyond high school but not having completed college, and completed college.

#### *Smoking Status*

Smoking status at baseline (never-smoker, former smoker, light smoker, heavier smoker) was indexed in several steps. First, participants were asked, "During your entire life, have you smoked at least 100 cigarettes?" Participants who responded "no" were coded as never-smokers. Next, participants who reported having smoked at least 100 cigarettes in their entire life were asked, "Do you smoke cigarettes now?" Those who reported that they did not currently smoke cigarettes were coded as former smokers. Those who reported that they currently smoked cigarettes were coded as either light or heavier smokers based on their response to a question that asked, "On an average, how many cigarettes do you usually smoke each day?" Response choices were as follows: less than 1, 1–4, 5–14, 15–24, 25–34, 35–44, and 45 or more. Following definitions of light smoking used in other studies (Falba, Jofre-Bonet, Busch, Duchovny, & Sindelar, 2004; Godtfredsen, Prescott, & Osler, 2005; Godtfredsen, Prescott, Vestbo, & Osler, 2006; Hatsukami et al., 2006; Wilson et al., 1999), light smoking was operationalized as less than 15 cigarettes/day. Heavier smoking was operationalized as 15 or more cigarettes/day (Hatsukami et al., 2006).

#### *Years of Smoking*

Among former smokers, years of regular smoking was indexed by a question that asked, "How many years were you a regular smoker? Do not count the times you stayed off cigarettes."

Response choices were as follows: less than 5 years, 5–9 years, 10–19 years, 20–29 years, 30–39 years, 40–49 years, and 50 or more years. To index approximate 10-year increments in smoking across categories, the categories indexing less than 5 years and 5–9 years were combined to index smoking less than 10 years.

*Quality of Life*

PHRQL was measured by the four physical health scales of the Short-Form Health Survey (SF-36; Ware, 2000; Ware & Sherbourne, 1992)—physical functioning (10 items), role limitations due to physical health (4 items), pain (2 items), and general health (5 items). Possible scores on each scale ranged from 0 to 100, with higher scores indicating better functioning. The SF-36 is a widely used measure of PHRQL in smoking studies (Laaksonen et al., 2006; Schmitz et al., 2003; Strandberg et al., 2008; Wilson et al., 1999, 2004; Woolf et al., 1999).

*Mortality*

Death (surviving = 0, death = 1) was confirmed by death certificate. Mortality was assessed across a follow-up period of slightly more than 10 years (maximum years to death = 10.81 years, mean years to death = 5.21 years).

### Statistical Analyses

Multiple linear regression analyses were used to analyze the relation of smoking status to PHRQL cross-sectionally at baseline and prospectively at a 3-year follow-up. Cox proportional hazards regression analyses were used to analyze the relation of smoking status to mortality risk across the 10-year follow-up period. In analyses restricted to former smokers, multiple linear regression and Cox proportional hazards regression analyses were conducted to investigate the relation of number of decades of regular smoking to baseline PHRQL and 10-year mortality, respectively. All analyses controlled for age (in years), educational level (less than a high school education was the reference group), and ethnicity (White was the reference group). To facilitate interpretation of the coefficients, covariates were mean centered in all analyses.

## RESULTS

### Descriptive Smoking Statistics

At baseline, 46,248 (51%) of participants had never smoked, 38,912 (43%) were former smokers, and 5,689 (6%) were current smokers. Among current smokers at baseline, 3,006 (53%) were light smokers and 2,683 (47%) were heavier smokers. By the end of the study period, 1,800 (34.2%) of baseline smokers had quit smoking, operationalized as self-reported as not smoking at both of the participants' last two assessments.

### Analyses of Missing Data and Attrition

*Missing Data*

Using the full sample of 93,676 baseline participants, we compared participants who provided sufficient data on the measures used here ($n$ = 90,849) with those who did not provide sufficient data ($n$ = 2,827, 3.0%). The only noteworthy differences involved educational level and ethnicity. For educational level, missing data were most likely among individuals with less than a high school education (4.7%) compared with other educational groups (average of 2.1%; ($\chi^2(3, N = 92{,}909) = 154.78$, $p < .01$). For ethnicity, missing data were most likely among Hispanics (6.3%) and least likely among Asian or Pacific Islanders (2.2%) and non-Hispanic Whites (2.4%; ($\chi^2(5, N = 93{,}411) = 367.80$, $p < .01$).

*Three-Year Attrition*

In addition, we examined attrition in the prospective PHRQL analyses at the 3-year follow-up. As an example, here, we examine attrition on the pain scale, which involved the highest response rate among the PHRQL scales. In fact, the level and pattern of attrition was comparable across the four PHRQL outcomes. Among the 90,755 participants who responded to the pain scale, we compared surviving participants ($n$ = 80,129) with those who did not participate at the 3-year follow-up ($n$ = 10,626, 11.7%). The only noteworthy differences involved smoking status, educational level, and ethnicity. For smoking status, missing data were more likely among current smokers, both heavier smokers (20.5%) and lighter smokers (17.8%) than among former smokers (11.5%) or those who never smoked (10.9%; $\chi^2(3, N = 90{,}755) = 333.75$, $p < .01$). For educational level, missing data were more likely among participants with less than a high school education (25.4%) compared with other educational groups (average of 11.5%; $\chi^2(3, N = 90{,}755) = 1133.33$, $p < .01$). For ethnicity, missing data were most likely among Hispanics (24.8%), Blacks (23.4%), and American Indian/Alaskan Natives (22.6%), and least likely among non-Hispanic Whites (9.9%; $\chi^2(5, N = 90{,}755) = 1820.22$, $p < .01$).

### Quality of Life

*Baseline*

We began by examining the cross-sectional association between smoking status (never-smokers were the reference group) and PHRQL at baseline. Separate multiple linear regression analyses were run for each PHRQL outcome. All analyses controlled for age, educational level, and ethnicity. Results for each PHRQL outcome are presented in Table 1. For all outcomes, with the exception of role limitations due to physical health, light smokers had significantly worse PHRQL than participants who had never smoked ($p < .05$). Further, for all outcomes, heavier smokers had significantly worse PHRQL than those who had never smoked ($p < .01$). In addition, former smokers differed significantly from never-smokers on the outcomes of pain and physical functioning ($p < .01$). The regression coefficients of never-smokers and the estimated differences for the other three smoking groups yielded estimates of the means for never-smokers, former smokers, light smokers, and heavier smokers, adjusting for the covariates. Except for role limitations for heavy smokers, these means compare favorably with normative sample means for women aged 55–64 (Ware, Snow, Kosinski, & Gandek, 1993), which are 66.6 for pain, 62.87 for general health, 71.61 for physical role limitations, and 73.09 for physical functioning, consistent with the fact that the participants in the WHI were generally healthier than other women in their cohort (Langer et al., 2003). The means for this sample were also higher than those reported for women aged 65 and older (Ware et al., 1993), which are 63.44 for pain, 61.64 for general health, 56.11 for physical role limitations, and 61.86 for physical functioning.

**Table 1. Regression Coefficients From Multiple Linear Regression Analyses With Smoking Status (Never-Smokers Were the Reference Group) Predicting Four PHRQL Scales at Baseline in Separate Analyses**

| | Pain ($n$ = 90,755) | General health ($n$ = 90,177) | Role limitations ($n$ = 90,448) | Physical functioning ($n$ = 89,731) |
|---|---|---|---|---|
| Never-smokers (Intercept) | 74.57** | 74.01** | 72.94** | 81.59** |
| Former smokers | −0.44** | −0.09 | 0.06 | −0.62** |
| Light smokers | −1.08* | −1.11** | −1.10 | −1.24** |
| Heavier smokers | −2.93** | −4.26** | −5.03** | −5.36** |

*Note.* PHQRL = Physical health–related quality of life.
Analyses controlled for age, ethnicity, and education. All covariates were mean centered. Scales are scored so that higher scores indicate better functioning.
*$p < .05$. ** $p < .01$.

**Table 2. Regression Coefficients From Prospective Multiple Linear Regression Analyses With Smoking Status (Never-Smokers Were the Reference Group) Predicting Four PHRQL Scales at a 3-Year Follow-Up in Separate Analyses**

| | Pain ($n$ = 80,129) | General health ($n$ = 78,842) | Role limitations ($n$ = 79,198) | Physical functioning ($n$ = 78,071) |
|---|---|---|---|---|
| Never-smokers (intercept) | 72.55** | 64.39* | 69.98** | 78.23** |
| Former smokers | −0.56** | −0.14 | −0.30 | −0.45** |
| Light smokers | −1.90** | −.72* | −2.38** | −1.58** |
| Heavier smokers | −2.93** | −4.07** | −6.49** | −4.60** |

*Note.* PHQRL = Physical health–related quality of life.
Analyses controlled for age, ethnicity, education, and the respective baseline physical quality of life score. All covariates were mean centered. Scales are scored so that higher scores indicate better functioning.
*$p < .05$. ** $p < .01$.

*Three-Year Follow-Up*

Next, we examined the prospective association between smoking status (never-smokers were the reference group) and the four PHRQL outcomes at a 3-year follow-up in multiple linear regression analyses. All analyses controlled for the respective PHRQL variable at baseline, as well as for age, educational level, and ethnicity. Results for each PHRQL outcome are presented in Table 2. Both light smokers and heavier smokers differed significantly from never-smokers ($p < .05$) on all four PHRQL outcomes. In addition, former smokers differed from never-smokers ($p < .01$) on outcomes of pain and physical functioning.

### Ten-Year Mortality

We also examined the association between smoking status (never-smokers were the reference group) and mortality across the 10-year follow-up period in a Cox proportional hazards regression analysis. The analysis controlled for age, educational level, and ethnicity. One covariate, ethnicity, did not meet the proportional hazards assumption that the hazards ratio [HR] for any two observations remain constant over time. Thus, following convention (Singer & Willett, 2003, pp. 556–562), ethnicity was stratified in testing the model. Compared with never-smokers, light smokers experienced a more than 2 times greater hazard of mortality ($HR = 2.20$, $p < .01$, 95% $CI = 1.95, 2.48$), and heavier smokers experienced a close to 4 times greater hazard of mortality ($HR = 3.88$, $p < .01$, 95% $CI = 3.50, 4.31$). In addition, compared with never-smokers, former smokers experienced a 43% greater hazard of mortality ($HR = 1.43$, $p < .01$, 95% $CI = 1.35, 1.51$).

Figure 1 plots estimated cumulative hazard across 10 years by baseline smoking status. Observations are excluded beyond 10 years where there are relatively fewer observations and cumulative hazard is disproportionally large. The y-axis depicts model-predicted total accumulated risk (equal to the negative log of the survival probability). The figure shows the total accumulated hazard of mortality for an individual in each smoking status group from baseline until the respective time point across the follow-up period (Singer & Willett, 2003). The plot shows that accumulated hazard of mortality is consistently greatest for heavier smokers, intermediate for light smokers, lower for former smokers, and lowest for never-smokers.

Based on evidence that even very light, daily smoking (1–4 cigarettes/day; Bjartveit & Tverdal, 2005) is associated with increased mortality risk, we examined mortality risk between contrasting levels of light, daily smokers (never-smokers were the reference group) in an additional Cox proportional hazards regression analysis ($n$ = 48,937), again stratifying on ethnicity. Very light smokers were defined as 1–4 cigarettes/day ($n$ = 799) and moderately light smokers were defined as 5–14 cigarettes/day ($n$ = 1890). Both, very light smokers ($HR = 2.04$, $p < .01$, 95% $CI = 1.61, 2.59$) and moderately light smokers ($HR = 2.39$, $p < .01$, 95% $CI = 2.07, 2.75$) showed a more than 2 times greater hazard of mortality compared with never-smokers.

### Years of Smoking Among Former Smokers

In addition, following Ostbye et al. (2002), we examined the relationship between years of smoking and PHRQL at baseline and mortality across the 10-year follow-up period among

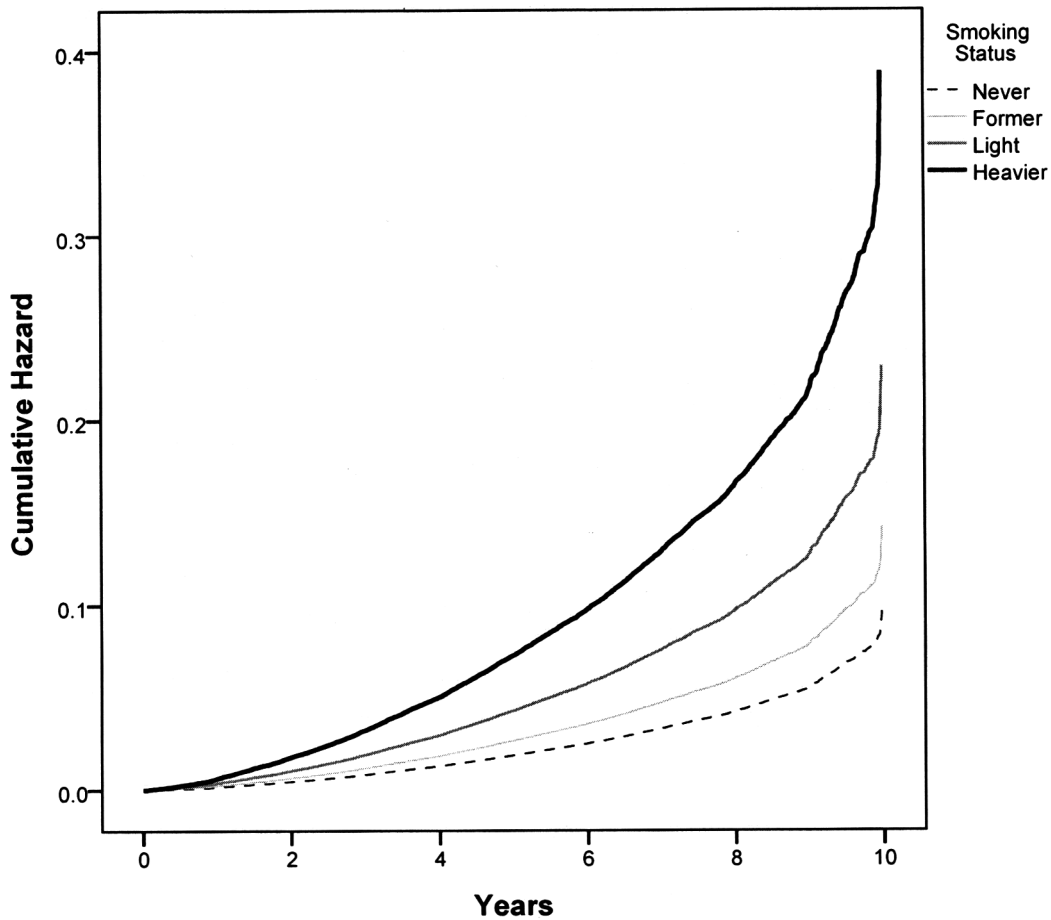


**Figure 1.** Cumulative hazard of mortality risk across 10 years by smoking status at baseline.

former smokers. Unlike current smokers, of whom more than three quarters had smoked for more than 20 years, duration of smoking varied considerably among former smokers. All analyses controlled for age, educational level, and ethnicity. In separate multiple linear regression analyses, we found a significant inverse relationship between each approximately 10 years of additional smoking and all four PHRQL outcomes, encompassing pain ($n$ = 37,340; $\beta = -.54$, $p < .01$), general health ($n$ = 37,143; $\beta = -.76$, $p < .01$), physical functioning ($n$ = 36,994; $\beta = -1.23$, $p < .01$), and role limitations due to physical health ($n$ = 37,243; $\beta = -.84$, $p < .01$). Further, in a Cox proportional hazards regression analysis, again stratifying on ethnicity, each approximately 10 years of additional smoking among former smokers was associated with a 26% increase in the hazard of mortality ($n$ = 38,912; $HR$ = 1.26, $p < .01$, 95% $CI$ = 1.22, 1.29).

## CONCLUSIONS

Using data from the WHI Observational Study, the present study demonstrates a consistent link between the smoking status and both PHRQL and mortality among middle-aged and older women. Extending previous research on smoking status and quality of life (Arday et al., 2003; Hays et al., 2008; Ostbye et al., 2002; Sarna et al., 2008; Wilson et al., 1999), we found that smoking status was significantly related to PHRQL cross-sectionally at baseline and prospectively at a 3-year follow-up among middle-aged and older women. In line with previous studies (Ostbye et al., 2002; Sarna et al., 2008; Schmitz et al., 2003; Wilson et al., 1999), the relation of smoking to self-perceived physical quality of life was dose related. These statistical relationships were clinically meaningful (Samsa et al., 1999) for heavier smokers but small for light and former smokers. In addition, extending previous research on smoking status and mortality (Shavelle, Paculdo, Strauss, & Kush, 2008) to middle-aged and older women, we found that smoking status at baseline was significantly related to a 10-year total mortality risk. Here, statistical relationships were large for light and heavier smokers and meaningful for former smokers.

Among middle-aged and older women who were former smokers, those who had smoked longer, showed significantly lower PHRQL, consistent with Sarna et al. (2008), and significantly increased mortality risk. The health decrements for both PHRQL and mortality were essentially linear for each approximately 10 years of additional smoking. Across the full range of years of regular smoking, these associations were clinically meaningful (Samsa et al., 1999) for PHRQL and large for mortality risk.

Overall, these findings reinforce those of previous research (Hermanson, Omenn, Kronmal, & Gersh, 1988; Ockene, 1993; U.S. DHHS, 2001, 2004) documenting significant health

benefits of smoking cessation for middle-aged and older women. Past research has shown reduced mortality risk for women with smoking cessation (Kenfield et al., 2008), with substantial reduction in mortality risk for cardiovascular disease over 5 years, and a slower reduction in mortality risk for respiratory diseases. Further, these results extend research on smoking and quality of life by clarifying previously conflicting findings with women. Consistent with Heikkinen et al. (2008), Sarna et al. (2008), and Wilson et al. (2004), we found a link between smoking status and PHRQL among these middle-aged and older women, with the strongest association for heavier smoking.

The relationships for light versus heavier smokers are instructive. Both light and heavier smoking showed large associations with objectively indexed mortality. In fact, consistent with Bjartveit and Tverdal (2005), even very light, daily smoking of 1–4 cigarettes/day was associated with a more than 2 times greater mortality risk compared with never smoking. In contrast, on self-perceived PHRQ, whereas heavier smokers showed large, clinically meaningful associations, light smokers showed only small associations. Researchers have suggested that the link between heavier smoking and perceived quality of life may motivate heavy smokers to reduce or quit smoking (Wilson et al., 1999). Without comparable perceptions, light smokers may underestimate the risks of light smoking (Ayanian & Cleary, 1999; Donze et al., 2007; Moran, Glazier, & Armstrong, 2003), especially in regard to cardiovascular disease (Moran et al., 2003). For example, in a study of women in midlife, Moran et al. (2003) found that only heavier smokers perceived an above-average risk for heart disease. It remains possible that adverse quality-of-life effects may become apparent to continuing light smokers in later aging (U.S. DHHS, 2010).

There is relatively little research on the relationship of light smoking to health (Fagan & Rigotti, 2009). However, emerging evidence suggests that light smoking carries considerable health risk (Bjartveit & Tverdal, 2005; Pope et al., 2009; Prescott, Scharling, Osler, & Schnohr, 2002; Shavelle et al., 2008). The relationship of smoking to cancer is dose dependent, and light smoking is associated with a higher risk for heart disease, with the mortality curve for cardiovascular risk steepest at lower levels of smoking (Rogers, Hummer, Krueger, & Pampel, 2005).

The present study has some limitations. The WHI smoking measure assessed smoking by self-report and did not include biochemical verification of smoking. However, evidence suggests that self-report measures of smoking are accurate in most situations, particularly in studies of adults who are not in smoking intervention, as is the case in the WHI (Caraballo, Giovino, Pechacek, & Mowery, 2001; Rebagliato, 2002). In addition, the present results may not generalize to all middle-aged and older women. The participants in the WHI Observational Study were healthier both physically and mentally than others of their cohort (Langer et al., 2003) and show a lower prevalence of smoking compared with other women of their age.

In conclusion, the results of this study indicate that smoking status is related to both lower physical quality of life and higher total mortality risk in middle-aged and older women. These findings extend research on smoking and self-perceived quality of life to middle-aged and older women, who have been relatively neglected in smoking research (Brown et al., 2004; Donze et al., 2007). These results also further our understanding of light smoking. Light smoking is not well-understood because it is less addictive than heavier smoking (Shiffman, 2009) and light smokers have tended to be excluded from tobacco cessation trials (Fagan & Rigotti, 2009). Our findings suggest that the immediate and long-term risks of smoking may not be evident to light smokers. With a substantial proportion of middle-aged and older smokers light smokers (Donze et al., 2007; Holahan et al., 2011), these results suggest that educational interventions targeted to middle-aged and older women stressing the consequences of light smoking may be particularly beneficial.

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## DECLARATION OF INTERESTS

*None declared.*

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