Reductions in Cigarettes per Day and Mortality Among Older Adults in The United States

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ABSTRACT

Many smokers do not quit but instead reduce the number of cigarettes that they smoke per day (CPD) over their lifetime, yet the associations of such changes in CPD with health risks are unclear. We examined the association of changes in CPD with subsequent mortality (2004-2011) among 253,947 participants of the NIH-AARP Diet and Health Study. We identified cigarette smokers who quit, decreased, maintained, or increased their CPD between ages 25-29 and 50-59 using a questionnaire assessing smoking history in 2004-2005. Hazard ratios (HR) and 95% confidence intervals (CI) were from multivariable-adjusted Cox proportional hazards regression. Relative to never smokers, smokers who maintained a consistent CPD had 2.93 times (95%CI: 2.82, 3.05) higher all-cause mortality risk, with still higher risks observed in participants who increased their CPD (HR: 3.37, 95%CI: 3.23, 3.52). Risks were lower among participants who decreased their CPD (HR: 2.38, 95%CI: 2.25, 2.52) or quit smoking (HR for quitting between 30-39 years: 1.32, 95%CI: 1.25, 1.39). Similar patterns were observed for smoking-related causes of death, with particularly strong associations for lung cancer and respiratory disease. Reductions in CPD over the lifetime meaningfully decrease mortality risk. But cessation provides a larger benefit than even large declines in CPD.

Key words: lifetime change, smoking, cigarette, mortality, prospective study

Abbreviations: US: United States; CPD: cigarettes per day; NIH-AARP: National Institutes of Health-AARP; ICD: International Classification of Diseases; COPD: chronic obstructive pulmonary diseases; HR, hazard ratio; CI: confidence interval;

Tobacco products are estimated to cause 6 million premature deaths per year worldwide,[1] including 480,000 deaths per year in the United States (US) from cigarette smoking alone.[2] Many studies indicate that the behaviors that lead to greater cumulative exposure, including younger age at initiation[3-6] and more cigarettes per day (CPD)[3,4,7,8] increase risk and that quitting lowers risk.[3,7-9] The data are unambiguous: non-smokers should not start and smokers should quit.

Nevertheless, despite declines in prevalence, an estimated 15% of US adults currently smoke,[10] and 39% of US adults smoked regularly at some point in their life.[11] During the lifetime, many smokers do not quit smoking but instead make changes in their cigarette use, reducing or increasing their CPD over time.[12-14] In recent years, a growing number of daily smokers have reduced their CPD and some have become occasional smokers, rather than quitting. Surprisingly little data, however, are available on the possible health effects of such changes, despite the possibility that they may be substantial. Data from three prior studies suggest that reducing CPD may have some benefit for lung cancer risk, [15-17] but associations with other endpoints, including overall mortality, have generally been null.[17-23] However, these previous studies tended to have modest size and assess changes in cigarette use over a relatively short time period.

As part of the National Institutes of Health (NIH)-AARP Diet and Health Study, over 260,000 participants detailed their cigarette use at different age-periods in their life. These data allowed us to investigate the impact of changes in number of CPD on the risks of all-cause and cause-specific mortality.

METHODS

Study population

The NIH-AARP cohort has been described previously.[24] Briefly, between 1995-1996, 566,398 male and female participants from six US states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, Georgia and Detroit, Michigan) completed a questionnaire detailing tobacco use, diet, and lifestyle. Between 2004-2005, 313,363 participants (62.3%), aged 59-82, completed a follow-up questionnaire with detailed cigarette smoking questions. We excluded proxies (n=14,072), those who died before their questionnaires were scanned (n=4), those with incomplete smoking information (n=9,295), those who reported ever cigarette smoking but not smoking at 25-29 years (n=25,142), and those who reported smoking less than 100 cigarettes in their lifetime (n=10,903), leaving 253,947 participants in our analysis. The cohort was approved by the Special Studies Institutional Review Board of the NCI. Baseline questionnaires included a statement that participants provide informed consent by completing and returning the questionnaires.

Exposure assessment

As part of the 2004-2005 questionnaire, participants reported their cigarette smoking during nine age-periods (<15, 15-19, 20-24, 25-29, 30-39, 40-49, 50-59, 60-69, and 70+ years) using eight intensity categories for CPD (none, <1, 1-10, 11-20, 21-30, 31-40, 41-60, and ≥61). To assess changes in daily cigarette use, we classified participants who smoked cigarettes at age 25-29, at which point most ever-smokers smoked, by their later use at age 50-59: participants who had quit (at ages 30-39, 40-49, or 50-59),

maintained a consistent amount at both ages, reduced but did not quit at age 50-59, or increased at age 50-59. As some participants completing the questionnaire were younger than 60 years old, we did not include reported CPD at age 60-69 or 70 and over in our analysis.

The 2004-2005 questionnaire also assessed body mass index (computed using self-reported height and weight), physical activity, perceived general health, and history of certain health conditions. Age, sex, race/ethnicity, education, and 124 dietary items, including alcohol, were assessed on the original 1995-1996 questionnaire.

Cohort follow-up and Endpoints

Follow-up was from the date when the completed and returned 2004-2005 questionnaire was scanned until death or December 31, 2011, whichever came first. Participants were followed by linkage to the National Change of Address database maintained by the US Postal Service and change of address requests.

Mortality data were obtained by linkage to the National Death Index maintained by the National Center for Health Statistics. International Classification of Diseases (ICD)-9 and ICD-10 codes were used to define outcomes as follows: all cancer (ICD-9 140-208, 238.6; ICD-10 C00-C97); lung cancer (ICD-9 162.2-162.9; ICD-10 C34); heart disease (ICD-9 390-398, 401-404, 410-429, 440-448; ICD-10 I00-I13, I20-I51, I70-I78); stroke (ICD-9 430-438; ICD-10 I60-I69); and respiratory disease (e.g. pneumonia, influenza, chronic obstructive pulmonary diseases (COPD), and allied conditions; ICD-9 480-487, 490-496; ICD-10 J09-J18, J40-J47).

Statistical analysis

We computed mortality rates between ages 60 and 85 by change in cigarette use from ages 25-29 to 50-59 (quit, decreased, same, and increased) in men and women separately, with never smokers as the referent group. Hazard ratios (HR) and 95% confidence intervals (CI) were computed from Cox proportional hazards regression models[25] using person-years of follow-up as the underlying time metric. To adjust for birth-cohort effects, we stratified the baseline hazards by age groups (<65, 65-69, 70-74, ≥75) using the strata statement in the proc phreg procedure as well as adjusted for age in a continuous scale. Other covariates in the final models included sex, education (high school or less, post-high school training, some college, completion of college), race/ethnicity (Non-Hispanic white, Non-Hispanic black, Hispanic, Asian, Pacific Islander, or Native American), alcohol intake (none, >0-1, >1-3, >3 drinks per day), and age at smoking initiation. We did not adjust the final models for body mass index, perceived general health, and previous diagnosis of chronic diseases because these factors are affected by cigarette use and also are associated with mortality. Adjustment for physical activity made little difference on the risk estimates (<2%), thus they were not included in the final models. We included variable-specific indicators for missing data in the regression models; less than 5% of the cohort lacked any single covariate. Our analyses were performed with SAS version 9.3 (Cary, North Carolina). All analyses were two-sided and a statistical significance was defined as P <0.05.

In subgroup analyses, we present analyses stratified by age group (<65, 65-69, 70-74, and ≥75), sex, and by the first five or more years of follow-up. We also evaluated

associations among participants who reported never regularly using pipes or cigars and among those who did not report a previous diagnosis of heart attack, stroke, COPD, or cancer. We investigated detailed changes in CPD from age 25-29 to age 50-59, with participants who reported smoking a consistent amount during both age periods as the referent group. Finally, we evaluated changes in reported CPD between the 1995-1996 questionnaire and the later 2004-2005 questionnaire.

RESULTS

Of the 253,947 cohort participants (age range: 59-82; mean: 71) included in the analysis, 111,473 participants (56%) were never smokers and 142,474 (44%) reported smoking at age 25-29. A majority (69%) of smokers began smoking prior to age 20 years. Of smokers at age 25-29, 64% quit smoking by the age of 50-59, whereas 18% reported maintaining a consistent amount, 7% smoked less but did not quit, and 11% smoked more.

Table 1 tabulates various aspects of cigarette smoking history including age at initiation, demographics, lifestyle, and health conditions overall and by category of cigarette use. Many demographic parameters, such as age, race, and body mass index, were similar across smoking categories. Participants who smoked more CPD at age 50-59 than at age 25-29 were less likely to have a college education, less physically active, more likely to report higher alcohol consumption, and report fair or poor perceived general health, COPD, or a previous stroke than those who smoked less at age 50-59 or those who had quit.

During a median follow-up of 7.1 years, 32,774 participants died from cancer (n=12,195) including lung cancer (n=3,396), heart disease (n=8,328), stroke (n=1,468), respiratory disease (n=2,784), and other causes (n=5,496). The mortality rate was lowest among never smokers and progressively increased among former smokers, those who had reduced their CPD but did not quit, those who maintained a consistent amount, and those who had increased their CPD from ages 25-29 to 50-59 (**Figure 1**). Mortality rates at age 80-85 were 3,380 per 100,000 among never smokers, and 4,542, 5,949, 7,260, and 7,870 per 100,000 among smokers who quit, decreased but did not quit, maintained same, and increased CPD, respectively, in men and 2,986, 3,975, 5,440, and 5,984 per 100,000, respectively, in women.

Relative to never smokers, all-cause mortality risk among participants who maintained a consistent CPD at ages 25-29 and 50-59 years was 2.93 times higher (95%CI: 2.82, 3.05), whereas still higher risk was observed among participants who had increased their CPD (HR: 3.37; 95%CI: 3.23, 3.52; **Table 2**). Participants who had decreased their CPD but had not quit had 2.38 times higher risk (95%CI: 2.25, 2.52) than never smokers; however, mortality risk was substantially lower among participants who had quit smoking, with the lowest risks observed among those who had quit at 30-39 years (HR: 1.32; 95%CI: 1.25, 1.39). Adjusting for previous diagnoses of chronic disease (heartattack, high blood pressure, high cholesterol, stroke, COPD, and cancer) did not change the association (data not shown).

In age-stratified analysis, associations were strongest among participants below age 65 years at baseline and modestly attenuated with older age (*P*-interaction: <0.0001)

(**Web Table 1**). Relative to never smokers, the HRs were 3.10 (95%CI: 2.62, 3.66), 3.56 (95%CI: 3.10, 4.09), and 4.70 (95%CI: 4.03, 5.47) for smokers who had decreased, maintained a consistent amount, or increased CPD among participants less than 65 years with corresponding HRs of 2.07 (95%CI: 1.89, 2.27), 2.57 (95%CI: 2.41, 2.73), and 2.90 (95%CI: 2.70, 3.11) for these same comparisons among participants who were 75 years or older. Associations were slightly stronger in women than in men (*P*-interaction: 0.009). For example, relative to never smokers, the HR among those who increased CPD was 3.83 (95%CI: 3.54, 4.14) in women and 3.19 (95%CI: 3.02, 3.37) in men, and the HR among those who decreased CPD but did not quit was 2.79 (95%CI: 2.51, 3.10) in women and 2.25 (95%CI: 2.11, 2.40) in men. Comparable associations were observed for deaths occurring in the first five years or later in follow-up, after excluding participants who reported ever regularly using pipes or cigars on the 1995-1996 questionnaire, and after excluding participants who reported one or more previous diagnosis of heart attack, stroke, COPD, or cancer.

Consistent patterns were observed for deaths due to a range of smoking-related diseases, with especially strong associations observed for lung cancer and respiratory disease mortality (Table 2). HRs for decreasing, consistent, and increasing CPD from ages 25-29 to 50-59 relative to never smokers were the following for all cancer (reduce: 2.37; consistent; 3.26; increase: 3.53), lung cancer (reduce: 13.47; consistent: 21.75; increase: 27.16), heart disease (reduce: 2.12; consistent: 2.46; increase: 2.84), stroke (reduce: 1.68; consistent: 1.95; increase: 2.19), or respiratory disease (reduce: 11.42; consistent: 15.66; increase: 20.31).

We also performed an analysis examining whether more granular changes in CPD between the ages of 25-29 and 50-59 years were associated with mortality risk, using participants who maintained a consistent CPD as the referent group (**Table 3**). We observed evidence for a dose-response across increasing categories of reported use (*P* for trend <0.0001), with larger changes in CPD associated with larger changes in mortality risk. For example, relative to consistent >0-10 CPD smokers at both age periods, the HRs for those who increased to 11-20, 21-30, and >30 CPD were 1.39 (95%CI: 1.25, 1.55), 1.47 (95%CI: 1.23, 1.75), and 1.82 (95%CI: 1.47, 2.24), respectively; whereas the HR for those who had quit was 0.70 (95%CI: 0.65, 0.76). Conversely, relative to consistent >30 CPD smokers, the HRs for reducing to 21-30, 11-20, >0-10 CPD were 0.85 (95%CI: 0.73, 0.99), 0.76 (95%CI: 0.63, 0.91), and 0.64 (95%CI: 0.51, 0.80), with a HR for quitting of 0.51 (95%CI: 0.48, 0.55).

The analyses described above relied on participants recalling their historical cigarette use. As such recall may be affected by misclassification, we examined whether changes in cigarettes per day between the 1995-1996 questionnaire and the later 2004-2005 questionnaire were associated with subsequent mortality risks. Although this analysis was restricted to current smokers in 1995-1996 (n=141,084) and as such had lower statistical power than our main analyses, results were concordant with those from the larger cohort (**Web Table 2**).

DISCUSSION

Our data suggest that the association of smoking with mortality is dynamic and sensitive to changes in CPD over the lifetime. Larger decreases in CPD from ages 25-29 to 50-59

years were associated with lower mortality risks than smaller decreases in CPD. Conversely, larger increases in CPD were associated with higher mortality risks than smaller increases in CPD. Nevertheless, mortality rates were substantially lower among former smokers than among participants who had reduced their CPD but continued to smoke.

Many prior studies have demonstrated associations between mortality and age at smoking initiation,[3-6] age at smoking cessation,[3,7-9] and CPD.[3,4,7,8] Just four prior studies, however, have examined how changes in CPD in the lifetime affect mortality risks. Compared to those smoking a consistent amount, HRs for reducing CPD were 1.04 (95%: 0.95, 1.14),[21] 1.02 (95%CI: 0.89, 1.17),[19] 1.02 (95%CI: 0.84, 1.22),[17] and 0.85 (95%CI: 0.77, 0.95) in these prior studies.[18] Of the two prior studies investigating increasing CPD, risk estimates were 1.14 (95%CI: 0.99, 1.32)[18] and 1.16 (95%CI: 1.06, 1.28)[21] relative to those smoking a consistent amount. Three prior studies,[15-17], including the largest to date,[16] observed evidence for lower risk of lung cancer in participants who reduced their CPD. Results for other outcomes were generally null.[17-23] However, these prior studies tended to be both smaller and assess changes in cigarette use over a shorter time frame than the current study. The current study assessed changes in CPD over decades, whereas prior studies assessed changes over a shorter time period (from two years[18] to a maximum of 3-13 years[17]). Although results from the previous studies are not completely consistent, our results are plausible. Many previous studies have demonstrated dose-dependent associations with CPD and lifetime exposure metrics, such as pack-years, with disease endpoints and mortality.[2] Lower mortality risks among people who quit smoking than those who did not quit but instead reduced their cigarette

use to <10 CPD are also plausible and consistent with recent findings from the NIH-AARP cohort that smokers who consistently smoked <1 and 1-10 CPD over their lifetime have higher mortality risks than never smokers and benefit from cessation.[12]

Key strengths of our study include its very large size, prospective design, and detailed assessment of cigarette smoking over the lifespan. One advantage of the prior studies is that they independently assessed smoking at two time-points as opposed to asking participants to recall their previous smoking over their lifetime in the current study. Although such recall may lead to misclassification, self-reported smoking has been shown with good correlation with biomarkers, such as nicotine and its metabolites, in blood and urine.[26,27] Recalling previous smoking history has also shown good validity for CPD 20 years earlier (κ=0.63) and fair validity for CPD 32 years earlier (κ=0.36) in middle-aged adults.[28] In the NIH-AARP cohort, we previously showed that 74% of participants who reported consistently smoking ≤10 CPD on the 2004-2005 questionnaire reported smoking a consistent CPD on the 1995-1996 questionnaire.[12] We also observed comparable findings in a sensitivity analysis where we defined changes in CPD across two separate study questionnaires administered 8-10 years apart, which provides reassurance with regards to our main findings.

A general limitation of studies to date is a lack of information on participant's motivation for changing their cigarette use. One possibility is poor health, which likely would have led to a smoking reduction rather than the reverse. However, similar associations were observed after excluding participants who reported a previous chronic disease diagnosis, or after excluding deaths that occurred during the first five years of

follow-up in the current study, even though such exclusions preferentially affected heavy smokers in the cohort. Also, we observed that participants who had reduced their CPD subsequently reported better health and less COPD than participants who had maintained a consistent CPD. These data are supportive of the observed association between reducing CPD and lower mortality risk.

As participants in our analysis had a median age of 71 and a minimum age of 59, we were unable to assess risks in younger adults. Heavy smokers were less likely to have lived long enough to enter our study than lighter and former smokers.[14,29] Therefore, one might predict that our study underestimates the impact of smoking on mortality and may underestimate the magnitude of associations with quitting smoking and reducing CPD over the lifetime. Our study represents a specific point in time, birth cohorts who began smoking in the 1940s and 1950s and began to quit in large numbers after the publication of the 1964 Surgeon General's report.[14,30] Our study participants are also predominantly non-Hispanic whites. Studies in younger populations, in other birth cohorts, and in ratial/ethnic minority populations are clearly needed. We lacked assessment of inhalation, and this and other aspects of smoking topography may change over the lifetime. For example, in order to satisfy their craving for nicotine, participants who reduced their cigarettes per day may compensate by smoking each remaining cigarette more intensely.[22,31] Nevertheless, the current findings suggest that any compensatory effects are secondary to the larger effects of increasing or reducing CPD. Lastly, as in all observatiobal studies, residual confounding by measured and unmeasured factors are possible.

Based on the time-point and age-distribution of the cohort, we can assume that most participants altered their use in the absence of nicotine replacement therapy, e-cigarettes, or other nicotine delivery devices. Nevertheless, our data suggest that partial substitution of cigarettes with other tobacco products might have health benefits, should the other products be less harmful than cigarettes. However, future studies are needed to directly evaluate the health risks of low-CPD cigarette use in combination with other tobacco products, particularly as dual use of cigarettes and other tobacco products are increasingly common.

In addition to providing important information for public health, our results may also have implications for risk prediction. For example, eligibility for lung cancer screening is typically determined based on lifetime pack-years of exposure, the product of smoking duration and typical or recent CPD.[32] Yet, we found that the HRs for lung cancer mortality varied substantially by changes in CPD over the lifetime. Therefore, models that incorporate CPD at just a single time in life may not optimally identify people who should be screened for lung cancer. Future studies are needed to evaluate the impact of changing CPD over the lifetime on the effectiveness of lung cancer screening.

In conclusion, among older Americans in a large prospective cohort study, participants who increased CPD over their lifetime had higher mortality rates, whereas participants who reduced CPD but did not quit had lower mortality rates, although substantially higher than for participants who quit smoking. Our data indicate that the best thing is never smoking, and that cessation provides the greatest benefit for current smokers. Nevertheless, reducing CPD was associated with lower mortality rates.

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FIGURE LEGENDS

Figure 1. Mortality Rate per 100,000 from Ages 60 to 85 by Prior Change in Cigarette Use from Ages 25-29 to 50-59 Reported in the 2004-2005 Questionnaire among A) Men and B) Women in the National Institutes of Health-AARP Diet and Health Study

TABLES

Table 1. Characteristics Among All Participants and by Category of Cigarette Use between the Ages 25-29 Years and Ages 50-59 Years Assessed in the 2004-2005 Questionnaire of the National Institutes of Health-AARP Diet and Health Study

Category[a]	All participants (*n* = 253,947), %	Never smoker (*n* = 111,473), %	Quit smoking by 50-59 years (*n* = 90,841), %	Continued to smoke at both ages		
				Smoked less at age 50-59 (*n* = 10,466), %	No change in cigarettes per day (*n* = 25,853), %	Smoked more at age 50-59 (*n* = 15,314), %
Age at start of follow-up[a,b]	71.1 (66.4, 75.1)	70.9 (66.3, 75.1)	70.7 (66.1, 74.9)	70.5 (65.8, 74.7)	72.1 (67.4, 75.7)	72.4 (67.9, 75.6)
Age started smoking[a]						
Never	43.9	100	0	0	0	0
< 15 years	12.6	0	21.0	26.9	24.7	24.3
15-19 years	25.9	0	46.8	48.3	46.0	41.1
20-24 years	15.0	0	27.4	22.4	25.5	27.7
25-29 years	2.6	0	4.8	2.4	3.8	6.9
Cigarette use at ages 25-29[a]						
None	43.9	100	0	0	0	0
<1-20 cigarettes per day[c]	34.9	0	61.4	50.5	67.8	64.8
21-40 cigarettes per day	18.9	0	33.4	45.3	29.6	34.0
≥ 41 cigarettes per day[c]	2.3	0	5.2	4.2	2.6	1.2
Cigarette use at ages 50-59[a]						
None	79.7	100	100	0	0	0
<1-20 cigarettes per day[c]	11.8	0	0	91.0	67.8	19.1
21-40 cigarettes per day	6.9	0	0	8.7	29.6	57.7
≥ 41 cigarettes per day[d]	1.6	0	0	0.3	2.6	23.2
Sex (Male)[e]	57.6	49.1	68.6	65.9	56.1	50.7
Race (White)[e]	92.6	91.7	93.6	93.2	92.3	93.5
Education (College)[e]	44.4	48.3	45.0	42.0	33.7	31.7
Body mass index[a,b]	26.5 (23.8, 29.6)	26.1 (23.6, 29.3)	26.6 (24.3, 29.9)	26.6 (23.9, 29.8)	26.2 (23.5, 29.3)	26.6 (23.8, 30.2)
Alcohol (>3 drinks/day)[e]	7.3	3.4	9.3	11.2	11.7	12.8
Leisure activity (MET-hrs/week)[a,b]	14.9 (4.3, 36.6)	15.0 (4.3, 36.6)	18.8 (4.3, 40.8)	14.4 (4.2, 36.6)	10.8 (2.2, 29.5)	8.3 (1.1, 25.0)
Reported health (Fair/Poor)[a]	12.9	10.2	12.1	16.3	19.1	23.8
Previous diagnosis[a]						

Heart attack	18.2	13.8	20.5	23.7	22.3	24.9
High blood pressure	53.9	51.4	55.7	55.3	54.7	58.1
High cholesterol	55.3	51.5	57.3	59.1	57.1	59.1
Stroke	3.5	2.9	3.4	4.4	4.9	5.6
Chronic obstructive pulmonary disease	8.1	3.9	6.8	14.8	18.0	24.4
Cancer	26.9	25.2	27.9	28.4	28.3	29.6

MET: metabolic equivalent

[a] Assessed in 2004-2005.

[b] Values are expressed as median (interquartile range).

[c] Includes two categories (<1 CPD and 1-10 CPD) from the questionnaire that were collapsed together.

[d] Includes wo categories (41-60, and >60 CPD) from the questionnaire that were collapsed together.

[e] Assessed in 1995-1996.

Table 2. Association between Change in Cigarette Use between Ages 25-29 Years and 50-59 Years Reported in the 2004-2005 Questionnaire and Subsequent All-Cause and Cause-Specific Mortality in the National Institutes of Health-AARP Diet and Health Study

Smoking Status	No.	All Causes			All Cancers			Lung Cancer		
		Death No.	HR[a]	95% CI	Death No.	HR[a]	95% CI	Death No.	HR[a]	95% CI
Never smoker	111,473	9,821	1.00	Referent	3,468	1.00	Referent	253	1.00	Referent
Quit smoking										
Quit at 30-39 years	21,397	2,075	1.32	1.25, 1.39	795	1.38	1.27, 1.51	119	3.07	2.45, 3.86
Quit at 40-49 years	35,202	4,203	1.52	1.45, 1.59	1,595	1.60	1.49, 1.72	326	4.86	4.07, 5.80
Quit at 50-59 years	34,242	5,082	1.93	1.85, 2.01	1,913	2.03	1.89, 2.17	594	9.17	7.81, 10.77
Continued to smoke at 50-59 years										
Smoked less	10,466	1,926	2.38	2.25, 2.52	662	2.37	2.16, 2.59	260	13.47	11.21, 16.20
Smoked the same amount	25,853	5,855	2.93	2.82, 3.05	2,308	3.26	3.05, 3.47	1,069	21.75	18.71, 25.27
Smoked more	15,314	3,912	3.37	3.23, 3.52	1,454	3.53	3.29, 3.80	775	27.16	23.27, 31.71
P for trend[b]			< 0.0001			< 0.0001			< 0.0001	
Smoking Status	**No.**	**Heart Disease**			**Stroke**			**Respiratory Disease**		
		Death No.	**HR[a]**	**95% CI**	**Death No.**	**HR[a]**	**95% CI**	**Death No.**	**HR[a]**	**95% CI**
Never smoker	111,473	2,631	1.00	Referent	550	1.00	Referent	324	1.00	Referent
Quit smoking										
Quit at 30-39 years	21,397	520	1.17	1.05, 1.31	103	1.33	1.04, 1.71	90	2.34	1.83, 2.99
Quit at 40-49 years	35,202	1,087	1.38	1.26, 1.50	199	1.43	1.16, 1.76	216	3.12	2.59, 3.77
Quit at 50-59 years	34,242	1,346	1.81	1.67, 1.97	208	1.56	1.27, 1.91	409	6.02	5.12, 7.08
Continued to smoke at 50-59 years										
Smoked less	10,466	455	2.12	1.90, 2.37	64	1.68	1.26, 2.23	225	11.42	9.50, 13.71
Smoked the same amount	25,853	1,377	2.46	2.27, 2.67	206	1.95	1.60, 2.38	858	15.66	13.55, 18.09
Smoked more	15,314	912	2.84	2.60, 3.10	138	2.19	1.76, 2.74	662	20.31	17.50, 23.57
P for trend[b]			< 0.0001			< 0.0001			< 0.0001	

CI: confidence interval; HR: hazard ratio

[a] From Cox proportional regression adjusted for age, sex, education, race/ethnicity, alcohol intake, and age at smoking initiation, stratified by age group (< 65, 65-69, 70-74, ≥ 75) using the STRATA statement. Never smokers served as the referent group.

[b] Chi-square test for linear trend across increasing categories, with never smokers as the referent group.

Table 3. Association between Changes in Cigarette Use between Ages 25-29 Years and 50-59 Years Reported in the 2004-2005 Questionnaire and Subsequent All-Cause Mortality in the National Institutes of Health-AARP Diet and Health Study

No. of Cigarettes Smoked Per Day at Ages 50-59 Years	No. of Cigarettes Smoked per Day at Ages 25-29 Years															
	<1-10[a]				11-20				21-30				>30[b]			
	No.	Death No.	HR[c]	95% CI	No.	Death No.	HR[c]	95% CI	No.	Death No.	HR[c]	95% CI	No.	Death No.	HR[c]	95% CI
None	23,131	2,338	0.70	0.65, 0.76	32,660	4,049	0.57	0.54, 0.59	19,776	2,640	0.50	0.47, 0.53	15,274	2,333	0.51	0.48, 0.55
<1-10	6,856	999	1.00	Referent	4,263	689	0.80	0.74, 0.87	1,201	188	0.64	0.55, 0.74	436	79	0.64	0.51, 0.80
11-20	2,645	505	1.39	1.25, 1.55	11,996	2,597	1.00	Referent	2,021	394	0.74	0.66, 0.82	575	123	0.76	0.63, 0.91
21-30	694	143	1.47	1.23, 1.75	3,560	862	1.17	1.08, 1.26	5,287	1,438	1.00	Referent	766	189	0.85	0.73, 0.99
≥31	368	97	1.82	1.47, 2.24	2,362	645	1.23	1.12, 1.34	3,835	1,124	1.06	0.98, 1.15	4,768	1,521	1.00	Referent
P for trend[d]			< 0.0001				< 0.0001				< 0.0001				< 0.0001	

CI: confidence interval; HR: hazard ratio

[a] Includes two categories (<1 and 1-10 cigarettes per day) from the questionnaire that were collapsed together.

[b] Includes three categories (31-40, 41-60, and >60 cigaretteper day) from the questionnaire that were collapsed together.

[c] From Cox proportional hazard regression adjusted for age, sex, education, race/ethnicity, alcohol intake, and age at smoking initiation, stratified by age group (< 65, 65-69, 70-74, ≥ 75) using the STRATA statement. Referent group is those participants who reported smoking a consistent amount at both age periods.

[d] Chi-square test for linear trend across increasing categories, with former smokers at age 50-59 as a referent group.