

Facial Wrinkling in Men and Women, by Smoking Status

ABSTRACT

Objectives. This study examined the association of smoking status and pack-years of smoking with facial wrinkling in men and women.

Methods. We conducted a cross-sectional study of 299 never smokers, 551 former smokers and 286 current smokers, aged 30 through 69 years, drawn from a health maintenance organization. Smoking status, pack-years of smoking, and potential confounding variables were assessed by questionnaire. Facial wrinkle category, a dichotomous variable, and facial wrinkle score, a computed continuous variable, were assessed by blinded standardized visual assessment. Wrinkling was so uncommon among 30- through 39-year-old subjects that analyses were restricted to subjects aged 40 and over (227 never smokers, 456 former smokers, and 228 current smokers).

Results. With age, average sun exposure, and body mass index controlled, the estimated relative risk of moderate/severe wrinkling for current smokers compared to never smokers was 2.3 (95% confidence interval [CI] = 1.2, 4.2) among men and 3.1 (95% CI = 1.6, 5.9) among women. Pack-years was positively associated with facial wrinkle score in women aged 40 through 69 years and in men aged 40 through 59 years. In both groups, the increased risk of wrinkling was equivalent to about 1.4 years of aging.

Conclusions. Our results support earlier findings that risk of facial wrinkling is greater in cigarette smokers than in never smokers. (*Am J Public Health.* 1995;85:78-82)

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Introduction

Cigarette smoking is the leading known cause of premature death in the United States.^{1,2} Several studies have also suggested that cigarette smoking is associated with facial wrinkling,^{1,3} but most of these studies were small,⁴⁻⁶ used unblinded assessment of wrinkling,^{4,7} or failed to control for potential confounders such as age and sun exposure.⁴ If confirmed, information about the association between cigarette smoking and facial wrinkling might be more effective in convincing young persons not to smoke and smokers to quit than evidence of the more serious long-term health consequences of smoking. We examined cigarette smoking and facial wrinkling in 1136 men and women, using objective, blinded measures of wrinkling and controlling potential confounding variables including age, sex, sun exposure, alcohol consumption, and body mass index.

Methods

Eligible subjects were adults between 30 and 69 years of age who had completed a multiphasic health screening examination at Kaiser Permanente Medical Center in Oakland, California in 1990 or 1991. Because facial wrinkling is relatively uncommon among African Americans and Asians, the study was limited to Whites. Based on data collected at the time of health screening, about 12 000 persons were classified by sex, age (in eight 5-year age groups between 30 and 69), and smoking status (never smoker, former smoker, or current smoker). Based on differences in wrinkling between smokers and never smokers reported elsewhere⁷ and our hypothesis that the extent of wrinkling in former smokers would be

midway between that of smokers and never smokers, we estimated a priori that we required 18 never smokers, 18 current smokers, and 30 former smokers in each of the 16 age-sex strata. From the Kaiser database, we then randomly selected subjects from each stratum and invited them to participate in the study, a process that continued until we had enrolled close to the desired number for each strata. Well into the data collection process, we recognized that almost all individuals aged 30 through 39 years in our study population had either no facial wrinkling or only mild wrinkling and decided to stop enrolling subjects in that age group.

All procedures and data collection were performed by three research associates who were rigorously trained prior to enrolling study subjects. Before reporting for the study visit, participants were asked to wash their faces, brush their teeth, and avoid wearing makeup. They were also asked not to bring cigarettes to their appointment and not to discuss their smoking status with the research associate. At the time of the study visit, four specific areas of each participant's face were clinically examined and scored for

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facial wrinkling: (1) the right crow's-foot area (area extending radially from 0.5 cm medial to the lateral canthus of the right eye to the hairline); (2) the forehead (area bounded laterally by the hairlines, inferiorly by a horizontal line at the top of the brows, and superiorly by a line at the original hairline); (3) the superior perioral area (area bounded laterally by lines from the corner of the mouth to the lateral nasolabial fold, superiorly by a horizontal line below the nose, and inferiorly by the vermilion border of the lips); and (4) the right cheek (area bounded superiorly by the zygomatic arch, laterally by the hairline, medially by the line from the corner of the mouth to the nasolabial fold, and inferiorly by the mandible). The number of wrinkles in each area was recorded, as well as the depth (shallow, medium, or deep) and length (in centimeters) of each wrinkle. Shallow wrinkles were weighted 1, medium wrinkles 1.5, and deep wrinkles 2. A facial wrinkle score was calculated by multiplying the weighted depth by the length of each wrinkle and adding these scores for all wrinkles within three of the four facial areas: the crow's-foot, forehead, and perioral areas. The cheek measure was not included in the wrinkle score because it proved impossible to judge wrinkle number and length for individuals who had wrinkles that formed a diffuse cobblestone pattern on the cheek. The intraclass correlation coefficient for the facial wrinkle score determined independently by the three research associates on the same set of 20 pilot test subjects was .92. The research associate also assigned an overall facial wrinkle category to each subject: none (essentially no wrinkles), mild (no more than two shallow wrinkles in any of the four facial areas), moderate (more than two shallow wrinkles but less than two medium wrinkles in any of the four areas), and severe (more than two medium wrinkles or any deep wrinkles in any of the four areas). The research associates also took standardized photographs of the study participants' faces. The results of blinded evaluation of the photographs were generally consistent with those based on the clinical examination, and only the latter are reported here.

At the end of the clinical examination, but before having the study subject complete the questionnaire that elicited smoking history information, the research associate recorded her best guess as to the smoking status of the subject. We later examined the agreement between re-

sponses to this item and the actual smoking status of the subjects and found poor agreement between the two measures (κ of 0.22); in other words, the research associates appeared to be unaware of the smoking status of the subjects at the time they performed the clinical assessments.

Current smoking status and smoking history were assessed by self-administered questionnaire and interview. Never smokers were defined as those who answered no to the question "Have you smoked at least 100 cigarettes in your entire life?" or the question "Have you ever smoked one or more cigarettes per day on a daily basis?" Current smokers were defined as those who answered yes to both questions and had smoked within the past 6 months. Former smokers were those who answered yes to both questions but had last smoked more than 6 months previously. Pack-years of smoking (average number of packs per day multiplied by years smoked) were calculated for each current and former smoker.

Subjects were also questioned about time spent in the sun in summer and winter during various periods in their lives (ages 6-14, 15-18, 19-22, and by decade thereafter). Average sun exposure per year was then calculated by dividing the total duration of exposure by the number of years of exposure since age 6, with winter exposure time weighted at two thirds of summer exposure time. Alcohol consumption was self-reported as average number of drinks (beer, wine, or hard liquor) consumed per day during the previous 12 months. Current body height and weight were measured and body mass index was calculated as weight in kilograms/height in meters squared.

Cigarette smoking, as the main predictor variable, was analyzed both as a categorical variable (never smoker, former smoker, or current smoker) and as a continuous variable (pack-years). Facial wrinkling, the outcome of interest, was also assessed both as a dichotomous variable (none or mild vs moderate or severe wrinkling) and as a continuous variable (facial wrinkle score). Separate analyses were performed for men and women. To calculate odds ratios, we used logistic regression modeling with presence of moderate or severe wrinkling as the outcome. We also used linear regression to calculate beta coefficients for the association of pack-years of smoking with facial wrinkle score. All analyses were performed with Statistical Analysis Software (SAS Inc, Cary, NC).

TABLE 1—Number of Study Subjects (n = 1136) by Sex, Age, and Smoking Status

	Smoking Status		
	Never	Former	Current
Men			
30-39 y	37	40	29
40-49 y	34	73	37
50-59 y	39	70	29
60-69 y	38	86	41
Women			
30-39 y	35	55	29
40-49 y	37	74	37
50-59 y	38	71	40
60-69 y	41	82	44
Total	299	551	286

Results

Table 1 shows the distribution of study subjects by sex, age, and smoking status. As noted, our sampling strategy was designed so that greater numbers of former smokers than current or never smokers would be included. The 1136 participants represented 54% of the eligible men and women identified through the Kaiser multiphasic examination patient rosters who were invited to participate.

The two primary outcome variables, the presence of moderate or severe wrinkling and the facial wrinkle score, were strongly associated. In all age groups, men and women in the wrinkle categories "none" or "mild" had much lower facial wrinkle scores than those in the "moderate" or "severe" categories (data not shown but available upon request). Facial wrinkle scores were uniformly low in the age group 30 through 39 years; only 2 of the 102 women and 3 of the 111 men in that age group had moderate wrinkling, and there were no individuals with severe wrinkling. Therefore, subsequent analyses are confined to individuals aged 40 years and older: 227 never smokers, 456 former smokers, and 228 current smokers.

The proportions of individuals who had moderate or severe wrinkling are shown in Figure 1 by smoking status, pack-years of smoking, sex, and age. Across age and sex groups, a higher proportion of current smokers than never smokers had moderate or severe wrinkling, with the exception of men aged 60 through 69 years, but there was not a consistent pattern for former smokers

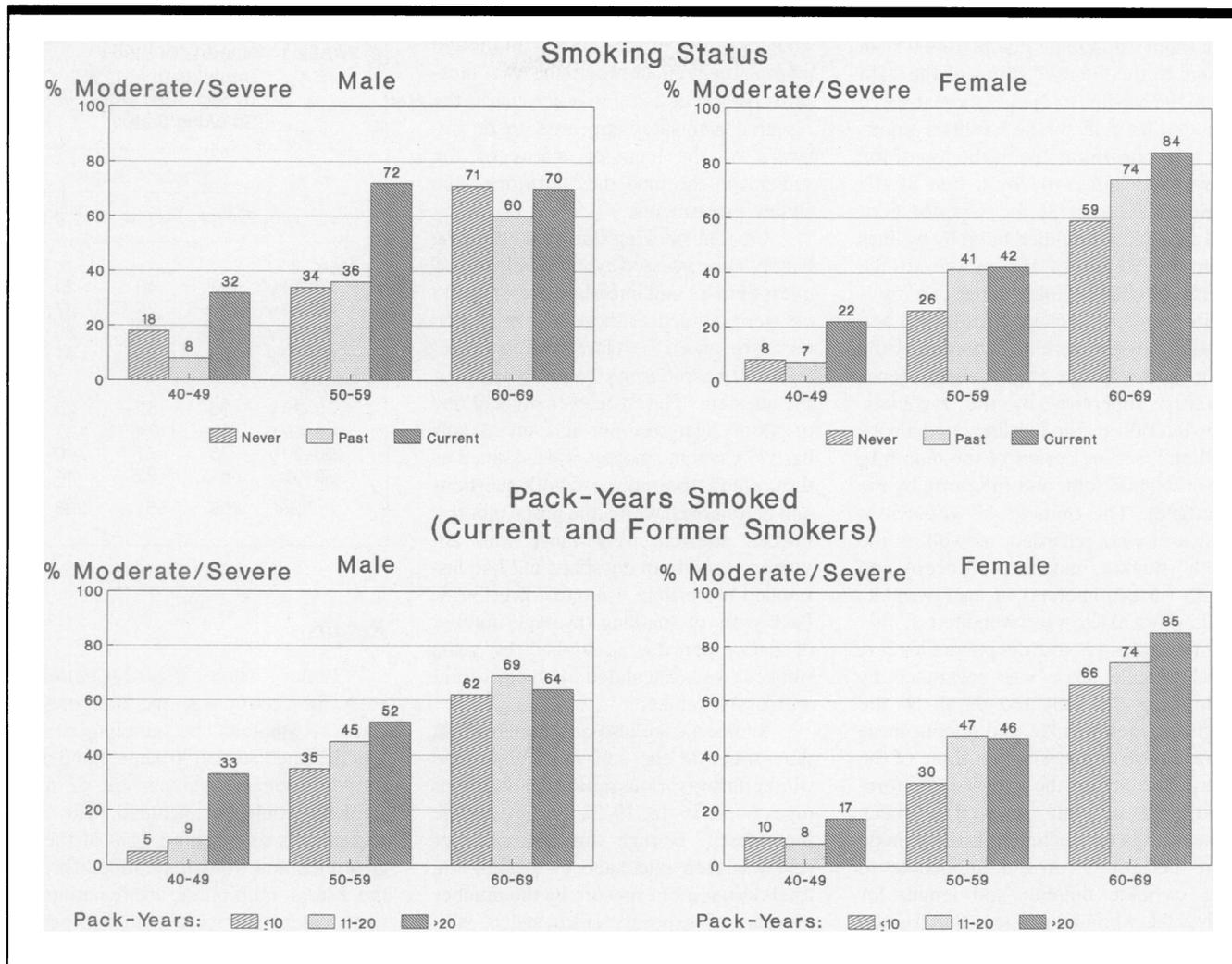


FIGURE 1—Percentage of subjects with moderate/severe facial wrinkling, by age, sex, smoking status, and pack-years of smoking.

relative to current or never smokers. Among ever smokers (current and former smokers combined), individuals with more than 20 pack-years of exposure were more likely to be classified in the moderate or severe wrinkling category than those with 10 or fewer pack-years of exposure, but there was not a consistent dose-response gradient between pack-years of smoking and wrinkle category. When we examined the relationship between the smoking variables and facial wrinkle score (data not shown), we also found higher scores for current smokers than for never smokers, again with the exception of men aged 60 through 69 years, and no consistent pattern for former smokers. There was no strong or consistent dose-response gradient across age and sex groups between pack-years of smoking and wrinkle score.

In analyses adjusted only for age, the estimated relative risk (odds ratio, OR) of

moderate or severe wrinkling associated with being a current smoker was 2.3 (95% confidence interval [CI] = 1.2, 4.2) for men and 2.9 (95% CI = 1.6, 5.5) for women. The estimated relative risk associated with more than 20 pack-years of exposure compared with never smokers was 1.4 (95% CI = 0.8, 2.3) for men and 2.9 (95% CI = 1.6, 5.2) for women (Table 2). In men, there was no increase in risk for former smokers or those with 20 or fewer pack-years of smoking. In women, the odds ratios for former smokers and for those with 11 to 20 pack-years of smoking were elevated, although of marginal significance (for former smokers, OR = 1.8, 95% CI = 1.0, 3.1; for those with 11 to 20 pack-years, OR = 2.0, 95% CI = 0.9, 3.9). We also examined the effect of several potential confounding variables on facial wrinkling, again adjusting only for age. Average daily sun exposure of 2 hours or

more was associated with an increased risk of wrinkling in both men and women, and higher body mass index categories were associated with lower risk. There was no statistically significant effect on risk of moderate or severe wrinkling of alcohol consumption within the past 12 months.

The results of two multivariate models, for men and women separately, are shown in Table 3. In the first model, the smoking variable included is smoking status (never, former, or current smoker); in the second, it is pack-years of smoking. Both models include age, average sun exposure, and body mass index. As expected, of all the variables entered in the two models, age was the strongest independent predictor of facial wrinkle category. Average daily sun exposure was positively associated with facial wrinkling in women but not consistently or significantly in

men, while body mass index was inversely associated with facial wrinkling in both sexes. With respect to the independent effect of smoking status, we found that in both men and women, current smokers had elevated risks of moderate or severe facial wrinkling compared with never smokers (for men, OR = 2.3, 95% CI = 1.2, 4.2; for women, OR = 3.1, 95% CI = 1.6, 5.9). In women, but not in men, there was a marginally significant increased risk for former smokers as well (OR = 1.8, 95% CI = 1.0, 3.1). With respect to amount smoked, an interaction between age and pack-years was found for men; examination of the data showed that the relationship between pack-years and wrinkling was different in men aged 60 through 69 years than in the younger two age groups, and so the second model for men is confined to those aged 40 through 59 years. In both sexes, a significantly increased risk of wrinkling was associated with more than 20 pack-years of smoking (for men, OR = 2.8, 95% CI = 1.4, 6.0; for women, OR = 3.2, 95% CI = 1.8, 6.0).

We also performed multiple regression analyses of the relationship of pack-years of smoking to facial wrinkle score, controlling for age, average sun exposure, and body mass index, all treated as continuous variables, in men aged 40 through 59 and women aged 40 through 69. As shown in Table 4, pack-years showed a significant independent positive association with facial wrinkle score in both men and women. In both sexes, 10 pack-years of smoking was equivalent to about 1.4 years of aging.

Discussion

We found that current smoking increased risk for facial wrinkling two to threefold among White men and women, with the exception of men aged 60 through 69 years. These results are in agreement with other studies, although the degree of increased wrinkling among smokers in our study is less than that reported elsewhere.⁵⁻⁷

The strengths of our study include the use of trained examiners and standardized techniques to evaluate facial wrinkles. As noted, we attempted to minimize examiners' awareness of subjects' smoking status, and the data suggest that examiners were generally blind; we cannot, however, entirely rule out the possibility of examiner bias. The study was large enough to examine the association of smoking and facial wrinkling in men and

TABLE 2—Odds Ratios for Moderate or Severe Facial Wrinkling for Subjects Aged 40 through 69 Years, by Selected Risk Factors

Variable ^a	Men			Women		
	n	OR	95% CI	n	OR	95% CI
Age, y						
40-49	143	1.0	...	148	1.0	...
50-59	137	3.8	2.2, 6.5	149	5.0	2.7, 9.2
60-69	164	9.6	5.5, 16.5	166	22.2	11.9, 41.4
Smoking status						
Never smoker	110	1.0	...	116	1.0	...
Former smoker	228	0.8	0.5, 1.3	226	1.8	1.0, 3.1
Current smoker	106	2.3	1.2, 4.2	121	2.9	1.6, 5.5
Pack-years						
Never smoker	110	1.0	...	116	1.0	...
≤10	82	0.6	0.3, 1.3	114	1.3	0.7, 2.5
11-20	68	0.9	0.5, 1.8	76	2.0	0.9, 3.9
>20	183	1.4	0.8, 2.3	155	2.9	1.6, 5.2
Sun exposure						
<1 h/d	52	1.0	...	128	1.0	...
1-2 h/d	170	1.3	0.7, 2.7	210	1.4	0.8, 2.4
>2 h/d	222	2.0	1.0, 3.9	125	2.1	1.1, 3.8
Body mass index						
Lower third	144	1.0	...	153	1.0	...
Middle third	147	0.8	0.5, 1.3	155	0.7	0.4, 1.2
Upper third	152	0.6	0.4, 1.0	154	0.6	0.4, 1.1
Alcohol consumption						
Nondrinker	50	1.0	...	60	1.0	...
≤1 drink/wk	125	0.9	0.4, 1.9	201	0.7	0.4, 1.4
2 drinks/wk-1 drink/d	128	0.9	0.5, 1.9	116	0.6	0.3, 1.3
>1 drink/d	138	0.7	0.4, 1.5	82	0.7	0.3, 1.5

Note. OR = odds ratio; CI = confidence interval.

^aAll variables (except age) adjusted for age.

women by age, to evaluate current and former smokers separately, and to control for age, sun exposure, and body mass index.

Limitations of the study include the lack of biochemical verification of smoking status; the fact that several potential confounding factors—including fairness of skin and use of sunglasses, sunscreens, and other protective products—were not controlled; and the possibility of bias in sun exposure recall across wrinkle groups. We had originally proposed collecting blood for cotinine analysis to validate current smoking status, but the review group that approved our application for funding disallowed that procedure. Given that our data were collected in person in offices of the health maintenance organization that provides medical care to the study subjects, we expect that motivation to correctly report smoking status was high. Uncontrolled variables, such as use of sun protection products, may have played a role in our findings, but only if they are related both to smoking status and to wrinkling. We know of no evidence

that that is the case, and, because of the difficulty of accurately assessing lifetime exposure to those products, we decided not to quantitate them. Although we did not control for skin type, our analysis is confined to Whites. Again, we know of no evidence that among Whites skin type is related to smoking status. We did attempt to assess and adjust for lifetime sun exposure, but we cannot rule out the possibility that individuals in the more severe wrinkling categories and individuals with less wrinkling had differential recall of sun exposure.

The effect of smoking on facial wrinkling does not appear to become evident until middle age: facial wrinkling was rare among both smokers and never smokers aged 30 through 39 years. Women may be somewhat more sensitive to the effects of smoking on facial wrinkles than men. Among current smokers, the relative risks for wrinkling were higher in women than in men, and risk appeared to increase after 10 pack-years of smoking in women compared with 20 pack-years in men. In addition, male former smokers

TABLE 3—Adjusted Odds Ratios for Moderate or Severe Facial Wrinkling for Subjects Aged 40 through 69 Years, by Selected Risk Factors

	Men				Women			
	Aged 40–69 y, Multivariate Model 1		Aged 40–59 y, Multivariate Model 2 ^a		Aged 40–69 y, Multivariate Model 1		Aged 40–69 y, Multivariate Model 2	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Age, y								
40–49	1.0	...	1.0	...	1.0	...	1.0	...
50–59	4.3	2.4, 7.8	3.5	2.0, 6.3	5.3	2.8, 10.0	4.7	2.5, 8.9
60–69	11.4	6.4, 20.4	...	...	28.1	14.5, 54.5	25.8	13.4, 49.8
Smoking status								
Never smoker	1.0	...	...	...	1.0	...	...	...
Former smoker	0.8	0.5, 1.3	...	...	1.8	1.0, 3.1	...	...
Current smoker	2.3	1.2, 4.2	...	...	3.1	1.6, 5.9	...	...
Pack-years								
Nonsmoker	...	...	1.0	...	...	...	1.0	...
≤10	...	...	0.7	0.3, 1.7	...	...	1.2	0.6, 2.4
11–20	...	...	1.1	0.5, 2.7	...	...	2.0	0.9, 4.1
>20	...	...	2.8	1.4, 6.0	...	...	3.2	1.8, 6.0
Sun exposure								
<1 h/d	1.0	...	1.0	...	1.0	...	1.0	...
1–2 h/d	1.3	0.6, 2.6	0.9	0.3, 2.2	1.4	0.8, 2.4	1.5	0.8, 2.5
>2 h/d	2.0	0.9, 4.0	1.0	0.4, 2.5	2.2	1.2, 4.1	2.3	1.2, 4.3
Body mass index								
Lower third	1.0	...	1.0	...	1.0	...	1.0	...
Middle third	0.7	0.4, 1.3	0.6	0.3, 1.2	0.7	0.4, 1.3	0.7	0.4, 1.2
Upper third	0.6	0.3, 1.0	0.5	0.2, 0.9	0.6	0.4, 1.1	0.6	0.3, 0.99

Note. AOR = adjusted odds ratio; CI = confidence interval. The results shown for each of the four variables in each model are adjusted for the other three. The smoking variable in multivariate model 1 is smoking status (never/past/current). The smoking variable in multivariate model 2 is pack-years category.

^aBecause an interaction was found between age and pack-years among men, only men aged 40–59 years were included in the multivariate model that includes pack-years (model 2).

TABLE 4—Beta Coefficients from Multiple Regression Analyses of the Relationship of Age, Pack-Years, Average Sun Exposure, and Body Mass Index to Facial Wrinkle Score

	Men		Women	
	Aged 40–59 y		Aged 40–69 y	
	β	P ^a	β	P
Age (per 10 y)	17.2	<.001	12.6	<.001
Pack-years of smoking (per 10 pack-years)	2.5	.008	1.8	.006
Average sun exposure (per 100 h/y)	0.4	.298	0.4	.164
Body mass index (Wt/Ht ²) (per Wt/Ht ² unit)	-1.2	.002	-0.41	.040

^aP of test for coefficient β = 0.

had no increased risk for facial wrinkling, whereas risk was increased about twofold in female former smokers.

We can only speculate as to mechanisms that might be responsible for the relationship between cigarette smoking and facial wrinkling. If the effect is topical, it may be due to a drying or irritating effect of cigarette smoke on the

skin. Alternatively, the effect could be systemic. Multiple components of cigarette smoke are absorbed systemically and could cause vascular or connective tissue damage in the skin. Cigarette smoke has been shown to acutely decrease capillary and arteriolar blood flow in the skin,^{8,9} perhaps causing chronic ischemia of the dermis. In the lungs, cigarette smoke

damages collagen and elastin, connective tissue elements that are important to maintaining the integrity of the skin. It has been hypothesized that smoking may decrease levels of vitamin A, which may provide protection against oxygen radicals that damage DNA and connective tissue.¹⁰

We are not aware of any evidence that facial wrinkling per se is associated with morbidity or premature mortality. However, concerns about the increased risk of facial wrinkling might be more effective in convincing people not to start smoking than evidence of the more serious long-term health consequences of cigarette use. It is appropriate to include information about the possible increased risks of facial wrinkling associated with cigarette smoking in smoking prevention materials and programs. □

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