

# Improved Smoking Cessation in Smokers Given Ultrasound Photographs of Their Own Atherosclerotic Plaques<sup>1</sup>

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**Background.** We examined whether making smokers aware that they had developed peripheral atherosclerosis would improve smoking cessation.

**Methods.** Smokers selected from the general population were randomly allocated to undergo high-resolution B-mode ultrasonography of their carotid and femoral arteries. All smokers received quit-smoking counseling. Smokers with  $\geq 1$  atherosclerotic plaque were given two photographs of a plaque with a relevant explanation. Quit rates were assessed by telephone 6 months later.

**Results.** Seventy-nine smokers did not undergo ultrasonography (A). Among the 74 smokers submitted to ultrasonography, 20 had no plaque (B) and 54 had  $\geq 1$  plaque (C). Quit rates were, respectively, 6.3, 5.0, and 22.2% in groups A, B, and C. Quit rates were higher in smokers submitted to ultrasonography (B + C vs A;  $P = 0.031$ ) and in those receiving photographs (C vs A + B;  $P = 0.003$ ). Smoking cessation was independently associated with intervention C (OR = 6.2; 95% CI = 1.8–21) and a white-collar job but not with age or gender.

**Conclusions.** Providing smokers with photographs demonstrating atherosclerosis on their own person was an effective adjunct to physician's advice to quit smoking. Since ultrasonography is used increasingly

often in clinical practice for cardiovascular risk stratification, this can provide an additional opportunity and means to deter smokers from smoking. © 2002 American Health Foundation and Elsevier Science (USA)

**Key Words:** smoking cessation; ultrasonography; peripheral atherosclerosis; counseling.

## INTRODUCTION

The worldwide epidemic of tobacco-related disease and death continues to worsen as tobacco use spreads. Smoking causes approximately 30–40% of all deaths among the middle-aged population (35 to 69 years) and those killed by tobacco lose on average 20–25 years of the nonsmoker life expectancy [1]. Smoking cessation prevents tobacco-related diseases within a few years of cessation: it prevents the occurrence of disease and it reduces the risk of further disease [2–4].

Although about 70–80% of smokers want to quit and about one-third have made at least three serious smoking cessation attempts, less than half of smokers succeed in stopping permanently before the age of 60 [5]. Interventions against smoking are limited by nicotine dependence, which seems as powerfully addictive as heroin or cocaine [6], large social acceptance of this culturally ingrained habit, and the low recognition of this health hazard by the public, hindered by the tobacco industry's advertising and promotion [7]. Therefore, approaches to smoking cessation rely on public health interventions to strengthen smokers' motivation to quit (e.g., health education, policies to control tobacco products) and individual-centered activities to reduce dependence-related difficulties for smokers to quit (behavioral and pharmacological treatment) [5,8].

In this study, we examined, for the first time to our

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knowledge, whether smokers receiving ultrasound photographs of their own atherosclerotic plaques, together with a relevant explanation, would quit smoking more often than smokers receiving quit-smoking counseling alone. Provided this intervention is effective, and considering that arterial ultrasonography is used increasingly often in medical practice, this might generate an additional opportunity and means for the prevention of tobacco-related diseases in clinical practice.

## METHODS

The Seychelles islands lie in the Indian Ocean, approximately 1800 km east of Kenya and 1800 km north-east of the island of Mauritius. The total population was 74,331 in 1994, with 90% living on the main island, Mahé. Around two-thirds of the population are of predominantly black descent. The gross domestic product per capita has increased from US\$600 in 1976 to US\$5,850 in 1994. Among the population aged 25–64 years, 53.8% of men and 10.1% of women reported regular smoking in 1989 [9]. These figures were, respectively, 37.0 and 8.4% in a survey in 1994 conducted a few months after the retail price of cigarettes increased substantially [10].

Data for this study came from the Seychelles Heart Study II, a community-based cross-sectional survey conducted in 1994 to assess cardiovascular risk factors in the general population. The study protocol had been approved by the Ministry of Health. Detailed methods and general findings have been published elsewhere [10]. Briefly, a random age- and sex-stratified sample was drawn out of the entire population of Mahé aged 25–64 years. From the 1226 eligible subjects invited by a personalized letter to attend the survey, 1067 participated (504 men and 563 women), an overall attendance rate of 87%. A structured questionnaire was administered to all participants through a face-to-face interview. Regular cigarette smoking was defined for persons reporting to currently smoke at least one cigarette per day during the previous week. High-resolution B-mode ultrasonography of the right and left carotid and femoral arteries was also performed. Ultrasonography was, however, submitted to only half of all participants due to time constraints. Patients submitted to ultrasonography were randomly selected by matching preestablished random sequences of numbers to numbers corresponding to the rank of arrival of the participants to the study center.

High-resolution B-mode ultrasonography was performed by one examiner (FPe) who followed a standard measurement protocol and was kept uninformed of the cardiovascular risk factor status of the subjects investigated. Details on the procedure used in this study and its reproducibility have been published elsewhere [10,11]. Briefly, an echocardiographic system equipped

with a mechanical 7.5-MHz annular phased array probe was used (Vingmed CFM 800C, Horten, Norway). Scans of the carotid arteries included the common part from the base of the neck, the bifurcation, and the first 2 cm of the internal and external branches. Scans of the femoral arteries included the common part from the groin, the bifurcation, and the first 2 cm of the superficial and deep branches. The largest identified lesion was imaged in longitudinal and transversal views and two photographs were printed (longitudinal and transversal views). A plaque was defined as a visually identifiable focal wall thickening of 1 mm or more according to previously published recommendations [12].

A smoking cessation intervention was administered to the last consecutive 155 participants to the Seychelles Heart Study who reported current regular smoking. In line with the above-mentioned survey, around half of the smokers were randomly allocated to undergo ultrasonography of their left and right carotid and femoral arteries. Smokers undergoing ultrasonography who were found to have one or more atherosclerotic plaques received two photographs of one of their plaques together with an approximately 5-min relevant explanation on the general significance of plaques and their impact on health. Hence, three groups of smokers could be considered: smokers not randomized to ultrasonography and not shown a plaque (group A); smokers randomized to ultrasonography with no plaque identified, hence not shown a plaque (group B); and smokers randomized to ultrasonography with at least one plaque identified, hence shown a plaque (group C). Smokers in all three groups received 10-min quit-smoking counseling by a physician based on a published leaflet on smoking cessation [13]. One-week smoking abstinence was assessed 6 months later by telephone by one nurse who had experience in surveys, had not participated in the initial survey, and was blind to the baseline number of cigarettes smoking by the study subjects and the subjects' group assignment. Two persons could not be traced so this study includes 153 smokers (99% follow-up information).

Differences in proportion rates and means across categories were tested using Fisher's exact test and ANOVA, respectively. Differences in estimates were tested by comparing (a) the smokers not allocated to ultrasonography vs the smokers allocated to ultrasonography (A vs B + C) and, in a post hoc analysis, (b) the smokers not shown to have a plaque vs the smokers shown to have a plaque (A + B vs C). Exact binomial 95% confidence intervals of quit rates were calculated. Associations between selected variables and quit-smoking rates were examined with univariate and multivariate logistic regression. Two-tailed *P* values less than 0.05 were considered significant. Analyses were performed with Stata for Windows, version 5.0 (Stata Corporation, College Station, TX).

## RESULTS

Among the 153 smokers included in this study, 79 were randomly allocated to smoking cessation counseling and 74 to this intervention combined with an ultrasonography. Among those submitted to ultrasonography, 20 had no demonstrated plaque and 54 had at least one demonstrated plaque. Selected baseline characteristics among intervention groups are displayed in Table 1. Age differed across intervention groups with persons without demonstrated plaques being younger than persons with demonstrated plaques. Gender and job categories were not distributed differently across groups. The average number of cigarettes smoked per day was fairly low in all groups (10–12 cigarettes/day) and only 10% of smokers smoked at least 20 cigarettes per day. In all groups, large proportions of smokers were aware of the detrimental effect of their smoking on health, expressed the wish to reduce smoking, reported previous attempt to reduce smoking, and had visited a doctor over the previous year.

Six months after the interventions, the proportions of quitters among the three groups were, respectively, 6.3% (95% CI: 2.1–14.1) in group A, 5.0% (0.1–24.8) in group B, and 22.2% (12.0–35.5) in group C (Table 2). The average quit rate was higher in smokers randomized to ultrasonography (among whom 73% were shown a photograph of a plaque) compared to those who did not undergo ultrasonography (among whom 0% were shown a photograph of a plaque), respectively, 17.6 and 6.3% ( $P = 0.031$ ). In a post hoc analysis, the average quit rate was higher in the 54 smokers who were shown a photograph of a plaque compared to the 99 smokers who were not, respectively, 22.2 and 6.1% ( $P = 0.003$ ). These findings suggest that showing photographs of their own plaques to smokers results in a substantially higher quit rate at 6 months. Smokers in group C also

tended to have a larger decrease in the average number of cigarettes smoked per day but this difference was less apparent when quitters were excluded in the analysis.

Multivariate logistic regression on smoking habits (yes/no) indicated that smoking cessation was independently associated with intervention C (OR = 6.2; 95% CI = 1.8–21) and a white-collar job (3.5; 1.1–11) but not with age and sex (Table 3). There was a nonsignificant trend for quit rates to decrease with older age categories.

## DISCUSSION

This study strongly suggests that providing smokers with photographs of ultrasonic images demonstrating their own atherosclerotic lesions together with relevant explanation resulted in a higher quit rate at 6 months compared to providing counseling only (22% vs 6%). Noticeably, no selection was carried out to preferably include smokers with optimal readiness to quit and no complementary interventions (e.g., nicotine replacement therapy, stop smoking classes, follow-up telephone calls) were arranged to reinforce or potentate the initial intervention. The absence of preselection of smokers would tend to enhance the generalizability and applicability of the findings. On the other hand, quit rates found in this study for smokers receiving only physician's counseling (5–6%) are consistent with rates of 5–6% at 12 months following general practitioners' advice [3,14,15] or a net effect of 3% in a meta-analysis of simple physician advice for smoking cessation [16].

The 22% quit rate found for smokers provided with a picture of their own plaques compares with rates found for secondary prevention interventions. For example, consolidated quit rates were 14–20% after hospitalization to medical and surgical services [17,18], 25–36% after admission for myocardial infarction [19],

TABLE 1

Baseline Characteristics of Smokers Across Intervention Groups

	No ultrasonography (A)	Ultrasonography		<i>P</i> value
		No plaques (B)	Plaques (C)	
Number of persons ( <i>n</i> )	79	20	54	—
General variables and cigarette consumption				
Mean age (years, SD)	45.7 ± 10.4	39.2 ± 10.1	48.9 ± 9.7	0.002
Men (%)	86.3	80.0	85.2	0.793
White-collar job (%)	29.1	20.0	14.8	0.160
Cigarettes per day ( <i>n</i> )	11.7 ± 10.6	10.5 ± 6.7	12.8 ± 10.4	0.668
Knowledge, attitudes, and practices on smoking and health				
Believed that smoking is very detrimental to health (%)	55.0	75.0	51.8	0.190
Wished to reduce smoking (%)	93.7	94.8	96.2	0.799
Tried to reduce smoking over past 12 months (%)	73.7	78.9	75.9	0.820
Reported smoking reduction over past 12 months (%)	45.0	47.3	53.7	0.723
Visited a doctor at least once over past 12 months (%)	78.1	95.0	90.7	0.040
Number of medical visits over past 12 months (%)	3.6 ± 3.7	1.8 ± 1.0	4.5 ± 5.1	0.044

**TABLE 2**  
Smoking Habits 6 Months after Intervention

	No ultrasonography, no plaque shown (A)	Ultrasonography		<i>P</i> value	
		No plaque shown (B)	Plaque shown (C)	(A vs B + C)	(A + B vs C)
Number of persons	79	20	54	—	—
Follow-up (days)	192 ± 13.0	192 ± 10	190 ± 17	0.717	0.758
Cigarettes per day ( <i>n</i> )	11.3 ± 8.8	9.8 ± 5.9	9.4 ± 8.1	0.783	0.448
Difference in cigarettes per day after vs before intervention	-0.44 ± 10.3	-0.70 ± 4.74	-3.41 ± 10.0	0.156	0.071
Difference in cigarettes per day ex- cluding quitters	-0.80 ± 8.85	0.21 ± 4.31	1.21 ± 9.70	0.123	0.120
Quit-smoking rate (%)	6.3	5.0	22.2	0.031	0.003

and 51% after coronary artery bypass graft surgery [20]. This is likely to relate to increased motivation in smokers who no longer perceive smoking as a hypothetical and remote hazard but as a cause of a current health problem. Awareness of a health hazard that can be prevented is believed to be an important determinant of behavior change [21].

The efficacy of interventions for smoking cessation has also been related to stage of readiness to change. In this respect, low efficacy of interventions among unselected smokers has been attributed to the fact that a majority of smokers (up to 80%) may be in early stages of change (e.g., "precontemplation" where smokers are not thinking about quitting or "contemplation" where they are just thinking about it) [22,23]. Demonstrating atherosclerotic plaques to smokers could facilitate the transition from the "early" stages to the "action" stages. Further studies should demonstrate if increased awareness of a health hazard (such as the presence of artery plaques) facilitates progression along stages of change

(including adherence to the last stage of "maintenance" of the newly adopted behavior). The efficacy of the intervention examined in this study should also be examined in other populations, as large cultural differences in smoking-related behaviors have been described [24].

Few randomized controlled trials of smoking cessation have included clinical tests showing health consequences of smoking [25-29]. Among three controlled trials assessing both spirometry and physician counseling [25-27], two showed increased smoking cessation related to spirometry results [25,27] whereas one did not [26]. Three noncontrolled trials assessing the efficacy of spirometry for motivating cessation among selected smokers showed a 12-month quit rate of 18 to 29% [30-32]. Making smokers aware of expired air carbon monoxide did not seem more effective than a minimal intervention [28]. An intervention based on both spirometry and carbon monoxide resulted in a larger cessation rate at 12 months of follow-up (40% vs 12%)

**TABLE 3**  
Association of Smoking Status with Intervention Type and Selected Variables

	<i>N</i>	Quitters <i>N</i> (%)	Univariate		Multivariate	
			OR	95% CI	OR	95% CI
<b>Intervention</b>						
Group A (no ultrasonography)	79	5 (6.3)	1	1	1	1
Group B (ultrasonography, no plaque shown)	20	1 (5.0)	0.77	0.08-7.06	0.76	0.07-7.27
Group C (ultrasonography, plaque shown)	54	12 (22.2)	4.22	1.39-12.8	6.19	1.83-21.0
<b>Gender</b>						
Women	23	4 (17.4)	1	1	1	1
Men	130	14 (10.8)	0.57	0.17-1.92	0.65	0.16-2.46
<b>Age (years)</b>						
25-34	30	4 (13.3)	1	1	1	1
35-44	29	3 (10.3)	0.75	0.15-3.68	0.57	0.10-3.11
45-54	55	7 (12.7)	0.95	0.25-3.54	0.54	0.13-2.39
55-64	39	4 (10.3)	0.74	0.17-3.24	0.47	0.10-3.35
<b>Job</b>						
Blue collar	35	7 (20.0)	1	1	1	1
White collar	118	11 (9.3)	2.43	0.86-6.84	3.46	1.05-11.4

compared to a simple education program performed by nurse practitioners [29].

Professional attainment was associated with smoking cessation in our study. This relation is consistent with other cessation approaches which were more effective in persons of higher socioeconomic status [33,34]. This may relate to better understanding of the hazard of smoking, higher self-efficacy, or larger compliance to social norms (which presently often advocate a smoke-free society) which all are established determinants of behavior change [21,35]. Gender was not associated with quit rate. Noticeably, the number of cigarettes smoked per day, which is known to relate inversely with cessation [34], was fairly low in our study, consistent with consumption figures in the general population in the Seychelles [9,10].

Our study protocol did not include a biochemical verification of self-reported cessation. Self-reports may be inaccurate because of imprecision of recall or socially desirable answers. However, such biases are unlikely to occur differentially across interventions groups and should therefore not substantially alter the observed differences in cessation rates among groups. Furthermore, the high follow-up rate and the fact that the investigator assessing smoking rates at 6 months was blind to baseline cigarette consumption are strengths of this study. The quit rate in our study may be overoptimistic due to the relatively short follow-up used to assess consolidated behavior change. However, a 6-month follow-up, as that used in our study, has been considered sufficient for this type of research [15].

It is noticeable that most smoker-centered cessation strategies (e.g., utilization of self-help material, participation to quit smoking classes) employ a reactive recruitment whereby smokers decide themselves whether to participate by contacting a provider of services. Recruitment rates for such reactive interventions have been often disappointingly low [36] and samples were generally predominantly female, better educated [37], and ready to change [38]. In contrast, making smokers aware of their own plaques does not necessitate a smoker's prior decision to quit smoking and this is not limited to treatment-seeking smokers (likely to be more prone to cessation [37,39]). The proactive recruitment strategy in this study implies that a large proportion of smokers in the general population could potentially benefit from this intervention, as most smokers regularly visit a doctor (85% of smokers visited a doctor over the past 12 months in our study) and as plaques can be demonstrated in a large proportion of them (two-thirds of all smokers in our study).

Noninvasive B-mode peripheral arterial ultrasonography is being used increasingly often in clinical practice to assess a patient's cardiovascular risk since the presence of plaques on peripheral arteries predicts the occurrence of subsequent cardiovascular events [40].

Our finding that providing ultrasonography pictures of their plaques to smokers with relevant advice substantially improves subsequent quit rate could therefore have concrete clinical relevance. If a substantial effect on cessation is confirmed in other studies, this intervention could be cost-effective in view of the high prevalence of peripheral plaques in middle-aged smokers and the low cost of the intervention (semi-quantitative assessment of carotid atherosclerosis by ultrasonography can take as little as 5 min and cost less than US\$40 [e.g., Switzerland]). Alternatively, research should examine to what extent making smokers aware of negative findings (e.g., absence of plaques) could decrease cessation as these smokers could perceive less of a reason to quit. Further research should also examine how this intervention could be potentiated with concomitant other approaches such as nicotine replacement therapy [41], bupropion hydrochloride [42], or tailored self-help material [43,44]. In the meantime, the opportunity of showing photographs of their plaques to smokers, together with a relevant explanation, should not be missed when smokers undergo peripheral arterial ultrasonography for currently established indications.

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