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Reduction of Quantity Smoked Predicts Future Cessation Among Older Smokers

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## ABSTRACT

**Aim:** To examine whether smokers who reduce their quantity of cigarettes smoked between two periods are more or less likely to quit subsequently.

**Study Design:** Data come from the Health and Retirement Study, a nationally representative survey of older Americans aged 51-61 in 1991 followed every 2 years from 1992 to 1998. The 2,064 participants smoking at baseline and the first follow-up comprise the main sample.

**Measurements:** Smoking cessation by 1996 is examined as the primary outcome. A secondary outcome is relapse by 1998. Spontaneous changes in smoking quantity between the first two waves make up the key predictor variables. Control variables include gender, age, education, race, marital status, alcohol use, psychiatric problems, acute or chronic health problems, and smoking quantity.

**Findings:** Large (over 50%) and even moderate (25-50%) reductions in quantity smoked between 1992 and 1994 prospectively predict increased likelihood of cessation in 1996 compared to no change in quantity (OR 2.96,  $p < .001$  and OR 1.61,  $p < .01$  respectively). Additionally, those who reduced and then quit were somewhat less likely to relapse by 1998 than those who did not reduce in the two years prior to quitting.

**Conclusions:** Successfully reducing the quantity of cigarettes smoked appears to have a beneficial effect on future cessation likelihood, even after controlling for initial smoking level and other variables known to impact smoking cessation. These results indicate that the harm reduction strategy of reduced smoking warrants further study.

**Keywords:** Reduced Smoking, Smoking Cessation, Cigarette Fading, Tobacco Use, Health and Retirement Study, Longitudinal Study

## INTRODUCTION

Harm reduction strategies are potentially important new methods for combating harms related to tobacco use. However, since these strategies remain largely untested, the public health and medical communities have approached them with understandable caution. At the same time, approaches such as reduced or controlled smoking may be necessary for recalcitrant smokers who have faced years of failed quit attempts or simply lack the motivation to attempt to quit “cold turkey”. Reduced smoking or cigarette fading, a reduction in the usual amount of cigarettes smoked per day, can be seen as one type of potential harm reduction strategy. A systematic mapping of harm reduction strategies and the state of the science on each can be found in a recent review article (1).

The term “harm reduction” encompasses a vast array of methods designed to reduce the harms caused by tobacco use, including “potential reduced-exposure products” or PREPs, nicotine replacement therapy or other pharmaceutical agents for reduced or controlled smoking, and reduced or controlled smoking itself. Interestingly, reduced smoking, nicotine fading, or brand switching have also been proposed and studied as treatment methods for achieving cessation, and not necessarily as goals in and of themselves.

The objective of this paper is to evaluate whether reductions in number of cigarettes smoked are associated with increased likelihood of future cessation and ultimately continued abstinence. The study evaluates whether reductions are equally effective for different types of smokers, as measured by the level of smoking at baseline. This study uses data from the Health and Retirement Study, a nationally representative longitudinal survey of older Americans. The sample contains 2,064 smokers who smoked at the first two waves of the study. This sample of

smokers is large compared to that used in other samples, over thirty percent more smokers than used in prior studies.

## **BACKGROUND**

As Hughes points out, research in the area of reduced smoking has concentrated on several important questions: (1) Can smokers reduce and maintain a reduction?; (2) Does compensatory smoking, the process of adjusting the level of nicotine to achieve constant levels, eliminate any benefit from reduced smoking?; (3) Does reduction actually lower smoking related disease?; and, (4) Is reduced smoking an alternative or a gateway to smoking cessation? (2). Evidence from prior studies suggests that smokers are able to reduce and maintain reductions for significant amounts of time (3-8). Additionally, relapsers often return to levels lower than their previous levels and maintain their reduction for some time (9-11). On the issue of compensation, there is less evidence, although it appears that while some compensation occurs, significant reductions in toxins still remain (5-8, 11). Findings regarding risk reduction from lower smoking levels are inconsistent and more controversial. While it appears that morbidity and mortality from smoking have dose response relationships, these relationships have only been shown in cross-sectional analyses (12, 13). As of yet, no suitable biochemical marker has been found that could validate reduced toxicity, leaving only the option of very lengthy longitudinal studies to determine the relationships (14).

Arguably, if in fact reduction is feasible and does promote cessation, resolving the questions of compensatory smoking and risk reduction is less essential. That is, reduced smoking could simply be a pathway to abstinence and therefore substitution effects and the intermediate impacts are not very important. In theory, reduced smoking could lower

dependence and improve self-efficacy making cessation more likely. On the other hand, smokers may see less of a need for total abstinence if controlled smoking is seen as a “safer” alternative to heavier smoking, thus undermining cessation. Even if cessation is not undermined, it might be the case that those who quit by reducing first are more prone to future relapse since they feel ‘in control’ of their smoking. For this reason, both short and long-term smoking abstinence should be evaluated.

Several small clinical studies have attempted to study reduced smoking or nicotine fading as a method of smoking cessation (15-22). These studies have been limited by sample size, and typically look only at populations interested in quitting. Generally reductions are found to be effective in promoting eventual abstinence, however most studies combine scheduled reduction with other behavioral approaches and typically do not have suitable control groups (15, 18, 20-22). Little has been made of these findings in practice as witnessed by the lack of any discussion in the Clinical Practice Guidelines (23).

Two recent population-based studies of self-motivated reduction and quitting most similar to this one conclude that smoking reduction does not impede cessation, but they present only limited support for the idea that reduction may actually *promote* subsequent cessation. One study uses data from the Community Intervention Trial for Smoking Cessation (COMMIT), and although it finds that a substantial number of smokers are able to reduce their smoking and maintain the lower level for long periods of time, even reductions of over 50 percent do not promote cessation in a multivariate analysis (4). A second uses data from the California Tobacco Survey (CTS), and finds that significant reductions (over two-thirds) lead to increased cessation (3). Results for smaller reductions were unclear. However, because the CTS data consisted of only one follow-up, initial reductions in smoking were measured retrospectively and may

therefore be subject to recall bias. Given the much lower likelihood of reduction reported here compared to the COMITT data (16% versus 40%), this recall bias may be important.

Additionally, this study looks only at Californians, a group not representative of the nation when it comes to smoking behavior (24, 25).

## **METHODS**

**Data:** The data for this study come from the Health and Retirement Study (HRS) conducted at the University of Michigan. The HRS is a nationally representative sample of individuals born between 1931 and 1941 and their spouses (regardless of age-eligibility). Beginning in 1992, 12,652 individuals from 7,702 households were surveyed in face-to-face interviews. Mexican-Americans, Blacks and residents of Florida were oversampled. The survey contains extensive information on individual's health behaviors, health and functional status, including self-reports of more objective disease diagnosis on both individuals and their spouses. More information on the HRS has been published elsewhere (26).

**Sample:** Subjects with valid information for all relevant variables for the first four waves were included in the sample. Of 12,652 individuals interviewed at wave 1, 11,594 (92%) remained at wave 2, 10,962 (94%) remained at wave 3, and 9,989 (91%) remained at wave 4, equivalent to 79% of the wave 1 sample. An additional 508 observations (5%) were dropped due to missing data. Of those remaining at wave 4, 2,064 individuals were included who reported smoking at both wave 1 and wave 2 (21.7%). No significant changes in results occurred when the sample inclusion criterion was limited to presence at wave 3 (as opposed to wave 4). For consistency, analysis is limited to the sample present at all four waves.

**Measures:**

Cessation: The primary outcome variable is abstinence at wave 3. This is measured in the 1996 survey with the question “Do you now currently smoke cigarettes?”. The secondary outcome is continued abstinence at wave 4 (1998).

Smoking Reduction: The key predictor variable is the reduction or increase in the amount of cigarettes smoked per day between the 1992 and 1994 interviews. This is defined based on the question asked to those who reported currently smoking in both 1992 and 1994, “How many cigarettes do you currently smoke per day on average?” Three measures of change are used: a dichotomous measure of any reduction (reduced versus no change or increase), categorical percentage changes (greater than 50% decrease, 25-50% decrease, 1-25% decrease, no change, 1-50% increase, and greater than 50% increase), and actual percentage change (with a negative value indicating a reduction, and a positive value an increase).

Control Variables: Several variables that have been found to be important predictors of cessation in other research are included in the analysis. These include gender, age (in years), race (black, Hispanic origin, all others omitted), education (in years), marital status, psychiatric history, moderate to heavy alcohol use, acute health problems, chronic health problems, and number of cigarettes smoked at baseline. For some analyses, categorical measures for light, moderate and heavy smoker are used. Light smokers are defined as smoking less than 15 cigarettes per day, moderate between 15 and 25 per day, and heavy more than 25 per day. Psychiatric history at baseline is assessed with the question “Has a doctor ever told you that you had emotional, nervous, or psychiatric problems?” A dummy for moderate or heavy alcohol use is defined as reporting more than 2 drinks per day. This is assessed with the question “In general, do you have less than one drink a day, one to two drinks a day, three or four drinks a day, or five or more drinks a day?” A history of acute and chronic health problems is recorded at wave 2 and wave 3

through self-reports of physician diagnosis. Acute health problems considered are heart attacks, strokes, or cancers. Chronic health problems considered are chronic heart failure, chronic lung disease, diabetes, or heart disease. Binary variables indicate the history of acute and chronic conditions separately.

**Analyses:** Between waves 1 and 2, bivariate relationships between the direction of change in smoking and each of the control variables is assessed using ANOVA procedures to describe the likelihood of a reduction in smoking, no change in smoking, or increase in smoking. Tukey tests of mean differences are reported.

The relationships between cessation and changes in smoking quantity are assessed using unadjusted and adjusted logistic regression to compare the likelihood of cessation in 1996 for those in the six change categories (three decrease, no change, and two increase), using no change as the reference group. Similar regressions are run for smoking status at wave 4 (1998) for those individuals who were abstinent at wave 3 (1996) to test if earlier reduced smoking is associated with higher relapse rates.

To evaluate if these effects are significantly different for smokers depending on the baseline level of smoking, logistic regressions are conducted using an interaction of baseline quantity smoked and each of the percentage change categories.

Finally, the fit of a model based solely on the continuous measure of percentage change and initial quantity of smoking is tested. This logistic regression includes the actual percentage change, percentage change squared (to capture any non-linear relationship), an interaction allowing the squared term to vary for those with reductions as opposed to increases, an interaction between the number of cigarettes smoked in 1992 and the percentage change in



smoking, the number of cigarettes smoked in 1992, and the number of cigarettes in 1992 squared.

## RESULTS

Table 1 presents the demographic characteristics of those who reduced, did not change, or increased smoking between 1992 and 1994. Reduction of any amount is quite common in this population, as nearly 33 percent reported some reduction between 1992 and 1994. Among reducers, the average percentage decline was 42% or 10 cigarettes. Age, education, and gender were not found to vary across the three categories. However there was a statistically significant difference in the number of blacks found in the ‘increase’ group as opposed to the ‘no change’ group. More psychiatric problems were detected in the “increase” and “reduce” groups than the no change group, but these differences were not statistically significant. While the number of major and chronic health problems at both waves 2 and 3 tended to be higher among the “reduce” group when compared with the no change group, these differences were also not statistically significant. The primary variable that is correlated with changes in quantity smoked is the number of cigarettes smoked per day at baseline. This is also reflected in the distribution of types of smoker across change categories. Light smokers are most often found in the “increase” category (55.4%), moderate smokers in the no change category (57.4%), and heavy smokers in the “reduce” category (41.5%). This possible ‘regression to the mean’ reveals that baseline smoking quantity is a key control variable.

[INSERT TABLE 1 HERE]

Table 2 describes the pattern of change in smoking between waves 1 and 2 by smoking level at wave 1 more thoroughly. The categories of percentage change are also expanded. Of

the 2,064 individuals who were smoking at wave 1 and wave 2, 5.4% decreased by more than 50 percent, 18.4% decreased by more than 25% and up to 50%, and 9.2% decreased by up to 25%. As shown in Table 1, the plurality of smokers did not change their smoking quantity; 43.2% reported no change between the waves. A significant fraction reported increases. Eight percent reported up to a 50% increase, and 15.8% reported greater than a 50% increase.

[INSERT TABLE 2 HERE]

Table 3 shows the relationship between these changes in smoking quantity and wave 3 cessation likelihood for all smokers combined. In Model 1, unadjusted odds ratios are presented for the five percentage change categories with respect to the no change category. Model 2 presents the adjusted version of this regression. For all smokers combined, greater than a 50% decrease between wave 1 and wave 2, and a decrease between 25 and 50% are consistently associated with increased wave 3 cessation in both the unadjusted and adjusted models. In both Model 1 and Model 2, there is a tendency for an increase of more than 50% between wave 1 and wave 2 to be associated with increased cessation at wave 3 ( $p < .10$ ), although this effect is not significant at conventional levels. Higher initial number of cigarettes smoked per day is associated with a lower likelihood of cessation. Pre-existing major and chronic health problems (those present at both wave 2 and wave 3) are not associated with cessation, while new major or chronic health problems are strongly associated with an increased likelihood. More advanced age is associated with an increased likelihood of quitting, while none of the other control variables show a significant relationship with cessation. The addition of these controls has little impact on the coefficient of the smoking change variables. Lastly, Model 3 tests all ‘reducers’ compared to both no change and ‘increasers’ and reveals that any reduction is significantly associated with a greater likelihood of cessation.

[INSERT TABLE 3 HERE]

Table 4 presents the same three models for the outcome of relapse at wave 4 (1998). Both the unadjusted and adjusted models show that all three reduction categories are associated with lower likelihood of relapse, although these effects are not always significant. Nevertheless there is no evidence that these groups have an increased chance of relapse.

[INSERT TABLE 4 HERE]

Estimates of separate regressions for light, moderate and heavy smokers were also obtained but are not presented here. In general, significance of the coefficients is reduced due to the smaller sample size in each regression. Few differences in the effect magnitudes are detected across smoker type. In fact, very little distinguishes the odds ratios of the light and moderate smokers. However, the unadjusted effects for the heavy smokers are not statistically significant except at the 10 percent level, and only for the largest decrease group. Although not reported here, tests were run to check if the effects of reductions in quantity smoked on future smoking status differed by baseline smoking status. Results from a model including interaction terms of baseline smoking quantity and each of the 5 smoking change categories in the fully adjusted model from Table 3 revealed no significant difference in effects for heavy versus non-heavy baseline smokers.

Finally, a graphical interpretation of these relationships is shown in Figure 1. This figure shows the predicted probabilities of cessation for three representative smokers: one light (10/day), one moderate (20/day), and one heavy (30/day), based on a flexible model of the relationship between actual percentage change in smoking, initial level of smoking that allows for non-linearities in this relationship. A light smoker who reduces by 60% has a predicted probability of quitting of 38.5 percent, while a light smoker who stayed constant has a

probability of quitting of 20.5 percent. A moderate smoker who reduces by 60% has a predicted probability of quitting of 26.9 percent, while the same smoker who stayed constant has a 15.4 percent probability of quitting. The results of the model that generates these results are displayed in Table 5.

[INSERT FIGURE 1 HERE]

[INSERT TABLE 5 HERE]

A technical difference between this study and the two other population-based studies is worth noting. In this study, the group with no change is used as the comparison group, whereas the group of non-reducers is the comparison group in the other two studies. Given that there is some tendency (significant at the 10% level) for large increases in smoking quantity to lead to cessation, the significance of smaller reductions over *no reduction* will be somewhat less. For the group of all smokers, the odds ratio for a reduction of 25-50% was 1.56 and remained significant at the .01 level when those who did not reduce were used as the omitted group. Therefore, the finding of even smaller reductions being advantageous is not an artifact of the choice of reference group. Additionally, as is reported in Tables 3 and 4, any reduction versus no reduction reveals an increased likelihood of cessation for all reducers combined.

## **DISCUSSION**

The evidence from this study strongly supports the hypothesis that smokers who reduce the quantity that they smoke are more likely to quit subsequently. This is true even after controlling for demographic characteristics, initial smoking quantity, physical and mental health, and other health behaviors such as drinking. The findings are weaker when considering only heavier smokers. It appears that heavier smokers must approach much lower levels of smoking

before the reduction can have an effect (3). Distinct from earlier studies, (3, 4) the results here indicate that for some smokers even smaller reductions can lead to increased likelihood of cessation. It also appears from these results that those who reduced smoking prior to quitting were not more vulnerable to future relapse at the 1998 follow-up. This is potentially important for revealing that ‘reducers’ do not simply have more erratic smoking patterns and greater long-run relapse potential.

Somewhat consistently, the results for large increases in smoking quantity are associated with greater cessation likelihood than ‘no change’. Some of this effect is diminished with the inclusion of baseline smoking quantity as increases over 50% occur disproportionately among lighter smokers. However, this remains a puzzle that warrants further exploration. It may be the case that more erratic smokers are more likely to quit regardless of prior change patterns.

Of course the extent to which these findings can be given a casual interpretation depends on the ability to control for as many confounding factors as possible. Can it be concluded that reduced smoking actually causes cessation; or is it simply that those most likely to quit are also likely to reduce smoking in the period prior? While it is not known whether individuals who reduced did so based on any intervention or treatment, the robustness of the results after controlling for many things associated with nicotine dependence or cessation gives credence to the causal interpretation. While health status and health events are strongly predictive of cessation, they are not associated with reduction. In fact, reduction appears quite random in this population save for its relationship with baseline smoking quantity.

One possibility is that reduced smokers have recently relapsed from a quit attempt and have resumed at a lower level. This is highly plausible given the two-year interval between reports of smoking quantity. The extent to which reduced smokers are more interested in

quitting cannot be measured directly with this data, however, the fact that reduction is not associated with health changes implies this may not strongly apply. Additionally, the bias caused by this omission may be slight given that another study found that while the length of earlier quit attempts was associated with reduction likelihood, earlier quit attempts did not predict future cessation when also controlling for quantity smoked at baseline (3). Nevertheless, this is a limitation.

Another possibility is that the least dependent smokers are both able to reduce smoking and quit smoking with greater ease than their more dependent counterparts. While these data do not contain a measure of dependence such as a Fagerstrom score, the next best approximation available is initial quantity smoked. These results help bolster a causal story as odds ratios are nearly identical for light and moderate smokers, groups that have clearly distinct Fagerstrom scores in other studies (27, 28). Since smoking quantity is controlled for in the main regressions and the effects do not significantly vary by smoker type, it appears that dependence levels alone are not likely to be driving these results.

Another limitation is the lack of generalizability of the sample to younger ages since the average age of this population is fifty-five. Studies have shown that although intent to quit and actual cessation are similar across age groups conditional on stage of change, there are systematic differences in predictors of stage of change across age groups (29). Yet, the age of the sample should not detract from the significance of the findings, especially since this group may be considered a more difficult to treat population, and one for whom clinicians will be eager to intervene with alternative treatment options as older smokers are more likely to be ‘hard-core’ smokers (30).

Smoking status and quantity are assessed in this study through self-reports. While this is a limitation, other studies have shown self-reports are reliable (31, 32). Additionally, since the Health and Retirement Study was not at all centered around the issue of tobacco use, it is less likely that individuals would feel inclined to hide their smoking status.

Reports of quantity smoked are likely subject to rounding error. Those who did not change smoking quantity were more likely to report smoking exactly one pack a day. To the extent that some of these smokers had actually reduced and some actually increased, the net effect of this rounding error is unknown. However it is not likely to affect the basic result since the more substantial reductions associated with cessation would tend to place individuals in new ‘half-pack’ intervals. Additionally, we do not know if reductions in quantity smoked were concomitant with changes in nicotine or tar levels in cigarettes. While it is not clear what the effect of these changes would be on the results presented here, for practical purposes it would be useful to know if ‘reducers’ are actually fading off nicotine or simply changing other aspects of their smoking behavior prior to quitting.

The use of pharmacotherapy or other treatments to aid in reduction or cessation is not documented in the HRS. The likely effect of this omission on the results is unclear. However, since nicotine replacement therapy is not currently advised as a treatment for reducing smoking, it is unlikely that reducers were much more likely to be using NRT at the time of reduction. At the wave 3 follow-up, it is not clear whether reducers would be more or less likely to use NRT or other pharmacotherapy in making a cessation attempt.

## **CONCLUSION**

Using a nationally representative sample of older adults this study finds that reduced smoking increases the likelihood of later cessation, even when controlling for relevant factors. Taking advantage of a large and rich longitudinal dataset allows progression beyond previous studies in this area. These findings have important policy implications for tobacco control policy and treatment. If reduced smoking is a more palatable alternative for some smokers, the results here suggest that recommending reduced smoking for some will not impede cessation but rather promote cessation among those able to successfully reduce smoking. Thus, reducing smoking could be considered for new policy initiatives including quit lines, medical guidelines, worksite programs, and the like. The healthcare community and ultimately smokers themselves may embrace this approach as more quantitative studies indicate that the approach is successful and for whom, when and how it is best used.

However, the framing of the message could be of extreme importance in that for those who reduce but continue to smoke, they may falsely have the illusion of benefit where none exists. Smokers should know that reducing can be helpful in increasing their likelihood of quitting, but they should quit altogether.

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**Table 1: Demographic characteristics by smoking change between wave 1 and 2**

	All 2064	Reduced 680 (32.9%)	No Change 891 (43.2%)	Increased 493 (23.9%)
N				
Female	54.4%	53.5%	54.0%	56.4%
Age in years	54.3 (5.5)	54.5 (5.6)	54.2 (5.5)	54.2 (5.3)
Black	16.4%	16.7%	14.2%	19.8% c
Hispanic Origin	7.2%	8.1%	5.7%	8.7%
Years education	11.5 (3.0)	11.4 (3.1)	11.6 (2.9)	11.7 (3.1)
Married	79.2%	80.4%	79.6%	76.7%
History of psychiatric illness <sup>d</sup>	13.1%	14.0%	11.3%	14.8%
Drinks more than 2 drinks / day at wave 1	9.7%	9.9%	9.4%	10.1%
History of major disease diagnosis at wave 2 <sup>d,f</sup>	15.0%	16.3%	13.4%	16.0%
History of major disease diagnosis at wave 3 <sup>d,f</sup>	18.6%	20.7%	16.9%	18.7%
History of chronic disease diagnosis at wave 2 <sup>d,e</sup>	23.7%	26.6%	22.1%	22.5%
History of chronic disease diagnosis at wave 3 <sup>d,e</sup>	31.4%	33.7%	30.2%	30.0%
# cigs / day at wave1	20.9 (12.6)	24.2 (14.1)	21.8 (10.7)	14.6 abc (11.6)
Light smoker (<15 per day)	29.0%	22.1%	19.8%	55.4% bc
Moderate smoker (15-24 per day)	43.4%	36.5%	57.4%	27.4% abc
Heavy smoker (25+ per day)	27.6%	41.5%	22.9%	17.2% ab
change # cigs / day between wave1-wave2	-0.7 (10.3)	-9.9 (8.1)	0.0	10.5 abc (10.7)
Not smoking at wave 3	16.8%	21.1%	13.5%	17.0% a

Note: Tukey tests of significance across columns at the 5 percent level denoted by:

a = reduced-no change; b = reduced-increased; c = no change - increased

<sup>d</sup> History indicates respondent ever had condition as of wave 1.

<sup>e</sup> Self report of physician diagnosis of chronic heart failure, chronic lung disease, diabetes, or heart disease.

<sup>f</sup> Self report of physician diagnosis of heart attack, stroke, or cancer (excluding skin).

## Reduced Smoking and Cessation of Older Smokers

**Table 2: Smoking Changes and Future Cessation by Percentage Change Category between waves 1 and 2 (1992 and 1994)**

	<i>All</i>	<i>&gt; 50 % Decrease</i>	<i>25-50% Decrease</i>	<i>1-25% Decrease</i>	<i>No Change</i>	<i>1-50% Increase</i>	<i>&gt;= 50% Increase</i>
<b>All</b>							
Frequency	100.0%	5.4%	18.4%	9.2%	43.2%	8.0%	15.8%
N	2064	111	379	190	891	166	327
# cigs/day at wave 1 (std dev)	20.9 (12.6)	20.7 (16.1)	24.7 (12.9)	25.1 (14.8)	21.8 (10.7)	20.1 (14.3)	11.8 (8.8)
change # cigs/day (std dev)	-0.7 (10.3)	-15.8 (13.8)	-10.4 (5.9)	-5.5 (3.6)	0.0 (0.0)	5.6 (3.9)	13.0 (12.0)
not smoking at wave3	16.8%*	31.6%*	20.1%*	16.9%	13.5%	14.3%	19.8%
<b>Light (&lt;15 cigs/day)</b>							
Frequency of All	29.0%	2.0%	3.2%	2.0%	8.5%	2.8%	10.5%
Frequency of Light	100.0%	7.0%	11.2%	6.8%	29.4%	9.5%	36.1%
N	599	42	67	41	176	57	216
# cigs/day at wave 1 (std dev)	7.4 (3.3)	6.6 (3.5)	7.6 (3.1)	8.5 (2.6)	8.5 (2.9)	6.9 (2.8)	6.5 (3.5)
change # cigs/day (std dev)	3.4 (10.0)	-4.8 (2.6)	-3.1 (1.5)	-1.5 (0.6)	0.0 (0.0)	1.8 (0.3)	11.2 (0.8)
not smoking at wave3	21.4%*	38.1%*	29.9%*	29.3%	16.5%	10.5%	20.8%
<b>Moderate (15-25 cigs/day)</b>							
Frequency of All	43.3%	1.7%	6.7%	3.6%	24.8%	2.1%	4.5%
Frequency of Moderate	100.0%	3.9%	15.5%	8.3%	57.2%	4.8%	10.3%
N	894	35	139	74	511	43	92
# cigs/day at wave 1 (std dev)	19.5 (1.5)	19.4 (1.6)	19.1 (1.9)	19.4 (1.6)	19.8 (0.9)	16.3 (2.1)	19.7 (1.1)
change # cigs/day (std dev)	-0.5 (7.4)	-14.8 (2.8)	-8.9 (1.9)	-4.3 (1.4)	0.0 (0.0)	4.6 (1.5)	15.8 (7.3)
not smoking at wave3	14.9%*	28.6%*	20.9%*	16.2%	11.9%	16.3%	15.2%
<b>Heavy (&gt;25 cigs/day)</b>							
Frequency of All	27.7%	1.6%	8.4%	3.6%	9.9%	3.2%	0.9%
Frequency of Heavy	100.0%	6.0%	30.3%	13.1%	35.7%	11.6%	3.3%
N	571	34	173	75	204	66	19
# cigs/day at wave 1 (std dev)	37.3 (10.0)	39.3 (15.4)	35.9 (9.6)	39.9 (12.0)	38.4 (7.1)	34.0 (12.3)	34.5 (6.9)
change # cigs/day (std dev)	-5.5 (12.3)	-30.4 (15.6)	-14.4 (5.7)	-8.9 (3.0)	0.0 (0.0)	9.5 (2.7)	21.1 (10.1)
not smoking at wave3	15.1%*	26.5%*	15.6%	10.7%	14.8%	12.1%	21.1%

\*Tukey tests of significance compared to 'no change' of at least 5 percent.

Change in # of cigarettes per day is difference between wave 1 (1992) and wave 2 (1994).

**Table 3: Full Logistic Regressions both unadjusted and adjusted for other covariates  
Dependent Variable: Cessation at wave 3 (1996)**

N=2064	Model 1		Model 2		Model 3	
	O.R.	C.I.	O.R.	C.I.	O.R.	C.I.
Reduced between 1992 & 1994					1.65***	(1.29-2.12)
Didn't reduce between 1992 & 1994					1.00	
>50% decrease	2.96***	(1.90-4.61)	2.72***	(1.71-4.33)		
25-50% decrease	1.61**	(1.17-2.21)	1.65**	(1.19-2.30)		
1-25% decrease	1.30	(0.85-2.00)	1.42	(0.92-2.19)		
No Change	1.00		1.00			
1-50% increase	0.93	(0.57-1.53)	0.87	(0.53-1.45)		
>= 50% increase	1.53+	(1.10-2.14)	1.38+	(0.96-1.97)		
# cigs/day at wave 1			0.98**	(0.97-0.99)	0.98***	(0.97-0.99)
Age in years			1.04***	(1.02-1.07)	1.04***	(1.02-1.07)
Male			1.00			
Female			1.06	(0.82-1.38)	1.02	(0.79-1.32)
Non-black or hispanic			1.00			
Black			0.92	(0.66-1.29)	0.93	(0.66-1.30)
Hispanic			1.28	(0.79-2.08)	1.31	(0.81-2.11)
Years education			1.04	(0.99-1.08)	1.04	(0.99-1.08)
History of major disease diagnosis at wave 2 <sup>a,c</sup>			0.24***	(0.14-0.43)	0.24***	(0.14-0.43)
History of major disease diagnosis at wave 3 <sup>a,c</sup>			3.92***	(2.36-6.50)	3.94***	(2.38-6.52)
History of chronic disease diagnosis at wave 2 <sup>a,b</sup>			0.52**	(0.33-0.83)	0.55**	(0.35-0.86)
History of chronic disease diagnosis at wave 3 <sup>a,b</sup>			1.75**	(1.16-2.63)	1.71**	(0.47-1.31)
Drinks more than 2 drinks / day at wave 1			0.78	(0.47-1.31)	0.78	(0.47-1.31)
Drinks more than 4 drinks / day at wave 1			0.96	(0.37-2.52)	1.00	(0.38-2.62)
History of psychiatric illness <sup>a</sup>			1.07	(0.74-1.54)	1.09	(0.76-1.57)

\*\*\* p<.001 \*\* p<.01 \*p<.05 +p<.10

Model 1 is the unadjusted model including only the six categorical percentage change in smoking variables with 'no change' omitted. Model 2 includes the categorical percentage change variables and the full set of controls.

Model 3 presents a fully adjusted model using a single indicator variable for reduction with 'no change' or increase omitted in lieu of the six change categories.

<sup>a</sup> History indicates respondent ever had condition as of wave 1.

<sup>b</sup> Self report of physician diagnosis of chronic heart failure, chronic lung disease, diabetes, or heart disease.

<sup>c</sup> Self report of physician diagnosis of heart attack, stroke, or cancer (excluding skin).

**Table 4: Full Logistic Regressions both unadjusted and adjusted for other covariates  
Dependent Variable: Relapse by wave 4 (1998)**

	Model 1		Model 2		Model 3	
	O.R.	C.I.	O.R.	C.I.	O.R.	C.I.
<i>N</i> =347						
Reduced between 1992 & 1994					0.625+	(0.39-1.00)
>50% decrease	0.43*	(0.19-0.97)	0.53	(0.22-1.28)		
25-50% decrease	0.59+	(0.33-1.06)	0.59+	(0.31-1.10)		
1-25% decrease	0.64	(0.29-1.43)	0.66	(0.29-1.53)		
No Change						
1-50% increase	0.71	(0.33-1.53)	0.77	(0.34-1.73)		
>= 50% increase	0.62	(0.31-1.23)	0.95	(0.44-2.02)		
# cigs smoked at w1			1.04**	(1.01-1.06)	1.04 **	(1.02-1.06)
Age in years			0.97	(0.93-1.01)	0.97	(0.93-1.01)
Male						
Female			1.92*	(1.16-3.19)	1.93*	(1.16-3.20)
Non-black or hispanic						
Black			0.97	(0.50-1.86)	0.95	(0.50-1.80)
Hispanic			0.87	(0.33-2.28)	0.84	(0.33-2.17)
Years education			0.94	(0.87-1.02)	0.94	(0.86-1.01)
History of major disease diagnosis at wave 2 <sup>a,c</sup>			1.86	(0.68-5.10)	1.86	(0.68-5.09)
History of major disease diagnosis at wave 3 <sup>a,c</sup>			0.48	(0.20-1.16)	0.49	(0.20-1.16)
History of chronic disease diagnosis at wave 2 <sup>a,b</sup>			1.53	(0.64-3.66)	1.52	(0.64-3.65)
History of chronic disease diagnosis at wave 3 <sup>a,b</sup>			0.62	(0.28-1.33)	0.61	(0.28-1.31)
Drinks more than 2 drinks / day at wave 1			1.65	(0.59-4.60)	1.65	(0.59-4.60)
Drinks more than 4 drinks / day at wave 1			0.54	(0.09-3.36)	0.55	(0.09-3.41)
History of psychiatric illness <sup>a</sup>			0.78	(0.38-1.60)	0.78	(0.38-1.59)

\*\*\* p<.001 \*\* p<.01 \*p<.05 +p<.10

Model 1 is the unadjusted model including only the six categorical percentage change in smoking variables with 'no change' omitted. Model 2 includes the categorical percentage change variables and the full set of controls.

Model 3 presents a fully adjusted model using a single indicator variable for reduction with 'no change' or increase omitted in lieu of the six change categories.

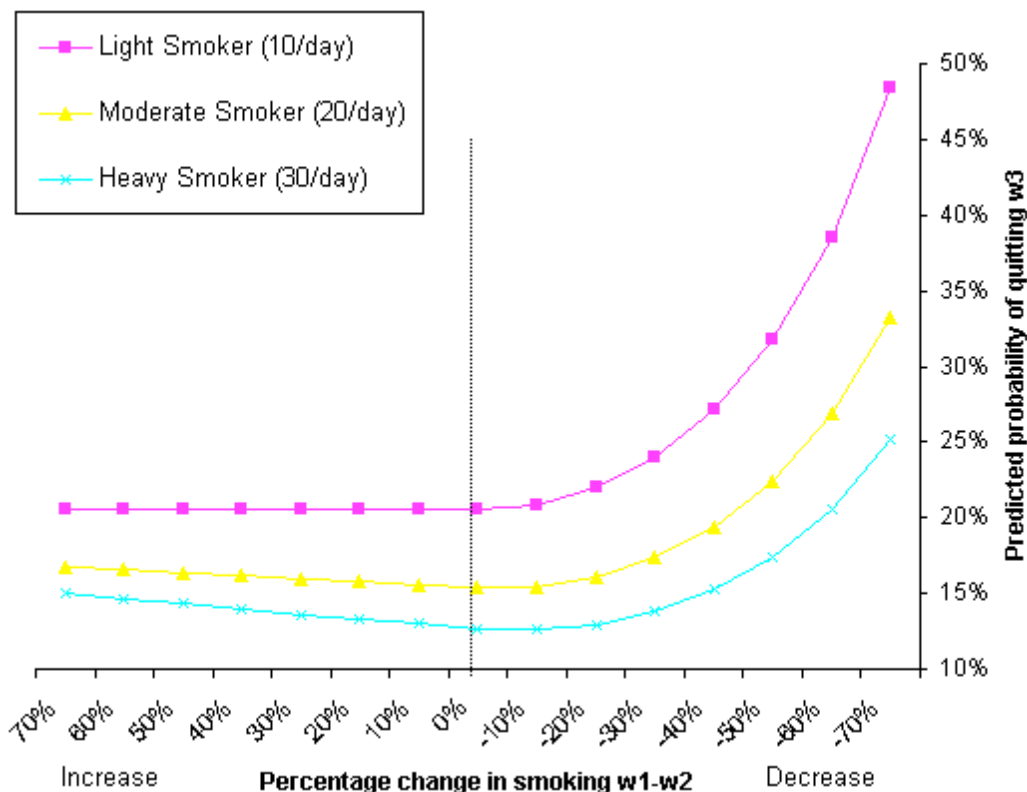
<sup>a</sup> History indicates respondent ever had condition as of wave 1.

<sup>b</sup> Self report of physician diagnosis of chronic heart failure, chronic lung disease, diabetes, or heart disease.

<sup>c</sup> Self report of physician diagnosis of heart attack, stroke, or cancer (excluding skin).



**Figure 1: Predicted probability of wave3 cessation as a function of percentage change in smoking for three different smoker types (light, moderate, and heavy)**



Note: Full model includes percentage change in smoking, percentage change squared, percentage change squared times an indicator for reduction, percentage change times initial number of cigarettes per day, initial cigarettes per day, cigarettes per day squared, plus all other control variables. Predictions are shown for a white male, aged 55, with 12 years education and no health problems.

**Table 5: Logistic regression model of cessation at wave 3 based on continuous percentage change in smoking and interactions with baseline smoking quantity**

N=2064	coef.	std. error
% change # cigs	-0.122	(0.08)
% change # cigs (squared)	0.004	(3.1E-03)
% change # cigs squared (if reduced)	1.743	(0.42) <sup>***</sup>
# cigs / day at wave 1	-0.043	(1.3E-02) <sup>***</sup>
# cigs / day (squared)	0.000	(2.0E-04) <sup>**</sup>
% change # cigs * # cigs / day	0.012	(9.2E-03)

<sup>†</sup> Adjusted regression includes all covariates listed in Table 3.

<sup>\*\*\*</sup> p<.001 <sup>\*\*</sup> p<.01 <sup>\*</sup>p<.05 <sup>+</sup>p<.10