

Are Heavy Smokers Different From Light Smokers?

A Comparison After 48 Hours Without Cigarettes

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Correlates of heavy smoking (≥ 25 cigarettes per day) were examined in a group of 380 smokers participating in a minimal-contact smoking relapse prevention trial. The results indicate that heavy smokers are more dependent on cigarettes. Compared with smokers consuming 15 or fewer cigarettes per day, heavy smokers reported greater difficulty quitting, were more troubled by withdrawal symptoms, experienced stronger urges and cravings, and had higher scores on a modified version of the Fagerstrom tolerance questionnaire. Heavy smokers weighed more and were more obese as measured by body mass index. Eighty percent of heavy smokers were classified correctly using discriminant function analysis with two dependence-related measures entering as the most important discriminator variables. Logistic regression analyses yielded similar results. The findings underscore the importance of addressing potential physical dependence factors when developing smoking-cessation treatments for heavy smokers.

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ALTHOUGH the percentage of cigarette smokers in the US population has declined since the 1960s, the proportion of smokers who smoke 25 or more cigarettes per day has increased.¹ To boost

**See also pp 1565, 1570,
1575, 1593, and 1614.**

cessation rates among these "heavy smokers," who are at increased risk for cancer, heart disease, and other illnesses,² correlates of heavy smoking and especially factors that might influence the

maintenance of the smoking habit need to be identified and, ultimately, addressed in the course of treatment.

There is substantial evidence that cigarette smoking may often occur as a form of drug dependence, with nicotine serving as the specific dependency-producing agent.³ The various physiological and psychological changes that frequently accompany tobacco deprivation suggest the existence of a tobacco withdrawal syndrome. Several of these changes have been shown to occur reliably following cigarette smoking cessation.⁴ In addition to withdrawal phenomena, tolerance to nicotine exposure has also been demonstrated.⁵

Although heavy smoking, compared with light smoking, may reflect dependence processes more directly, the relevant evidence has been mixed and the literature is surprisingly small. For example, Gritz and Jarvik⁶ found no differ-

ences in craving between light and heavy smokers deprived of cigarettes for 48 hours. Shiffman and Jarvik⁷ have reported similar results.

Other research suggests that heavy smokers may be more dependent on cigarettes. Schachter⁸ presented data indicating that heavy smokers regulate nicotine level and concluded that consumption by some light smokers appears largely unrelated to nicotine. Preabstinence plasma nicotine concentration has been shown in a recent report to correlate significantly with craving and other withdrawal phenomena.⁹

Several studies suggest that heavy smokers' cigarette consumption is linked preponderantly to internal cueing most probably arising from variation in nicotine level. In one experiment, smoking behavior was observed during periods of social interaction and during isolation. Light smokers decreased their smoking during social intercourse, suggesting that consumption was determined, at least in part, by situational cues. In contrast, heavy smokers' consumption did not vary across conditions.¹⁰ In a second report, light smokers again showed a sensitivity to situational cues while heavy smokers altered consumption only in response to manipulation of cigarette nicotine level.¹¹

Our group is currently conducting a large-scale trial examining the effectiveness of psychological and pharmacologic approaches to smoking-relapse prevention presented in self-help treatment formats.¹² Potential participants are told to quit smoking for 48 hours using any method available to them. Persons are randomized to one of 12

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treatment cells if they report no smoking for 48 hours and have expired-air carbon monoxide levels below nine parts per million. To date, more than 1200 subjects have been randomized.

In the context of this study, we are gathering data on measures of tobacco dependence and a variety of other psychological and behavioral variables that may influence cessation of smoking or maintenance of the habit. This article focuses on heavy (≥ 25 cigarettes per day) and light (≤ 15 cigarettes per day) smokers in the first group of 600 randomized participants, using analysis of variance, logistic regression, and discriminant function analysis to explore factors associated with higher levels of cigarette consumption. The definitions of heavy and light smoking were based on National Health Interview Survey cut points.¹³ We hypothesized that heavy smokers, compared with light smokers, would report more difficulty in quitting smoking, manifest more intense dysphoria and dysfunctional mood states, and show a greater level of dependence on cigarettes. Since there is some evidence that heavy and light smokers may differ in the availability of social resources,¹⁴ which may be crucial in providing support for sustained abstinence, we also included a standard measure of family environment in the assessment battery.

SUBJECTS AND METHODS

Out of the first 600 randomized participants, 259 met the criterion for heavy smoking (≥ 25 cigarettes per day) and 121 met the criterion for light smoking (≤ 15 cigarettes per day). Of these 380 participants, 189 are men and 191 are women. Of 259 heavy smokers, 147 were men and 112 women. Of the 121 light smokers, 42 were men and 79 women. Heavy smokers consumed a mean of 35.6 cigarettes (SD = 10.2) per day prior to the 48-hour quit. Light smokers used a mean of 10.5 cigarettes (SD = 3.7) per day (Table 1).

Recruitment

Program announcements were placed in local San Francisco Bay-area newspapers and on radio and television. Interested smokers were instructed to telephone the program office nearest them (Stanford, Oakland, or San Jose). A baseline interview was conducted at the time of the initial telephone contact to collect background information and determine eligibility. To participate in the study, each person was required to quit smoking for 48 hours and then make a postquit visit to the program office for biochemical confirmation of nonsmoking. At this visit successful quitters also

Table 1.—Characteristics of Heavy and Light Smokers

Characteristic	Heavy* (n = 259)		Light* (n = 121)		χ^2	P
	No.	%	No.	%		
Men	147	56.8	42	34.7	16.0	.0001
Women	112	43.2	79	65.3		
White	232	89.6	93	76.9	13.2	.04
Black	13	5.0	16	13.2		
Latino	7	2.7	4	3.3		
Married	129	49.8	57	47.1	0.9	.84
Divorced	73	28.2	34	28.1		
Never married	52	20.1	26	21.5		
Widowed	5	1.9	4	3.3		
Employed	196	75.5	87	71.9	10.4	.11
Unemployed	11	4.2	4	3.3		
Retired	9	3.5	12	9.9		
Student	6	2.3	5	4.1		
Homemaker	18	6.9	9	7.4		

*Heavy smokers consumed 25 cigarettes or more per day; light smokers, 15 cigarettes or fewer per day.

completed a postquit assessment battery and received instructions and materials for their eight-week smoking-relapse prevention program.

Prequit Baseline Telephone Interview

Each caller completed a baseline telephone interview at the time of the initial contact. The following information was obtained:

Smoking History.—Various aspects of current and past smoking behavior were assessed (ie, the number of cigarettes smoked per day, the age at which the caller started smoking, the number of years he or she smoked, etc).

Modified Fagerstrom Dependence Index.—Imbedded within the smoking history were five questions modified from the Fagerstrom Tolerance Questionnaire, an instrument designed to assess tobacco dependence.¹⁵ The five questions referred to the following aspects of an individual's cigarette consumption pattern: (1) difficulty in refraining from smoking where it is forbidden, (2) smoking more in the morning, (3) smoking when bedridden with illness, (4) depth of inhalation, and (5) time after awakening before smoking one's first cigarette.

Personal Characteristics.—The following personal characteristics were assessed: age, gender, race, marital status, employment status, and education.

Medical Status.—Twelve questions were used to determine medical eligibility for using nicotine chewing gum.

Test-retest reliability for each of the telephone interview questions was established in a pilot study with 57 smokers. Pearson correlations were calculated between smokers' response to each item at time 1 and time 2 (mean interval between assessments was 15.5 days).

Adequate stability of survey responses ($r > .70$) was observed on all but two of the questions, which were subsequently dropped from the interview.

Following completion of the baseline telephone interview, callers wishing to participate set a specific quit date and were scheduled for a postquit visit. The date of the postquit visit was scheduled to occur as soon as possible after participants had refrained from smoking cigarettes for 48 hours (and no longer than 96 hours after the smokers' "last puff"). Since one aim of the study was to assess how smokers quit on their own, no direct assistance (ie, quitting aids, self-help materials, or suggestions) was provided. The 48-hour-quit requirement was included in this study for two reasons. First, the intervention materials focus on relapse prevention, as this is the most important aspect of sustained smoking cessation (most smokers report previous quit attempts with abstinence periods as long as several months). Second, we wished to exclude persons who were likely to fail early on so we could offer the intervention to those most likely to benefit.

Postquit Survey

As noted, randomization occurred only after subjects quit smoking for 48 hours and showed expired-air carbon monoxide levels below nine parts per million. Following randomization, subjects had their height and weight recorded and completed a postquit survey that contained several instruments and a variety of questions linked conceptually to smoking cessation and relapse.

Height/Weight.—Height and weight were recorded on a standard balance-beam scale. Participants removed shoes, jacket, and any additional heavy clothing before they were measured.

Table 2.—Spearman Correlations Between Tobacco-Dependence Variables and the Profile of Mood States (N = 380)

Variable	Anxiety	Depression	Anger	Vigor	Fatigue	Confusion
Dependence index	.30*	.21*	.20*	-.07	.08	.20*
Difficulty quitting	-.45*	-.28*	-.23*	.18†	-.11‡	-.24*
Withdrawal symptoms	.73*	.45*	.50*	-.29*	.36*	.53*
Craving	.46*	.24*	.24*	-.15†	.10‡	.22*

* $P < .0001$.

† $P < .01$.

‡ $P < .05$.

Profile of Mood States (POMS).¹⁶—

A well-researched instrument with established psychometric properties was used to provide information on the following mood states: anxiety, depression, anger, vigor, fatigue, and confusion.

Family Environment Scale.—The Moos Family Environment Scale (FES)¹⁷ is designed to assess various social and environmental characteristics of families. Six of the ten subscales were included in the assessment: cohesion, expressiveness, conflict, independence, moral/religiousness, and control. The cohesion, expressiveness, and conflict subscales assess the degree of commitment, help, and support family members provide for one another; the degree of freedom to express feeling afforded to family members; and the level of conflict and aggression present in the family. Independence and moral/religious scales assess the extent to which family members are self-sufficient and the degree of emphasis placed on ethical and religious issues in the family. Control taps the extent to which set rules and procedures are used to run family life.

Tobacco Withdrawal Symptoms Inventory.—Twenty-seven items from Schneider's Smokers Complaint Scale¹⁸ and the Shiffman-Jarvik withdrawal symptoms scale¹⁹ constituted this instrument. Subjects were asked to indicate what symptoms they had experienced during the last 48 smoke-free hours and to rate on a six-point scale how upsetting each symptom had been and/or continued to be. A withdrawal score was created by summing across items and dividing by the total number of items.

Craving.—A separate craving score based on two items included in the withdrawal symptoms scale was computed. (Have you felt cravings for a cigarette? Have you felt strong urges to smoke?) Subjects rated on a six-point scale how upsetting cravings and urges had been in the last 48 hours. A score was obtained by summing the two items and dividing by two.

Difficulty in Quitting for 48 Hours.—Subjects provided a rating of the level of difficulty associated with quitting smoking for 48 hours on a six-point scale ranging from (1) very hard to (6) very easy (a lower score on this item indicated greater difficulty in quitting).

Statistical Methods

Spearman correlations were computed to examine the association between tobacco dependence variables and the POMS. χ^2 Analyses were conducted to compare heavy and light smokers on the following variables: gender, marital status, race, and employment status. Two-way analysis of variance (sex by smoker type [heavy/light]) was conducted to compare heavy and light smokers and men and women on the following: age, educational level, FES subscales, POMS subscales, body mass index (BMI), dependence index, withdrawal symptoms, craving, and the estimated difficulty of quitting for 48 hours. The utility of study variables for predicting smoking type (heavy/light) was examined using logistic regression analysis. A discriminant function analysis was computed to examine the power of study variables in producing correct smoker-category classifications.

RESULTS

Smoking History Variables

Heavy and light smokers did not differ on a variety of smoking history variables, including the number of years that the individual has smoked (heavy, mean = 26.2 years [SD = 10.2 years]; light, mean = 24.3 years [SD = 11.6 years]; $t = 1.2$, $P = .21$), the age at which he or she started smoking (heavy, mean = 17.6 years [SD = 3.5 years]; light, mean = 18.3 years [SD = 4.2 years]; $t = 1.6$, $P = .11$), the nicotine level of the cigarette brand used (heavy, mean = 0.75 [SD = 0.32]; light, mean = 0.70 [SD = 0.28]; $t = 1.2$, $P = .21$), and the number of previous quit attempts (heavy, mean = 3.4 attempts [SD = 1.9 attempts]; light, mean = 3.5 attempts [SD = 1.9 attempts]; $t = .98$, $P = .33$).

Spearman Correlations

Correlations between the POMS and tobacco dependence variables are presented in Table 2. Correlations between the dependence index and mood states were uniformly low. The estimate of quitting difficulty and the craving score following 48 hours of nonsmoking both correlated moderately with anxiety, but correlations between these variables and the other subscales were low. The correlations between the withdrawal symptoms score and the different POMS subscales ranged from moderate to high. For example, withdrawal symptoms correlated .73 ($P < .0001$) with anxiety, .50 with anger ($P < .0001$), and .53 ($P < .0001$) with confusion.

χ^2 Analyses

Compared with light smokers, a higher proportion of heavy smokers were men ($P < .0001$). Although 85% of the sample was white, the racial makeup of heavy and light smoker samples was somewhat different, with blacks being more highly represented among light smokers ($P = .04$). The marital ($P = .11$) and employment ($P = .84$) statuses of heavy and light smokers were similar.

Analysis of Variance

Heavy smokers weighed more and were more obese as measured by the BMI (weight/height²), reported more dysfunctional mood states as assessed by the POMS, were more dependent as measured by the modified Fagerstrom dependence index, and reported more difficulty in quitting smoking and higher levels of craving and withdrawal symptoms following quitting. Heavy smokers scored slightly higher on the FES independence subscale and somewhat lower on the moral/religious subscale. Heavy and light smokers did not differ on the following variables: age, educational level, and these FES subscales: family cohesion, expressiveness, conflict, and control (Tables 3 and 4).

Men differed from women on the following variables: POMS "vigor" (male mean, 15.4; female mean, 14.2; $F = 4.8$, $P < .03$), POMS "fatigue" (male mean, 6.7; female mean, 8.7; $F = 9.4$, $P < .002$); and BMI (male mean, 26.1; female mean, 24.3; $F = 12.9$, $P < .0004$). There were no sex by smoker type interactions.

Logistic Regression Analysis

Separate multiple logistic regression analyses were conducted for each of the following sets of variables: personal (age, gender, education, marital status, employment status, and BMI), mood state (POMS subscales: anxiety, depression, anger, vigor, fatigue, and confusion), family environment (FES

Table 3.—Comparing Heavy and Light Smokers on Demographic, Psychological, and Tobacco-Dependence Variables

Variable	Heavy (n = 256), Mean (SD)	Light (n = 121), Mean (SD)	Main-Effect F Test	P
Personal				
Age, y	43.8 (10.2)	42.6 (11.1)	1.4	.23
Education, y	14.9 (2.8)	15.3 (2.6)	0.9	.31
Body mass index, weight/height ²	25.8 (4.5)	24.0 (3.4)	8.9	.003
Profile of Mood States				
Anxiety	15.6 (7.7)	11.4 (6.8)	28.9	.0001
Depression	10.2 (10.0)	8.3 (9.5)	4.1	.04
Anger	10.9 (9.1)	7.9 (7.5)	10.6	.001
Vigor	14.3 (6.4)	16.0 (6.5)	8.2	.004
Fatigue	7.9 (6.3)	7.0 (6.5)	4.1	.04
Confusion	8.4 (5.4)	6.8 (4.4)	8.0	.004
Family Environment Scale				
Cohesion	7.1 (2.2)	7.4 (1.9)	1.4	.23
Expressiveness	6.1 (2.1)	5.9 (2.1)	0.1	.74
Conflict	2.4 (2.1)	2.8 (1.9)	2.9	.08
Independence	7.1 (1.3)	6.7 (1.5)	4.6	.03
Moral/religious	4.1 (2.3)	5.0 (2.3)	8.7	.003
Control	3.8 (2.1)	4.1 (1.9)	1.4	.23
Tobacco dependence				
Dependence index	16.4 (3.2)	12.3 (3.4)	107.8	.0001
Craving	4.3 (1.2)	3.0 (1.5)	69.2	.0001
Withdrawal symptoms	2.2 (1.0)	1.5 (1.0)	39.8	.0001
Difficulty quitting	2.3 (1.1)	3.3 (1.2)	65.8	.0001

Table 4.—Mean Weight and Body Mass Index of Heavy and Light Smokers*

Variable	Men		Women	
	Heavy	Light	Heavy	Light
Body mass index, weight/height ²	26.4 (4.1)	25.2 (3.3)	24.9 (4.8)	23.3 (3.3)
Weight, kg	82.7 (13.4)	79.7 (12.1)	68.1 (14.5)	63.1 (8.9)

*Numbers in parentheses indicate SD. In the analysis of variance for body mass index, for the sex effect, $F = 13.7$ and $P = .0002$; for the smoker type effect, $F = 9.7$ and $P = .002$. In the analysis of variance for weight, for the sex effect, $F = 113.9$ and $P = .0001$; for the smoker type effect, $F = 7.5$ and $P = .006$.

Table 5.—Logistic Regression Results for the Prediction of Heavy Smoking

Predictors	χ^2	P	r^2
Family environment			
Cohesion	4.8	.03	.02
Conflict	4.9	.03	
Moral/religious	5.5	.02	
Mood state			
Anxiety	14.9	.0001	.04
Personal			
Gender [†]	13.0	.0003	.04
Body mass index	10.2	.001	
Tobacco dependence			
Dependence index	49.6	<.0001	.26
Difficulty quitting	8.1	.004	
Full regression			
Dependence index	48.1	<.0001	.31
Difficulty quitting	15.3	.0001	
Gender	8.0	.005	
Body mass index	7.8	.005	

subscales), tobacco dependence (dependence index, craving, withdrawal symptoms, and difficulty quitting), and full regression (all study variables). The tobacco dependence variables, with most of the predictive power accounted for by the dependence index and estimate of quitting difficulty, were most highly correlated with smoker type

($r^2 = .26$). The r^2 for the full regression was .31 (Table 5).

Discriminant Function Analysis

In discriminant function analysis, 50% correct classification would be expected by chance. Eighty percent of heavy smokers were classified correctly and 83.5% of light smokers were classi-

fied correctly with all study variables entered into the discriminant function. When a stepwise discriminant analysis was performed, 80% of both heavy and light smokers were correctly classified. The variables that entered into the discriminant function (in order of their importance) were modified Fagerstrom dependence index, estimated difficulty in quitting for 48 hours, gender, and BMI.

Since 77% of men were heavy smokers, discriminant analyses were also conducted for men and women separately. For women, 84% of heavy smokers and 91% of light smokers were classified correctly. For men, 82% of heavy smokers and 76% of light smokers were classified correctly.

COMMENT

The results indicate that heavy smokers are more dependent on cigarettes than light smokers. Compared with smokers consuming 15 or fewer cigarettes per day, heavy smokers reported greater difficulty quitting, were more troubled by withdrawal symptoms, experienced stronger urges and cravings, and had higher scores on the modified Fagerstrom instrument. Eighty percent of heavy smokers were classified correctly using discriminant function analysis, with two dependence-related measures, the modified Fagerstrom dependence index and estimated difficulty in quitting for 48 hours, entering as the most important discriminator variables.

The results of the logistic regression analyses were complementary. A comparison of the r^2 values showed that the set of tobacco-dependence variables were more predictive of smoker type than were the personal, mood state, or family environment factors. The full regression, employing all study variables, increased the predictive power of the dependence variables model only slightly.

Heavy smokers differed from light smokers on each of the mood state subscales. Although we evaluated the POMS separately from the tobacco-dependence variables, changes in mood state may reflect a dependence process. For example, Hatsukami and colleagues⁴ have shown that changes in the POMS confusion scale occur reliably following tobacco deprivation. Correlations between the withdrawal symptoms scale used in this study and the mood state subscales were reasonably high. However, reported withdrawal symptoms, whether indexed via mood state or measured by the withdrawal scale, were less powerful than the dependence index and estimates of diffi-

culty in quitting distinguishing heavy from lighter smoking.

Heavy and light smokers did not differ on the social support factors measured by the FES. Billings and Moos¹⁴ also failed to find differences between heavy and light smokers with this instrument in an earlier report. However, social support may be conceptualized in a variety of ways. Social and environmental influences originating in the workplace or stemming from friends outside the family may have greater impact on cigarette consumption.¹⁴

Body weight and mean BMI were higher for heavy smokers among both men and women. This finding, which is consistent with other research,²⁰ is interesting because smokers typically weigh less than nonsmokers.²¹ Although the mechanisms producing the relationship between smoking and lower body weight have not been clearly established, there is evidence that smoking produces an increase in energy expenditure, which could help account for the observed differences between smokers and nonsmokers.²² Our finding is interesting because, assuming a straightforward energy expenditure model, we might expect heavy smokers, who consumed an average of 35 cigarettes per day before quitting, to weigh less than light smokers who smoked about ten cigarettes per day prior to the study. Although obesity is more prevalent among lower socioeconomic groups, socioeconomic differences cannot serve to explain the results, since heavy smokers did not differ from light smokers on the socioeconomic measures (age and education level) employed in this study.

It is widely believed that women have greater difficulty quitting smoking than men, in part because they experience more severe withdrawal symptoms. Recently, several authors have challenged this belief.^{23,24} Although some studies have shown that women experience more severe withdrawal symptoms than men,²⁵ others have failed to document this relationship.²⁶ We found little evidence of gender differences in this study. Men and women did not differ on any of the dependence-related variables and were very similar on four of the six POMS subscales.

Some caution should be exercised in generalizing these results. Study participants were motivated to make an attempt to quit smoking and remain free of cigarettes for 48 hours. They may not be representative of all smokers. However, approximately 51% of those who scheduled a quit date were successful and were randomized. This finding suggests that a sizable proportion of smokers may be able to quit for 48 hours.

Therefore, our results would appear generalizable to a substantial segment of the smoking population. Furthermore, differential selection by smoker type for the variables examined in this study is an unlikely explanation of the findings, especially considering their strength and consistency.

As we noted previously, more than 1200 subjects have been randomized to the trial. Recruitment occurred continuously during a 2.5-year period and many data were collected on each subject. When we had complete and verified information on 600 randomized subjects, we deemed the sample large enough to warrant initial analyses. With an *N* of 600, the study is already among the larger controlled smoking investigations yet conducted. By comparison, much of the research investigating dose-dependency phenomena in this field has been conducted with small, clinic-based samples.^{7,9,10}

Although the health risks of heavy smoking are widely appreciated, surprisingly little information on heavy smokers has appeared in the literature. Our findings suggest that smoking-cessation programs designed for heavy smokers may need to include strategies enabling them to cope with the effects of physical dependence. Nicotine resin chewing gum is a useful pharmacologic treatment approach that physicians should consider when assisting patients who are trying to quit smoking.^{27,28} Our data suggest that this approach may be particularly helpful for heavy smokers, especially those who report high levels of craving and withdrawal symptoms during previous quit attempts.

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