CHARACTERISTICS OF ADULT AND ADOLESCENT SMOKERS SEEKING CESSATION

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Summary

This study compared characteristics of adult and adolescent smokers seeking to quit, and analyzed their cigarette intake and levels of cotinine, a metabolite of nicotine. Adolescents smoked fewer cigarettes and were less motivated to quit, despite having similar health problems and significantly more psychiatric problems. Cigarette use and cotinine levels were significantly related within both populations and revealed substantial nicotine uptake in both groups. This study may help develop more effective smoking-cessation programs for adolescents.

Introduction

Smoking among adolescents is a significant concern. Every year nearly two million adolescents, age 11-17, smoke their first cigarette, and nearly half of them will become regular smokers (1). The average age of first smoking has remained steady for over 35 years, averaging 15.4 years in 1998 (2). The importance of adolescent smoking in establishing the adult habit was revealed in 1991 data, showing that 89% of smokers had started smoking before they could legally buy cigarettes at age 18 (3). However, most research on smoking and its consequences concerns adult smokers. More research is needed on adolescent smoking in order to develop innovations in the prevention and treatment of adolescent smokers.

Cigarette smoking among high school students varied greatly during the past decade. Smoking rates (smoking in the past 30 days) for 8^{th} graders increased by an alarming 47% from 1991 to 1996 to a high of 21.0%. However, these rates dropped steadily from 1997 to 2001, ending with a low of 12.2%, with similar trends among 10^{th} graders and 12^{th} graders (4). In addition, the prevalence of 12^{th} graders who were daily smokers declined to 19.0% in 2001, from 24.6% in 1997 and 26.9% in 1975. The rate of 12^{th} graders smoking at least half a pack a day declined more substantially over time to 10.3% in 2001 from 14.3% in 1997 and 17.9% in 1975 (4). A number of factors related to prevention and cessation are believed to have contributed to these trends, such as increases in cigarette prices, the initiation of anti-smoking campaigns, and a growing awareness among adolescents of the negative consequences of smoking (4).

Although the overall prevalence of smoking is declining, a significant number of adolescents continue to smoke. However, research is limited on this important group. Researchers published only thirteen studies on adolescent smoking cessation through 2000 (Appendix A). More studies have been published since, but no effective treatments have been found. It is important to achieve consistent reductions in adolescent smoking because of the demonstrated "cohort effect," which means higher rates established at an early age are likely to endure as that group ages (4). Although prevention of smoking has been improving recently among adolescents, effective cessation programs remain necessary.

Quitting smoking as early as possible is one of the best ways to reduce health risks, since the negative consequences of smoking increase the longer a person smokes (5). Remarkably, 40% to 80% of adolescent smokers have attempted to quit smoking, but few remain abstinent (3, 5). Data from the 1997 Youth Risk Behavior Survey show that 72.9% of high school students who

ever smoked daily had tried to quit, but only 13.5% had quit successfully (6). Another study found that 67% of high school students expressed the intent to quit, and 60% actually attempted to quit. Of the students who attempted to quit, 21% had not smoked for 30 days, but only 3% had not smoked for at least 12 months (7).

Many of the treatments for adolescent smoking cessation have been adapted from the treatments provided for adults. However, research shows that adolescents and adults have different psychological, social, and physical changes in their lives that could affect the success of smoking cessation programs (8). For example, adolescents have limited access to cigarettes, and dependence on nicotine and withdrawal symptoms may be quite different for the two groups (8). These factors could be used to create different smoking cessation programs specifically for adolescents.

For the study reported here, cotinine, a metabolite of nicotine and a measure of nicotine intake, was used to compare the relationship of cotinine levels and cigarette use within both the adult and adolescent populations. When the nicotine found in tobacco enters the body, it is oxidized to cotinine (Figure 1). Nicotine is metabolized in the liver by microsomal cytochrome P_{450} enzymes to its primary metabolite, cotinine (9). Other metabolic products may form from the reaction, but 80% of the nicotine absorbed by a smoker is metabolized to cotinine (10).

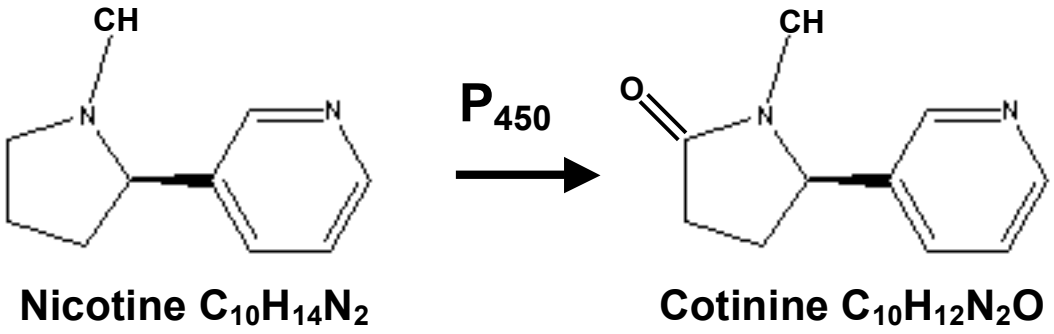

Figure 1: Reaction of nicotine to cotinine (http://www.chemfinder.com)

In this project, in addition to monitoring cotinine levels, the differences in the smoking characteristics between adolescent and adult populations were identified, such as motivation to quit smoking, number of cigarettes smoked per day, and other factors that affect addiction. Identifying age-related characteristics may provide insight into specific areas that should be taken into account to help people, especially adolescents, quit smoking. My research was based on two data sets from studies by Hanson et al. (in press) and Hatsukami et al. (in submission) on smoking cessation. The adolescent study (Hanson et al.) was collected from June of 1997 to August of 1999, and the adult study (Hatsukami et al.) was collected from July of 1999 to May of 2000.

The hypothesis for the first set of data was that tobacco-use history and smoking-related factors of adolescents and adults differ. Specifically, four hypotheses were predicted. Of adults and adolescents seeking treatment, adults smoke a greater number of cigarettes than adolescents. Adults have greater motivation to quit smoking, because they are more concerned about health and affected by other negative consequences associated with smoking. More adults than

adolescents use other tobacco products such as cigars, pipes, and smokeless tobacco. More adults than adolescents report significant health problems, alcohol use, medication use, and emotional problems, such as depression.

From the second set of data, it was hypothesized that cotinine levels can provide insight into the different smoking histories of adolescents and adults. Additionally it was predicted that there is a greater correlation between cotinine levels and number of cigarettes smoked per day among adults than adolescents, because smoking has stabilized among adults.

Methods

The first data set (Hatsukami and Hanson, unpublished) was obtained from groups of adolescents and adults who were recruited to participate in smoking-cessation studies. Adolescents were recruited through advertisements in college and high school newspapers and announcements on radio and television. Additionally, recruitment presentations were given at schools, and flyers and brochures were distributed at schools and medical clinics. Free smoking-cessation treatments that included nicotine patches and weekly support sessions were advertised for adolescents 13 to 19 years old. For adults, advertisements were placed in newspapers asking for volunteers for a study on the use of new smoking-cessation medications and nicotine patches. Adults were asked to call if they were regular smokers and in good health, with no other eligibility criteria indicated.

Interested adolescents and adults called the Tobacco Use Research Center at the University of Minnesota for additional information. Callers completed a standardized telephone-screening questionnaire on topics such as smoking habits, tobacco use history, and physical and mental-health history. Potential subjects were asked all questions on the questionnaire to determine eligibility. Identifying information on the caller was obtained only from those individuals who met eligibility criteria for the study. No information on eligibility criteria was given to the callers.

Adolescents between 13 and 19 years old who smoked at least ten cigarettes a day for a minimum of six months were chosen to be in the smoking cessation study. They could not use other tobacco products more than once per week and could not be using nicotine-replacement therapy. Adolescents had to be motivated to quit smoking, showing a self-assigned score of 7 or greater on a motivation rating scale, where 0 was “not at all” and 10 indicated “very much.” Subjects were excluded if they had medical problems that precluded them from using a nicotine patch, problems with alcohol or drug abuse, severe emotional problems in the last year, or had used psychoactive medications (except those used to treat ADHD) in the previous six months.

The adult subjects were required to be between 18 and 55 years old and to have smoked 20 to 49 cigarettes daily for at least one year. They were required to have a history of experiencing Diagnostic Statistical Manual (DSM) IV symptoms (based on the 1994 American Psychiatric Association standard) for nicotine withdrawal syndrome, they had to be in good physical and mental health, and they could not use any psychotropic medications (antidepressants, antipsychotics, or anxiolytics) or other tobacco or nicotine products.

From the primary screening population, subjects who met the eligibility criteria were selected to participate in the study. Adolescents attended an orientation meeting that included completion of

forms on smoking history and a physical examination to confirm that they were eligible. Adult subjects also completed smoking history forms and underwent a physical examination to confirm their eligibility. All subjects gave informed consent prior to any procedures. For adolescents under age 18, parents also gave written consent.

If eligible and motivated to quit, patients were enrolled in the treatment study. Prior to cessation, participants completed two weeks of baseline daily diary records of their regular smoking habits to evaluate their smoking patterns. For adolescents, saliva samples were collected by research associates to measure cotinine levels, and for adults, blood samples were collected by a medical doctor to analyze for serum cotinine. Samples were collected once for adolescents and twice for adults in the first week of each study, but the two studies were not simultaneous. Additional samples were collected during the smoking-cessation treatment, but the resulting data were not used for the study reported here, which deals only with smoking patterns and nicotine intake during *ad lib* smoking prior to cessation.

In this project, analyses were conducted on two previously collected data sets described above: the telephone-screening questionnaires, and data collected during the baseline clinic visits. The first study analyzed screening data characterizing two large groups of adolescent and adult smokers who wanted to quit. The second study examined a more detailed data set that focused on a small subset of the screened subjects in order to understand their daily smoking patterns, cotinine levels, and the relationship between these two factors.

In the first study, the answers to the telephone-screening questionnaires were analyzed in order to describe statistically the characteristics of adult and adolescent smokers. A statistical analysis computer program (the SAS System), was used to calculate means and standard deviations of specific smoking-related factors for both the adolescent and adult groups. The SAS System was used to compare the characteristics of adult and adolescent smokers with t-tests and χ^2 analyses, to determine whether the data were significantly different between the groups. For both the t-tests and χ^2 analyses, p-values of ≤ 0.01 were considered statistically significant.

In the second study, the smaller subset was used to examine smoking patterns, cotinine levels, and the relationship between cotinine and cigarette intake within the adult and adolescent smoking populations. No differences between populations were examined because of the differences in inclusion criteria between the adolescent and adults groups. The two methods of collecting cotinine samples, serum for adults and saliva for adolescents, have been shown to produce similar results. Specifically, saliva cotinine levels were between 257 ng/ml to 458 ng/ml in prior studies that examined adult smokers enrolled in treatment (11, 12). Pearson correlations were used to determine significant relationships between smoking rate and cotinine within each population.

Results

Table 1 compares characteristics of adolescents and adults who wanted to quit smoking. On average, adults smoked more cigarettes per day than adolescents ($p < 0.0001$). Adults had been smoking for a significantly longer time ($p < 0.0001$) and had a higher motivation to quit than adolescents ($p < 0.0001$). Compared with adults, more adolescents had been treated for psychiatric or emotional problems ($p < 0.00001$) and had been seen for treatment within one year

($p < 0.001$). More adolescents than adults had been diagnosed with ADHD ($p < 0.00001$). Adolescents consumed more alcoholic drinks per occasion ($p < 0.0001$) but drank fewer days per week than adults ($p < 0.0001$). More adults than adolescents used alcohol ($p = 0.00004$) and took medication ($p < 0.00001$).

Table 1: Characteristics of Adolescent (N = 375) and Adult Smokers (N= 665) Seeking Treatment for Smoking Cessation

Measure	Adults Mean	SD	Adolescents Mean	SD	P-Value
Cigarettes (per day)	22.1	9.1	16.7	7.3	< 0.0001
Age (years)	41.6	10.5	16.6	1.5	< 0.0001
Duration of smoking (months)	233.1	127.3	29.5	18.1	< 0.0001
Motivation to quit (0 – 10)[1]	8.7	1.4	8.3	1.5	< 0.0001
Maximum # of drinks on any one occasion	3.9	2.6	4.4	6.3	0.2852
Number of days/week drink	4.4	6.4	1.8	3.8	< 0.0001
Alcoholic drink/occasion	1.9	1.8	4.1	3.4	< 0.0001
Measure	**% Adults**	**N**	**% Adolescents**	**N**	**P-Value**
Alcohol use	74.8	483	63.0	231	0.00004
Use cigars, pipes or smokeless tobacco	6.9	46/(665)	7.5	28/(375)	0.7407
Significant health problems/chronic diseases	28.1	104	28.0	75	> 0.05
Ever treated for psychiatric or emotional problems	25.0	162	45.1	167	<0.00001
Last seen for treatment of psychiatric or emotional problems (≤ 1 year)	26.3	25/(95)	90.8	128/(141)	< 0.001
Currently taking medication	63.8	414	17.7	29	<0.00001
Currently taking anti-depressant medication	10.1	66	7.2	27	0.11161
Ever diagnosed with ADHD	0.0	2	8.9	33	<0.00001
Ever diagnosed with depression	14.5	94	16.2	60	0.52455

[1] Motivation to quit assessed on a 0 to 10 scale with 0 = “not at all” and 10 = “very much.”

The following data comparisons of adults and adolescents were not statistically different ($p > 0.05$): maximum number of drinks on any one occasion, use of cigars, pipes or smokeless tobacco, significant health problems or chronic diseases, currently taking anti-depressant medication, and ever diagnosed with depression.

Table 2 shows smoking patterns, level of nicotine uptake, and the relationship between cigarettes smoked per day and cotinine levels for adults and adolescents. The correlation was significant between the number of cigarettes smoked per day and cotinine levels for both the adolescent and

adult groups. Figure 2 shows the range of cigarette intake and cotinine levels for adults and adolescents during baseline smoking.

Table 2: Relationship Between Cigarettes Per Day and Cotinine

	Adults (N = 117)	Adolescents (N = 77)
Mean CPD[1] (SD)	25.01 (8.41)	13.67 (4.15)
Mean SD (SD)	3.99 (1.90)	3.21 (1.75)
Mean Cotinine (ng/ml) (SD)	294.89 (106.33)[2]	204.17 (99.51)[3]
Correlation between CPD[1] and Cotinine levels	0.36**	0.30*

[1] CPD = Cigarettes per day
[2] Serum sample
[3] Saliva sample
* $p < 0.01$ ** $p < 0.001$

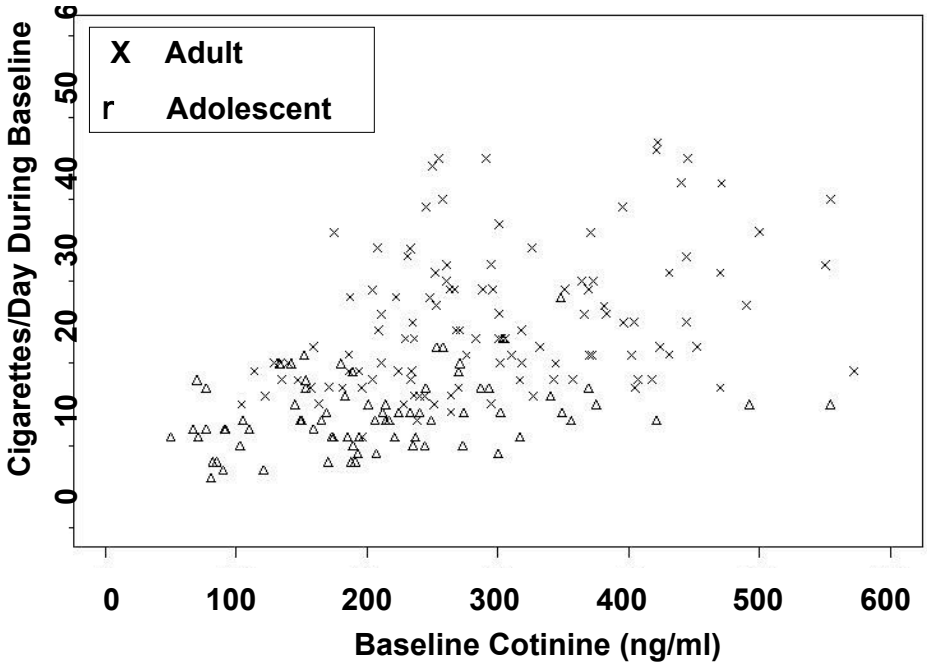

Figure 2: Relationship between cigarette intake and cotinine levels for adults (X) and adolescents (Δ)

Discussion

Adults seeking treatment smoked significantly more cigarettes per day than adolescents seeking treatment, who smoked on average over a half a pack per day. While the correlation between cigarettes smoked and cotinine was significant within adolescents and adults, both groups were found to have high levels of nicotine uptake. This indicates that both adolescents and adults were likely to be dependent on nicotine prior to seeking treatment. The high levels of cotinine found among adolescents in the study could mean that adolescents absorb nicotine more efficiently or smoke differently due to time restraints on smoking and limited access to cigarettes. This suggests the difficulty of successful cessation for adolescents, even though they had fewer years to attain stable smoking patterns.

The rate of use of other tobacco products tended to be low among both adults and adolescents. However, these data were limited by inconsistencies. For example, some adolescents answered "yes" to using other forms of tobacco but answered "0" for frequency of use; these data had to be eliminated. As a result of these limitations, the data must be interpreted with some caution.

Adults had a significantly higher motivation to quit than adolescents, though the differences may not be clinically relevant. In general, both populations were highly motivated to quit. The prevalence of both adolescent and adult smokers experiencing health problems or chronic diseases was similar among both populations, even though the adolescent smokers were younger and had experienced fewer years and lower amounts of smoking. Differences in the screening questions asked of the adolescents and adults could account for the lack of statistical significance. For example, different health problems were listed for the two groups, making it difficult to compare the answers quantitatively. It is difficult to know whether these health problems can be solely attributed to smoking, or whether adolescents who become smokers are already predisposed to health problems. However, a high number of adolescent smokers reported health problems, which may serve as a motivator to quit. In fact, concern about future health problems was reported in a recent study of adolescent smokers as the most important motivator to quit (13).

In general, both adolescent and adult smokers tend to have high rates of psychiatric disorders compared to the general population (14, 15). However, the rate of adolescent smokers ever treated for psychiatric disorders was significantly higher than for adult smokers in this study. Among adolescents, almost half the population reported being treated for psychiatric or emotional problems, whereas only about a quarter of adult smokers reported this experience. This finding may be explained by (a) a tendency for the adolescent years to be associated with turmoil, (b) a tendency for adolescents to report any contact with counselors as treatment for emotional problems, or (c) a tendency for adolescent smokers to experience a high rate of psychiatric disorders. This finding supports several conclusions. The first is that psychiatric disorders, particularly depression, tend to predispose smokers to relapse (16). Second, treatment of psychiatric issues may be an important element of smoking cessation among adolescents.

The rate of alcohol use was higher among adults than adolescents, but over half of the adolescents used alcohol. These rates were similar to those found in a general population of adolescents (4). Compared with adults, the adolescents reported fewer days per week of drinking but a significantly higher number of drinks per occasion, signifying that these adolescent

smokers are likely to binge drink. This type of binge drinking is more likely to lead to a relapse of smoking because it impairs coping skills that help a person resist smoking.

In summary, the issues that need to be targeted for adolescents are similar to those of adults, but particular attention may need to be paid to psychiatric problems and binge drinking. Adolescent smokers seeking treatment tend to be addicted to nicotine, perhaps as addicted as adults, even though they smoke fewer cigarettes than adults. Health concerns may effectively motivate cessation among adolescents. Phone questionnaires limited the amount of data collected because of time and other restrictions. A future study would benefit by having more similar inclusion criteria and questions for the two groups. A more in-depth study is needed to compare the characteristics of these two populations, and identify the unique factors that affect adolescent smoking cessation.

Appendix A

Table 3: Studies on Adolescent Smoking Cessation (1978-2000)

	Year	Study
1.	2000	Hurt, Croghan, Beede, Wolter, Croghan & Patten
2.	1999	Aveyard et al.
3.	1998	Pallonen et al.
4.	1996	Smith et al.
5.	1995	Prince
6.	1995	Hollis, Vogt, Stevens, Biglan, Severson & Lichtenstein
7.	1995	Sussman, Dent, Burton, Stacy & Flay
8.	1987	Weissman, Glasgow, Biglan & Lichtenstein
9.	1983	Lotecka & McWhinney
10.	1983	Perry, Telch, Killen, Burke & Maccoby
11.	1983	St. Pierre, Shute & Jaycox
12.	1980	Perry, Killen, Telch, Slinkard & Danaher
13.	1978	Greenberg & Deputat

Works Cited

1. American Lung Association. "Adolescent Smoking Statistics." http://www.lungusa.org/press/tobacco/not_stats.html, 2002.
2. US Department of Health and Human Services. *Summary of Findings From the 2000 National Household Survey on Drug Abuse*; Office of Applied Studies, Substance Abuse and Mental Health Services Administration, DHHD Report 01-3549. Rockville, MD, 2001.
3. Lynch, Barbara S. and Richard J. Bonnie, ed. *Growing Up Tobacco Free: Preventing Nicotine Addiction In Children and Youths*. Institute of Medicine. National Academy Press: Washington, D.C., 1994.
4. US Department of Health and Human Services. *Monitoring the Future, National Survey Results on Drug Use, 1975-2001, Volume 1: Secondary School Students*; National Institute of Health, National Institute on Drug Abuse, NIH Report 02-5106. Bethesda, MD, 2002.

5. U.S. Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General*. Public Health Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Atlanta, GA, 1994.
6. Centers for Disease Control and Prevention. "Trends in cigarette smoking among high school students-United States, 1991-1999." *Journal of the American Medical Association* Vol. 284: 1507-1508, 2000.
7. Burt, R.D., and A. V. Peterson. "Smoking cessation among high school seniors." *Preventive Medicine,* 27, 319-327, 1998.
8. Colby, Suzanne M., Stephen T. Tiffany, Saul Shiffman, Raymond S. Niaura. "Are Adolescent Smokers Dependant on Nicotine? A Review of the Evidence." *Drug and Alcohol Dependence*. Vol 59, Suppl 1: S83-S95, 2000.
9. Witter, A. E., D.M. Klinger, X. Fan, M. Lam, D.T. Mathers, and S.A. Mabury. "Quantitative Determination of Nicotine and Cotinine in Urine and Sputum Using a Combined SPME-GC/MS Method." *Journal of Chemical Education*. Vol. 79 No. 10, October 2002.
10. Murphy, S. E., L. M. Johnson, and D. M. Pullo. *Chem. Res. Toxicol,* Vol.12: 639, 1999.
11. Hatsukami, Dorothy K., et al. "Signs and Symptoms From Nicotine Gum Abstinence." *Psychopharmacology*, Vol. 104: 496-504, 1991.
12. Hatsukami, Dorothy K., et al. "Gender and the Effects of Different Doses of Nicotine Gum on Tobacco Withdrawal Symptoms." *Experimental and Clinical Psychopharmacology*, Vol. 3: 163-173, 1995.
13. Riedel, Brant W., Leslie A. Robinson, Robert C. Klesges, Bonnie McLain-Allen. "What Motivates Adolescent Smokers to Make a Quit Attempt?" *Drug and Alcohol Dependence*, Vol. 68: 167-174, 2002.
14. Brown, R.A., P.M. Lewinsohn, J.R. Seeley, E.F. Wagner. "Cigarette Smoking, Major Depression and Other Psychiatric Disorders Among Adolescents." *Journal of the American Academy of Child and Adolescent Psychiatry*, Vol. 35: 1602-1610, 1996.
15. Lasser, Karen et al. "Smoking and Mental Illness: A Population-Based Prevalence Study." *Journal of American Medical Association,* Vol. 84, #20: 2606-2610, 2000.
16. Killen, J.D., S.P. Fortmann, H.C. Kraemer, A.N. Varady, L. Davis, B. Newman. "Interactive Effects of Depression Symptoms, Nicotine Dependence, and Weight Change on Late Smoking Relapse." *Journal of Consulting and Clinical Psychology,* Vol. 64: 1060-1067, 1996.

References Not Cited

- Colby, Suzanne M., Stephen T. Tiffany, Saul Shiffman, Raymond S. Niaura. "Measuring Nicotine Dependence Among Youth: A Review of Available Approaches and Instruments." *Drug and Alcohol Dependence*. Vol 59, Suppl 1: S23-S39, 2000.
- Hanson, Karen, Sharon Allen, Sue Jensen, Dorothy Hatsukami. "Characteristics of Adolescents Who Seek Smoking Cessation Treatment." To be resubmitted in 2003.
- Hanson, Karen, Sharon Allen, Sue Jensen, Dorothy Hatsukami. "Treatment of Adolescent Smokers With the Nicotine Patch." *Nicotine and Tobacco Research*, in press.
- Hatsukami, Dorothy K., et al. "Role of $5HT_3$ in Mediating Subjective and Behavioral Responses to Cotinine." *Pharmacology, Biochemistry and Behavior*, in submission.

- Johnson, L.D., P.M. O'Malley, and J.G. Bachman. *The Monitoring the Future National survey results on adolescent drug use: Overview of key findings, 1999.* National Institute on Drug Abuse, c. 56, NIH Publication No. 0-4690. Rockville, MD, 2000.
- Mermelstein, Robin, et al. "Methodological Issues in Measuring Treatment Outcome in Adolescent Smoking Cessation Studies." *Nicotine and Tobacco Research*, in press.
- US Department of Health and Human Services. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders.* Smoking and Tobacco Control Monograph 4, NIH Report 93-3605; Environmental Protection Agency. Washington, DC, 1993.