

Validation of Students' Self-Reported Cigarette Smoking Status with Plasma Cotinine Levels

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Abstract: Plasma cotinine levels were measured in 137 students (ages 14 to 17 years), as an independent validation of self-reported cigarette smoking status. Ninety-five per cent of the students who reported daily cigarette smoking had detectable cotinine levels. In contrast, only 2 per cent of students who reported that they never smoke cigarettes had detectable levels of plasma cotinine. Results suggest that adolescents can report accurately on their smoking status if sufficient assurance of confidentiality is stressed. (*Am J Public Health* 69:1272-1274, 1979.)

During the past few years, several innovative approaches to the problem of childhood onset of cigarette smoking have been developed. The most successful preventive measures appear to be school-based programs which utilize peer group dynamics and focus on external pressures to smoke (peer group, advertisements, parent role models) as well as internal psychological pressures.¹⁻³ Evaluation of the success of these intervention strategies has depended primarily on students' self-reported cigarette smoking behavior surveyed before and after intervention. The validity of such self-reports has been questioned since cigarette smoking as a taboo behavior for young teenagers would be likely to be underreported.⁴

The following study reports on a comparison of students' confidential reports of their smoking behavior and simultaneous plasma levels of cotinine as a means of measuring the validity of the students' responses.

Materials and Methods

A random subsample of students participating in the health screening portion of a school health education program, "Know Your Body,"⁵ were selected for the cotinine study. Since the health screening already included a survey of health habits and a venous blood sample for total cholesterol, a random number of 140 blood samples were marked for cotinine analysis without knowledge of the smoking status of the child. Students were not aware that cotinine levels would be measured on a subsample of participants. Selected students were 14 to 17 years of age (grades 8, 9, or 10), 64 male, 73 female, 134 white and 6 black. All attended public school in two predominantly white (95 per cent) middle class New York school districts. Three students were excluded from the data analysis because of lost questionnaires or insufficient blood sample. One hundred thirty-seven matched cotinine levels and smoking self-reports were available for analysis. All data were collected between January and May, 1978.

Students completed a Health Habits Survey consisting of 12 questions related to cigarette smoking and alcohol use. Questionnaires were filled out in private and then placed into a slotted ballot box. Students were assured that all data from this questionnaire would be used for research purposes only and would not be identified with the students' name in any reports.

Venipuncture was performed within 10 minutes of completion of the smoking questionnaire. Plasma cotinine levels* were determined by radioimmunoassay as described by Langone, et al.^{6,7} This method uses specific rabbit antisera produced by injection of trans 4'-carboxycotinine conjugated to albumin and provides levels comparable to those

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*Cotinine is the major metabolite of nicotine with a plasma half life greater than 30 hours, compared with 30 minutes for nicotine. It is usually found in the blood at levels greater than that of nicotine, and levels remain fairly constant in individuals who smoke according to a consistent pattern.⁶

TABLE 1—Self-Reported Cigarette Smoking Status and Plasma Cotinine Levels in 137 Students, 14–17 years of Age, New York, 1978

Self-Reported Cigarette Smoking	Plasma Cotinine Level (ng/ml)	
	Detectable	Non-Detectable (ND)
Daily		
Mean Cotinine	158 ng/ml	ND
Range	5–616 ng/ml	ND
No. Students	19 (95%)	1 (5%)
No. Cgt/Week	50 per week	50 per week
Occasional		
Mean Cotinine	80 ng/ml	ND
Range	29–131 ng/ml	ND
No. Students	4 (21%)	15 (79%)
No. Cgt/Week	16 per week	1 per week
Never		
Mean Cotinine	4 ng/ml	ND
Range	3–5 ng/ml	ND
No. Students	2 (2%)	96 (98%)
No. Cgt/Week	0	0

obtained by gas liquid chromatography.⁷ The interassay variation is 10 per cent for cotinine, while the sensitivity is 370 pg/ml.

Results

Of the 137 students, 20 (14.6 per cent) reported daily cigarette smoking, 19 (13.9 per cent) reported occasional cigarette smoking, and 98 (71.5 per cent) reported that they never smoked cigarettes. The proportion of students in each smoking category who had detectable plasma cotinine levels is given in Table 1.

Ninety-five per cent of the 20 students who reported daily use of cigarettes had detectable levels of cotinine, with a mean plasma level of 158 ng/ml. These 19 students smoked an average of 50 cigarettes a week. Twenty-one per cent of the 19 "occasional" smokers had detectable cotinine levels with a mean plasma level 80 ng/ml. These four students smoked an average of 16 cigarettes per week, while the other 15 "occasional" smokers with non-detectable cotinine levels smoked only an average of one cigarette per week. Infrequent smoking could not be detected by cotinine measurement (half life 30 hours) unless that one cigarette had been smoked within about 48 hours of blood sampling.

Ninety-eight per cent of the 98 students who reported "never" smoking cigarettes, had non-detectable levels of cotinine in their blood. The two students who had detectable levels were of very low magnitude (3 ng/ml and 5 ng/ml). This may have resulted from passive exposure to the cigarette smoke of others, although further studies would be needed to confirm this finding.

Thirteen of the 20 daily smokers, and 14 of the 19 occasional smokers were female, approximately the 2:1 female to male smoking ratio found in the general survey of students in

TABLE 2—Sensitivity and Specificity of Students Self-Reported Cigarette Smoking Questionnaire as a Screening Instrument¹

		Screening Questionnaire	
		Positive ²	Negative ³
Plasma Cotinine Detected	Positive Negative TOTAL	19 1 20	2 96 98
(N = 118)			
Sensitivity = $\frac{19}{20} = .95$		False negatives = $\frac{1}{20} = .05$	
Specificity = $\frac{96}{98} = .98$		False positives = $\frac{2}{98} = .02$	

¹Students reporting "occasional" cigarette use were eliminated due to infrequency of smoking and inability to determine this by plasma cotinine levels at its known half life.

²Daily cigarette use

³Never smoke cigarettes

these two schools. Neither sex, age, nor ethnicity of the student appeared to be related to validity of self-smoking reports in this study, although the numbers were small.

Discussion

The data presented in this report suggest that adolescents can report accurately on their own cigarette smoking status if sufficient assurance of confidentiality is stressed. Simultaneously determined cotinine levels indicated that 95 per cent of those reporting daily cigarette use, did indeed have detectable cotinine levels, while 98 per cent of those reporting never using cigarettes had non-detectable cotinine levels. Hence both sensitivity and specificity were very high if one considers the self-report of smoking habits as a screening tool. In addition, the proportion of false positives and false negatives was very low as summarized in Table 2, considering only daily smoking and non-smoking students.

The students reporting occasional smoking appear to be a mixture of some who are really almost daily smokers, and others who are experimenting with one or two cigarettes a week. Cotinine levels could be expected to be detectable only in the former daily group and non-detectable in the latter experimenting group, since the half life of cotinine is 30 hours. If one only measured cotinine levels, rather than asking for student self-reports of smoking, it would not be possible to distinguish between those who were occasional (1-2 cigarettes per week) smokers from those who never smoked. Measurement of plasma or serum thiocyanate which has a half life of 14 days would have a greater likelihood of differentiating between these two groups of students.⁸⁻¹⁰

While the students' self-reports of smoking in the current study appear to be highly valid, one cannot generalize these findings to students of other ages, particularly younger students where the perceived taboo is even stronger, or for students of differing socioeconomic or ethnic backgrounds. Additional studies are planned to answer some of these questions.

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Changes in the Cigarette Consumption of Smokers in Relation To Changes in Tar/Nicotine Content of Cigarettes Smoked

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Abstract: Over a 13-year period, 59 per cent of 28,561 smokers decreased the tar and nicotine (T/N) level in the cigarettes they smoked without changing the number of cigarettes smoked to any important extent. On the other hand, more than 54 per cent of the "less than one pack a day" smokers as compared to only 25 per cent of the "one pack or more a day" smokers increased the number of cigarettes smoked. Nicotine dependency plays a minor role in determining the smoking habits of those who continue to smoke on a long-term basis. (*Am J Public Health* 69:1274-1276, 1979.)

Several investigators have suggested that lowering tar and nicotine (T/N) content of cigarettes may result in in-

creasing the cigarette hazard because smokers will increase the number of cigarettes they smoke.^{1, 2} An increase in nicotine dependence or "regulation" occurs over short periods of time,³ suggesting to some that lowering T/N content may do more harm than good. However, T/N yields have declined by about one-half over the past 15-20 years without a doubling of cigarette consumption.⁴

Evidence from the American Cancer Society (ACS) study indicates that low T/N smokers had small but measurable reductions in mortality from all causes, heart disease, and lung cancer compared to those who smoked relatively high T/N cigarettes,⁵ yet those who smoked one or more packs a day of low T/N cigarettes had higher mortality rates than those who smoked, less than one pack a day, high T/N cigarettes. Thus the number of cigarettes smoked could be a more important factor in morbidity than the T/N level of the cigarettes smoked. Findings of the ACS study, suggesting that most smokers who reduced the T/N content of the brand of cigarettes smoked the same number of cigarettes two years later,⁶ have been challenged as statistical artifacts.³ For this reason, the ACS study data were reworked and re-analyzed.

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