Immediate Effects of Smoking on Healthy Young Men

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A CAUSAL relationship has been demonstrated between lung cancer and the carcinogenic compounds present in cigarette smoke. Studies of persons with atherosclerotic heart disease have shown an increased risk of the disease in heavy smokers of cigarettes (*1–9*).

Health educators are particularly concerned with the relationship between cigarette smoking and health because they are called upon to influence the behavior of those who smoke as well as those who are deciding whether or not they should smoke.

Many educational efforts emphasize disease as the end result of smoking and, of necessity, concentrate on the long-range effects. We hypothesize that this approach often does not effectively alter the smoking behavior of young people because the threat to health is so far removed. Thus it is reasonable to investigate the immediate effects of cigarette smoking.

We explored the important variates related to the immediate effects of smoking in a healthy male population, under 22 years of age, at San Fernando Valley State College, Northridge, Calif. Our observations could be applied to the development of educational programs aimed at affecting smoking behavior.

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Procedures

To attract 400 volunteer student participants (200 smokers and 200 nonsmokers), we made an intensive effort to publicize our project by radio and television and in the newspapers. A one-page information sheet was mailed to each potential participant to sensitize the target population. This mailing was followed by a letter of invitation and an application form, with a reprint of a newspaper article on the project and a return self-addressed envelope. We selected the study participants from the respondents. Consent slips allowed us to use the following research procedures.

Two types of written tests. The first test, given during the first appointment, was a personal information questionnaire dealing with the determination of social, economic, and behavorial data. The second test probed for the student's knowledge of smoking and health, with questions formulated to assess the student's ability to recall, translate, analyze, synthesize, evaluate, and apply information.

Expired-air analysis. To assess the relationship between smoking and physiological response, we thought it important to identify the chemical constituents of the air expired by

smokers and nonsmokers. Numerous studies have reported the constituents of cigarette smoke and the effect of such smoke on tissue samples from a variety of mammals including man (*10–16*). No information has been reported dealing with the chemicals in the expired air from smokers. If a pattern of respiratory volatiles associated with cigarette smoking could be established, the pattern would be useful in (*a*) elucidating the chemicals absorbed by the lungs and (*b*) identifying actual smoking behavior. We analyzed by gas chromatography (GLC) the expired air samples that were obtained from the smoker before and after smoking and from the nonsmoker before and after a comparable rest period.

Electrocardiograms. Electrocardiograms (ECG's) of each participant were taken with a new device, the Cardiostat. Its transmitter was used to send measurements from limb leads I, II, and III before and after a student smoked to a central receiving station for processing.

Blood analysis. We completed various types of analyses on blood taken from smokers before and after smoking. These analyses included serum lipids—cholesterol phospholipids, alpha and beta lipoproteins, serum triglycerides, and free fatty acids (total and relative amount of each type). Such analyses could indicate the nature of the relationship between cigarette smoke and the elements that are important in atherogenesis. We assessed the thrombogenic effects of smoking by measuring the blood clotting time of each smoker before and after smoking.

Work-performance assessment. We assessed the work-performance efficiency levels of smokers and nonsmokers by measuring the flow of respiratory gases, the heart rate, and the blood pressure. These measurements were obtained from smokers during rest and exercise before and after smoking. The same measurements were obtained from nonsmokers, who were not required to smoke.

Observing and analyzing the measurements for one smoker could yield the information that is needed to establish an integrated pattern of physiological response to cigarette smoking. It is possible to examine a change in the magnitude of each variate and between variates for a smoker before and after smoking. In addition, the specific relationships among groups of variates can be determined; for example, the relationship between serum lipids and clotting behavior and between serum lipids and work performance. Serum lipids and the absorbed constituents of smoke can be evaluated. These specific relationships are of particular value in formulating new in-depth studies and in identifying areas that would be useful in future educational programs.

This study, during the first year, was a massive undertaking. More than 400 students participated in more than 2,400 appointments. Several comments are in order.

1. The research effort had an impact on all the college students, the faculty, and the staff. They became interested because of the nature of the study.

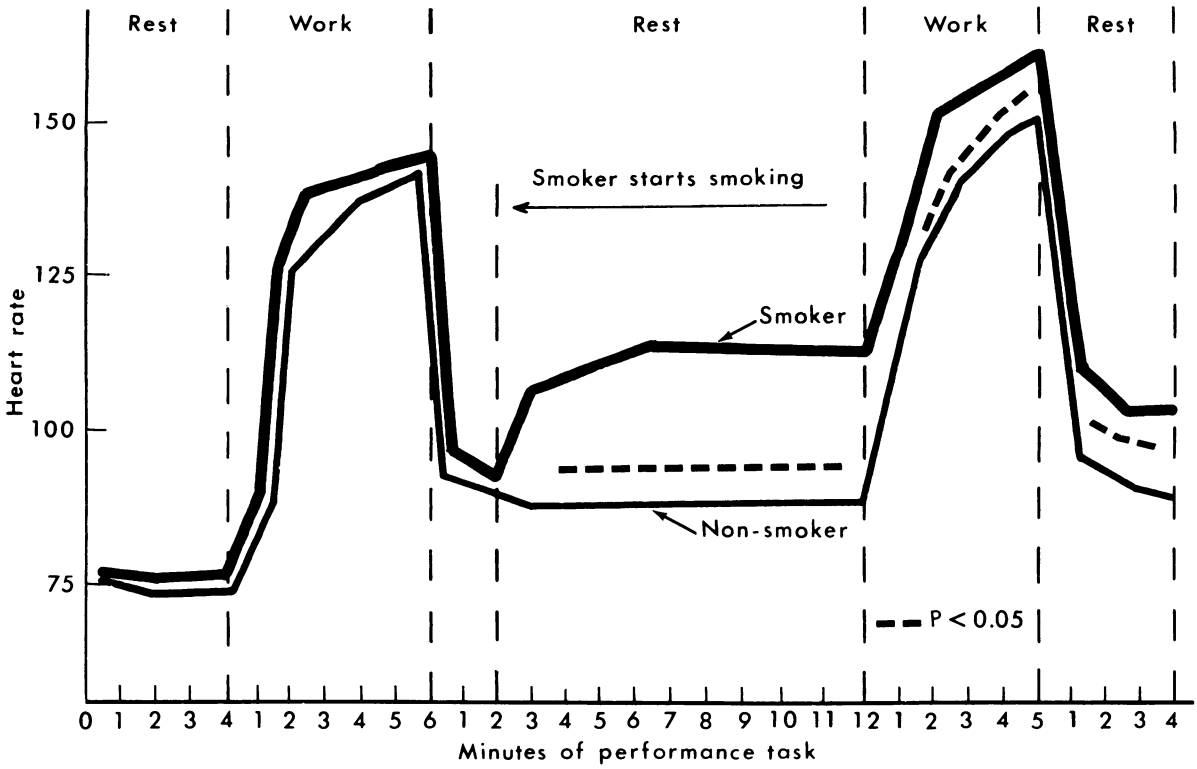
2. The project permitted the hiring of approximately 30 student assistants, who gained research experience that otherwise would not have been available to them.

3. The very nature of the project called for a unique interdisciplinary approach. The staff of the Biostatistics Research Laboratory, Inc., helped with statistical analyses and also analyzed expired air and free fatty acids. The California Foundation for Medical Research, Los Angeles, analyzed clinical information. And Ferber Associates, Sherman Oaks, allowed us to use their Cardiostat and receiving center. Dr. Addie Klotz and the staff of the college's student health service conducted the clinical tests. Human performance tests were carried out by Dr. George Rich and Dr. George Holland and the staff at the college's human performance laboratory. In short, academicians from the health science and physical education disciplines, biochemists, laboratory technicians, physicians, a pathologist, a cardiologist, and consultants in cancer and physiological exercise worked effectively together in this project.

Results

Pretest differences. When the smokers and nonsmokers entered the study, they displayed differences in certain items of the cognitive skills test and the personal information questionnaire and in serum lipids and expired air.

Figure 1. Heart rates during work performance tasks and rest periods



In the written tests, the nonsmokers reported that they had more academic problems, carried a higher unit load in college, were more involved in religious activities, were more actively engaged in sports activities, and were less active in social groups. As might be suspected, the nonsmokers reported that fewer members of their families smoked. Generally, the nonsmokers were less informed about the effects of smoking on health.

In the blood-chemistry analysis, the smokers showed higher levels of triglycerides and fatty acid type 18:1 before smoking than the nonsmokers. All participants fasted and smoked no cigarettes for 12 hours before the test—which is significant.

In the expired-air analysis, the GLC patterns between smokers and nonsmokers were significantly different. Chemicals that were not found in the expired air of nonsmokers were found in the GLC pattern of smokers.

Single discriminant index numbers reflecting all these measurements were computed for each participant. Using the frequency distribution of these pretest index numbers, we properly identified 83 percent of both the smokers and nonsmokers. The mean-index-number difference between smokers and nonsmokers was statistically significant ($P<0.05$).

Post-test minus pretest differences (immediate effects). The heart rates of smokers increased significantly after smoking, and their T-waves changed. As stated previously, a single discriminant index number for each participant reflected his ECG measurements (leads I, II, and III). By frequency distribution of the discriminant index numbers (post-test minus pretest) for the immediate effects, 79 percent of both the smokers and the nonsmokers were properly identified. The mean-index-number difference between smokers and nonsmokers was statistically significant ($P<0.05$).

The clotting time measurement indicated that the smokers' blood clotted faster after smoking. In addition, the level of free fatty acids type 18:1 increased. Although a difference between smokers and nonsmokers was indicated, the difference was not statistically significant. ($P<0.05$).

The differences between smokers and non-

smokers during the work tasks were primarily related to heart rate and blood pressure. Specifically, the smokers' heart rate increased immediately after smoking and remained elevated during the entire smoking period, the next work period (5 minutes), and the final rest period (fig. 1). The systolic and diastolic blood pressure of smokers also increased immediately after smoking (fig. 2). Notably interesting is the decrease in the smokers' diastolic blood pressure during the last minute of each work task.

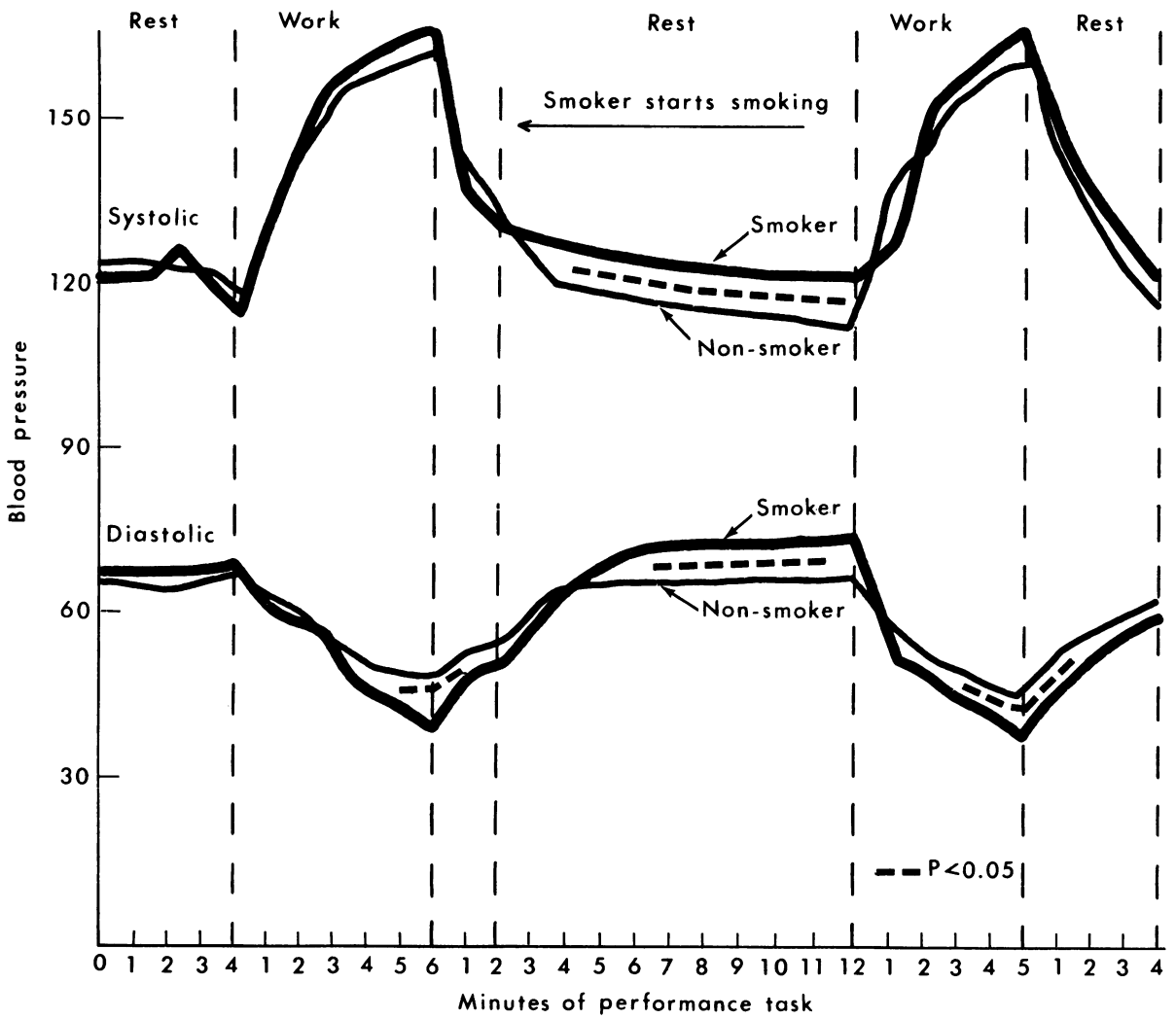
By frequency distribution of the discriminant index numbers (post-test minus pretest), 76 percent of both the smokers and the nonsmokers were properly classified in work performance. The difference in the mean index numbers between smokers and nonsmokers was statistically significant ($P<0.05$).

Oxygen and carbon dioxide ratios also were computed during the human performance work tasks. Although the findings were not statistically significant, smokers tended to have a higher ratio of oxygen (O_2, or diatomic gas) uptake and carbon dioxide (CO_2) release (see table). The higher ratios of O_2 and CO_2 indicate that the work task required more effort from the student.

Discussion

Although the smokers seemed to be more informed about the effects of smoking on health, the information in itself did not deter them

Figure 2. Blood pressure changes during work performance tasks and rest periods



Differences in ratios of oxygen uptake and carbon dioxide release during work tasks

Work tasks	O_2 uptake [1]	CO_2 release [2]
No. 1:		
Smoker	1. 86	1. 67
Nonsmoker	1. 81	1. 61
No. 2:		
Smoker	1. 89	1. 63
Nonsmoker	1. 80	1. 57

[1] $VO_2 = \frac{V}{100} \times$ true O_2. [2] $VCO_2 = \frac{V}{100} \times$ true CO_2.

NOTE: V = volume.

from smoking. From an educational viewpoint, we found that merely disseminating information about the ill effects of smoking may not alter smoking behavior.

Our findings on the personal-information questionnaire—information on religious, social, and athletic activities—are inconclusive. These findings need further investigation to determine their specific educational significance. For example, our information suggests that the nonsmoker is more actively involved in sports. Perhaps the nonsmoker is more interested in sports than the smoker. Therefore, a program encouraging smokers to use sports as a means of altering their smoking behavior might not be effective. Additional research on the factors that motivate smoking is needed.

The pretest differences showing a higher level of triglycerides and fatty acid type 18:1 in smokers could indicate that even though a person has been smoking for a relatively short period—the age group studied was 17 to 22—certain changes in blood chemistry, with detrimental long-range effects, may already be taking place.

Pretesting the differences between the expired-air samples of smokers and nonsmokers may prove to be an effective means of evaluating smoking behavior after teaching about the hazards of smoking. Current evaluative techniques include questionnaires to determine changes in smoking behavior. As smoking becomes less socially acceptable, these techniques may prove to be inadequate. The expired-air procedures, if properly refined, could be used as a substitute for such questionnaires or to validate them.

Our data on post-test minus pretest differences (immediate effects) between smokers and nonsmokers, reflecting changes in heart action, blood pressure, and blood chemistry, may indicate that young smokers are already undergoing changes that will affect their future health. These data, if valid, could be translated into meaningful teaching about the relationship of smoking to health—present and future.

The differences found support the notion that any program on smoking and health cannot be treated as an isolated segment. Education in smoking is in fact education in health when the multiplicity of related physical, mental, and social factors are considered. What we are suggesting is that such programs cannot deal solely with cigarette smoking and its effect on a single organ or on several organs, but rather with the total functioning and well-being of man.

As an integral part of the study, our data will be synthesized to (*a*) establish major concepts, (*b*) identify behavioral objectives, and (*c*) develop learning opportunities for college, high school, junior high school, and elementary school students.

Summary

This study was made to attempt to identify the immediate effects of smoking on healthy young college men. In the first phase of the study, 200 smokers were compared with 200 nonsmokers concerning their differences in knowledge about smoking and health and in religious activities, academic experiences, and social relationships. Pretest differences were found in certain clinical tests. The smokers had higher levels of triglycerides and fatty acid type 18:1 than the nonsmokers. The smokers also had different patterns of expired air before smoking than the nonsmokers.

The immediate effects of smoking that were observed included changes in the heart rate and in the T-wave of electrocardiograms and changes in the systolic and diastolic blood pressure while smoking and during exercise. Smokers had faster blood clotting times after smoking than nonsmokers and were less efficient during work tasks; however, the differences in clotting time and in work efficiency between smokers and nonsmokers were not statistically significant.

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New Graduate School of Medical Sciences

A new Graduate School of Medical Sciences is being established by the University of the Pacific in San Francisco in cooperation with the Institute of Medical Sciences and the Presbyterian Hospital of the Pacific Medical Center.

The new graduate school will offer courses leading to the master of science degree in clinical sciences and the doctor of philosophy degree in the visual sciences as well as graduate and postdoctorate training to a limited number of graduate students.

Dr. Robert Dyar, presently chief of the division of research of the California State Department of Public Health, Berkeley, will be dean of the new school. From 1945 to 1959 he was chief of the division of preventive medical services for the California State Department of Public Health. Other staff members will be drawn from the Institute of Medical Sciences and the Presbyterian Hospital of the Pacific Medical Center.

Two divisions, one for research and one for education, will be established within the school. These divisions will also include continuing education for the practicing physician and intern and resident training programs with the Pacific Medical Center.

The agreement for establishing the new school was completed in September and made possible through cooperation between the University of the Pacific, the Institute of Medical Sciences, and the Pacific Medical Center. Facilities of both the Institute and the Medical Center will be used for the research and the education divisions.