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Comparison of Army Flight School Performance in Smokers and Nonsmokers

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The effects of smoking on performance were examined in this study by comparing flight school performance in groups of nonsmoking and smoking Army aviation students. Academic and in-flight grades for five phases of Initial Entry Rotary Wing (IERW) classes between January 1984 and November 1986 were extracted from Aviation Center records and compared to the student's responses on the auxiliary questionnaire portion of the Aviator Epidemiologic Data Register, a comprehensive database collected yearly on every Army aviator by the joint effort of the U.S. Army Aeromedical Research Laboratory and the Aeromedical Activity. There were 2,025 students with data sufficiently complete and analysis, with the average age of 24.5 years, and with a rank and sex distribution as follows: 96.3 percent males, 3.7 percent females; 53.2 percent commissioned officers, 46.7 percent warrant officers. Through past studies (1982) have shown 56 percent of all Army personnel were smokers, strict criteria defining smokers and nonsmokers in this study, plus recent decreases in smoking rates, produced a 15:85 ration of smokers to nonsmokers (recent quitters and those who smoke less

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than one pack/day were not included in the analysis.

That smoking is detrimental to overall health is clear from many controlled medical studies, however, using a very adequate number of aviators, no evidence of a statistically significant relationship was found between smoking behavior and flight school performance.

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Background

Tobacco has been taken intentionally into the human body for many centuries. Man has sought the various chemical and psychological effects of tobacco components to augment or alter his behavior and feelings primarily through smoking, chewing, and sniffing this plant throughout the world. In the United States, early uses are recorded before the time of Columbus; Sir Walter Raleigh carried smoking back to Europe in 1565 after contact with the Indians in the New World, and its popularity mushroomed there, making tobacco one of the financial attractions of settling the new continent (Vogt, 1982).

Other historical milestones in the growth history of tobacco use are the introduction in 1884 of machinery to mass produce cigarettes which allowed less expensive and more widespread distribution of smoking tobacco, and the World War I distribution of free cigarettes to American soldiers with the resulting addiction and the development of the image of the soldier as a smoker (7 percent of cigarettes produced in 1944 were consumed by GIs). Cigarette consumption in the US peaked in 1963 and since has decreased by about 20 percent; the rates in military populations still are almost twice that in age-matched civilian groups (COSH, 1986). Smokeless tobacco, on the other hand, lost popularity after 1930 until a recent upswing in use that has been significant (NIH, 1986).

Age, occupation, and sex are prime variables in the demographic description of the smoker. Data from 1985 (DOD, 1979) show the overall smoking prevalence rate of the US population to be 30 percent (33 percent among males, 28 percent among females) down from 33 percent in 1980. The rate is 30 percent in the 18-29 age group, increasing to 36 percent in the 30-44 year range, then decreasing steadily thereafter. (Smoking rates in the under 18-year-old females exceeded the male rate, but in all older age groups, the male rate exceeds the female. Teenage smoking rates have decreased overall since 1977 to 21 percent from 27 percent.)

Blue collar workers smoke more than white collar workers (male/female rates are 47 percent/39 percent and 33 percent/32 percent, respectively). Smoking rates are higher than average for minority groups and lower than average for those with college educations and higher incomes (Vogt, 1982).

In military populations, smoking rates in large studies in 1980, 1982, and 1985 showed higher than average rates though the rates are decreasing with time (52 percent, 53 percent, 47 percent, respectively). These are significantly higher than the general population rates of 25-30 percent. The age specific smoker/nonsmoker rates are steady up to age 39 (52-54 percent); however, the average daily consumption increased with age.

A study of smoking rate distribution and military rank structure shows the following: junior enlisted 55 percent, senior enlisted 61 percent, junior officers 23 percent, and senior officers 28 percent. Viewing the service as a category (1982), the following rates are found among all personnel: Navy = 56 percent, Army = 56 percent, Marines = 54 percent, and Air Force = 45 percent (DOD, 1986).

The Department of Defense has supported smoking behavior until recently by the practice of sale of discounted cigarettes through the military system. Attempts to ban such sales have failed; however, recent restriction of smoking areas on military posts and banning of smoking aboard Army aircraft indicate a trend away from such support (TRADOC letter, 1984).

Significance

Discussion of the physical health impact of tobacco use is not necessary here, as these effects have become understood more clearly and better defined over the past 10 years. The morbidity attributable to tobacco use includes diseases of the respiratory and cardiovascular systems and cancer. Death and hospitalization rates are much higher in the smoking population; nearly 300 deaths and over 54,000 bed-days were directly attributable to smoking behavior in the DOD system in 1984 (DOD, 1985).

Decreased physiological tolerances also are described which may impact performance, particularly in the aviation population. Smokers are more prone to effects of hypoxia and to decompression sickness. Physical endurance is decremented; an Army study showed that smokers took an average of 2 minutes longer to finish the 2-mile run portion of the physical fitness test. An Air Force study from Wilford Hall Medical Center tested 419 airmen, average age 19, finding the nonsmokers covered significantly more distance in a 12-minute maximum running test and that the distance covered was inversely related to the number of cigarettes smoked. Smoking without inhaling had no appreciable effect on performance. The positive effect of training (towards better performance) was reported to be less in smokers than in nonsmokers (Cooper, Gey, and Bottenberg, 1968).

The total effects of smoking on performance are difficult to predict because the two major chemical constituents of cigarette smoke (nicotine and carbon monoxide) have rather opposite effects on human physiology. Nicotine is a powerful stimulant of the nervous and cardiovascular system, whereas carbon monoxide, which can reach significant levels, has a depressant effect. Further complicating the smoker/nonsmoker performance research is the sometimes pronounced effect of withdrawal from active smoking on behavior.

Both physiological and behavioral effects are well documented, and have been reported to impact performance. Most researchers examining the effects of cigarette smoking on learning behavior have found that smoking produces a decrement. Hull (1924), Williams (1980), Andersson and Post (1974), Andersson (1975), and Mangan (1983) found that the amount learned was lower and the length of time that the material was retained was shorter among smokers than among nonsmokers. Stevens (1976) and Elgerot (1976) found slower rates of problem solving among smokers, and Carter (1974) found that smokers performed more poorly than nonsmokers in a letter/digit substitution test. Carter (1974) found no difference in learning behavior in his study of smokers versus nonsmokers. Conversely, Battig (1970) and Bovet-Nitti (1966) found an increased learning ability in rats forced to breathe smoke. Garg (1969) found a consolidation of memory function in smokers, and Hull (1924) found an increase in arithmetic ability among smokers compared to nonsmokers.

Ague' (1974) found that smokers tended to overestimate the length of time intervals compared to nonsmokers. Peters and McGee (1982) found no difference in the learning ability of smokers deprived of smoking compared with nonsmokers.

The study described in this paper is undertaken to compare the overall performance of smokers versus nonsmokers in an aviation training environment to determine whether the effect of smoking enhances or decrements the performance of these flight school students.

Method

Medical data have been collected more extensively on all new Army aviation candidates since 1984 than in prior years and entered into the Aviation Epidemiology Data Register (AEDR) at Fort Rucker, Alabama, under a joint project of the US Army Aeromedical Research Laboratory (USAARL) and the US Army Aeromedical Activity. The AEDR is a database containing both physical examination data (from the SF 88 and additional information on anthropometrics and biochemical test results) and medical history data (from the SF 93 and additional information on family history, medication history, alcohol and smoking history, and flight hour records) for use in tracking individual and population disease trends in Army aviation.

Also at Fort Rucker, the Initial Entry Rotary Wing (IERW) training now is conducted under the auspices of the Aviation Center. The AEDR collects (among many other data points) epidemiologic information on smoking behavior.

The combination of the smoking behavior/history and student academic and flight grade data is possible through cooperation of the agencies involved and was accomplished to answer the primary question of this research, "What is the relationship of smoking behavior and flight school performance?"

Flight school grades for all the students that entered IERW training between January, 1984 and November, 1986 were extracted from the computer tape compiled from IERW data. These data were transferred to the VAX computer at USAARL and compared with a data file extracted from the AEDR of the matching Social Security numbers of those students contained in the grade file. This match produced 2,441 students with both grade data and smoking behavior data. Because of incomplete data, 416 of these subjects were excluded, leaving 2,025 for the analysis. These students had an average age of 24.5 years and had a military rank and sex distribution as follows: 96.3 percent were males, 3.7 percent females; 53.2 percent were commissioned officers and 46.8 percent were warrant officers.

The statistical analysis was done using the SPSS statistical package, using Match Files, Frequencies, Correlation, and ANOVA routines.

The grades file had been designed using five groups, corresponding to the five phases of flight training: primary, contact, instruments, combat tactics, and night. For each of these five phases, grades are assigned for the academic phase and the flight phase.

Variables used in the analysis include flight grade and academic grade for each phase, cigarette packs per day, number of years smoking and a composite of the prior two variables, pack-years (packs per day x number of years smoking). A collapse of the smoking behavior into two groups was accomplished, grouping those who had not smoked at all during the last 6 months or more (nonsmokers) and those who are currently smoking one or more packs per day (smokers).

Based on the statistical principle that performing a large number of comparisons increases the probability of finding statistically significant relationships by chance alone, the alpha level was adjusted in a conservative direction using the formula:

Number comparisons times alpha (hypothesis) EQUALS
alpha (per individual comparison)
yielding .05/10 = .005.

When considering analysis of variance and Pearson correlation coefficient results, the chance of finding that outcome in a given individual test by chance alone was required to be less than .005 before the result was considered statistically significant.

Results

Table 1 summarizes the average test scores and standard deviations for each of the grade variables (flight and academic) for each of the five phases of the flight school curriculum broken down by groupings of smokers, nonsmokers, and pooled averages. It is obvious by comparing mean grades of smokers and nonsmokers that only very small differences in performance exist.

Table 1.

Mean grades (and SD) by phase for smokers/nonsmokers

		Smokers		Nonsmokers	
Primary	FL1	87.86		87.85	
		(3.48)		(3.90)	
	AC1		90.56		90.68
			(4.67)		(3.38)
Contact	FL2	85.73		85.94	
		(3.90)		(3.52)	
	AC2		98.16		98.33
			(3.38)		(3.21)
Instrument	FL3	85.96		86.03	
		(4.43)		(3.82)	
	AC3		93.53		93.61
			(5.08)		(4.94)
Cmbt skill	FL4	89.22		88.68	
		(5.41)		(5.86)	
	AC4		91.14		91.16
			(6.53)		(6.55)
Night	FL5	86.61		86.37	
		(3.54)		(3.24)	
	AC5		90.68		91.20
		(4.28)		(4.49)	
Overall			88.71		88.84
			(3.13)		(3.28)

"FL" are flight grades, "AC" are academic grades.

Table 2 presents correlation coefficients (r) and the associated p values for these coefficients, crossing flight and academic grades with pack-years. None of the correlations are significant at the .005 level.

Table 2.
Pearson correlation analysis:
Flight school grades with smoker/nonsmoker status

	Primary		Contact		Instrument		Cmbt skills		Night		
	FL1	AC1	FL2	AC2	FL3	AC3	FL4	AC4	FL5	AC5	Overall
r	-.0031	-.0096	-.0289	-.0248	-.0152	-.0147	.0422	-.0035	-.0420	-.0465	-.0173
p	.441	.317	.090	.119	.243	.248	.091	.444	.103	.031	.197

Table 3 shows the analysis of variance outcomes, using smoking/ nonsmoking as a categorical variable and flight and academic grades as the continuous variable. The F scores and their associated p values are listed and support the trends detailed in the Pearson correlation analysis above; none of the analyses show a significant difference at the .005 level between smoker and nonsmoker performance.

Table 3.
Analysis of variance:
Flight school grades with smoker/nonsmoker status

	Primary		Contact		Instrument		Cmbt Skills		Night		
	FL1	AC1	FL2	AC2	FL3	AC3	FL4	AC4	FL5	AC5	Overall
F:	.145	.197	.016	.126	.462	.003	.018	.730	1.346	.030	.157
p:	.703	.657	.899	.723	.497	.954	.895	.394	.247	.863	.692

Discussion

Using an adequate number of aviators, no evidence of a statistically significant relationship could be found between smoking and flight performance. The task types in flight school performance are many; the variables involved in the motivations to smoke and the effects of smoking are multiple, creating a large mix of sometimes self-canceling pressures and outcomes and this may be the explanation for finding no effect.

In fact, analysis of the score data without the correction described above for choosing the sensitivity level (using the .05 level instead of the .005 level) fails to identify significant variables. The flight grade portion of the night phase is the lowest p value at the p=.247 level.

Decrementing effect of smoking on night vision has been described. The speed and ultimate level of visual dark adaptation have been found by some studies to be less in smokers (Young and Erikson, 1980; Sheard, 1946; Luria and McKay, 1979; Durazzini, Azao, and Bertoni, 1975). McFarland's work (1970) suggests that carbon monoxide and not nicotine is the element in smoking that lowers dark adaptation. Research in other visual areas suggests that smoking has little or no effect on visual acuity, a questionable effect on accommodation, and perhaps enhances vigilance. These visual effects could show themselves in flight school performance, but fail detection if present in this analysis.

Also, an interesting postulation is that of the manner in which caffeine may confound this equation. If the stimulant effects of nicotine are added to those of the caffeinated beverage drinker, some of the depressant effects of carbon monoxide may be counterbalanced and not be apparant in the test score analysis. Including caffeine and other stimulant intake (though no others except occasional phenylephrine decongestants are approved for use in flying aviators) should be controlled for in future studies.

Conclusion

That smoking is detrimental to overall health is clear from many controlled medical studies. However, this study could demonstrate no association between student aviator smoking behavior and flight performance grades.

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Aeromechanics Laboratory
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