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# Drug Violations and Aviation Accidents: Findings from the U.S. Mandatory Drug Testing Programs

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## Abstract

**Aims—**To assess the role of drug violations in aviation accidents.

**Design—**Case-control analysis.

**Setting—**Commercial aviation in the United States.

**Participants—**Aviation employees who were tested for drugs during 1995 through 2005 under the post-accident testing program (cases, n=4,977) or under the random testing program (controls, n=1,129,922).

**Measurements—**Point prevalence of drug violations, odds ratio of accident involvement, and attributable risk in the population. A drug violation was defined as a confirmed positive test for marijuana (≥ 50 ng/ml), cocaine (≥ 300 ng/ml), amphetamines (≥1000 ng/ml), opiates (≥ 2000 ng/ml), or phencyclidine (≥ 25 ng/ml).

**Findings—**The prevalence of drug violations was 0.64% [95% confidence interval (CI), 0.62–0.65%] in random drug tests and 1.82% (95% CI, 1.47–2.24%) in post-accident tests. The odds of accident involvement for employees who tested positive for drugs was almost three times the odds for those who tested negative (odds ratio 2.90, 95% CI, 2.35–3.57), with an estimated attributable risk of 1.2%. Marijuana accounted for 67.3% of the illicit drugs detected. The proportion of illicit drugs represented by amphetamines increased progressively during the study period, from 3.4% in 1995 to 10.3% in 2005 ($p<0.0001$).

**Conclusions—**Use of illicit drugs by aviation employees is associated with a significantly increased risk of accident involvement. Due to the very low prevalence, drug violations contribute to only a small fraction of aviation accidents.

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**Keywords**

Accidents; aviation; drug testing; epidemiology; policy; substance abuse

## INTRODUCTION

Drug testing programs started in the US military in the early 1980s following the 1981 USS Nimitz crash, in which 7 of the 14 fatally injured crew members tested positive for marijuana [1]. President Reagan initiated the federal drug-free workplace program in 1986 through Executive Order 12564, which made provisions for testing employees with safety-sensitive functions for five illicit drugs: marijuana, cocaine, amphetamines, opiates, and phencyclidine [2]. Since then, drug testing has become an increasingly common practice in occupational settings. By 2004, about two-thirds of all US companies had established drug testing programs [3]. Implementation of workplace drug testing programs has been linked to reduced drug use by employees [4,5].

Despite the widespread adoption of drug-free workplace programs by employers, testing employees for drugs is controversial [6]. In addition to legal, ethical, and economic concerns, the effectiveness of mandatory drug testing in improving occupational safety has not been well established [2, 7-10]. Empirical evidence suggests that the effectiveness of drug-free workplace programs may vary among industries. Using data from the Fatality Analysis Reporting System of the National Highway Safety Administration between 1983 and 1998, Jacobson estimated that mandatory drug testing in the trucking industry was associated with a 9% reduction in crash fatalities [2]. Wickizer and colleagues analyzed worker's compensation claims data for the State of Washington from 1994 through 2000 and found that implementation of drug-free workplace programs was associated with reduced injury rates for employees working in the construction, manufacturing, and services industries, but not for employees in the agriculture, transportation, finance, and other industries [8].

The relationship between drug use behavior and safety performance has been studied extensively in a variety of occupational settings [7,11-13]. It has been reported that postal workers and truck drivers who use illicit drugs have significantly higher injury rates than their respective counterparts [12,13]. Although mandatory drug testing programs have been implemented in the U.S. aviation industry since 1990, there is a paucity of information about the role of drugs in aviation accidents. With a case-control design, this study aims to assess the association between drug violation rates and the risk of accident involvement in aviation employees.

## METHODS

Data for this study came from the annual reports of drug testing results submitted to the FAA by aviation employers, including all major airlines (Part 121 certificate holders), commuter air carriers and air taxi operators (Part 135 certificate holders), and air traffic control facilities that are not operated by the FAA. Federal regulations mandate that aviation employers report annual alcohol and drug test statistics to the FAA using standard protocols and procedures [14]. The Drug Abatement Division of the FAA is responsible for implementation of the Anti-Drug and Alcohol Misuse Prevention Programs for Personnel Engaged in Specified Aviation Activities, including collecting, maintaining, and auditing alcohol and drug testing data submitted by aviation employers. To ensure data quality and accuracy, the FAA requires that the annual report be signed by a representative of the employer and the original testing records be stored for at least five years and be made

available to the federal agency for inspection upon request. False statements or reports may constitute a criminal offense and are punishable by a fine up to $10,000 or up to 5 years of prison, or both [14].

Drug tests under the federally mandated testing programs are performed by laboratories certified by the US Department of Health and Human Services (HHS) according to the procedures codified in 49 CFR Part 40 ("Procedures for Transportation Workplace Drug and Alcohol Testing Program") [14]. Aviation employees covered by the mandatory testing programs are those performing safety-sensitive functions, including flight crewmembers, flight attendants, flight instructors, aircraft dispatchers, aircraft maintenance personnel, ground security coordinators, aviation screeners, and air traffic controllers. These employees are subject to a standard set of drug testing programs. This study was based on data from two programs: random testing and post-accident testing. Random testing is the predominant program, accounting for 96% of all drug tests performed on aviation employees [15]. Each year, at least 25% of employees are selected at random for drug testing immediately before, during, or immediately after their work shift. Post-accident testing stipulates that all employees whose performance may have contributed to the accident submit to drug testing as soon as possible following the accident, but not later than 32 hours after the accident [16]. An aviation accident is defined by the US federal government as an event associated with the operation of an aircraft in which any person suffers fatal or serious injury, or in which the aircraft receives substantial damage[17]. About 5% of the accidents involving major airlines and 20% of the accidents involving commuter air carriers and air taxis result in at least one fatality [18].

Department of Transportation (DOT) drug tests are conducted using only urine specimens. Urine collection must be conducted in such a place that will provide visual privacy for the employee and minimize opportunities for adulteration or substitution of the specimen. The security and integrity of the collection site is maintained by a trained and qualified collector, who will also inspect specimens for any signs of tampering or substitution. The collector will divide the specimen into primary and split samples and will send both samples to an HHS-certified laboratory, which will test for marijuana, cocaine, amphetamines, opiates, and phencyclidine using the primary sample. The laboratory will also complete validity testing on the primary sample to determine if the specimen is consistent with human urine, and whether it has been diluted, substituted, or adulterated. Specimens with drug concentrations at or above the thresholds (marijuana ≥ 50 ng/ml, cocaine ≥ 300 ng/ml, amphetamines ≥1000ng/ml, opiates ≥ 2000 ng/ml, or phencyclidine ≥ 25 ng/ml) must undergo confirmation testing. A test is considered positive only when the confirmation test result is at or above the confirmation thresholds: marijuana ≥ 15 ng/ml, cocaine ≥ 150 ng/ml, amphetamines ≥ 500 ng/ml, opiates ≥ 2000 ng/ml, or phencyclidine ≥ 25 ng/ml. Drug testing results are reported to the medical review officer, a physician knowledgeable in substance abuse disorders, interpretation of drug and validity test results, and DOT guidelines, who will determine if there is a legitimate medical explanation for a laboratory-confirmed positive, adulterated, or substituted result, and will review and report these results to the employer. The employee may request a test of the split specimen by a second laboratory for results that are positive or when the specimen meets the criteria for substitution or adulteration [14, 19].

A drug violation refers to a confirmed positive test, refusal to submit to testing, adulterated/ substituted test, or shy bladder. A shy bladder is operationally defined as failure to provide a sufficient amount of urine when directed if there is no adequate explanation following a medical evaluation. Of the drug violations reported to the FAA, 91% were based on positive urine tests, 6% due to refusals to submit to testing, and 3% due to adulterated/substituted tests or shy bladders [15].

The association between drug violation and the risk of accident involvement was assessed with the case-control method. Employees who were tested post-accident served as the cases, and employees who were tested under the random testing program during the same time period served as the controls. The strength of the association between drug violation and the risk of accident involvement was measured by the odds ratio (OR), which was computed using the formula below [20]:

$$OR = (a \times d) / (b \times c),$$

where *a* is the number of cases with drug violation; *b*, the number of controls with drug violation; *c*, the number of cases without drug violation; and *d*, the number of controls without drug violation. The OR would approximate the risk ratio if the selection of employees for drug testing is unbiased and if accident involvement is a rare occurrence. Unbiased selection entails that all employees with safety-sensitive functions who are involved in accidents have the same chance of being selected for post-accident testing and all covered employees have the same chance of being selected for random testing.

The contribution of drug violations to aviation accidents was measured by the attributable risk in the population (AR), which was calculated using the formula below [20]:

$$AR = [p \times (OR - 1)] / [1 + p \times (OR - 1)],$$

where p denotes the prevalence of drug violations detected in random testing. The AR represents the proportion of all aviation accidents that are attributable to drug violations. The research protocol was reviewed and approved through exemption by the Columbia University Medical Center's institutional review board.

## RESULTS

During 1995 through 2005, the FAA recorded a total of 4,977 post-accident drug tests and 1,129,922 random drug tests, which detected 91 and 7,211 drug violations, respectively. The estimated odds ratio of accident involvement associated with drug violations was 2.90 [95% confidence interval (CI), 2.35–3.57]. Given the estimated odds ratio, 2.90, and the prevalence of drug violations based on the random testing data, 0.64% (7211/1129922), it was estimated that 1.2% of aviation accidents were attributable to drug violations.

Occupation-specific drug testing data were available only for the years 2003–2005. Data from the random testing program revealed that the prevalence of drug violations varied substantially across occupations, ranging from 0.05% (95% CI, 0.03–0.06%) for flight crews to 1.2% (95% CI, 0.62–1.98 %) for aviation screeners (Table 1). The estimated odds ratios of accident involvement associated with drug violations ranged from 2.49 (95% CI, 1.68–3.70) for aircraft maintenance personnel to 13.55 (95% CI, 3.26–56.42) for flight attendants (Table 2). The overall estimated odds ratio based on the 2003-2005 data was 3.40 (95% CI, 2.42–4.75).

Of all the drugs detected by the mandatory testing programs during 1995 through 2005, 67.3% were marijuana, 23.9% were cocaine, 6.1% were amphetamines, 2.1% were opiates, and 0.6% were phencyclidine. Although the prevalence of drug violations remained fairly stable during the study period, the composition of detected drugs changed considerably (Fig. 1). Specifically, the proportion of illicit drugs accounted for by amphetamines increased markedly, from 3.4% in 1995 to 10.3% in 2005 ($p<0.0001$), whereas the proportion

accounted for by marijuana decreased from 68.4% to 62.2% (p=0.0001) during the same time period (Fig. 1).

## DISCUSSION

Substance abuse has long been recognized as one of the most important public health issues in the U.S. Data from the National Household Survey on Drug Abuse indicate that about 15% of employees aged 18 years older reported using illicit drugs in the past year [21]. Data from federally mandated random testing programs suggest that the overall point prevalence of drug violations is approximately 7% for the general U.S. workforce and 2% for employees with safety-sensitive functions [22]. Although previous studies have found that employees with substance abuse problems tend to be at a greater risk for job-related injury than other employees [12, 13], the role of drugs in occupational accidents has not been adequately examined based on analytical epidemiological studies using drug testing data. Results of this study indicate that aviation employees as a whole are much less likely to use illicit drugs than employees in other transportation modes (e.g., trucking, transit, and railway) and the general workforce [22]. Overall, less than 1% of the aviation employees tested positive for illicit drugs under the random testing program. Drug violations are especially rare in flight crews; on average, it takes about 2000 random tests to detect one drug violation. Although the prevalence of employee drug violations in aviation is far lower than in other industries, the patterns and time trends of drugs detected are similar across occupations [22]. For instance, the increase in the use of amphetamines found in this study has been well documented in the general population as well as in different occupational groups [22, 23].

Contrasting the random testing data with the post-accident testing data enabled us to quantitatively assess the association between drug violation and the risk of accident involvement in aviation employees. The finding that aviation employees who test positive for illicit drugs are at a significantly increased risk of being involved in accidents is consistent with studies conducted in other industries [12, 13] and the estimated odds ratio is comparable to that associated with alcohol violations [24]. The estimated attributable risk suggests that drug violations play a very small role in aviation accidents, accounting for approximately 1.2% of all aviation accidents.

It is worth noting that data in this study were limited to employees of major airlines, commuter air carriers, and air taxis. General aviation, which accounts for over 90% of all aviation accidents and fatalities [18], consists of noncommercial flights and thus is not covered by the mandatory drug testing programs. Given the differences in demographic characteristics, flight environments, and regulations between commercial aviation and general aviation, findings from this study are unlikely to be applicable to private flights. Secondly, our analysis relied on aggregated data reported to the FAA. In the absence of individual-level data, we were unable to examine the prevalence of drug violations by employee characteristics and assess the association between drug violation and the risk of accident involvement with adequate adjustment for potential confounding variables. Our stratification analysis based on occupations suggests that the estimated odds ratios of accident involvement associated with drug violations tend to be greater for flight attendants and flight crewmembers than for other aviation employees. Thirdly, one should not infer causality directly from the association between drug violations and aviation accidents reported in this study because a positive drug test post-accident does not necessarily mean that the employee was under the influence of the drug at the time of accident. The detection time of drugs in the urine varies from 24 hours for opiates to three months for marijuana, depending on the dosage, route of administration, duration and frequency of drug use, and other factors [25, 26]. Finally, the rarity of aviation accidents and the low prevalence of drug

violations in aviation employees made the data too sparse for us to assess the relationship between drug violation and the risk of accident involvement according to specific drug types and different drug combinations.

Nevertheless, this study provides much-needed empirical data for understanding the role of illicit drugs in aviation accidents and for evaluating the mandatory drug testing programs in aviation employees. The estimated odds ratio, a measure of the strength of the association between drug violations and aviation accidents, suggests that use of illicit drugs may triple the risk of accident involvement. Although the strong association between drug violations and aviation accidents is statistically significant, the role of illicit drugs in aviation accidents appears to be very small, with only 1.2% of all aviation accidents attributable to drug violations. Further research is needed to examine the possible impact on safety of the increased use of amphetamines by aviation employees and determine the extent to which the overall low prevalence of drug violations in aviation employees is due to the deterrent effects of the various testing programs.

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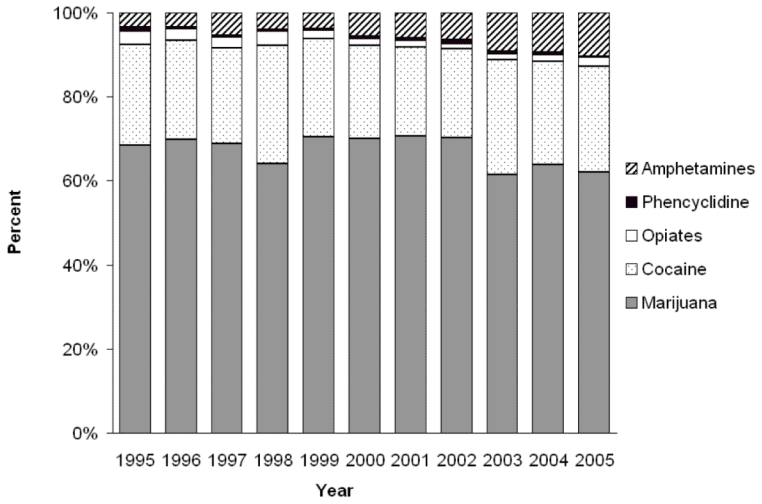


**Figure 1.**
Percentage distribution of illicit drugs detected in aviation employees by year and drug, United States, 1995-2005

## Table 1

Prevalence of drug violations in aviation employees by occupation, United States, 2003–2005.

| Occupation | Number of Random Tests | Number of Violations | % |
|---|---|---|---|
| Flight Crewmembers | 73153 | 33 | 0.05 |
| Flight Instructors | 2306 | 4 | 0.17 |
| Air Traffic Controllers | 1134 | 3 | 0.26 |
| Flight Attendants | 81953 | 317 | 0.39 |
| Ground Security Coordinators | 19637 | 119 | 0.61 |
| Aircraft Dispatchers | 8666 | 59 | 0.68 |
| Aircraft Maintenance | 115856 | 1159 | 1.00 |
| Aviation Screeners | 1116 | 13 | 1.16 |
| **Total** | **303821** | **1707** | **0.56** |

**Table 2**

Estimated odds ratios (ORs) and 95% confidence intervals (CIs) of accident involvement associated with drug violations in aviation employees by occupation, United States, 2003–2005.

| Occupation | Drug Violation | Cases | | Controls | | OR | 95% CI |
|---|---|---|---|---|---|---|---|
| | | n | (%) | n | (%) | | |
| Flight Crewmembers | Yes | 2 | (0.5) | 33 | (0.1) | 10.21 | 2.44–42.69 |
| | No | 434 | (99.5) | 73,120 | (99.1) | | |
| Flight Attendants | Yes | 2 | (5.0) | 317 | (0.4) | 13.55 | 3.26–56.42 |
| | No | 38 | (95.0) | 81,636 | (99.6) | | |
| Ground Security Coordinators | Yes | 5 | (4.0) | 119 | (0.6) | 6.83 | 2.74–17.02 |
| | No | 120 | (96.0) | 19,518 | (99.4) | | |
| Aircraft Maintenance | Yes | 26 | (2.5) | 1,159 | (1.0) | 2.49 | 1.68–3.70 |
| | No | 1,032 | (97.5) | 114,697 | (99.0) | | |
| Other[a] | Yes | 0 | (0.0) | 79 | (0.6) | *b* | *b* |
| | No | 45 | (100.0) | 13,143 | (99.4) | | |
| **Total** | **Yes** | **35** | **(2.1)** | **1,707** | **(0.6)** | **3.40** [c] | **2.42–4.75** |
| | **No** | **1,669** | **(97.9)** | **302,114** | **(99.4)** | | |

[a] Including air traffic controllers, aviation screeners, flight instructors, and aircraft dispatchers.

[b] Not estimable because none of the cases tested positive for drugs.

[c] Based on the Mantel-Haenszel method and the logit estimator with a correction factor of 0.5 in every cell containing a zero.