Epidemiology of Drug Abuse: An Overview

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Issues regarding the use of epidemiology in drug abuse research are discussed and systems for monitoring national trends and identifying risk factors are described. Data indicate a general decline in marijuana use among youth, a cohort aging effect among heroin and marijuana users, and increased prevalence and health consequences associated with cocaine use.

THE APPLICATION OF EPIDEMIOLOGY TO THE STUDY OF drug abuse is relatively recent. Despite the long history of drug abuse in society, the use of the epidemiologic approach to study this complex public health problem began in earnest less than two decades ago. It was during the outbreak of heroin abuse in the late 1960's that the use of the term "epidemic" to describe drug abuse came into vogue. Although most of the scientific community recognized both the validity and the benefit inherent in using the tools of the epidemiologist in understanding and addressing the problem of drug abuse during that era (*1–8*), the introduction of the technique was not without its critics (*9, 10*).

One focus of concern during that time was that the initial introduction of drugs into the body was voluntary. This was contrasted with diseases involuntarily contracted that were being investigated by the traditional medical epidemiology model. It was argued by some that since drug abuse was a self-imposed condition, it was automatically excluded from the jurisdiction of the epidemiologist, whose imperative was to study infectious disease. In response, Greene made a strong case that heroin addiction was a communicable disease in the classical sense, with the drug itself being the infectious agent, the host and reservoir being man, and the drug-using peer as the vector (*11*).

Another major concern of the day was the potential for indiscriminate use of quarantine (in this case also known as incarceration) as a preventative against the spread of drug abuse to the general population. This argument centered on the conclusion, held inevitable by some, that drug abusers once identified would be automatically imprisoned. Neither of these objections stimulated much action beyond debate and posed no serious impediment to the efficacious introduction of epidemiology to the study of drug abuse.

There was also much discussion about whether drug abuse more closely paralleled a chronic relapsing disease or an acute disease pattern. The popular view was that drug abuse was a unidimensional phenonmenon, that is, no distinction was made between the type of drugs used, etiology, and populations at risk. There was an attempt to classify drug-using behavior into one of two apparently distinct categories. More recently, the recognition of the wide differences in classes of drugs abused and the diversity of abuser populations point up even further distinctions in the underlying motivations for initial use and resultant adverse health consequences. Over the years drug abuse has moved from the position of being challenged as an appropriate object for epidemiologic study to challenging the creativity of epidemiology itself.

Recent history shows that in contrast to the issues in which drug abuse differs from other types of epidemiologic investigation, the areas of similarity are immediately evident. Drug abusers demonstrate patterns of behavior that can be measured, incidence curves can be drawn, rates of prevalence can be computed, attack rates can be calculated, risk factors can be identified, etiologies and consequences can be determined, and prevention programs can be implemented.

As with most social behavior, the etiology of drug abuse is complex, varying through time, by geographic region, and by demographic characteristics. The underlying causes of drug abuse are as diverse as the populations that they affect. Peer pressure, curiosity, depression, hedonism, attempts to increase or improve performance, rebellion, alienation, and a wide variety of other reasons have been cited as responsible for abuse of substances ranging from solvents to stimulants to opiates. Changes have been observed in the types of drugs abused both in national waves as well as regional and localized ripples, from marijuana in the 1960's through heroin in the 1970's to cocaine in the 1980's.

Risk factors change and are subject to the same demographic and geographic variations that affect other aspects of drug abuse. The factors that placed populations at high risk for heroin abuse in the late 1960's and early 1970's have changed dramatically in the 1980's. In the earlier period, the profile of a heroin addict was a male in the middle to late teens who was initiated into heroin use during the previous several years, disproportionately from minority groups, and living in an inner city area. In the mid-1980's, the heroin addict population still is composed primarily of males, but in their early to mid-30's, the majority of whom have a history of heroin abuse that extends back to the late 1960's and early 1970's. They are, in fact, the earlier use cohort.

Not only are certain populations at risk for abuse of specific types of drugs, but drug abuse itself constitutes an antecedent condition for other adverse health consequences. Thus, intravenous drug abusers are at high risk for contracting acquired immune deficiency syndrome (AIDS) as well as a host of other diseases. The consequences of drug abuse vary just as widely and change just as substantially over time. Changes in patterns of abuse, such as engaging in more dangerous routes of administration, increasing dosage units, or using drugs in combination, increase vulnerability to toxic effect. For example, the recent domestic cultivation of sinsemilla marijuana has introduced much higher levels of tetrahydrocannabinol into the marijuana-abusing population, thus increasing the amount of psychoactive substance ingested and the probability of acute adverse health consequences. In addition, social and psychological problems resulting from chronic cocaine abuse have

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been identified that were totally unsuspected just a few years ago. In fact, the compulsive drug-seeking behavior associated with cocaine abuse has led to a redefinition of the term "addiction," which previously had been restricted to the physical withdrawal symptoms resulting from opiate and depressant dependence.

Measurement Issues

Measurement of the drug abuse problem is complicated by the fact that drug abuse is an illicit behavior and that populations of interest may not be studied by traditional research methodologies. In addition, drug abuse itself may be considered a deviant behavior or it may be considered a disease (that is, addiction), or, as mentioned above, it may be regarded as an antecedent to a disease, such as AIDS, subacute bacterial endocarditis, and others. In the first case, the population at risk is the general population of the United States. In the second case, the population at risk might be defined as those who had abused a certain drug more than a given number of times and, in the third case, the population at risk might be defined as intravenous (IV) drug abusers.

Analytical epidemiology has been used on many occasions to document specific risk factors associated with drug abuse (*12–14*), but findings in this paper are based on data from national drug abuse surveillance programs. One of the most effective measurement tools employed in the descriptive epidemiology program for drug abuse is surveys. Repeated cross-sectional surveys are used to monitor trends, changes in the attitude of the population, and the prevalence of drug use. Two such surveys, the National Household Survey on Drug Abuse and the High School Senior Survey, are sponsored by the National Institute on Drug Abuse (NIDA). These surveys use probability samples, thus allowing extrapolation to the general population.

The annual High School Senior Survey collects information from approximately 16,000 to 18,000 public and private high school seniors located in approximately 130 high schools in the contiguous United States. These survey data are used to monitor trends in drug abuse and, through a longitudinal study of a subsample of each class, to monitor maturational factors associated with drug abuse. The measures and procedures employed have been standardized and applied consistently in data collection since 1975.

Although the exclusion of dropouts and absentees from the study may result in somewhat conservative estimates of drug abuse in the high school senior class population, the stability of the survey provides an excellent measurement of drug abuse trends, including both prevalence and incidence data as well as changes in attitudes and beliefs about drugs. In addition, the follow-up design in the survey provides information on drug abuse subsequent to high school graduation, which is vital to determination of age-related risk factors. For example, these data indicate that while the extent of marijuana abuse does not change significantly after high school, the abuse of cocaine increases dramatically. This finding, in addition to findings from other studies, has been used to suggest that the age of risk for cocaine abuse may be different from that for other drugs (*15*).

The National Household Survey on Drug Abuse, a general population survey of household members aged 12 and above, has been conducted every 2 to 3 years since 1971. This survey excludes populations in institutionalized settings (prisons, military bases, colleges) as well as transient and nonresidential populations. Therefore, estimates of drug abuse may be conservative. Still this household survey remains the single most important measure of drug abuse in our general population. In addition to monitoring trends by age, sex, and other demographic variables, the size of the database permits analysis of a variety of questions on drug abuse. For example, data from the 1982 survey suggested that current abuse of marijuana as well as annual prevalence (use in the past year) of marijuana abuse had decreased for both males and females between 1979 and 1982. These decreases were greater for males, pointing to the possibility that incidence rates during the period may have been higher for females (*16*). More detailed analysis of the 1982 survey data regarding first use of marijuana for the previous year indicated that the incidence of marijuana abuse was higher among females than males in the age group 12 to 25 (Table 1). The incidence rates in Table 1 represent new use of marijuana as a percentage of the population at risk and exclude those who have used marijuana previously.

Table 1. Population using marijuana for the first time in the preceding year and incidence rates for marijuana use. Data from 1982.

Age group	First use (%)		Incidence	
	Males	Females	Males	Females
12 to 17	4.0	8.0	5.3	9.6
18 to 25	0.7	1.4	2.3	3.3
Sample size	1404	1460	845	938

In another study, the National Household Survey on Drug Abuse database was used in an attempt to define the population at risk for cocaine abuse. Analysis of the household data suggested that, not only were cocaine abusers likely to have abused marijuana prior to abuse of cocaine, but the probability of abusing cocaine increased with the frequency and recency of marijuana abuse (*17*). The inclusion of drug problem and dependency scales in the most recent survey will enable researchers to assess risks according to levels of abuse. For example, a recent study of high-risk cocaine abusers (defined as having abused cocaine at least 12 times in the previous year) indicated that the number of self-reported dependency symptoms increased with frequency of abuse (*18*).

There are two more data systems that are used by NIDA. The Drug Abuse Warning Network (DAWN) reports consequences of drug abuse as reflected by emergency room episodes for drug-related problems and medical examiner cases for drug-related fatalities. The Client Oriented Data Acquisition Process (CODAP) reports treatment data.

Both data systems have been used to monitor drug abuse trends and health consequences. For example, DAWN data have been used to measure recent changes in reported cocaine morbidity and mortality, increases in speedballing (the use of heroin and cocaine in combination), and increases in the median age of heroin abusers. In addition, DAWN data were used to monitor the spread of the combination of pentazocine and tripelennamine, known on the street as "T's and blues." With the reformulation of pentazocine to include the narcotic antagonist naloxone, DAWN reflected a subsequent decline in the number of emergency cases and fatalities related to T's and blues (*19*).

An example of the use of CODAP data is a recent analysis of admissions for treatment in the Southwest which showed that the abuse of inhalants is particularly serious among the Hispanic population in that area. With a sample controlled for age it was found that 60% of Hispanics admitted to drug abuse treatment programs had less than a 12th-grade education. This figure rose to 85% when only inhalant abusers were examined (*20*). While each of the trend indicator or measurement systems cited has recognized methodological limitations, each provides a particular view of drug abuse behavior or consequences and together form a reasonably solid foundation for tracking epidemiologic trends.

Patterns and Trends of Selected Drugs of Abuse

Heroin. In many respects, heroin is one of the most difficult drugs to investigate. In spite of its visible presence during the past 20 years as a national social and health problem, its association with crime, and the recent relation established between IV drug abuse (predominantly IV heroin abuse) and AIDS, heroin abuse continues to be a relatively rare event and involves a population that seeks to remain hidden. These circumstances virtually preclude the use of traditional research methods, such as general surveys, in studying incidence, prevalence, and consequences of abuse.

Treatment data reported to CODAP, however, have been used to identify relative changes in incidence through calculation of year of first heroin use. Because of the difficulty in identifying denominator data, raw counts rather than rates have to suffice for incidence trend analysis. Figure 1 shows that epidemics of heroin abuse occurred in the United States during the mid-1960's, the mid-1970's, and the early 1980's.

The data show that the epidemics which occurred in the 1960's and 1970's were national in scope, whereas the epidemics of the 1980's were more localized in geographic location. In the latter case, the country in which the heroin originated was identified as an important link to the area of the United States affected (*21*).

In comparison with incidence analysis, problems are even more complex in estimating the prevalence of heroin abuse. Over the years, various methods have been used, including snowball techniques and multiplier methods as well as mathematical and systems analysis models (*22*). In spite of the inherent difficulties of definition and measurement, various estimates of the heroin addict population have been surprisingly similar and consistent for the last decade, for the most part ranging between 400,000 and 600,000.

Although heroin prevalence appears to have remained relatively stable in recent years, changes have occurred in characteristics of abusers, most notably an aging effect, as evidenced in both treatment and DAWN emergency room data. For example, the percentage of all heroin-related nonfatal emergencies reported to DAWN, which involved persons 30 years of age or older, increased from 36% in 1979 to 58% in 1983, whereas a similar increase from 41 to 56% occurred during the same time period among heroin treatment admissions. These age data make a strong case, when combined with declining incidence data, that the preponderance of current heroin abusers were initiated into heroin abuse between the mid-1960's and mid-1970's.

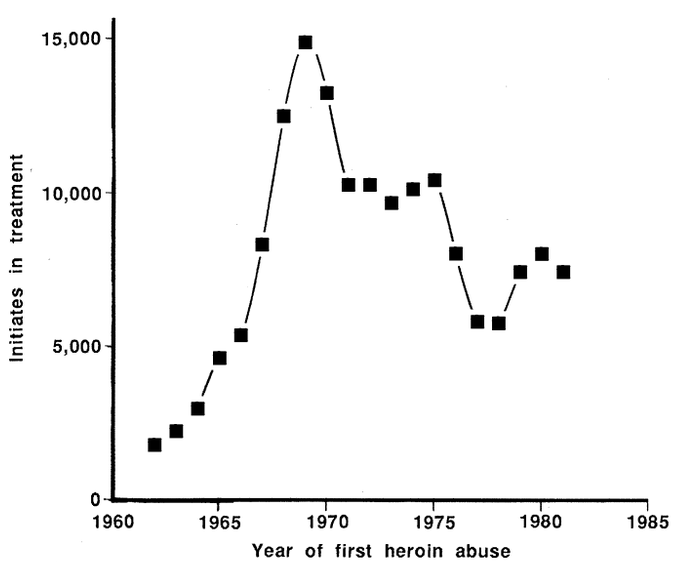

Fig. 1. Incidence of heroin abuse. Data are based on admissions to a panel of federally funded treatment programs.

Table 2. Trend in estimated prevalence of marijuana use among three age groups, 1971–1982.

Prevalence	Population using marijuana (%)						
	1972	1974	1976	1977	1979	1982	1985
			12- to 17-year-olds				
Ever used	14.0	23.0	22.4	28.0	30.9	26.7	23.7
Used in past year		18.5	18.4	22.3	24.1	20.6	20.0
Used in past month	7.0	12.0	12.3	16.6	16.7	11.5	12.3
Sample size	880	952	986	1272	2165	1581	2287
			18- to 25-year-olds				
Ever used	47.9	52.7	52.9	59.9	68.2	64.1	60.5
Used in past year		34.2	35.0	38.7	46.9	40.4	37.0
Used in past month	27.8	25.2	25.0	27.4	35.4	27.4	21.9
Sample size	772	849	882	1500	2044	1283	1804
			26 years and older				
Ever used	7.4	9.9	12.9	15.3	19.6	23.0	27.2
Used in past year		3.8	5.4	6.4	9.0	10.6	9.5
Used in past month	2.5	2.0	3.5	3.3	6.0	6.6	6.2
Sample size	1613	2221	1708	1822	3015	2760	3947

A variety of risk factors and health consequences have been related to heroin abuse over the years. Most recently, reports of the growing availability of "black tar" heroin, a type of heroin purported to be of high purity and low price, may be responsible for recent increases in heroin-related morbidity and mortality (*23*). Additional risk factors include abuse of heroin in combination with other substances. A particularly lethal combination in recent years has been the ingestion of heroin in temporal proximity to the consumption of alcohol (*12*). The most dramatic issue of the day, though, is the association between IV drug abuse and AIDS. Not only has the percentage of AIDS cases associated with IV drug abuse been increasing, but in some areas, such as New York and New Jersey, IV drug abusers are threatening to become the majority risk group, and this group is viewed as representing the potential bridge to the general population.

Marijuana. The most widely abused illegal drug in the country today is marijuana. The 1982 National Household Survey on Drug Abuse indicated that an estimated 56 million people in the United States had used marijuana at least once and slightly more than 20 million were estimated to have consumed it during the month before the survey (*16, 24*). By 1985, lifetime prevalence increased to 62 million, while use in the past month decreased to 18 million. These estimates represent a substantial percentage of the national population, but the lifetime (ever used), annual, and past month prevalence trends show a decline or leveling among all age groups during the most recent measurement points (Table 2).

The increase in the 26 and older age category was found to be the result of a cohort effect—that is, the entry of the 23- to 25-year-old age cohort into the 26 and older age group between 1979 and 1982. The net change in the older adult group was not statistically significant (*17*).

These national household trends are reflected in data from high school senior classes which reached their apex in marijuana use with the classes of 1978 and 1979 and have since declined through 1984 and leveled off in 1985 (Table 3). A clue to the reasons underlying the surge in marijuana abuse during the 1970's and its subsequent decline also may be garnered from the High School Senior Survey. The point at which marijuana abuse had reached its peak was the same point at which perceived harmfulness was at its nadir. For

Table 3. Trend in estimated prevalence of marijuana use among high school senior classes, 1975–1985.

Prevalence	High school seniors using marijuana (%)										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Ever used	47.3	52.8	56.4	59.2	60.4	60.3	59.5	58.7	57.0	54.9	54.2
Used in past year	40.0	44.5	47.6	50.2	50.8	48.8	46.1	44.3	42.3	40.0	40.6
Used in past month	27.1	32.2	35.4	37.1	36.5	33.7	31.6	28.5	27.0	25.2	25.7
Used daily in past month	6.0	8.2	9.1	10.7	10.3	9.1	7.0	6.3	5.5	5.0	4.9
Sample size	9,400	15,400	17,100	17,800	15,500	15,900	17,500	17,700	16,300	15,900	16,000

example, in 1978 monthly prevalence among high school seniors was at 37% and almost 11% used marijuana daily. At the same time, only 12% of seniors nationwide believed that there was great risk of harm associated with occasional use, and 35% perceived great risk with regular use. By 1985 monthly prevalence declined to 26% and daily use to below 5%, whereas perceived risk for occasional use rose to 25% and for regular use to 70%.

Thus, the belief that marijuana use, even once or twice, poses no great risk is highly correlated with an increase in prevalence trends and probably had its genesis in the social status afforded the drug during the 1960's and early 1970's and the lack at that time of conclusive findings regarding short- or long-term health consequences (*25*). Now it is clear that marijuana has a serious impact on social functioning as well as health. Behaviorally, use of marijuana, especially long-term heavy use, has been directly related to subsequent abuse of other illicit drugs (*26*). Marijuana has been called a "gateway" drug and, indeed, the single best predictor of cocaine use is frequent use of marijuana during adolescence (*27*).

Clinical effects of marijuana also have been documented, specifically the effect of marijuana on the nervous system as well as the cardiovascular, respiratory, and other major body systems (*28*). In addition, long-term marijuana abuse, just as long-term cigarette smoking, can produce serious chronic effects over time and recent evidence suggests that marijuana abuse adversely affects performance (*29*). With these considerations in mind, the Institute of Medicine has called for further epidemiologic study in the form of cohort and case-control studies to identify the long-term health consequences of marijuana abuse (*28*).

Cocaine. In 1973, the Strategy Council on Drug Abuse stated that morbidity associated with cocaine abuse did not appear to be great. It also stated that at the time there were virtually no confirmed cocaine overdose deaths and that a negligible number of people were seeking medical help or treatment for problems associated with cocaine abuse (*30*). In 1972, approximately 48% of young adults between 18 and 25 years of age had tried marijuana, but only 9% had ever tried cocaine. Between 1974 and 1985, lifetime prevalence of cocaine use increased from 5.4 million to 22.2 million. Estimates of current prevalence, use in the past 30 days, increased from 1.6 million in 1977 to 4.3 million in 1979, remained stable through 1982, and increased to 5.8 million in 1985. Data from the High School Senior Survey also show increases in current use of cocaine among high school seniors in the past 2 years. By 1985, 6.7% of high school seniors had used cocaine in the past 30 days. Additional data collected in five waves of the Gallup Poll in late 1984 and mid-1985 did not indicate dramatic increases in the use of cocaine overall, but did suggest increases in current use in males aged 26 to 34. Annual prevalence did not appear to increase.

As with marijuana, increases in lifetime prevalence of cocaine abuse were noted in the 1982 National Survey. Unlike marijuana, however, the increases in cocaine abuse in the 26 and older population were, in fact, due to new users in that population (*17*), suggesting that the age of risk for abuse of cocaine differs from other drugs. Further evidence of the different age risks for cocaine abuse is provided by an 8-year follow-up sample of students from the High School Senior Survey. In this study, all prevalence measures rose substantially with age. By 1985, lifetime cocaine prevalence was 40% for 27-year-olds who were seniors in 1976. Use in the past year was 20% compared with approximately 13% among graduating high school seniors in the class of 1985. Interestingly, both annual prevalence and current prevalence among college students and the total sample up to 4 years after high school has been relatively stable between 1980 and 1985 (Table 4).

Table 4. Trend in annual prevalence of cocaine use among follow-up populations, 1 to 4 years after high school, 1980–1985.

Sample	Used cocaine in past 12 months (%)					
	1980	1981	1982	1983	1984	1985
Total	18.0	18.1	19.2	17.5	17.5	17.2
Full-time college students	16.9	15.9	17.2	17.2	16.4	17.3
Sample size	2855	2862	2861	2821	2790	2690

Overall, the data suggest relative stability in the annual prevalence pool estimated at approximately 12 million, but an increase in use in the past month. As previously mentioned, data from the Gallup Poll suggest increases in use in the past 30 days in the 26- to 34-year-old population. This is consistent with previous follow-up data from the High School Senior Survey and from other studies that suggest a general progression of frequency of use of cocaine. The 26- to 34-year-old population ranged in age from 16 to 24 in 1976 when marijuana abuse had yet to peak, and the cocaine epidemic was just beginning. Of note, a recent sample of 100 cases of high-risk cocaine abusers, defined as having used cocaine at least 12 times in the previous year, indicates that 60% of this population had been smoking marijuana for more than 10 years.

Even with the current increase in abuse of cocaine in the older population, the rise does not match the epidemic increases noted in the late 1970's. However, sharp increases have been noted in treatment admissions, emergency room cases, and mortality associated with cocaine abuse. Between 1981 and 1985, the number of DAWN nonfatal emergencies associated with cocaine increased threefold from 3296 to 9946, and cocaine-related deaths showed a similar threefold increase from 195 to 580. Recent reports of heart attacks in relatively healthy individuals have been attributed to the abuse of cocaine and have heightened awareness of the severe consequences of a drug once thought to be benign (*31–33*).

The rise in treatment admissions parallels the trend noted for emergency room and medical examiner cases. In 1977, primary cocaine abuse accounted for 1.8% of all admissions to federally funded treatment facilities. By 1981, they accounted for 5.8%, and in 1984 the 15 states still submitting treatment data to NIDA reported that primary cocaine admissions accounted for almost 14% of total clients. If secondary cocaine problems were included, more than a fourth (28.7%) of treatment clients reported to NIDA had a problem with cocaine.

Route of administration is particularly important with cocaine. In the past, inhaling (or snorting) the drug has been the predominant mode of administration, whereas inhaling the vapors of cocaine, that is, freebasing, was virtually nonexistent. Although the reported incidence of heart attacks in cocaine snorters clearly demonstrates that intranasal abuse of cocaine is not safe, researchers have suggested that more potent physiological and psychological consequences may occur from either the smoking or IV route.

On the basis of treatment data, it appears that freebasing cocaine has increased from less than 1% in 1977 to almost 5% in 1981 and 18% in 1984. Similarly, emergency room data show that in 1977 less than 1% of cases were associated with smoking cocaine compared with 6% in 1984 and 14% during the first quarter of 1986.

The increase in smoking cocaine in the first quarter of 1986 may reflect the introduction of a form of freebase cocaine known as "crack." An important aspect of "crack" is that it is sold on the street in the freebase form. In the past the user had to convert the cocaine from hydrochloride, the form that is snorted, to freebase. This new marketing tactic may bring about an increase in freebasing and subsequent casualties. In addition, the marketing of "crack" in 65- to 100-milligram doses for $10 rather than in gram lots for $100 initially removes the price barrier that has prohibited many, especially the young, from experimenting with cocaine. These are viewed as ominous signs with the potential to develop into a major public health problem.

Conclusion

Our knowledge of drug abuse has advanced substantially in a very short time. Much can be said about risk factors associated with other types of drug abuse. The variety and range of substances involved and the dynamic social nature of drug abuse sets it in a cycle of almost constant change. In addition, drug epidemics often are localized and involve specific subpopulations that make surveillance based on national data systems difficult. At the same time, the multifaceted nature of the problem has allowed us to apply investigative techniques from a variety of disciplines in public health, medicine, and the social sciences. Significantly, epidemiology has become a staple in the methodological armamentarium of drug abuse research.

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