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## Heroin Overdose Deaths and Heroin Purity Between 1990 and 2000 in Istanbul, Turkey\*

**ABSTRACT:** Turkey has continuously experienced problems with abuse of, and addiction to, opium derivatives. In this study, we analyzed the relationship between heroin overdose deaths and the characteristics of seized opium derivatives. Data were gathered from the Council of Forensic Medicine of the Ministry of Justice in Istanbul from 1990 to 2000. There were 636 heroin-related deaths during this period, 595 of which were classified as heroin overdose deaths. Mean crude and weighted heroin purities remained relatively constant and were calculated to be 46% (57–34%) and 51% (39–59%), respectively. The weight of heroin and the number of heroin seizures, but not the heroin purity, were significantly associated with the number of heroin-related deaths. Prevention strategies are needed to reduce the number of deaths caused by overdoses in countries situated on drug trafficking routes. These strategies should focus on drug trafficking, by providing increased levels of, and support for, law enforcement, stopping the supply of precursor chemicals, and combating corruption among border officials.

**KEYWORDS:** forensic science, heroin, purity, overdose, illicit, Turkey

Heroin use and heroin-related deaths are considered important social matters throughout the world, since annual prevalence is 0.3% of the global population between 15 and 64 years of age (1). The highest percentage of heroin-related deaths is attributed to overdoses (2). Other major causes of death among heroin users are pulmonary edema, AIDS, infection, suicide, homicide, and accidents (3–5).

Heroin is an illicit drug and for this reason, purity may vary. Moreover, it contains unpredictable amounts of adulterants, diluents, and contaminants, such as paracetamol (acetaminophen), codeine, morphine, and thebaine (6). Although it is not common, poisoning from contaminants, adulterants, and diluents have been recorded (7). However, fatal component of the seized heroin is the amount of pure drug (diacetylmorphine content). Fluctuations in heroin purity can play a major role in heroin overdose deaths. Heroin users themselves believe that variations in purity are the major cause of nonfatal and fatal overdoses (8).

Historically, Turkey has been an opium-producer and has continuously encountered abuse and addiction of opium derivatives (9,10). Significant increases in heroin abuse have been reported in some countries, such as Turkey, that lie along the main trafficking routes of opium (11). Despite the role of Turkey in drug trafficking, the issue of the relationship between heroin-related deaths and seizure data in Turkey has not been properly investigated. Although there are some shortcomings, experience has shown that seizure data, in combination with other indicators (purity data, price data, and, if available, drug production estimates, treatment data, arrest data, and drug use survey data) are a very powerful tool for investigating major trafficking flows and their trends (11).

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\*Presented in part at the Annual Forensic Medicine Meetings in Antalya, Turkey, May 16–19, 2002.

Received 1 April 2008; and in revised form 23 Sept. 2008; accepted 26 Oct. 2008.

In this study, we analyzed the relationship between heroin overdose deaths and the characteristics of seized opium derivatives in Istanbul between 1990 and 2000. (In this study, the term “heroin overdose death” was defined until 2000 by the presence of morphine in a body fluid, together with other evidence of an overdose death. After 2000, it was defined by the presence of 6-monoacetylmorphine.) We also investigated the trends in heroin overdose deaths in relation to the characteristics of seized opium.

### Materials and Methods

This research was a retrospective registry-based descriptive study covering all reported heroin-related deaths in Istanbul during the period between 1990 and 2000. According to the Methods of Criminal Judgement Law, all deaths due to poisoning or suspected poisoning require an autopsy in Turkey. All autopsies ( $n = 26,421$ ) that were performed at the Council of Forensic Medicine of the Ministry of Justice in Istanbul between 1990 and 2000 were reviewed. To include all deaths, the reports of the Fifth Committee of Council of Forensic Medicine for the same time period were examined. This Committee is responsible for analyzing and deciding on poisonings, allergies and immunology, paternity tests, prescription drugs, food, sleeping agents, and narcotic drugs (12). On the basis of coroners' and the Fifth Committee verdicts, 595 deaths were classified as heroin overdose deaths and heroin was found in 41 cases of deaths from homicides, suicides, and accidents during this period. When reaching a verdict of heroin overdose, the main criterion used by coroners and the Fifth Committee was the presence of morphine in one of the body fluids. However, the presence of heroin at the scene and police reports were also taken into account. Heroin overdose deaths were included in the statistical analyses, but homicides, suicides, and cases of accidental death were excluded.

All of the drugs ( $n = 2682$ ) seized by law enforcement and analyzed at the Council of Forensic Medicine of the Ministry of Justice in Istanbul between 1990 and 2000 were included. The purity of heroin was based on the concentration of diacetylmorphine.

Blood samples taken at autopsies performed between 1990 and 2000, and seized drugs, were subjected to a range of tests. Several different methods were used to detect morphine: Radioimmunoassay (RIA) was used between 1990 and 1993, enzyme multiplied immunoassay (EMIT) was used from 1994 to 2000, and cloned enzyme donor immunoassay (CEDIA) was used in 2000. Thin layer chromatography was used throughout the whole period, and gas chromatography-mass spectrometry (GC/MS) was used to confirm positive results after 1997. GC/MS was used to detect 6-monoacetylmorphine (6-MAM) after the second half of 2000. Prior to 2000, coroners and the Fifth Committee of Council of Forensic Medicine decided whether or not deaths were heroin- or morphine-related based on crime scene investigations and police reports. Agilent 6890N (Agilent, Palo Alto, CA) was used for determination of opiates. Data handling and system operations were controlled by the CHEMSTATION software (Agilent). *n*-Docosane is used as the internal standard. All reagents were of analytical reagent grade.

All data were analyzed on a monthly basis. After visualization of variables to determine how they changed over time, three characteristics of opium (total weight of drugs, heroin weight, and number of heroin seizures) were log-transformed to reduce heteroscedasticity. To determine the best statistical model between the regression models, a partial autocorrelation was performed. Prais-Winsten autoregression models were carried out to determine the relationship between heroin-related deaths and other characteristics of opium. Data gathered from this study were analyzed with a computer using spss 10.0 for Windows (Istanbul University with permission and license, 2005; Chicago, IL). The significance level was considered to be  $p < 0.05$ .

#### Definitions of Characteristics of Opium

The total weight was the overall weight of all opium derivatives including heroin, morphine, and opium. Heroin weight was defined as the total weight of seized heroin. The trace number was the frequency of heroin seized <1 g (for self-use, not for sale). The crude purity was the mean purity of drugs computed individually for every month (not affected by quantity of seized drugs). The weighted purity was determined by adding the amounts of seized drug at a certain month as a single total weight and purity calculated as if all were seized at one time (affected by quantity of seized drugs).

The formulae of crude and weighted purity are given below (13):

For  $n$  seizures, where the purity of the  $i$ th item is  $p_i$ , the crude purity,  $x$ , is given by:

$$x = \frac{\sum_{i=1}^{i=n} (p_i)}{n}$$

The weighted purity,  $x(W)$ , is given by:

$$x(W) = \frac{\sum_{i=1}^{i=n} (p_i)(W_i)}{\sum_{i=1}^{i=n} (W_i)}$$

where  $W_i$  is the weight of the  $i$ th item.

#### Results

There were 636 heroin-related deaths between 1990 and 2000 in Istanbul, Turkey; 579 were male and 57 were female drug users.

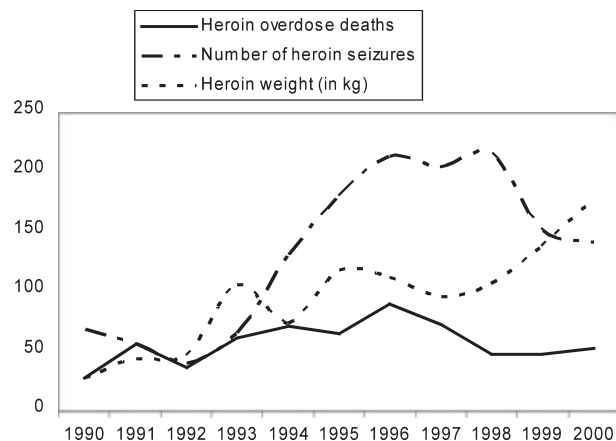


FIG 1—Number of heroin overdose deaths, total weight of drugs, and heroin weight during the period between 1990 and 2000.

Although they were mostly overdose deaths (595 cases), 41 cases died from suicides, homicides, and accidents. An upward trend was observed in number of heroin-related deaths between 1990 and 2000 (Fig. 1).

The total weight of seized drugs was *c.* 25,000 kg. The year 1996 was established as having the highest quantity of drug seizures, with 3600 kg; in contrast, the year 1992 had the lowest quantity of drug seizures with 700 kg in total weight. In the same way, deaths peaked in 1996 (87 deaths) and reached a nadir at 25 deaths in 1990. In 1990, the highest rate of weighted purity was established at 59%, the highest ratio of crude purity was 57% in 1995, and the weighted purity was recorded at 58% in 1995. Apart from these fluctuations, mean crude and weighted heroin purity were relatively stable and calculated to be 46% (57–34%) and 51% (39–59%), respectively, for the 11-year period of our study.

According to the Prais-Winsten autoregression equation, the heroin weight and number of heroin seizures were significant variables (Table 1).

#### Discussion

The main aim of the current study was to explore the relationship between heroin overdose deaths and the characteristics of opium, such as weight, number of seizures, and purity. We found that heroin weight and the number of heroin seizures were predictors of heroin overdose deaths. The main limitation of the study was the lack of some other important variables, such as price. On the other hand, the key point of this study was that the data completely covered Istanbul, the population of which was *c.* 14 million over an 11-year period.

TABLE 1—Prais-Winsten regression model for predicting heroin overdose deaths ( $R^2: 0.11$ ).

	Standard Error		Beta	<i>t</i>	<i>p</i>
	<i>B</i>	of Beta			
Total weight	2.03	1.27	0.42	1.59	0.11
Heroin weight	-3.21	1.33	-0.83	-2.40	0.01
Number of heroin seizures	3.32	1.04	0.36	3.17	0.001
Crude purity	3.04	2.17	0.30	1.40	0.16
Weighted purity	1.66	1.80	0.14	0.92	0.35
Constant	7.72	2.62		2.94	0.003

TABLE 2—Seized drugs and heroin overdose deaths between 1990 and 2000.

	Number of Deaths	Total Weight*	Total Number of Seizures	Number of Trace Seizures	Number of Heroin Seizures	Mean Heroin Weight*	Total Heroin Weight*	Weighted Heroin Purity (%)	Crude Heroin Purity (%)
1990	25	788	121	11	66	43	250	59	53
1991	53	929	110	10	53	101	410	55	49
1992	34	718	77	9	37	135	427	55	45
1993	58	1960	115	16	62	205	1033	54	52
1994	68	1700	264	52	127	69	708	53	52
1995	62	2994	342	44	177	79	1152	58	57
1996	87	3603	399	60	210	64	1092	48	44
1997	69	3014	401	48	202	59	928	43	34
1998	45	3051	379	40	213	60	1042	44	35
1999	44	3244	353	26	149	107	1353	39	35
2000	50	3579	238	16	139	112	1747	51	50
Total	595	25,580	2799	332	1435	1034	10,142	51	46

\*Weights are in kilograms.

Studies performed in Europe during the same period reported different purity levels, such as 25% in Vienna between 1987 and 1995, 42% in the UK in 1995, between 50% and 65% between 1995 and 1999 in Albania (13–15), and <10% in Finland between 2001 and 2002 (16). When all European countries were analyzed, the mean purity was between 20% and 35% in 1999 (17). In our study, in contrast to other data from Europe, purity levels were relatively stable and high during the period between 1990 and 2000. According to a time-series analysis, there was no relationship between heroin overdose deaths and weighted or crude purity in our sample. In like manner, in a study carried out in Vienna, Austria in 1999, researchers found that there was no relationship between heroin purity and drug-related deaths or drug-related emergencies (18).

We did find, however, that there was a statistical relationship between the number of heroin overdose deaths and the seized heroin weight and number of heroin seizures. Similarly, according to a study involving England and Wales between 1994 and 2001, a statistically significant relationship existed between fatal heroin poisoning and heroin seizures (19).

Turkey is considered a transit country in drug trafficking. Turkey has the most opiate seizures in Europe, a position held without interruption since 1987 (11). For example, in 2005, 7% of the world's seizures occurred in Turkey (1), indicating that drugs seized in Turkey are mostly for the international market and not for the domestic market. This hypothesis is also supported by the mean weights of seized drugs. The mean heroin weight was *c.* 1 kg, an amount obviously intended for trade. As shown in Table 2, the weighted purity levels were higher than the crude purity, the difference between them *c.* 10%. As weighted purity is high and it is affected by quantity, it can be assumed that the larger the size, the higher the purity.

In conclusion, there was no relationship between purity variables and heroin overdose deaths. The crude and weighted purity of heroin was relatively stable between 1990 and 2000 in Istanbul. The amount of seized drugs increased substantially during this period. While the number of deaths from heroin overdose in Istanbul was relatively small compared with developed countries, there was an upward trend between 1990 and 2000 and more than 50 heroin-related deaths were reported annually. Finally, according to the results of this study, a significant relationship existed between heroin overdose deaths, heroin weight, and number of heroin seizures. Hence, in order to decrease overdose deaths in countries situated on drug trafficking routes, prevention strategies should focus especially on drug trafficking, although informing, educating, and training at-risk individuals are also important. Increased levels of, and support for, law enforcement, stopping the supply of precursor

chemicals, combating corruption among border officials, improving the legal system, and encouraging international collaboration against organized crime and money laundering are all strategies that need to be employed to reduce drug trafficking.

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