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# Drug-related death in Denmark in 2007

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## ABSTRACT

**INTRODUCTION:** We investigated fatal poisonings among drug addicts in 2007. The cause of death, abuse pattern and geographic differences are presented.

**MATERIAL AND METHODS:** All drug-related deaths examined at the three forensic medicine institutes in Denmark in 2007 were evaluated.

**RESULTS:** The number of drug-related deaths in 2007 was 226. Methadone deaths had increased since 1997 while heroin/morphine deaths decreased. In earlier studies, very few deaths from central stimulants like cocaine and amphetamines occurred (1-1.5%), but in 2007 6% of the deaths were caused by these drugs. Multiple drug use was common. Heroin/morphine, cocaine, amphetamine, cannabis, methadone, benzodiazepines and alcohol were included in the poly-drug use.

**CONCLUSION:** This investigation shows stabilization in the number of fatal poisonings in drug addicts. Geographic differences were observed. Methadone was the most frequent cause of fatal poisoning and there was a continuous decrease in heroin/morphine deaths. Fatal deaths from cocaine and amphetamine have increased considerably. Multiple drug use was common.

**FUNDING:** not relevant.

**TRIAL REGISTRATION:** not relevant.

A broad toxicological screening for drugs was carried out to elucidate any poly-drug abuse.

## MATERIAL AND METHODS

The study included all fatal poisonings among drug addicts in 2007 (n = 226), examined at the three forensic medicine institutes in Copenhagen (Zealand, surrounding islands, and Bornholm), Aarhus (Jutland, excluding Southern Jutland), and Odense (Funen, surrounding islands, and Southern Jutland). The same definition of a drug addict was used in this study as in the common Nordic studies: "a person who according to information from the police and/or autopsy report is known to have abused drugs intravenously and/or abused drugs listed in the Single Convention on Narcotic drugs 1961, schedule I (heroin, morphine, ketobemidone, cocaine, etc.), and/or the International Convention on Psychotropic Substances 1971, schedules I and II (amphetamine, LSD, etc.)."

Fatal poisonings caused by two or more drugs were recorded according to the drug considered to be the main intoxicant. Heroin/morphine, methadone, ketobemidone (Ketogan), codeine, dextropropoxyphene, tramadol, buprenorphine, cocaine, amphetamine, cannabis, benzodiazepines, barbiturates, basic drugs (among

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A number of indicators can be used to evaluate the extent, development and consequences of drug abuse. These include crimes associated with drug abuse, the amount and type of seized drugs, number of abusers and abusers in treatment programs [1, 2]. The examination of fatal poisonings among drug addicts is valuable because broad toxicological screening determines which compounds were present when the drug addicts died.

The number of drug abusers in Denmark was estimated to be 27,000 in 2006. Included in this estimation were about 7,000 who only abused cannabis [2].

This study evaluated the fatal poisonings among drug addicts in 2007 in Denmark. Cases were examined at the three forensic medicine institutes of Copenhagen, Aarhus and Odense. The data were compared with earlier studies from 1991, 1997 and 2002 [3-5]. As in the former studies, 2007 data were included in a common Nordic study of fatal poisonings among drug addicts [6].



A large heroin seizure. Since 1997 there has been a decrease in the frequency of fatal intoxications with heroin/morphine. Nevertheless, a corresponding increase in methadone deaths was observed.

 TABLE 1

Fatal poisonings among drug addicts related to the forensic medicine institutes in Denmark. The values are n (%).

Forensic medicine institute	1991	1997	2002	2007
Copenhagen <sup>a</sup>	110 (67)	121 (56)	90 (52)	101 (44)
Odense <sup>b</sup>	21 (13)	40 (19)	18 (10)	40 (18)
Aarhus <sup>c</sup>	33 (20)	55 (25)	67 (38)	85 (38)
Total	164 (100)	216 (100)	175 (100)	226 (100)

a) Zealand, surrounding islands and Copenhagen (2.3 million inhabitants).

b) Funen, surrounding islands and south part of Jutland (0.7 million inhabitants).

c) The remaining part of Jutland (2.2 million inhabitants).

these antidepressants/antipsychotics) and alcohol were included in the toxicological screening in all cases with sufficient material. If other compounds were detected, they were included in the study. Heroin metabolizes quickly to 6-monoacetylmorphine and then to morphine and is therefore detected as morphine in the toxicological screening. Thus, in this study, heroin/morphine is stated in cases where morphine was detected. The toxicological evaluations of the detected drug concentrations were done according to the Institute's experience [7, 8] and reports from the literature [9-12].

*Trial registration:* not relevant.

## RESULTS

### Causes of fatal intoxication

In 2007, a total of 226 fatal poisonings were examined among drug addicts at the three forensic medicine institutes. This number constitutes 83% of all deaths among drug addicts in Denmark in 2007. The number of fatal poisonings increased compared with 2002, but remained unchanged over the ten-year period starting 1997 (Table 1). The number of fatal poisonings increased by 67% from 1986 to 1997 [4], but has stabilized around 200 since 1997. The number of fatal poisonings per year has remained unchanged in the areas covered by the Forensic Medicine Institute of Copenhagen; while there has been a marked increase in the areas covered by the institute of Aarhus (Table 1). The frequency of fatal poisonings in the capital area has decreased gradually from 53% in 1991 to 41% in 1997 and 31% in 2007 [3, 4]. Men comprised 81% of the fatal deaths. The age distribution showed a maximum in the group aged 35-39 years (median: 37.5 years; range 14-63 years). The average age was 38.5 years, which was unchanged compared with 2002, and 65% were older than 35 years.

According to the available information, 44 of the drug addicts (19%) were in methadone treatment at the time of death; while in earlier studies, 17-23% were re-

ceiving methadone treatment [3-5]. These figures are minimum numbers because information about methadone treatment was not available for all deaths. About one third of the drug addicts who died of fatal methadone intoxication were reported to be in methadone treatment. Heroin/morphine intoxication was the main cause of death in 33% of the cases. This is a marked decrease compared with earlier studies in 1991 (57%), 1997 (71%) and 2002 (44%) (Table 2). In the same period, the frequency of methadone intoxications increased from 31% in 1991 and 21% in 1997 to 51% in 2007 (Table 2). Thus, methadone was the most frequent cause of death in 2007. This trend was observed in all parts of Denmark (Table 3), especially in the area covered by the institute of Odense. However, the frequency of methadone deaths was highest in the areas covered by the institute of Copenhagen, of which half appeared in the Capital, i.e. Frederiksberg and Copenhagen municipalities (50%). In other parts of Denmark, there was a more equal distribution between deaths caused by heroin/morphine and methadone (Table 3).

 TABLE 2

Cause of death among fatally intoxicated drug addicts in Denmark. The values are n (%).

Main intoxicant	1991	1997	2002	2007
Heroin/morphine	94 (57.5)	153 (71)	76 (44)	75 (33)
Methadone	51 (31)	46 (21)	72 (41)	116 (51)
Cocaine	0 (0)	1 (0.5)	1 (0.5)	6 (3)
Amphetamine	1 (0.5)	1 (0.5)	2 (1)	6 (3)
Ketobemidone	8 (5)	12 (5.5)	9 (5)	5 (2)
Tramadol			5 (3)	2 (1)
Other <sup>a</sup>	10 (6)	3 (1.5)	10 (5.5)	16 (7)
Total	164 (100)	216 (100)	175 (100)	226 (100)

a) 2007: bromo-dragonfly: 1; buprenorphine: 1; oxycodone: 3.

 TABLE 3

Number of fatal heroin/morphine and methadone intoxications among drug addicts in Denmark related to forensic medicine institute. The values are n (%).

Forensic medicine institute	Heroin/morphine	Methadone
<i>Copenhagen</i>		
1997	74 (61)	40 (33)
2002	36 (40)	47 (52)
2007	24 (24)	64 (63)
<i>Odense</i>		
1997	38 (95)	0 (0)
2002	13 (72)	4 (22)
2007	18 (45)	20 (50)
<i>Aarhus</i>		
1997	41 (75)	6 (11)
2002	27 (40)	21 (31)
2007	33 (39)	32 (38)

In earlier studies, few deaths were caused by the central stimulants: amphetamine and cocaine, but there were 12 fatal intoxications with these drugs in 2007 (Table 2). There was one fatal poisoning from methylenedioxymethamphetamine (ecstasy), one from bromodragonfly (designer drug) and one death from petrol sniffing.

Eight percent of fatal deaths were caused by a legal medical drug other than methadone. These were (number in parenthesis): ketobemidone (5), oxycodone (3), tramadol (2), buprenorphine (1), propoxyphene (1), pethidine (1) and citalopram (2). There were three fatal intoxications involving benzodiazepines. In 2007 two or more drugs were judged to have contributed significantly to 28% of the fatal intoxications. This is an increase compared with 1997 when 18% were judged to be combined poisonings.

Our study showed that more than 90% of the drug addicts older than 29 years died from opioids, while only 75% of drug addicts younger than 30 years did. On the other hand, drug addicts younger than 30 years died more frequently (17.5%) from central stimulants (amphetamines (5%) and cocaine (10%)). Only 5% of drug addicts older than 29 years died from central stimulants and cocaine deaths did not occur in older drug addicts (> 39 years).

### Abuse patterns

The average number of drugs, including alcohol, detected in each case was 3.6 (median: 3). Eight to ten different drugs were found in ten drug addicts. Ethanol was detected in 34% of the drug addicts and the concentration was greater than 0.5 mg/g in 29% of the cases (Table 4). Methadone was the most frequent compound found in all parts of Denmark; it was detected in 139 (61%) drug addicts (Table 4). This is an increase compared with earlier studies performed in 1997 (31%) and 2002 (53%). This increase was observed in all parts of the country, but most markedly in the area covered by the institute of Odense where the frequency of methadone positive cases increased from 33% in 2002 to 58% in 2007.

Heroin/morphine was the second most frequent drug; it was detected in 90 (40%) drug addicts. The frequency of heroin/morphine decreased compared with 1997 (71%) and 2002 (48%) [4-5]. As in the 2002 and 1997 studies, cocaine was detected in 15% of the drug addicts. Cocaine is still one of the most frequently used drugs. Cocaine was the most frequent drug in the areas covered by the institutes of Copenhagen and Aarhus; as in the 2002 study, there were very few cocaine-positive cases in the area covered by the institute of Odense (Table 4). In 1997, 25% of the cases in Funen tested positive for cocaine [4].

The number of cases, in which amphetamine was

detected, have doubled from 1997 (4%) to 2002 (9%) and 2007 (10%). Amphetamine is now one of the more frequently used drugs. This increase has exclusively occurred in the area covered by the institute of Aarhus with a near doubling of amphetamine cases from 2002 (12%) to 2007 (21%). Similar to 2002, only a few cases tested positive for ecstasy/designer drugs.

Benzodiazepines were detected in 55% of the cases (Table 4). Diazepam (26%) was the most frequently found benzodiazepine, which is similar to the 2002 findings. The frequency of ketobemidone decreased from 12% in 2002 to 5% in 2007 and is now a less frequently used compound. In the same period, the frequency of tramadol increased from 3% in 2002 to 6% in 2007. Buprenorphine was detected in few cases, as in the study from 2002. Cannabis was detected in 34% and 30% of the cases in the areas covered by Aarhus and Copenhagen, respectively. The forensic medicine institute in Odense did not screen for cannabis.

Antidepressants were detected in 25% of the drug addicts. As in the study from 2002, citalopram was the most frequent antidepressant (10%).



TABLE 4

The results of the analytical screening program for medical drugs, narcotic drugs and poisons in fatally intoxicated drug addicts in Denmark in 2007. The values are number of cases in each forensic medicine institute.

Detected drugs	Copenhagen	Odense	Aarhus	Total
Heroin/morphine	32	21	37	90
Methadone	74	23	42	139
Propoxyphene	0	0	1	1
Ketobemidone	8	0	3	11
Codeine	7	6	5	18
Tramadol	5	4	4	13
Oxycodone	1	0	5	6
Cocaine	20	2	13	35
Amphetamine	4	1	18	23
Methamphetamine	0	1	0	1
Ecstasy	1	1	2	4
Tetrahydrocannabinol	30	n.a.	29	59
Benzodiazepines	74	7	43	124
Zopiclone	8	0	2	10
Zolpidem	1	0	0	1
Buprenorphine	1	0	3	4
Barbiturates	2	4	2	8
Citalopram/escitalopram	6	3	13	22
Other antidepressiva/antipsychotica	21	4	9	34
Ethanol > 0.5 mg/g	34	11	21	66
Ethanol 0-0.5 mg/g	7	2	3	12

n.a. = not analyzed.

## DISCUSSION

During the nineties, abuse of illicit drugs rose to an elevated level. Since 2000, this increase seems to have stopped [13]. Stabilizations in the number of abusers (judged to be 27,000) and in the experimental drugs used are supported by this study. The number of fatal intoxications among drug addicts seems to have stabilized since 1997 to around 200 per year with fluctuations. In earlier studies from 1991 to 2002, the average age of fatally intoxicated drug addicts increased gradually. The average age has stabilized at around 38 years and has not changed from 2002 to 2007. Despite the historically high level of experimental drug use among young people between 16-24 years [13], the age distribution among fatally intoxicated drug addicts has not changed, and most deaths are seen in the 35-39 year age group. Compared with other Nordic countries, the average age is significantly higher in Denmark [6], which may be due to more liberal use of methadone in the treatment of drug addicts.

Since 1997, there has been a decrease in the frequency of fatal intoxications with heroin/morphine; yet, there is a corresponding increase in methadone deaths. The increase in methadone deaths indicates that the number of opiate abusers has not changed significantly and that methadone is now used. This is supported by the finding that one third of the methadone-intoxicated drug addicts were receiving methadone treatment. This increase in methadone use was observed in all parts of the country, but most markedly in the area covered by the institute of Odense. Deaths from the central stimulants amphetamine and cocaine occurred infrequently in earlier studies, but are now significant causes of death. It is primarily people younger than 30 years who die from central stimulants; while older drug addicts more frequently die from opioids, especially heroin/morphine and methadone. This trend has also been observed in the treatment system; young abusers increasingly apply for help in connection with abuse of central stimulants, while older drug abusers are more frequently seen in methadone treatment programs [13]. The number of abusers in methadone treatment has more than doubled since 1995. In 2004, 5,700 opiate abusers were in methadone treatment [13]. In the same period, the increase in methadone deaths was immense. The average age of the fatally intoxicated drug addicts in Denmark is higher than that seen in other Nordic countries, which may indicate that methadone treatment has a positive net effect [6]. This is supported by the decrease in fatal intoxications in the capital area where a relatively high recorded proportion (40%) of drug addicts treated with methadone are living. Deaths from buprenorphine were practically absent although 600 opiate abusers were in substitution treatment with bu-

prenorphine in 2004 [13], which suggests that buprenorphine should be considered for substitution treatments.

Like in the former studies, multi-drug use is widespread and the average number of drugs detected per case was 3.6. Illicit drugs (heroin, cocaine, amphetamine and cannabis), medical drugs (methadone, tramadol, oxycodone, benzodiazepines, etc.) and alcohol form a part of the abuse. No changes were observed in the type of drugs detected in the drug abusers; rather, a shift in the abuse pattern has occurred. The decrease since 1997 in the use of heroin/morphine has been compensated by a corresponding increase in methadone. Methadone is now the most frequent compound detected in the dead drug addicts. The central stimulants have been incorporated in multi-drug use. The frequency of cocaine has remained unchanged since 1997 (14-15%); while the frequency of amphetamine in the same period has double, although it has remained unchanged since 2002. Studies conducted since 2000 on drug abuse among young users aged 16-24 years show a stabilization of amphetamine use, while the use of cocaine increased [13]. Denmark has the third highest use of cocaine in Europe [14]. Even if our study shows that the detection of cocaine has remained unchanged, the number of fatal cocaine intoxications has increased markedly in the past five years, especially among drug addicts younger than 30 years, which must be an indication of an increasing cocaine abuse.

Large differences in the abuse patterns in different parts of Denmark were observed. Methadone is much more frequent in the area covered by the institute of Copenhagen, while heroin/morphine is much more frequent in other parts of the country (Tables 3 and 4). Cocaine is more frequent in Zealand followed by Jutland, while there are very few cases in Funen (Table 4). Amphetamine abuse occurs mainly in Jutland (Table 4). Benzodiazepines are much more frequent in Zealand and Jutland than in Funen (Table 4). As in 2002, many drug addicts used antidepressants and citalopram was the most frequently used antidepressant [5]. This finding was observed in all parts of Denmark (Table 4) and 17-27% had used one or more antidepressants.

## CONCLUSION

In conclusion, this study shows considerable changes in abuse patterns and trends first observed in 2002 have continued. Methadone is now the most frequent cause of death. Fatal heroin/morphine intoxications have continued to decrease, while the increase in methadone seems to compensate for this. Cocaine and amphetamine constitute a considerable number of fatal poisonings; whereas these drugs were negligible in earlier studies. Large differences were detected between the different parts of Denmark; therefore, a follow-up study is strongly recommended.

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**CONFLICTS OF INTEREST:** none

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