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4 **Antero.** Fatal poisoning in drug addicts in the Nordic countries in 2017.

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## 6 **Abstract**

7 This study is the seventh report on fatal poisonings among drug addicts in the Nordic countries. In  
8 this report, we analyse data from the five Nordic countries: Denmark, Finland, Iceland, Norway and  
9 Sweden. Data on gender, number of deaths, places of deaths, age, main intoxicants and substances  
10 detected in blood were recorded to obtain national and comparable Nordic data, and to allow  
11 comparison with earlier studies conducted in 1984, 1991, 1997, 2002, 2007 and 2012.

12 The death rate (number of deaths per 100,000 inhabitants) was highest in Iceland (6.58) followed  
13 closely by Sweden (6.46) and then lowest in Denmark (4.29). The death rate increased in Finland  
14 (5.84), Iceland and Sweden and decreased in Denmark compared to earlier studies. The death rate in  
15 Norway, which has decreased since 2002, has stabilised around 5.7 as of 2017. Women accounted  
16 for 7–23% of the fatal poisonings. The percentage was lowest in Iceland and highest in Finland and  
17 Norway. The age range was 14 to 70 years. The median age (41 years) was highest in Denmark and  
18 Norway. The other countries had a median age between 33 and 35 years.

19 Opioids were the main cause of death. Methadone remained the main intoxicant in Denmark, while  
20 heroin/morphine was still the main intoxicant in Norway, as was buprenorphine in Finland.

21 However, the picture has changed in Sweden compared to 2012, where heroin/morphine caused  
22 most deaths in 2017. Sweden also experienced the highest number of deaths from fentanyl  
23 analogues (67 deaths) and buprenorphine (61 deaths). Deaths from fentanyl analogues also occurred

24 in Denmark, Finland and Norway, but to a smaller extent. Over the years, the proportion of opioid  
25 deaths has decreased in all countries except Sweden, which has experienced an increase. This  
26 decline has been replaced by deaths from CNS stimulants like cocaine, amphetamine and  
27 methylenedioxymethamphetamine (MDMA). Cocaine deaths have occurred in all countries but  
28 most frequently in Denmark. MDMA deaths have increased in all countries but mostly in Finland.  
29 Poly-drug use was widespread, as seen in the earlier studies. The median number of detected drugs  
30 per case varied from 4–6. Heroin/morphine, methadone, buprenorphine, cocaine, amphetamine,  
31 methamphetamine, MDMA, tetrahydrocannabinol (THC) and benzodiazepines were frequently  
32 detected. Pregabalin and gabapentin were detected in all countries, especially pregabalin, which was  
33 detected in 42% of the Finnish cases. New psychoactive substances (NPS) occurred in all countries  
34 except Iceland.

35

### 36 Highlights

- 37 • Finland had a different drug profile compared to the other countries.
- 38 • Opioids were the main cause of death among fatal poisoned drug addicts in all countries.
- 39 • Cocaine and MDMA deaths increased in all countries.
- 40 • Sweden saw a high number of deaths from fentanyl analogues.
- 41 • New psychoactive substances have emerged in all countries except Iceland.

42

43 Keywords: Fatal poisoning, Drug addict death, Nordic country, Main intoxicant, Drug abuse, New  
44 psychoactive substance

45

46 **1. Introduction**

47 According to the World Drug Report 2019, the severity and complexity of the world drug situation  
48 is increasing [1]. During the last decade, drug overdose deaths have continued to rise in Europe and,  
49 even more prominently, in North America. Opioids, often in combination with other substances, are  
50 present in the majority of fatal overdoses reported in Europe. Heroin remains the major illicit  
51 opioid, but methadone, buprenorphine, fentanyl and new synthetic opioids are increasingly involved  
52 [2]. The average mortality rate due to overdoses in Europe in 2017 is estimated at 22.6 deaths per  
53 million in the population aged 15–64, but this is likely to be an underestimation [2,3]. In the United  
54 States, synthetic opioids, primarily illicit fentanyl, surpassed prescription opioids in 2016 as the  
55 most common drugs involved in overdose deaths [4], and the drug overdose mortality rates in the  
56 US are now 3.5 times higher than in its peer countries (Denmark, Finland, United Kingdom,  
57 Australia etc.) [5].

58 The Nordic Countries – Denmark, Finland, Iceland, Norway and Sweden – report among the  
59 highest drug overdose mortality rates in Europe and some other Northern European countries, with  
60 more than 40 deaths per million inhabitants per year. The above average quality of forensic and  
61 toxicological investigation in the Nordic Countries at the European level, because of the reliable  
62 data produced, provides a better understanding of drug trends and health threats in the area [2,6].  
63 Fugelstad et al. [7] have pointed out that statistics based on forensic toxicology are more complete,  
64 provide more detail on abused substances and are usually available earlier than national mortality  
65 register–based statistics.

66 A working group of investigators representing the Nordic forensic authorities has been closely  
67 following the trends of fatal drug poisonings in the Nordic Countries over the course of 35 years. A  
68 remarkable series of previously published Nordic studies is available, covering the years 1984,

69 1991, 1997, 2002, 2007 and 2012, and all use the same definition for the term drug addict [8-13].  
70 Interestingly, in 1984, drug addicts accounted for 62% of all fatal intoxications in the Danish data,  
71 while the corresponding figures were 33% in the Norwegian, 16% in the Swedish and 5% in the  
72 Finnish data, and no deaths of drug addicts were found in Iceland [8]. Over the years, the death  
73 rates of drug addicts among the Nordic Countries have become more homogeneous. Nevertheless,  
74 significant differences in the principal toxic drugs have remained, with various opioids being the  
75 predominant agents [13].

76 In the present follow-up study, we investigate the fatal intoxications in Nordic drug addicts in 2017  
77 and compare the results with those of the previous studies using the established tables and figures.  
78 As earlier, the special forensic toxicology register-based information comprises poisoning mortality  
79 statistics, age distribution and a detailed account of the drugs of abuse that were involved.

80

## 81 **2. Materials and methods**

82 This study analysed data on fatal poisonings in drug addicts that were submitted for medico-legal  
83 autopsy and toxicological analysis in the five Nordic countries in 2017. A few medical autopsies  
84 were also included. These data were compared with similar findings reported in 1991, 1997, 2002,  
85 2007 and 2012. A drug addict was defined as “a person who, according to information from the  
86 police and/or autopsy report, is known to have abused drugs intravenously and/or abused the drugs  
87 listed in the Single Convention on Narcotic Drugs 1961, schedule I, and/or the International  
88 Convention on Psychotropic Substances 1971, schedules I and II”.

89 In almost all cases, except for a few in which suitable material was not obtained at autopsy,  
90 screening was performed for opiates, methadone, other opioids, amphetamines, cocaine, THC and

91 benzodiazepines. Additional drugs detected by the screening procedure or at the special request of  
92 the police were recorded, and the blood alcohol concentrations (BAC) were routinely determined.

93 The cause of death according to the autopsy report was systematically recorded, along with  
94 toxicological findings, police information about the deceased and the circumstances surrounding the  
95 death. Drugs and poisons were divided into four groups:

96 Group I: Drugs listed in the Single Convention on Narcotic Drugs 1961, schedule I (cocaine,  
97 fentanyl, heroin/morphine, methadone, oxycodone etc.) and schedule II (codeine, etc.).  
98 Tramadol, mitragynine and terpentadol were included because of their classification as  
99 opioids. Fentanyl analogues were also included in this group.

100 Group II: Drugs listed in the International Convention on Psychotropic Substances 1971, schedules  
101 I and II (amphetamine, methamphetamine, MDMA, GHB, methylphenidate, THC etc.).  
102 NPS (3-MeO-PCP, 5-APB, synthetic cannabinoids etc.) were also included in this group.  
103 Ketamine was included in this group.

104 Group III: Drugs listed in the International Convention on Psychotropic Substances 1971, schedules  
105 III and IV (benzodiazepines, buprenorphine, barbiturates, zolpidem etc.). Zopiclone was  
106 included because of its classification as a substance related to benzodiazepines.

107 Group IV: All other drugs and poisons, including ethanol.

108 Buprenorphine is an opioid and is therefore included in the comparison of opioid deaths. The  
109 number of opioid deaths is calculated per 100,000 inhabitants in the age group 15-64 in each Nordic  
110 country for the sake of comparison between the countries in figure 3.

111 Deaths caused by poisoning were recorded according to the drug that a forensic pathologist judged  
112 to be the main intoxicant. In cases involving multiple drugs in which the cause of death could not be

113 ascribed to a single substance, the drug with the lowest group number (see above) was considered  
114 the main intoxicant. Cases involving two or more drugs in the same group were recorded according  
115 to the drug judged to be the main contributor to death.

116 Heroin is rapidly metabolised to 6-monoacetylmorphine and further to morphine. Consequently, if  
117 6-monoacetylmorphine was not detected, it was impossible to determine on the basis of the analysis  
118 whether heroin or morphine was used. However, heroin intake was often indicated in police reports.  
119 In the present study, fatal intoxication by heroin/morphine was verified by the presence of morphine  
120 in the blood and, in many cases, also by the presence of 6-monoacetylmorphine in a biological  
121 specimen (usually blood or urine).

122 All laboratories participate in more than one international proficiency testing scheme relevant for  
123 the forensic analysis.

124 All findings, after primary screening by immunological analysis, gas chromatography (GC),  
125 GCMS, liquid chromatography (LC), UPLC–TOF-MS, and (UP)LC/MS, were confirmed and  
126 quantified by specific (UP)LC- and GC-chromatography methods.

127 All age groups (14–70 years) were included in the study. The death rate in each country was  
128 calculated as the number of deaths per 100,000 inhabitants in the 15–64 year age group, as the  
129 addicts were, with few exceptions, younger than 65 years old. Poisson distribution with 95% CI is  
130 used in Fig. 1.

131 Due to its low number of deaths, Iceland was sometimes considered and discussed separately, and  
132 comparisons were performed mainly for the other four countries.

133 *2.1. Ethical issues*

134 The Danish part of the study was approved by The Danish Data Protection Agency. The National  
135 Committee on Health Research Ethics in Denmark was informed about the Danish part of the study  
136 and determined that the survey did not need to be reported to the Committee. Only anonymised data  
137 is presented.

138 According to the Finnish legislation, no separate ethical approval is needed for studies that utilise  
139 de-identified register-based data (Personal Data Act 523/1999). Permission to use data was obtained  
140 from the maintainer of the register (Finnish Institute for Health and Welfare).

141 The Icelandic part of the study was approved by the Icelandic National Bioethics Committee (VSN-  
142 18-194), by the Icelandic Data Protection Authority and by the Directorate of Health, including the  
143 National Death Registry.

144 The Norwegian part of the study was approved by the Regional Committees for Medical and Health  
145 Research Ethics, Norway, 2017/2474/REK sør-øst C and by the Public Prosecutor at the Office of  
146 the Director of Public Prosecutions, 2017/01269-005 BIS/ggr 639.2. Only anonymised data is  
147 presented.

148 The Swedish part of the study was approved by the Regional Ethics Review Board in Linköping  
149 Sweden, before start (Dnr 2016/489-31).

150

## 151 **3. Results**

### 152 *3.1. Death rates*

153 Figure 1 shows the death rate per 100,000 inhabitants for all the Nordic countries from 1991 to  
154 2017. The death rate increased in Finland, Iceland and Sweden in 2017 compared to 2012, and  
155 decreased in Denmark and Norway. The death rate has been relatively stable in Denmark, with

156 variations from 6.54 in 1997 to 5.19 in 2012. In 2017, the death rate (4.29) in Denmark was at its  
157 lowest level compared to the earlier years and also to the other countries. In Finland, the death rate  
158 has increased since 1991, from 1.16 to 5.84 during these years. A similar increase was seen in  
159 Iceland, where the death rate was 0.64 in 1991 and 6.58 in 2017. In 2017, Iceland and Sweden had  
160 the highest death rates among the Nordic countries for the first time during the observed period. In  
161 Norway, the number has decreased since 2002, and 2017 was the first year in 20 years where  
162 Norway did not have the highest death rate of the Nordic countries. The death rate in Sweden  
163 increased, similarly to Finland and Iceland, from 1.53 in 1991 to 6.46 in 2017.

### 164 *3.2. Places of death*

165 The percentage of fatal poisonings among drug addicts in the capital and suburbs were similar in  
166 Denmark (29 %), Finland (26 %), Norway (30 %) and Sweden (29 %) and comparable to earlier  
167 years. The percentage of each country's population that live in this region is relatively similar as  
168 well. In Iceland, however, where a larger proportion of the population lives in the capital area, 87 %  
169 of the deaths occurred in the capital and suburbs. For all countries, more than 83 % of the deaths  
170 occurred indoors.

### 171 *3.3. Distribution of deaths by gender and age*

172 Fatal poisonings in the Nordic countries in 2017 mainly occurred in men; the percentages of women  
173 were 15 % (Denmark), 23 % (Finland and Norway), 17 % (Sweden) and 7 % (Iceland). These  
174 percentages were similar to those registered in 2012, with some differences for Finland, Denmark  
175 and Iceland [13].

176 The age ranges of the fatally poisoned drug addicts were 16–70 years (Denmark), 17–65 years  
177 (Finland), 14–68 years (Norway), 17–68 years (Sweden) and 20–41 years (Iceland). The mean and  
178 median ages were similar within each country. The median age in 2017 was 41 years for Denmark,



179 35 years for Finland, 41 years for Norway, 33 years for Sweden and 34 years for Iceland. In  
180 comparison to earlier years, the difference in median age between the Nordic countries is getting  
181 smaller [13]. The median age of the fatally poisoned drug addicts has increased in Finland and  
182 Norway and was almost unchanged in the other countries. Figure 2 shows that the highest death rate  
183 for Denmark and Finland was in the group aged 35–39 years, whereas in Norway, it was highest in  
184 the group aged 30–34 years and almost as high in the group aged 55–59 years. In Sweden, the  
185 highest death rate was observed in the group aged 25–29 years, although it was almost as high in  
186 the group aged 30–34 years.

#### 187 *3.4. Cause of death/main intoxicant*

188 The main intoxicants in the included drug addict deaths for all five Nordic countries are shown in  
189 Table 1; the three previous investigations 2002, 2007 and 2012 are included for comparison.

190 *Group I drugs* dominated as the main intoxicants in Denmark (90%), Norway (76%) and Sweden  
191 (72%) in 2017. Conversely, the proportion of fatal poisonings due to Group I drugs (35%) was  
192 almost at the same level as fatal poisonings due to Group III drugs (36%) in Finland, which is due  
193 to the high amount of buprenorphine intoxications.

194 Opioids including buprenorphine (Group III) were the most prevalent cause of death; these are  
195 illustrated in Figure 3. Overall, compared to earlier investigations, fatal poisonings due to opioids  
196 decreased in Denmark and Norway, but opioids were still the main intoxicants, with 3.5 cases and  
197 4.5 cases per 100,000 inhabitants, respectively, in 2017. Finland and Sweden saw an increase in  
198 opioid intoxications, with 3.3 cases and 5.4 cases per 100,000 inhabitants observed, respectively, in  
199 2017. On the contrary, when looking at the proportion of opioid deaths among all fatally poisoned  
200 drug addicts, Finland saw a decrease from 62% in 2012 to 55 % in 2017, and the decreasing trend  
201 continued in the proportion of opioid deaths observed since 1997 in Denmark (82%) and Norway

202 (77%). Furthermore, the trend toward an increase in opioid deaths observed since 2002 continued in  
203 Sweden (84%) in 2017. Regarding deaths caused by specific opioids, heroin/morphine has shown a  
204 decreasing trend in Denmark and Norway over the years, while the numbers have fluctuated over  
205 time in Sweden. Heroin/morphine was the most common main intoxicant in both Sweden and  
206 Norway in 2017. Intoxications by heroin/morphine almost disappeared in Finland in 2007 and have  
207 been continuously low in the follow-up studies.

208 Fatal poisonings with methadone have decreased since 2012, but it was still the most common main  
209 intoxicant in Denmark in 2017 (Table 1). In Finland, however, a small increase was observed in  
210 intoxications due to methadone.

211 Oxycodone deaths showed a threefold rise compared to 2012 in Finland and was the second most  
212 common intoxicant in 2017. Deaths due to oxycodone increased in all the Nordic countries.  
213 Intoxications due to tramadol were still high in Finland and Sweden. Fentanyl deaths decreased in  
214 Finland and Sweden but increased in the other Nordic countries. Deaths by codeine have declined in  
215 all countries except in Norway.

216 Included in the Group I drugs were also a considerable number of deaths due to fentanyl analogues,  
217 e.g. 52 fatal intoxications of cyclopropylfentanyl in Sweden alone. Deaths by fentanyl analogues  
218 were also seen in Denmark, Finland and Norway. Carfentanil deaths occurred in Finland, Norway  
219 and Sweden. Three deaths from the opioid U-47700 occurred in Finland and Sweden (Table 1).  
220 This increase in deaths due to other opioids can also be seen in Figure 3, for all the Nordic  
221 countries, when related to the number of inhabitants. This graph includes other opioids, mainly  
222 oxycodone and tramadol, besides the fentanyl analogues.

223 A little more than half of the fatal intoxications in Iceland were due to opioids, mostly fentanyl and  
224 oxycodone.

225 Since 2012 there was also a notable increase of cocaine intoxications in all the Nordic countries,  
226 especially in Denmark.

227 *Group II drug* intoxications have increased over the years in all countries except Sweden, Table 1.  
228 Amphetamine intoxications were most frequently seen in Finland, while a notable increase occurred  
229 overall in deaths due to MDMA. Methamphetamine poisonings were seen in all countries except  
230 Denmark but most frequently in Finland and Norway. Six deaths occurred due to NPS in group II;  
231 these were seen in Finland, Norway and Sweden. GHB as cause of death was only seen in Finland  
232 and Norway, while there was one single fatal intoxication with methylphenidate in Iceland.

233 *Group III drugs* as main intoxicants were significant in Finland, but an increase of deaths due to  
234 group III drugs was seen overall. In accordance with our previous publications, buprenorphine was  
235 the single most frequent cause of death in Finland in 2017. The number of buprenorphine  
236 intoxications has increased in all the Nordic countries, and especially in Sweden; where it was the  
237 second main intoxicant after heroin/morphine.

238 Fatal intoxications with benzodiazepines were seen in all countries except Iceland; these included  
239 non-prescription benzodiazepines in Denmark (flubromazolam) and Sweden (norfludiazepam).

240 Other causes of death were pregabalin and gabapentin in Finland, Sweden and Norway.

241 *Group IV drugs* still constituted 7 to 8% of the fatal intoxications in Finland and Sweden, similar to  
242 what was seen in 2012, while group IV drugs decreased to 2% in Denmark but increased to 3% in  
243 Norway. This group consists of different pharmaceutical drugs, poisons and alcohols. Norway saw  
244 one death from lighter gas. Intoxications due to ethanol were decreasing in all countries in 2017  
245 compared to previous years.

246 *3.5. Toxicological findings*

247 The frequency of all positive findings of medicinal and illicit drugs and alcohol in each country in  
248 2017 in comparison with 2002, 2007 and 2012 are presented in Table 2. That table clearly shows  
249 that poly-drug use was widespread in all countries. The median number of drugs (excluding  
250 ethanol) per case in each country varied between 4 and 6 (with the highest in Sweden and Finland  
251 and lowest in Norway). The abuse, as in the earlier years, was characterised by traditional illicit  
252 drugs (heroin/morphine, cocaine, amphetamine, MDMA and THC), medicinal drugs  
253 (buprenorphine, methadone, tramadol, oxycodone and benzodiazepines) and alcohol. However, a  
254 wide variety of NPS, and especially the fentanyl analogues, were detected in all countries except  
255 Iceland. Ethanol was detected in all countries, with 7–47% of the cases being positive for ethanol.  
256 The percentage was highest in Finland and lowest in Iceland. The ethanol concentration was above  
257 0.5 mg/g in most these cases.

### 258 *3.5.1. Illicit and medicinal drugs*

259 Opioids were frequently detected in all countries (Table 2). Heroin/morphine was most often  
260 detected in cases in Norway and Sweden, while methadone was the most frequent drug in Denmark.  
261 Buprenorphine was the most frequent opioid in Finland, as was the case in earlier studies. The  
262 decrease in heroin/morphine-positive cases, which was replaced by a corresponding increase in  
263 methadone in Denmark, Norway and Sweden since 1997, has stopped. Denmark and Sweden saw a  
264 slight increase in heroin/morphine positive cases, but these cases continued to decrease in Norway.  
265 The frequency of methadone-positive cases decreased in all countries except Finland, which  
266 experienced an increase. Nevertheless, as in the earlier years, only a few cases were positive for  
267 heroin/morphine and methadone in Finland. Norway had a large increase in buprenorphine-positive  
268 cases, from 7% in 2012 to 21% 2017, and is now at the same level as Sweden (23%). The frequency  
269 of buprenorphine-positive cases was high and unchanged in Finland (54%). By contrast, only few

270 cases were positive for buprenorphine in Denmark. Heroin/morphine, methadone and  
271 buprenorphine were detected in a few cases in Iceland.

272 Tramadol and oxycodone were observed in all countries but most frequently in Finland. The  
273 frequency of oxycodone increased in all countries except Denmark, which had the lowest  
274 frequency. Few cases were positive for tramadol and oxycodone in Iceland. Newer designer  
275 fentanyl analogues were detected in all countries except Iceland. Many different fentanyl analogues  
276 (acryoylfentanyl, methoxyacetylfentanyl, furanylfentanyl etc.) were found primarily in Sweden  
277 (Table 2 footnotes). U-47700 a NPS with opioid effect was detected in a few cases in Finland and  
278 Sweden.

279 The finding of amphetamine increased compared to 2012 in all countries except Denmark. The  
280 number nearly doubled in Norway and Sweden. Iceland showed the largest increase, and  
281 amphetamine was the most frequent drug detected in Iceland. Amphetamine was more frequently  
282 detected in Iceland compared to the other countries, followed by Finland. The frequency of  
283 methamphetamine increased in Finland from 9% to 20% and in Iceland from 0% to 27% while it  
284 decreased in Norway. Only a few methamphetamine-positive cases were seen in Sweden and  
285 Denmark,. In turn, Denmark saw a large increase in cocaine-positive cases compared to 2012, as  
286 cocaine was found in nearly half (44%) of all cases in Denmark. Cocaine was detected in all  
287 countries.

288 MDMA abuse increased in all countries and was most frequent in Finland and Iceland. Many  
289 different central stimulating NPS (Alpha-PVP, Alpha-PHP, 2-CB, 5CI-AB-PINACA etc.) were  
290 detected almost exclusively in Finland and Sweden. A single case of 5-APB was detected in  
291 Norway. GHB was detected to a lesser extent (1.5–5%) in Norway and Finland. Methylphenidate

292 was found in all countries and 2–8% of the cases were positive for methylphenidate. Four cases  
293 (27%) were positive for methylphenidate in Iceland.

294 Cannabis abuse has been frequent and unchanged through the years in all countries (34–41%) and  
295 remains one of the most frequently used drugs (Table 2). The z-hypnotics (zolpidem and zopiclone)  
296 were detected in all countries. Zopiclone was detected most frequently in Sweden (14%) with fewer  
297 cases (2.5–10%) in the other countries. Only a few cases (1–3%) were positive for zolpidem.  
298 Pregabalin and gabapentin were detected in all countries, especially pregabalin (8–42%). The  
299 highest percentage was seen in Finland (42%) followed by Sweden (30%). The frequency of cases  
300 with gabapentin varied from 4–14%, with the highest percentage seen in Finland (14%).

301 Antidepressants and antipsychotics (one or more per case) were detected frequently in all countries.  
302 The percentages varied between 16 and 53%. Citalopram and mirtazapine were the most commonly  
303 used antidepressants, while olanzapine and quetiapine were the most frequently detected  
304 antipsychotics.

### 305 3.5.2. *Benzodiazepines*

306 The percentage of cases in which benzodiazepines (one or more per case) were found varied from  
307 73.5–88% in all countries. Benzodiazepines were therefore the most frequent drugs detected in fatal  
308 poisonings in all countries. Many different benzodiazepines were detected, especially in Sweden  
309 (Table 3).

310 Clonazepam and diazepam were among the three most frequently detected benzodiazepines in all  
311 countries except Iceland, where clonazepam was not detected (Table 3). The increase in  
312 clonazepam use seen since 2002 continued in all countries, but to a lesser extent in Norway and  
313 Sweden. In 2017, clonazepam was the most frequently detected benzodiazepine in Denmark and  
314 Norway. In Finland, clonazepam shared the first place with diazepam. Cases with clonazepam and

315 alprazolam doubled from 2012 to 2017 in Denmark. The increase in alprazolam use seen since 2002  
316 continued in Denmark and Sweden but stopped in Finland and Norway. Alprazolam was the most  
317 frequently detected benzodiazepine in Sweden and Iceland and the third most used in Finland and  
318 Norway in 2017. In Denmark, nitrazepam (14%) was the third most used benzodiazepine shortly  
319 followed by alprazolam (13%).

320 Flunitrazepam, which was one of the most frequent benzodiazepines in Norway in 2002 and 2007  
321 and in Sweden in 2002, has almost disappeared. Only 2% of the fatal poisonings were positive for  
322 flunitrazepam in Sweden in 2017.

323 A number of different NPS benzodiazepines were found, especially in Sweden (Table 3). Thirteen  
324 percent (53 cases) of the fatal poisonings in Sweden contained the NPS benzodiazepine  
325 norfludiazepam. Another NPS benzodiazepine, phenazepam, was detected in 10 cases in Finland  
326 and in three cases in Sweden and in one case in Iceland. Flubromazolam was detected in Denmark,  
327 Finland and Sweden in 1–2 cases. Etizolam was detected in 3–4 cases in Finland and Sweden.

328

#### 329 **4. Discussion**

330 The definition used in this study for a drug addict was agreed upon by the Nordic working group in  
331 1984 and has been used in all subsequent papers [8-13]. The purpose of this definition was to focus  
332 on the problem of drug abusers applying an illicit route of administration, such as injection, or  
333 abusing the drugs listed in the international conventions from 1961 and 1971 [8].

334 Compared to the 2012 situation, the death rate increased in Finland, Iceland and Sweden but  
335 decreased Denmark and Norway, which had shown the highest death rates in previous years.

336 Overall, the differences between the Nordic countries have levelled off over the years.

337 Illicit drug abuse has changed over the years, but opioid overdose is still the main cause of death  
338 among fatally poisoned drug addicts. In 2017, a wide variety of fentanyl analogues were detected in  
339 most Nordic countries. Sweden experienced an epidemic of deaths due to fentanyl analogues, while  
340 the findings were more limited in Denmark, Finland and Norway, and no deaths occurred in  
341 Iceland. A report from the Swedish Police [14] described the course of the epidemic between 2015  
342 and 2018 and emphasised the crucial role of the local Internet vendors that were few in number but  
343 indirectly caused hundreds of deaths. This is an example of how a part of the illicit market has  
344 moved from the street to the Internet. It also shows how fast the drug market can change and how  
345 few criminals are able to supply NPS drugs to a large group of abusers.

346 In this study, Denmark and Norway showed a similar drug profile. Both countries had  
347 heroin/morphine, methadone and a CNS stimulant (cocaine in Denmark and amphetamine in  
348 Norway) among the three most prevalent drugs, besides THC and benzodiazepines. Finland differed  
349 from those, having buprenorphine, pregabalin and amphetamine as the three most prevalent drugs.  
350 Sweden showed similarities with Denmark and Norway but also with Finland, having  
351 heroin/morphine and pregabalin as the two most prevalent drugs, while amphetamine and  
352 buprenorphine shared third place. It seems as the abuse of amphetamines has changed from  
353 methamphetamine to amphetamine in Norway.

354 A recent study analysed the persistently high buprenorphine-related mortality in Finland [15]. The  
355 origins of buprenorphine abuse date back to the 1990s, when two general practitioners in Helsinki  
356 introduced buprenorphine unlawfully for the treatment of opioid addicts. Currently, most of the  
357 abused buprenorphine is illegally trafficked Subutex<sup>®</sup> tablets originating from France. Despite the  
358 presence of naloxone in Suboxone<sup>®</sup>, this product is also abused to a lesser extent. The percentage of  
359 parenteral Suboxone<sup>®</sup> users in which the pathologist has implicated buprenorphine in the cause of  
360 death was similar to that for parenteral Subutex<sup>®</sup> users [15].



361 Cocaine was previously rare in deaths in the north of Europe, but it has now made its appearance as  
362 a cause of death in all Nordic countries, and was the second most frequently drug detected in  
363 Denmark. This is in line with the fact that cocaine seizures in the EU reached record highs in 2017,  
364 with increased purity at the retail level [3]. MDMA also appeared as a marked cause of death in all  
365 Nordic countries. Similarly, in England and Wales [16], heroin/morphine and methadone continued  
366 to be the principal drugs involved in fatal poisonings, but a big increase in cocaine deaths and a  
367 steady increase in MDMA deaths was also found. Wastewater-based epidemiology from five  
368 Nordic capitals in 2016 has shown that cocaine use was still low compared with cities in the  
369 southern and western part of Europe, while MDMA and cocaine showed clear variations between  
370 weekdays and weekends, indicating recreational use during weekends [17].

371 Pregabalin and gabapentin have manifested themselves among components of poly-drug abuse, and  
372 these drugs were detected in all Nordic countries. Pregabalin was among the most frequently  
373 detected drugs in Finland and Sweden in both 2012 and 2017, and deaths from pregabalin were  
374 observed in these countries in both studies [13]. Pregabalin is prescribed to treat neuropathic pain,  
375 epilepsy and generalised anxiety disorder. It has been previously considered a drug with low abuse  
376 potential but more recent reports have demonstrated abuse and development of dependence [18-20].  
377 Pregabalin at high doses possesses sedative effects like benzodiazepines, and consequently it adds  
378 to the respiratory depression caused by opioids.

379 Antidepressants/antipsychotics were frequently detected in all countries except for Norway. Some  
380 illicit drugs can induce psychosis; however, individuals with psychiatric illnesses may use drugs as  
381 self-medication. The high prevalence of antidepressants/antipsychotics is also due to the fact that  
382 these drugs have considerable off-label use as hypnotics and anxiolytics in the treatment of addicts  
383 [13, 21].

384 A limitation of this study concerns the definition of the main intoxicant, since the following rule has  
385 been used in all studies: “if the cause of death cannot be ascribed to a single substance, the drug  
386 with the lowest group number is considered the main intoxicant”. This rule made sense in the earlier  
387 studies when heroin was the most widespread and problematic narcotic drug. However, as the drug  
388 situation has changed, this rule camouflages the influences of other drugs like buprenorphine as  
389 cause of death. This may affect the data presented in Table 1 and Figure 3. In future work, the  
390 groups may need to be reorganised for a better illustration of cause of death by including all opioids  
391 in Group I. Another issue concerns the target age group, which originally consisted of drug addicts  
392 that died at the age of 15–35 years [8]. The situation has changed, as drug addicts live longer;  
393 consequently, the age group in this study was extended to 14–70 years.

394 The series of the Nordic studies on fatal drug poisonings, commenced in 1984, is unique since the  
395 same definition for a drug addict has been used in all studies and by all Nordic countries. To our  
396 knowledge, no similar studies exist in the literature. The current data is easily compared with earlier  
397 data, as the results have been presented, with some minor modifications, in similar tables and  
398 figures [9-13]. During the present study period, the post-mortem toxicology rate among all deaths  
399 was approximately 12% in Finland, 7% in Iceland, 5% in Sweden and Norway and 2% in Denmark.  
400 However, the study material is assumed to be almost population based, since comprehensive  
401 toxicology is performed in suspected cases of fatal poisonings in all the Nordic countries. Even in  
402 Denmark, with the lowest autopsy rate, all drug related deaths are, by law, undergoing a  
403 medicolegal autopsy and toxicological analysis.

404

## 405 **5. Conclusion**

406 As in the previous years, abuse trends and patterns varied among the Nordic countries in 2017.  
407 Finland, in particular, had a different drug profile compared to the other countries. Opioids were  
408 still the main cause of death in all countries, but over the years the proportion of opioid deaths has  
409 decreased in all countries except Sweden. Instead, deaths from CNS stimulants like cocaine,  
410 amphetamine and MDMA have increased.

411 NPS were detected in all countries except Iceland. Fentanyl analogues appeared for the first time  
412 and were seen in all countries except Iceland. NPSs were most frequent in Sweden and changed  
413 from being the lowest cause of death in 2012 to the second highest cause of death in 2017. Abuse of  
414 pregabalin and gabapentin was established in all countries, with occasional death cases.

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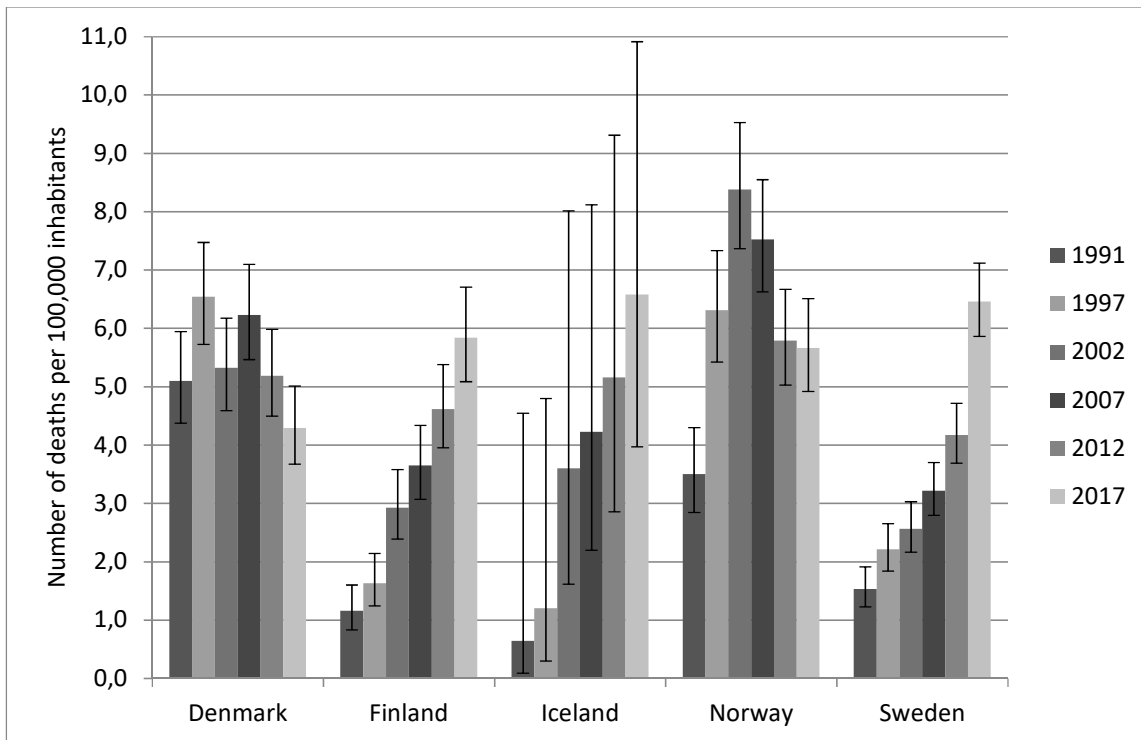


Figure1 Legend; Fatal poisonings among drug addicts in 1991, 1997, 2002, 2007 and 2017. Number of deaths per 100,000 inhabitants in 2017 was as follows: Denmark, 4.29; Finland, 5.84; Iceland, 6.58; Norway, 5.66; and Sweden, 6.46. The error bars in the figure are confidence intervals.

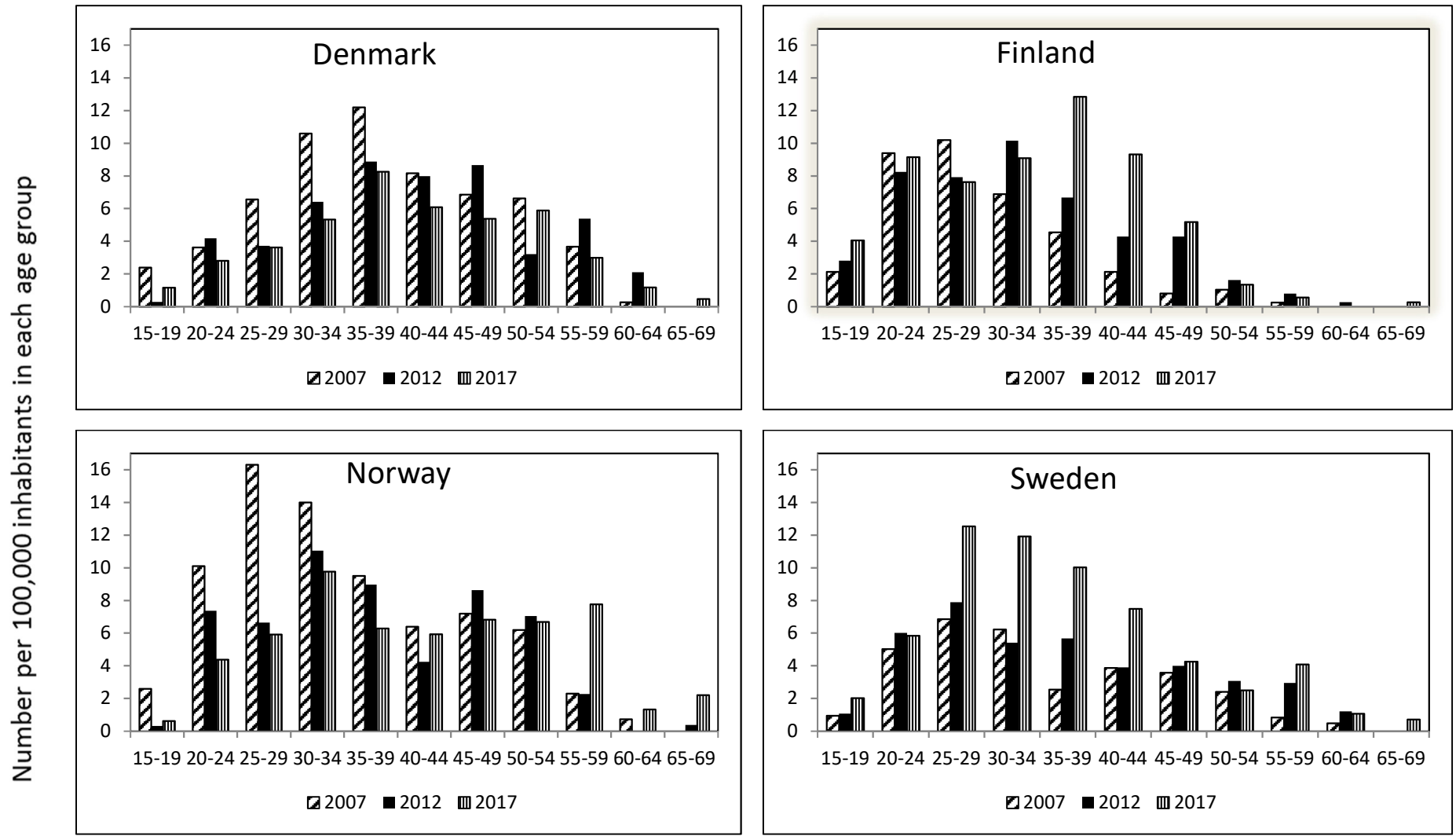


Figure 2 legend;  
 Age distribution in medico-legally examined fatal poisonings among drug addict deaths in the Nordic countries in 2007, 2012 and 2017.



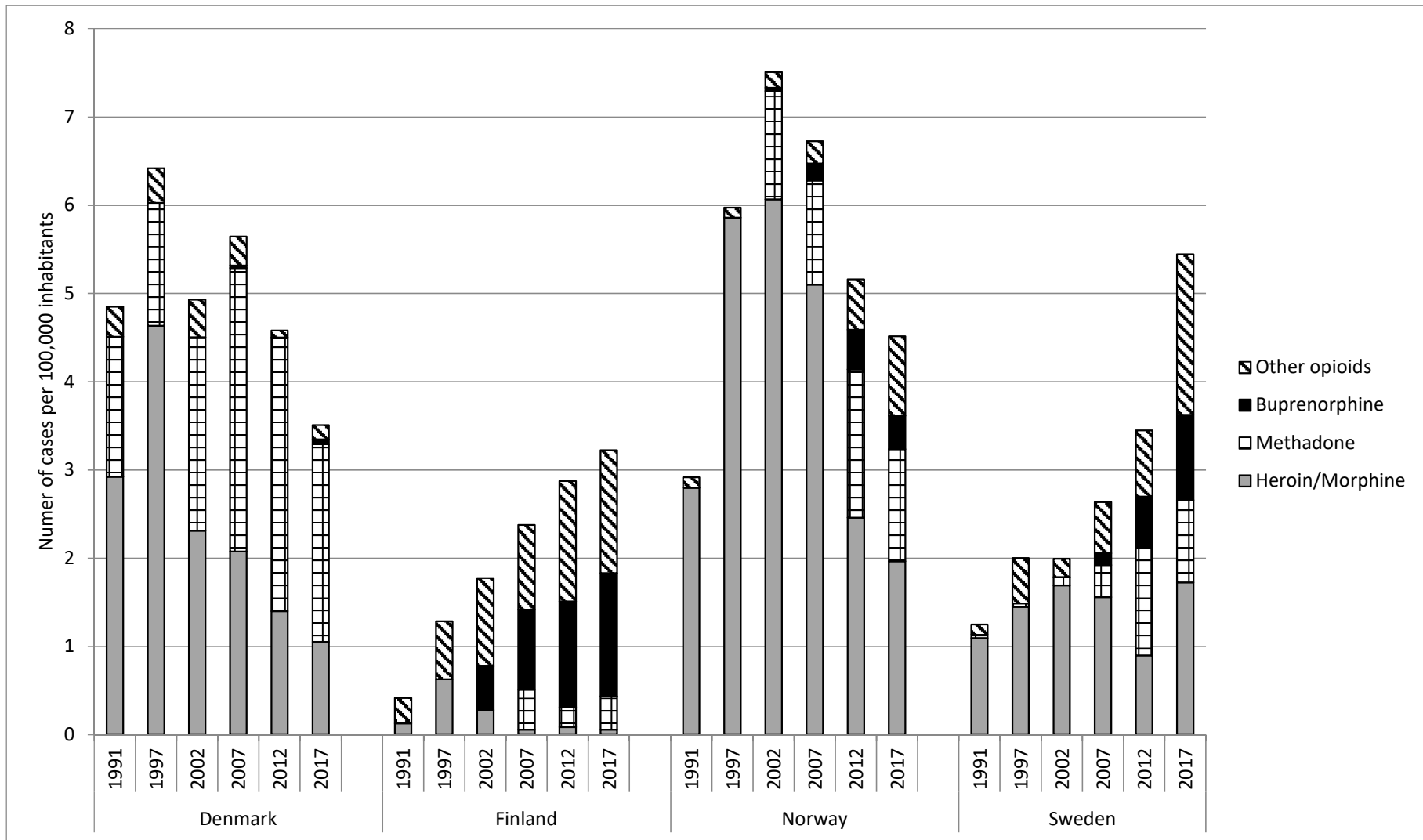


Figure 3 Legend:

Cause of death by opioids. Number of deaths per 100,000 inhabitants in 1991, 1997, 2002, 2007, 2012 and 2017. The years: 1991-2002 presents the age group 15-59 years and the years: 2007-2017 the age group 15-64 years.

	Denmark, n				Finland, n				Norway, n				Sweden, n				Iceland, n		
	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2007	2012	2017
Group I drugs sum <sup>a</sup>	163	209	169	146	43	52	60	70	210	206	156	155	107	151	176	292	8	7	9
Heroin/morphine	76	75	51	40	9	2	3	2	168	160	86	69	90	94	55	110	3	2	1
Methadone	72	116	111	85	0	16	8	13	34	37	56	46	5	22	75	59	3	0	1
Codeine	0	0	1	0	11	8	12	6	4	2	2	4	1	0	0	0	0	1	0
Cocaine	1	6	4	15	2	0	0	6	1	1	0	6	1	1	2	6	0	0	2
Fentanyl		0	0	2	3	7	12	3			3	7	0	10	27	16	2	0	2
Tramadol	5	2	1	1	9	14	18	16	0	2	4	6	2	12	8	21	0	3	0
Oxycodone	0	3	0	1	1	4	6	19	0	2	9	14	0	5	9	12	0	1	2
Group II drugs sum <sup>b</sup>	3	8	5	6	13	10	32	45	9	13	21	21	18	16	20	11	1	1	5
Amphetamine	2	6	2	2	12	8	13	14	9	9	4	7	16	11	8	3	0	0	1
Methamphetamine	0	0	0	0				8			10	7	1	0	1	1	0	0	1
MDMA	1	1	2	4	1	1	1	10			1	3	0	2	0	6	0	0	2
GHB		0	1	0		1	12	7		3	4	3	1	2	4	0	0	0	0
Methylphenidate		0	0	0		0	1	0		0	0	0		0	1	0	1	1	1
Group III drugs sum <sup>c</sup>	1	4	3	6	16	45	57	72	4	11	13	20	3	12	42	75	0	0	1
Buprenorphine		1	0	2	16	32	42	48	1	6	5	13		8	35	61			1
Pregabalin		0	0	0			10	9		0	0	1			3	3			0
Gabapentine		0	0	0			0	1		0	0	0		0	0	1			0
Group IV drugs sum <sup>d</sup>	8	5	11	4	22	22	13	16	9	7	3	7	8	15	17	30	1	3	0
Ethanol	0	1	1	0	7	13	7	6	2	3	1	1	0	1	8	4	0	1	
Total	175	226	188	162	94	129	162	202	232	236	194	203	136	194	255	408	10	11	15

2017 Comments: **Denmark:** <sup>a</sup> Acryloylfentanyl: 1, Methoxyacetylfentanyl: 1; <sup>c</sup> Alprazolam: 1, Clonazepam: 2, Flubromazolam: 1; <sup>d</sup> Antidepressant/antipsychotic: 3.

**Finland:** <sup>a</sup> Carfentanil: 2, Furanylfentanyl: 1, U-47700: 2; <sup>b</sup> 3-MeO-PCP: 1, alpha-PVP: 3, THC: 2; <sup>c</sup> Alprazolam: 3, Clonazepam: 3, Oxazepam: 2, Diazepam: 1, Chlordiazepoxide: 1, Zolpidem: 1, zopiclone: 2; <sup>d</sup> Antidepressants/antipsychotics: 3.

**Norway:** <sup>a</sup> Carfentanil: 1, Mitragnine: 1, Ethylmorphine: 1; <sup>b</sup> 5-APB: 1; <sup>c</sup> Alprazolam: 1, Clonazepam: 4, Diazepam: 1; <sup>d</sup> Antidepressants/antipsychotics: 4, Lighter gas: 1, methanol: 1.

**Sweden:** <sup>a</sup> Cyclopropylfentanyl: 52, Furanylfentanyl: 4, Acryloylfentanyl: 4, Methoxyacetylfentanyl: 3, Carfentanil: 2, 4F-isobutyrfentanyl: 1, Tetrahydrofuranfentanyl: 1, U-47700: 1; <sup>b</sup> Ethylphenidate: 1; <sup>c</sup> Alprazolam: 3, Clonazepam: 1, Flunitrazepam: 1, Norfludiazepam: 3, Zolpidem: 2; <sup>d</sup> Antidepressants/antipsychotics: 7, Loperamide: 4.

**Iceland:** <sup>a</sup> Ketobemidone.

Table 1 Legend; Fatal poisoning in medico-legally-examined drug addict deaths in the Nordic countries in 2017 in comparison with 2002, 2007 and 2012 grouped according to the assumed main cause of death, n = number of fatal poisonings in the different groups.

	Denmark				Finland				Norway				Sweden				Iceland			
	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017
Number of cases	175	226	188	162	94	129	162	202	232	236	194	203	136	194	255	408	6	10	11	15
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Group I drugs																				
Heroin/morphine	48	40	30	35	35	3	6	5	78	71	45	37	69	49	29	32	50	30	27	20
Methadone	53	61	71	65	2	13	7	12	19	21	34	29	7	14	32	17	17	30	0	7
Codeine	15	8	9	4	27	17	15	9	6	6	8	11	9	2	2	1	17	20	27	20
Cocaine	15	15	19	44	2	1.5	0	6	2	8	5	5.9	4	3	5	10	33	10	0	33
Fentanyl			0.5	5		7	9	2		0	3	4.9		5	11	5		20	0	13
Tramadol	3	6	6	3	11	18	15	16	0	3	3	7.9	7	12	7	10	0	20	36	20
Oxycodone	0	2	3	4	1	8	6	15	0	2	5	9.9	0	3	5	8		0	9	20
Other Group I drugs <sup>a</sup>	17	5.8	5	2.5	12	1.5	2	4	2	0.8	0.5	2.5	11	6	0.4	18	17	0	0	7
Group II drugs																				
Amphetamine	9	10	10	11	23	25	22	32	30	15	13	25	29	32	14	23	33	40	18	60
Methamphetamine	0	0.4	0	0.6		5.5	9	20		23	35	20	4	6	2	1	0	0	0	27
MDMA	0.6	1.8	1.6	5	8	4	5	13	2	3	1.5	4.9	3	4	1	4	0	10	0	40
GHB		0	1.6	0		0.8	7	5		1	3	1.5		1.0	1.5	0		0	0	0
Methylphenidate		0	4.8	6		3	2	2		0	2	3.9		0	9	8		20	36	27
Tetrahydrocannabinol	36	26	34	41	37	36	38	40	24	21	31	39	21	22	25	34	17	0	36	13
Other Group II drugs <sup>b</sup>		0.4	2.0	1		0	15	11		0.4	8	0.5		0.5	10	4		0	9	0
Group III drugs																				
Benzodiazepines <sup>c</sup>	41	55	71	73.5	71	82	88	88	67	70	80	75	51	59	71	74	33	40	27	80
Zopiclone		3.5	4	2.5		6	4	6		6	7	9.9		8	16	14			9	7
Zolpidem	0	0.4	1	1		0.8	0	3		0	2	1.0		2	2	2				0
Pregabalin		0	5	8		10	32	42		0.8	12	18			28	30			0	27
Gabapentin		0	0	4			1.2	14			0	7.4		0	3	6			0	13
Buprenorphine	0.6	2	4	8	19	40	54	54	2	6	7	21	2	10	24	23				13
Other Group III drugs <sup>d</sup>		0	0	0		0	0	0		3.2	0	0	9	3	0	0			0	7
Group IV drugs																				
Ethanol total	34	34	36	20	47	47	44	47	21	30	16	11	35	26	24	24	0	10	18	7
Ethanol >0.50 mg/g	25	29	18	11	40	41	34	30	16	22	11	8.9	23	20	16	15	0	10	18	7
Other Group IV drugs	41	45	65	70	50	68	66	49	52	32	40	43	68	47	47	52	33	70	73	47
Antidepressants/anti- psychotics			41	47			40	45			26	16			30	40			45	53

2017 comments: Denmark: <sup>a</sup>Ketobemidone: 0.6%, Hydromorphone: 0.6%; Acryloylfentanyl: 0.6%, Methoxyacetylfentanyl: 0.6%; <sup>b</sup> Ketamine: 1%; <sup>c</sup>Flubromazolam: 0.6%  
Finland: <sup>a</sup> Dextromethorphan 0.5%, U-47700 1%, Carfentanil: 1%, Acetylfentanyl: 1%, Furanylfentanyl: 0.5%; <sup>b</sup> Alpha-PVP 6%, Ketamine: 2.5%;  
2F-Methamphetamine: 0.5%, 5-MeO-MIPT: 0.5%, MDA: 0.5%, BZP: 0.5%, 2-CB 0.5%; <sup>c</sup>Etizolam: 1.5%, Flubromazolam: 1%  
Norway: : <sup>a</sup>Acetylfentanyl: 0.5%, Ethyl morphine: 1.0%, Carfentanil: 0.5%, Ketobemidone: 0.5%, Mitragynine: 0.5%, Tapentadol: 0.5%; <sup>b</sup>5-APB: 0.5%.  
Sweden: <sup>a</sup>Cyclopropylfentanyl: 13%, Furanylfentanyl: 1%, Acryloylfentanyl: 1%, Methoxyacetylfentanyl: 1%, Carfentanil: 0.5%, Tetrahydrofuranfentanyl: 0.5%;  
U-47700: 0.5%, Ethylmorphine 0.5%, 4F-isobutyrfentanyl: 0.2%, Tetrahydrofuranfentanyl: 0.2%; <sup>b</sup> Alpha-PHP: 1%, Alpha-PiHP: 1%, N-isopropylnorhexedrone: 1%,  
4F-N-ethylpentedrone: 0.5%, 5Cl-AB-PINACA: 0.2%, N-ethyl-4methylnorpentedrone: 0.2%, Ethylphenidate: 0.2%, 4F-Ethylphenidate: 0.2%. <sup>c</sup>Norfludiazepam 13%,  
Etizolam 1%, Phenazepam 0.7%, Flubromazolam 0.2%.  
Iceland: <sup>a</sup>Ketobemidone. <sup>d</sup>Phenobarbital.

Table 2 Legend; Analytical findings for drugs and poisons in medico-legally-examined fatal poisonings in drug addict deaths in the Nordic countries in 2017 in comparison with 2002, 2007 and 2012.

	Denmark				Finland				Norway				Sweden				Iceland			
	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017	2002	2007	2012	2017
Number of cases	175	226	188	162	94	129	162	202	232	236	194	203	136	194	255	408	6	10	11	15
Diazepam (%)	35	26	34	29	50	63	54	47	30	35	33	28	25	35	25	20	17	20	9	7
Clonazepam (%)	3	12	22	45	1	5	37	47	13	20	50	53	4	15	27	28	0	0		0
Alprazolam (%)	4.5	4	7	13	15	24	36	31	3	12	19	19	4	18	39	45	0	10		40
Nitrazepam (%)	3	9	18	14	0	0		0	6	19	10	7.9	6	4	6	3	0	0		0
Bromazepam (%)	8	12	16	10	0	0		0					0	0	0.4	0.2				7
Flunitrazepam (%)*	1	7	6	0	0	0	0	0	48	27	6		21	4	4	3	0	0		0
Temazepam (%)	0	0	0	0	44	38	17	10					0	0	0	0				0
Oxazepam (%)	7	5	7	2	38	48	16	13	2	11	6	11	2	1.6	4	2	0	0	9	13
Chlordiazepoxid(%)	4	11	12	9	3	4		3.5					0	0	0	0	17	10	9	7
Midazolam (%)		0	2	0.6			4.3	5				1.5								0
Phenazepam (%)**		0	2.7	0			1.2	5		1	1		0	0	0.8	0.7				7
Lorazepam (%)		0.5	1.0	0	3	2		3.5					0.7	0	0	1				0
Triazolam (%)		0	0	0				0							0.4	0				0
Etizolam (%)			0	0				1.5			0.5				1	1				0
Flubromazolam (%)				0.6				1												0.2
Norfludiazepam (%)																13				

\* 7-aminodesmethylflunitrazepam included, \*\* 3-OH-phenazepam included

Table 3 Legend; Frequency of benzodiazepines in medico-legally examined drug addict deaths in the Nordic countries in 2017 in comparison with 2002, 2007 and 2012.