

Naloxone distribution and possession following a large-scale naloxone programme

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ABSTRACT

Aims To examine uptake following a large-scale naloxone programme by estimating distribution rates since programme initiation and the proportion among a sample of high-risk individuals who had attended naloxone training, currently possessed or had used naloxone. We also estimated the likelihood of naloxone possession and use as a function of programme duration, individual descriptive and substance use indicators. **Design** (1) Distribution data (June 2014–August 2017) and date of implementation for each city and (2) a cross-sectional study among a sample of illicit substance users interviewed September 2017. **Setting** Seven Norwegian cities. **Participants** A total of 497 recruited users of illegal opioids and/or central stimulants. **Measurements** Primary outcomes: naloxone possession and use. Random-intercepts logistic regression models (covariates: male, age, homelessness/shelter use, overdose, incarceration, opioid maintenance treatment, income sources, substance use indicators, programme duration). **Findings** Overall, 4631 naloxone nasal sprays were distributed in the two pilot cities, with a cumulative rate of 495 per 100 000 population. In the same two cities, among high-risk individuals, 44% and 62% reported current naloxone possession. The possession rates of naloxone corresponded well to the duration of each participating city's distribution programme. Overall, in the six distributing cities, 58% reported naloxone training, 43% current possession and 15% naloxone use. The significant indicators for possession were programme duration [adjusted odds ratios (aOR) = 1.44, 95% confidence interval (CI) = 0.82–2.37], female gender (aOR = 1.97, 95% CI = 1.20–3.24) and drug-dealing (aOR = 2.36, 95% CI = 1.42–3.93). The significant indicators for naloxone use were programme duration (aOR = 1.49, 95% CI = 1.15–1.92), homelessness/shelter use (aOR = 2.06, 95% CI = 1.02–4.17), opioid maintenance treatment (OMT) (aOR = 2.07, 95% CI = 1.13–3.78), drug-dealing (aOR = 2.40, 95% CI = 1.27–4.54) and heroin injecting (aOR = 2.13, 95% CI = 1.04–4.38). **Conclusions** A large-scale naloxone programme in seven Norwegian cities with a cumulative distribution rate of 495 per 100 000 population indicated good saturation in a sample of high-risk individuals, with programme duration in each city as an important indicator for naloxone possession and use.

Keywords Naloxone, naloxone distribution, naloxone possession, overdose prevention, opioid overdose, people who inject drugs.

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INTRODUCTION

Opioid overdoses are a growing concern. North America has seen dramatic increases in opioid overdose mortality recently [1], with more than 60 000 overdose deaths in 2016 [2]. Increases in overdoses have also been seen in Australia [3] and throughout Europe [4]. Scandinavia has some of the highest reported rates of drug-induced mortality in Europe, and Norway has a recorded mortality rate nearly four times the European average [4]. Given this global concern, efforts towards overdose prevention are critical.

Take-home naloxone programmes (THN) were introduced in the 1990s as a potential method to prevent overdoses [5]. These programmes aim to train bystanders to administer the antidote during an overdose [5]. Collectively, THN programmes have been found to be effective in reducing overdose mortality with low rates of adverse events [6–10].

However, distribution rates must have adequate coverage to affect overdose mortality. Based on findings from Scotland, large-scale programmes should aim to distribute between nine and 20 times the annual fatality rates [11].

Findings from a THN programme in Massachusetts suggest that distribution rates should exceed that of 100 per 100 000 population, which was the point where they observed the greatest reduction in overdose deaths [10]. While these distribution goals give a starting estimate for large-scale programmes, a natural next question is to look into how these distribution rates result in actual naloxone carriage or possession rates, particularly to at-risk groups. McAuley *et al.* found in their survey of needle exchange participants that naloxone carriage rates were relatively low, and that in fact the rates had decreased between their two survey periods [12]. Understanding the uptake of naloxone interventions can help to optimize implementation of these programmes. In order to examine the naloxone uptake following the implementation of a large-scale naloxone programme in Norway, we analysed two separate data sets: (1) the distribution data from a large-scale THN programme and date of implementation and (2) the interview data from a sample of 497 illicit substance users recruited from street- and low-threshold services in seven Norwegian cities. Specifically, we estimated the naloxone distribution rates since programme initiation in June 2014 until August 2017 and the proportion among a sample of high-risk individuals, interviewed in September 2017, who had attended naloxone training, possessed and/or had used naloxone. Furthermore, we estimated the likelihood of naloxone possession and use as a function of individual demographic and substance use indicators, as well as of the programme duration, that varied by city.

METHODS

Design and data sources

This study used two separate data sets. The first had a prospective study design where naloxone distribution data was provided by the different participating facilities in various cities between June 2014 and August 2017. However, only the two first cities to implement the programme were able to provide complete distribution data including August 2017 at the time of data analysis. Date for programme implementation in each city was also provided, as the programme was introduced stepwise to gradually include more cities. The second data set had a cross-sectional study design and is part of a larger prospective cohort study published elsewhere [13]. It comprised a convenience sample of 497 street- or low-threshold service-recruited individuals who reported illegal opioid and/or stimulant use during the 4 weeks prior to inclusion in September 2017. Recruitment took place in seven Norwegian cities during 1–2 days in each city (Oslo, Bergen, Trondheim, Stavanger, Sandnes, Tromsø and Kristiansand). As in the original study, the targeted enrollment was approximately 100 participants from each city; this sample size balanced the statistical power and funding constraints. For analytical purposes,

Stavanger and Sandnes were combined. In the original study, cities were selected as they represented a variety of Norwegian cities and were among the largest cities in the country. The same inclusion criteria for cities were used in this data collection.

Participants were either street-recruited or recruited from or outside a wide range of facilities, such as needle-exchange services, day centres, housing, the supervised injection rooms in Oslo and Bergen and low-threshold cafes, health clinics and work facilities. Researchers and trained research assistants from the Norwegian Institute for Public Health recruited and interviewed the participants. Each interview took approximately 20 minutes to complete and was conducted out of earshot from others. The respondents received approximately €21/24 \$US (200 NOK) for participation.

Setting

Norway has a population of 5.2 million [14], an estimated 6900–9800 people who inject drugs (PWID) [15] and 250–300 overdose deaths annually [16]. Approximately one-third of these deaths occur in Norway's two largest cities, Oslo and Bergen [16]. In 2014, a large-scale THN programme was introduced as part of a national overdose prevention strategy [17]. This included funding and permission to distribute intranasal naloxone prescription-free throughout the cities most affected by overdose deaths. It was first initiated in Oslo and Bergen, and in September 2017 THN had expanded to 14 cities.

Distribution sites included low-threshold facilities, overnight shelters, drop-in day centres, safe injection rooms and medical facilities. At the time of this study, distribution within prisons was not firmly established. A train-the-trainer programme was developed to prepare staff from the above-mentioned facilities to train their clients. The training is provided at no cost to the facilities or clients. Although each distribution site followed the same training protocol, they were encouraged to tailor to the needs of their clients. Client trainings were brief, lasting approximately 5–10 minutes, and were held in both individual and group sessions. The training curriculum followed recommendations from the World Health Organization [18] and included recognizing the signs of an opioid overdose and how to respond (calling the ambulance, recovery position, cardiopulmonary resuscitation, assembly/use of intranasal naloxone and aftercare instructions). The initial findings from the programme implementation are published elsewhere [19,20].

The decision to use intranasal naloxone was based on a revision of previous THN programmes [21]. It was assumed that nasal naloxone would be easier for lay people to use, and that this route of administration would reduce the risk of potential injection accidents and the spread of blood-borne viral infections.

Study instrument

The interviewer-administrated questionnaire comprised demographic data (age and gender), if they were current opioid maintenance treatment (OMT) patients, incarceration history (ever or within the last 4 weeks), injection heroin use (within the last 4 weeks) and any injection drug use (within the last 4 weeks). The questionnaire is described in more detail elsewhere [13]. Participants were also asked three naloxone-related questions:

- 1 Do you have naloxone? (yes/ no, but have had previously/ no)
- 2 Have you attended a naloxone training? (yes/ no)
- 3 Have you used naloxone on someone who was unconscious? (yes/no)

Statistical analyses

Statistical analyses were conducted using Stata version 15.0. Naloxone distribution rates per population were calculated using city population estimates from 1 January 2016 [14]. As mentioned previously, only the two cities Oslo and Bergen provided data including August 2017 and the distribution rates were therefore estimated based upon these two cities.

We examined naloxone uptake by estimating the proportion of the sample of illicit substance users who reported naloxone training, possession and use both in total and for each city. The THN programme was implemented in six of the seven cities. The programme had been available in Oslo and Bergen since June 2014 in Trondheim, Stavanger and Sandnes since August 2016, and in Tromsø since March 2017. Kristiansand was the only city without THN. However, this latter city was included for comparison purposes, as it provides a reference population without naloxone distribution.

To estimate the likelihood for naloxone possession and use as a function of individual demographic and substance use indicators, we first examined the basic associations between these outcomes and each individual predictor of interest. Next, we estimated the likelihood of (a) naloxone possession and (b) naloxone use as a function of all individual demographic and substance use indicators (including programme duration). In both sets of analyses, we used random-intercepts logistic regression model with city as a clustering variable.

Measures

Naloxone possession and use were the two key outcomes in the random-intercept logistic regression analyses. As naloxone is a measure to prevent fatal overdose, we included well-known overdose risk and protective factors in the regression models. These variables included male, age, homelessness/shelter use, overdose during the past year,

overdose during the 4 weeks prior to inclusion, ever in prison, prison during the past 4 weeks and to be in OMT at the time of inclusion [22–30]. The prison variables were included as indicators for prison release. Additionally, programme duration in each city was included into the models, while city was included as the clustering variable.

Income sources are not likely to be associated with overdose. However, it is possible that to report theft, dealing and prostitution indicate a risky life-style that could be associated with overdose. We therefore included these indicators into the models. We also included into these models all substance use indicators available from the inclusion interview. Odds ratios (OR) and 95% confidence intervals (CI) are presented.

Ethics

The Norwegian Medical Ethics committee approved this study in June 2013 (2013/599/REK sør-øst A) and the additional inclusion of study participants September 2017 was approved by the same committee in May 2017.

RESULTS

Distribution

Distribution rates for the two cities first to implement the THN programme (Oslo and Bergen) show generally an increasing yearly trend (Table 1), with a cumulative rate of 495 per 100 000. However, Bergen had distributed far less in 2017 compared to previous years and to Oslo. Naloxone distribution began June 2014, and until the month directly prior to the survey study (August 2017) there were 4631 naloxone nasal sprays distributed in the two cities. While rates were generally similar in total, when adjusted for population Bergen distributed nearly double to Oslo, at 748 per 100 000 population cumulatively.

Proportion of illicit substance users attended training, possessed and used naloxone

More than half (53%) of the sample of 497 street- and low-threshold service-recruited illicit substance users interviewed in seven Norwegian cities in September 2017 had received training in how to use naloxone. However, one of the cities did not distribute naloxone at the time of study inclusion. If we omitted the 64 individuals recruited from this city, as many as 58% of the sample had received training.

Furthermore, more than one-third of the sample currently possessed naloxone. If the participants from the city without any distribution were omitted from the analysis, as many as 43% of the sample were currently in possession. Only 15% of the total sample had used naloxone on someone unconscious, and this changed to 18% if the

Table 1 Naloxone distribution rates from June 2014 to August 2017 in the two cities where the take-home naloxone (THN) programme was first implemented.

	2014	2015	2016	2017	Total	Per 100 000 population ^a	Suggested annual distribution ^b
Oslo	483	643	693	738	2557	388	480–1068
Bergen	246	684	763	380	2074	748	279–620

^aPopulation estimates are based on estimates from 2016 [14]. ^bSuggested annual coverage based on an ideal distribution rate of nine to 20 times fatality rates [11].

participants from the city without distribution was omitted from the analysis.

Table 2 shows the time of THN programme implementation and the proportions in each city who had received training, currently possessed and had used naloxone. The two cities where the THN programme first was implemented had the highest proportions of training, possession and use among the participants. Thereafter, the three cities that had implemented THN in 2016 had the third largest rates of training and possession, whereas the city that had implemented THN only 6 months prior to the interviews in September 2017 had the lowest rates of naloxone training and possession. We included the city without any THN for comparison purposes and, as expected, only a minority of the participants from this city had received any training (6%) or currently possessed naloxone (1%).

Descriptive characteristics of those in naloxone possession

Overall, 188 of the 497 street- and low-threshold service-recruited illicit substance users interviewed in September 2017 were in naloxone possession and an additional 24 reported that they had possessed naloxone previously. Of the 159 who reported recent heroin injection, 57% possessed naloxone. Furthermore, of the 360 who reported injection of any substance 42% possessed naloxone.

We estimated the likelihood for naloxone possession using random-intercept logistic regression analysis with

city as the clustering variable. In the univariate analysis, those younger, female, reported dealing as an income source and those who had injected any substance and/or heroin during the 4 weeks prior to the interview were more likely to currently possess naloxone (Table 3). Programme duration in each city measured in 6-monthly intervals was also a significant indicator. However, in the multivariate model only female gender, dealing and programme duration remained significant indicators of naloxone possession.

Descriptive characteristics of those who had used naloxone

Of the 212 who currently ($n = 188$) or previously ($n = 24$) possessed naloxone, 35% reported naloxone use at some point on a person who was unconscious. Similar to naloxone possession, we estimated the likelihood for naloxone use using random-intercept logistic regression analysis with city as the clustering variable (Table 4). In the univariate analysis, those who were younger, homeless or shelter users and those with past-year overdose experience, currently in OMT, reported dealing as an income source and had injected heroin and prescription drugs during the 4 weeks prior to inclusion were more likely to have used naloxone. Programme duration was also a significant indicator of naloxone use. However, in the multivariate model, to be homeless or shelter users, to be in OMT, to report dealing as an income source and to have injected heroin during

Table 2 Take-home naloxone (THN) programme introduction and the proportions of a sample of street- and low-threshold service-recruited illicit substance users ($n = 497$) who self-reported attending naloxone training, currently possessed or had used naloxone on someone unconscious.

	THN programme introduced	Received naloxone training 51% ($n = 255$)	Currently in possession 37% ($n = 188$)	Used naloxone 15% ($n = 76$)	Total 100% ($n = 497$)
Oslo	June 2014	71% (79)	62% (69)	27% (30)	100% (111)
Bergen	June 2014	64% (70)	44% (48)	28% (30)	100% (109)
Stavanger/ Sandnes ^a	August 2016	53% (39)	39% (29)	3% (2)	100% (74)
Trondheim	August 2016	55% (48)	37% (33)	15% (13)	100% (87)
Tromsø	March 2017	29% (15)	15% (8)	2% (1)	100% (52)
Kristiansand	None	6% (4)	1% (1)	0% (0)	100% (64)

^aThese are neighbouring cities with similar access to drug services and similar drug-using populations. Data collected on the same days in both cities. Only 21 individuals were included from Sandnes, and these were therefore analysed in combination with data collected from Stavanger ($n = 53$).

Table 3 Descriptive characteristics of those currently in naloxone possession among the 497 illicit substance users recruited from street and low-threshold services interviewed in September 2017. Estimates from the univariate and multivariable random-intercept logistic regression analysis for current naloxone possession; city was the clustering variable.

	<i>Not in possession 100% (n = 309)</i>	<i>Current possession 100% (n = 188)</i>	<i>Unadjusted odds ratios (95% CI)^a</i>	<i>Adjusted odds ratios (95% CI)</i>
Mean age (SD)	44.9 (10.2)	42.0 (10.2)	0.98 (0.96–1.00)*	0.98 (0.96–1.01)
Female	21% (64)	31% (58)	1.73 (1.10–2.72)*	1.97 (1.20–3.24)**
More than mandatory education ^b	62% (192)	65% (123)	1.04 (0.69–1.57)	–
Homeless or shelter user ^c	15% (46)	20% (37)	0.99 (0.58–1.68)	0.87 (0.48–1.58)
Overdose past year	14% (43)	16% (30)	0.91 (0.53–1.57)	0.75 (0.41–1.38)
Overdose previous 4 weeks	5% (16)	5% (9)	0.77 (0.31–1.91)	–
Ever incarcerated	80% (248)	73% (137)	0.68 (0.42–1.08)	–
Incarcerated previous 4 weeks	1% (3)	4% (7)	4.56 (0.95–21.89)	3.74 (0.82–17.11)
Currently in OST	48% (149)	56% (105)	1.48 (0.99–2.22)	1.40 (0.90–2.16)
Income sources previous 4 weeks				
Work	11% (33)	10% (18)	0.64 (0.33–1.22)	–
Social benefits	92% (283)	90% (170)	1.00 (0.49–2.03)	–
Other work	15% (46)	15% (28)	0.90 (0.52–1.56)	–
Theft	8% (25)	9% (17)	0.90 (0.45–1.77)	0.63 (0.28–1.43)
Dealing	21% (65)	43% (81)	2.13 (1.38–3.29)***	2.36 (1.42–3.93)***
Prostitution	3% (9)	4% (8)	0.96 (0.34–2.69)	0.51 (0.15–1.74)
Substances used in the previous 4 weeks				
Injected				
One or more substances	68% (209)	80% (151)	1.91 (1.21–3.04)**	–
Amphetamine	56% (173)	58% (109)	1.42 (0.94–2.13)	1.10 (0.68–1.76)
Heroin	22% (68)	48% (91)	1.99 (1.25–3.15)**	1.50 (0.87–2.56)
Prescription drugs	19% (59)	25% (47)	1.40 (0.85–2.31)	0.97 (0.54–1.74)
Morphine	17% (52)	19% (36)	1.44 (0.80–2.59)	1.42 (0.71–2.84)
Cocaine	4% (13)	4% (7)	0.62 (0.22–1.72)	0.33 (0.11–1.13)
Not by injection				
Amphetamine	25% (77)	19% (36)	0.84 (0.52–1.38)	0.89 (0.52–1.54)
Heroin	12% (38)	21% (40)	1.26 (0.74–2.16)	1.19 (0.66–2.16)
Prescription drugs	71% (219)	76% (142)	1.08 (0.68–1.72)	0.90 (0.54–1.50)
Alcohol	64% (198)	59% (111)	0.88 (0.59–1.32)	0.98 (0.63–1.54)
Cannabis	76% (236)	82% (154)	1.51 (0.93–2.47)	1.39 (0.82–2.37)
Time from programme implementation ^d	–	–	1.47 (1.15–1.89)**	1.44 (0.82–2.37)**
Random intercept parameter in the multivariable logistic regression model			Estimate (95% CI)	SE
City: identity				
var(_cons)			0.52 (0.10–2.65)	0.43

Exponentiated coefficients; 95% confidence intervals (CI) in brackets. OST = opioid substitution therapy; SD = standard deviation; SE = standard error. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. ^aCity was also the clustering variable in the univariate analyses. ^bIn Norway all children are expected by law to attend school for 10 years. Prior to 1997, it was 9 years. ^cIn the 4 weeks prior to inclusion. ^dMeasured in 6-monthly intervals.

the 4 weeks prior to inclusion, as well programme duration, remained significant indicators of naloxone use.

DISCUSSION

Naloxone distribution has increased since the programme began in June 2014, and the suggested annual distribution rates were met for the cities to first implement THN. The findings among the sample of street- and low-threshold-recruited illicit substance users from the same cities indicate good saturation of naloxone, as the majority had received naloxone training and a large proportion also

currently possessed naloxone. However, one of the cities (Bergen) distributed far less in 2017 compared to previous years. Interestingly, the proportions of illicit substance users in each city who reported naloxone possession corresponded to the time of when distribution was initiated in each city, and programme duration was a significant indicator when estimating the likelihood of both possession and use. Overall, 58% reported attending naloxone training, 43% currently possessed and 15% had used naloxone. The significant indicators for naloxone possession included programme duration, female gender and to self-report dealing as an income source. The significant indicators

Table 4 Descriptive characteristics of those who had used naloxone on someone unconscious among the 497 street- and low-threshold service-recruited illicit substance users interviewed September 2017. Estimates from the univariate and multivariable random-intercept logistic regression analysis for naloxone use; city was the clustering variable.

	Never used naloxone 100% (n = 421)	Used naloxone 100% (n = 76)	Unadjusted odds ratios (95% CI) ^a	Adjusted odds ratios (95% CI)
Mean age (SD)	44.9 (10.2)	42.0 (10.2)	0.97 (0.95–1.00)*	0.98 (0.95–1.01)
Female	24% (99)	30% (23)	1.38 (0.78–2.45)	1.34 (0.69–2.62)
More than mandatory education ^b	62% (192)	65% (123)	1.10 (0.64–1.90)	–
Homeless or shelter user ^c	15% (46)	20% (37)	2.22 (1.23–4.04)**	2.06 (1.02–4.17)*
Overdose past year	14% (43)	16% (30)	2.23 (1.20–4.15)*	1.76 (0.86–3.63)
Overdose previous 4 weeks	5% (16)	5% (9)	1.44 (0.53–3.95)	–
Ever incarcerated	80% (248)	73% (137)	0.86 (0.48–1.54)	–
Incarcerated previous 4 weeks	1% (3)	4% (7)	3.77 (0.89–16.01)	2.71 (0.60–12.24)
Currently in OMT	48% (149)	56% (105)	2.15 (1.25–3.67)**	2.07 (1.13–3.78)*
Income sources previous 4 weeks				
Work	11% (33)	10% (18)	1.00 (0.45–2.23)	–
Social benefits	92% (283)	90% (170)	1.38 (0.53–3.56)	–
Other work	15% (46)	15% (28)	1.25 (0.64–2.47)	–
Theft	8% (25)	9% (17)	1.18 (0.50–2.78)	0.49 (0.15–1.55)
Dealing	21% (65)	43% (81)	2.57 (1.50–4.41)***	2.40 (1.27–4.54)**
Prostitution	3% (9)	4% (8)	2.31 (0.78–6.81)	1.69 (0.39–7.30)
Substances used in the previous 4 weeks				
Injected				
One or more substances	68% (209)	80% (151)	1.72 (0.90–3.29)	–
Amphetamine	56% (173)	58% (109)	1.68 (0.98–2.88)	0.86 (0.45–1.63)
Heroin	22% (68)	48% (91)	3.28 (1.80–5.98)***	2.13 (1.04–4.38)*
Prescription drugs	19% (59)	25% (47)	2.47 (1.37–4.48)**	1.38 (0.68–2.83)
Morphine	17% (52)	19% (36)	2.07 (1.01–4.25)*	1.69 (0.64–4.44)
Cocaine	4% (13)	4% (7)	1.55 (0.51–4.76)	0.41 (0.10–1.60)
Not by injection				
Amphetamine	25% (77)	19% (36)	1.27 (0.69–2.35)	1.74 (0.85–3.55)
Heroin	12% (38)	21% (40)	1.05 (0.55–2.01)	0.67 (0.32–1.41)
Prescription drugs	71% (219)	76% (142)	1.42 (0.74–2.74)	0.95 (0.46–1.99)
Alcohol	64% (198)	59% (111)	0.84 (0.50–1.42)	0.83 (0.45–1.51)
Cannabis	76% (236)	82% (154)	1.32 (0.67–2.58)	0.99 (0.47–2.09)
Time from programme implementation ^d			1.61 (1.23–2.11)***	1.49 (1.15–1.92)**
Random intercept Parameter in the multivariable logistic regression model			Estimate (95% CI)	SE
City: identity var(_cons)			0.23 (0.01–3.91)	0.33

Exponentiated coefficients; 95% confidence intervals (CI) in brackets. OMT = opioid maintenance treatment; SD = standard deviation; SE = standard error. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. ^aCity was the also clustering variable in the univariate analyses. ^bIn Norway all children are expected by law to attend school for 10 years. Prior to 1997, it was 9 years. ^cIn the 4 weeks prior to inclusion. ^dMeasured in 6-monthly intervals.

for naloxone use were programme duration, homelessness or shelter use, OMT, dealing and to have injected heroin during the 4 weeks prior to inclusion.

Adequate naloxone distribution and coverage is an integral part of large-scale programmes. As demonstrated by others, the ability to observe reduction in overdose mortality relies upon sufficient naloxone distribution [8,10] and penetration to at-risk groups. The distribution rates from the study exceeded suggested annual coverage [10,11], and the majority of the surveyed sample had

attended a naloxone training (71% in Oslo, 64% in Bergen). This indicates that the distribution methods resulted in both sufficient naloxone distribution and in reaching this sample of illicit substance users. By involving existing staff and facilities there was access to a wide range of at-risk groups, while still being streamlined through a central host. The funding from the government, along with the ability to distribute it prescription-free, enabled broad access throughout the country. Therefore, the ability to achieve this coverage (somewhat rapidly) probably

resulted from broad programme involvement and participation [20].

Bergen distributed approximately half the amount of naloxone in 2017 compared to 2016. This may be due to harm reduction services in Bergen being somewhat centralized around one large low-threshold facility that distributes naloxone. It is possible that Bergen has reached a 'saturation point' with PWID in the city, thus resulting in lower distribution rates. Additionally, the proportion of refills for Bergen was higher than in Oslo, thus supporting this hypothesis [31]. Conversely, between the two first cities to implement THN, the proportion of illicit substance users in current naloxone possession were higher in Oslo. This corresponds to the naloxone distribution rates from the two cities between January and August 2017, where Oslo had the highest rate during this time. This may suggest that saturation point has not been reached, and that there is another reason for a lower distribution rate in the one city in 2017. Additionally, in the multivariable logistic regression analysis, programme duration in each city was one of the significant predictors for both naloxone possession and use. The cities first implementing the THN programme had the highest proportion of naloxone possession among the sample, whereas the city with the latest THN implementation had the smallest proportion. In the city with no THN, only one of the interviewed participants reported current naloxone possession. This underlines the importance of reaching high coverage rapidly, and then the continued high levels of distribution to reach and maintain naloxone access and use in the population at risk.

For those who had attended naloxone training ($n = 255$), 70% were in possession of naloxone. These rates are similar to the necessary carriage rates from the Scottish prison N-ALIVE study, which state that in order for naloxone to be effective there must be a person present, and that there should be a 75% naloxone carriage rate during the first 4 weeks following prison release [11]. A recent needle exchange survey study in Scotland [12] found low naloxone carriage rates among their participants, with 5–16% of their participants reporting naloxone carriage at the time of the survey [12]. However, carriage rates are subject to the nature of the survey, and participants from this study were not required to be carrying their naloxone on their person to be in possession of naloxone, thus possibly resulting in higher possession rates.

In addition to programme duration, to be female and to report dealing as an income source were significant predictors for naloxone possession. This is similar to a recent Canadian study that found a negative association between male gender and naloxone ownership [32]. McAuley *et al.* found that the highest proportions of naloxone supply were with those reported recent injecting [12]. This is similar to a study from Vancouver that

found half of those who were in possession of naloxone also reported daily heroin injection [33]. In this study, however, recent injection drug use was not found to be a significant predictor for naloxone possession, but it was for naloxone use. Other significant predictors for naloxone use were programme duration, as well as homeless or shelter use, to be in OMT and to report dealing as an income source. Dealing was a significant indicator for both naloxone possession and use, and this indicator is likely to be related to substance use. This may suggest that the naloxone distribution reach actively injecting illicit substance users who use dealing as an income source, pointing towards an appropriate targeting of at-risk populations.

Limitations and strengths

This convenience sample may not be representative of all illicit substance users who use low-threshold services throughout Norway or in other countries. Secondly, self-reported interview data are open to recall bias, under- and over reporting and imprecise estimation of illegal activities. However, the participants' characteristics were relatively similar to those from a study among naloxone trainees in Norway, as they were 67% male with a median age of 37 [20]. The participants were not asked to show their naloxone, so we do not have information on whether or not they were actually carrying it. The numbers are only self-reported, and there was no tracked follow-up or confirmation of use or carriage. However, previous studies have found that a majority of overdoses occur in private homes [29,34,35], and a study of ambulance call-outs in Bergen shows that more than one-third of non-fatal opioid overdose call-outs were to private homes [36]. The fact that someone is not carrying the naloxone with them at all times may therefore not be an issue if people are usually using at home, and therefore keep their kit at home, but this study is limited by not identifying the actual proportion of those carrying the naloxone compared to those leaving it at home. To recruit from or outside various low-threshold services may have led to an over-representation from some of the low-threshold services, as we do not have specific details on how many were recruited from each service. However, one of the study strengths is that it is likely to include participants who may not be available for inclusion in treatment or prison-based studies. The respondents received compensation for participation, which also probably increased consent with perhaps a more generalizable sample than if they had not received payment. Finally, analysing a data set collected independently of the THN programme evaluation allowed for a more general and unbiased overview in a high-risk population of the reach of the project.

CONCLUSION

This study adds to what is known about large-scale THN programmes and their coverage to relevant at-risk groups. The results from this study support that in addition to monitoring distribution rates, large-scale programmes ideally should also examine possession, use and attendance to a training as a means to gauge their reach to at-risk groups. Furthermore, as programme duration in each city was one of the significant predictors for both naloxone possession and use, it underlines the importance of continued high levels of distribution to reach and maintain reaching populations at risk.

Declaration of interests

None.

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