Drug and Alcohol Dependence 217 (2020) 108255

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Use of anabolic-androgenic steroids and other substances prior to and during imprisonment - Results from the Norwegian Offender Mental Health and Addiction (NorMA) study

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ARTICLE INFO

Keywords:
Anabolic androgenic steroids
image and performance enhancing drugs
human enhancement drugs
substance use
substance use disorder
prison health service
prison
crime

ABSTRACT

Background: Anabolic-androgenic steroid (AAS) use is associated with health problems and substance use. Substance use is common among inmates. This study aims to estimate lifetime and prison use of AAS and other substances, compare characteristics of groups of inmates, and describe factors associated with AAS use in a national prison population.

Methods: Data from the Norwegian Offender Mental Health and Addiction (NorMA) Study, a cross-sectional survey of people in prisons, included sociodemographic variables and lifetime and prison use of AAS and other substances. Altogether 1,499 inmates, including 96 (6.4%) women, were divided into three mutually exclusive groups according to lifetime AAS use, non-AAS substance use and no substance use.

Results: Lifetime AAS use was reported by 427 (28.5%) inmates; 6 women and 421 men. Non-AAS substance use was reported by 593 (39.6%) and 479 (31.9%) had never used AAS or non-AAS substances.

Compared to the non-AAS substance group, the AAS group reported younger debut ages for nearly all non-AAS substances, higher mean number of non-AAS substances used in their lifetime (8.9, 6.6, $p < 0.001$), during the six months prior to incarceration (5.2, 3.1, $p < 0.001$), and during (2.3, 1.3, $p < 0.001$) imprisonment. Although 120 (8.0%) inmates used AAS during the six months prior to incarceration, only ten continued during imprisonment.

Conclusions: Lifetime AAS use is common among inmates and may be an indicator of more severe substance use problems. Screening for previous and present AAS use at incarceration and increased staff awareness are needed to tailor treatment approaches appropriately.

1. Introduction

Use of anabolic-androgenic steroids (AAS) is associated with illicit substance use (Dodge and Hoagland, 2011; Garevik and Rane, 2010; Hakansson et al., 2012; Ip et al., 2011; Kanayama et al., 2003; Lundholm et al., 2015), and with an increased risk of developing a wide range of mental (Hall et al., 2005; Piacentino et al., 2015) and physical health problems (Baggish et al., 2017; Bjørnebekk et al., 2017; Horwitz et al., 2019; Pope et al., 2014), suicide (Thiblin et al., 1999), and mortality (Ljungdahl et al., 2019; Petersson et al., 2006a; Petersson et al., 2006b; Thiblin et al., 2015).

A meta-analysis of mainly selected samples suggests that the global lifetime prevalence of AAS use is 3.3 % (Sagoe et al., 2014). However, lifetime AAS use is found to be higher in some subpopulations such as illicit substance users (Hope et al., 2013; Lundholm et al., 2015), patients in substance use disorder (SUD) treatment (Havnes et al., 2020b; Kanayama et al., 2003; Nøkleby, 2013), and inmates in prison (Keene, 1997; Klötz et al., 2010; Korte et al., 1998; Lundholm et al., 2010; Pope et al., 1996). In Finland, 9.6% of 354 inmates reported lifetime AAS use (Korte et al., 1998). In Sweden, 25.6% of 3597 remand prisoners with illicit substance use (Lundholm et al., 2010) and 55.9% of 59 prisoners diagnosed with SUDs reported lifetime AAS use (Klötz et al., 2010). In Sweden, AAS screening among inmates when AAS use was suspected showed that 11.5% of urine samples nationwide were positive for AAS (Lood et al., 2012). Although AAS use among prisoners in Denmark has not yet been explored, a strong association between AAS use and imprisonment is reported (Christoffersen et al., 2019).

Prison inmates are often burdened with substance use and mental

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https://doi.org/10.1016/j.drugalcdep.2020.108255
Received 10 April 2020; Received in revised form 10 August 2020; Accepted 20 August 2020
Available online 29 August 2020

health problems prior to entering prison (Fazel and Baillargeon, 2011; Fazel et al., 2016; Fazel et al., 2017). AAS use is associated with mental and physical health problems (Horwitz et al., 2019; Pope et al., 2014) including AAS dependence (Kanayama et al., 2009, 2010). In addition, long-term AAS use reduces endogenous testosterone production due to suppression of the hypothalamic-pituitary-gonadal axis. Therefore, during AAS withdrawal, symptoms of androgen deficiency including depression will often occur and may last for months, and sometimes years (Aydogan et al., 2012; Kanayama et al., 2015; Nieschlag and Vorona, 2015; Rahnema et al., 2014). For inmates who have used AAS prior to imprisonment, cessation of AAS administration at incarceration may lead to androgen deficiency that includes depression and fatigue (Rahnema et al., 2014; Rasmussen et al., 2016). This may contribute to a worsening in prisoners' mental health status a few weeks after incarceration, which is already a high-risk period for mental health problems (Fazel et al., 2016).

Previous research on lifetime prevalence and prison use of AAS among inmates has been conducted with small samples, in a single or a few prisons (Keene, 1997; Klötz et al., 2010; Korte et al., 1998; Pope et al., 1996), among a selected group with substance use problems (Klötz et al., 2010; Lundholm et al., 2010), or only where AAS use is suspected (Lood et al., 2012). Little is known about use of AAS among inmates in a lifetime perspective, including in the period during imprisonment, and identification of high-risk AAS groups is crucial for effective prevention approaches. With these knowledge gaps as the point of departure, the aims of this study are to:

a estimate lifetime use of AAS and other substances in a national prison population;
b describe AAS use during the 6 months prior to incarceration and during imprisonment;
c compare substance use prior to and during imprisonment among lifetime AAS users and non-AAS substance users; and
d describe factors associated with AAS use in a national prison population.

2. Material and methods

2.1. Setting

At any given time, Norway has fewer than 4,000 inmates (Norwegian Correctional Service, 2020a) and the average national prison population was 3,787 in 2013 (Kristoffersen, 2014). Norway's incarceration rate is one of the lowest in the world at 60 persons per 100,000; in comparison, the United States incarcerates 655 per 100,000, and Canada incarcerates 107 per 100,000 (WBF, 2020). In Norway, liberty shall be restricted during punishment, and no other rights are removed by the sentencing court (Norwegian Correctional Service, 2020a). Therefore, the sentenced offender has all the same rights as all other inhabitants. The Norwegian criminal justice system adopts an explicitly rehabilitative perspective of incarceration, and life in prison should mirror life outside to the greatest extent possible. Universal health coverage is one of these rights, and 18 of 57 prisons have separate drug treatment units (Norwegian Correctional Service, 2020b).

Use and possession of AAS became illegal in Norway in 2013 when the Norwegian Drug Act was amended. Around the same time, non-prescribed use of AAS and other performance enhancing agents were included in the politics of substance use treatment, when the specialized SUD treatment system was assigned responsibility for this patient group. AAS users received patient rights to outpatient SUD treatment, and national detoxification guidelines stated that clinicians in the specialist health services should assess mental health symptoms following AAS cessation, and should provide supportive psychotherapy adjacent to treating other mental health issues.

2.2. Study design

Data are drawn from the Norwegian Offender Mental Health and Addiction (NorMA) study. In the NorMA study, researchers visited 57 of 67 prison units in Norway during 2013 and 2014 to inform all participants about the study and how to fill out the questionnaire, answer questions from participants, and to distribute and collect questionnaires. All participation was voluntary based on informed consent, and study participants completed the questionnaire independently from prison staff. The study did not have any exclusion criteria. The questionnaire was available in Norwegian, English, German, French, and Russian. A thorough description of the study setting and participants is available in an earlier publication (Bukten et al., 2015).

2.3. Measures and variables

The questionnaire included 116 items related to sociodemographics, psychoactive substance use, AAS use, criminality and mental health (Bukten et al., 2015). In the present paper, the following variables were utilized:

2.3.1. Sociodemographic factors

Variables about age, gender and whether the participant was born in a Nordic country or in any other country were included. Those who reported being unmarried, not having a partner or living alone before incarceration, were categorized as single. Level of education was categorized as less than high school education, or high school education or more. History of family problems was indicated by having grown up in a family with substance use or mental health problems.

2.3.2. Non-AAS substance use and AAS use

AAS and the following 15 different types of non-AAS substances were listed and included non-prescribed use of medications: cannabis, meth/amphetamines, benzodiazepines - sedatives, benzodiazepines - hypnotics, cocaine, GHB, methadone or buprenorphine, morphine and other prescribed opioids (codeine, oxycodone, tramadol), LSD, ecstasy, heroin, methylphenidate, synthetic cannabinoids and other substances.

2.3.3. Lifetime use and use during imprisonment

Multiple items queried AAS and substance use in different periods, including lifetime use, age of onset, use during the six months prior to current imprisonment (anytime, monthly, weekly, daily) and use during previous and current incarceration. Individuals were defined as having used any substance when responding positively to one or more substance type during any period. Lifetime use was defined as having used any substance (except alcohol) during any period. AAS and/or non-AAS substance use once or more times during *any* incarceration was registered as use *during* imprisonment. The participants were asked whether the AAS debut was prior to first incarceration, during current or previous incarceration or in between incarcerations.

The participants were categorized into three mutually exclusive groups according to lifetime substance use: AAS use, non-AAS substance use, and no substance use. The *AAS group* included those who currently used or had ever previously used AAS, either while incarcerated or outside of prison. The *non-AAS substance group* included those who currently used or had ever used at least one substance, but never AAS. Finally, the *no substance use group* was comprised of those who reported never using AAS, illicit substances or non-prescribed psychoactive medications.

2.4. Ethics

The study received ethical approval by three entities: The Regional Committees for Medical and Health Research Ethics (REK 2012/297), the Norwegian Social Science Data Services, and the Directorate of Norwegian Correctional Service. Inmates provided written informed

consent and were assured that non-participation would not be sanctioned. In addition, participants were informed that their answers were confidential from prison staff. To mitigate concern that disclosure of drug use would not be confidential, study investigators personally administered data collection at all stages; related to information, distribution and collecting questionnaires.

2.5. Analysis

After dividing the sample into an AAS group, non-AAS substance group, and no use group, descriptive statistics (chi square and ANOVA) were used to compare the groups' sociodemographic characteristics, with post-hoc t-tests to clarify group differences and alpha level set at 0.05. Substance use prior to and during incarceration were then compared between the AAS lifetime and lifetime substance use groups, again with chi squares and t-tests.

3. Results

3.1. Sample

Altogether 1,499 inmates participated in the study, of which 96 (6.4%) were women. The sample included approximately 40% of the national prison population. Lifetime AAS use was reported by 427 (28.5%); 421 (30.0%) of the men and 6 (6.3%) of the women. Non-AAS substance use was reported by 593 (39.6%); and the remainder, 479 (32.0%), reported no lifetime use of either AAS or other substances (Table 1).

The three groups differed in most sociodemographic and background characteristics, with statistical significance. The AAS group was on average two years younger than the non-AAS substance group and seven years younger than the no-use group when responding to the survey. A higher proportion of the AAS group was Nordic-born than the non-AAS substance group and no-use group. The AAS group also included fewer women than the non-AAS substance group and no-use group, was more likely to report less education, and more likely to report unstable housing before incarceration. The AAS and non-AAS substance groups were more often single and were more than twice as likely as the no-use group to report an upbringing with substance use and/or mental illness among parents/caregivers.

3.2. Age of onset and substance use during the 6 months prior to current incarceration

The mean age for first time AAS use was 21.3 years (range 13-40 years). The AAS group reported a higher mean number of non-AAS substances used during the six months prior to current imprisonment (5.2), than the non-AAS substance group, (3.1). Among the 120 individuals in the AAS group who reported AAS use during the six months prior to incarceration, 68 (56.7%) had only injected AAS, 5 (4.2%) used only oral AAS, and 26 (21.7%) combined injectable and oral AAS. Mode of administration was missing for 19 (15.5), and other for 2 (1.7%).

Cannabis was the most commonly used substance prior to incarceration for both groups, followed by meth/amphetamines and benzodiazepines. The least commonly used substances were hallucinogenic such as ecstasy and LSD, and non-prescribed methylphenidate (Table 2).

The AAS group also reported younger debut ages for every non-AAS substance except synthetic cannabinoids when compared with the non-AAS substance group. The range of debut ages for non-AAS substances for the AAS group was 14.8-25.5 years, and 16.6-26.8 years for the non-AAS substance group. Both groups had the youngest debut age for cannabis. The AAS group debuted with all substances before 24 years, except for synthetic cannabinoid use, while the substance use group debuted with synthetic cannabinoid, GHB, and non-prescribed opioid maintenance treatment medications after 24 years.

All but two inmates in the AAS group reported lifetime use of non-AAS substances, with a mean of 8.9 (SD 4.8) substances, compared to the non-AAS substance group´s mean of 6.6 (SD 4.5). Figure 1 displays the distribution of number of substances that have been used in lifetime perspective in the two groups. For example, the use of only one substance was reported by 16% of the non-AAS substance group compared to about three percent of the AAS group. Eleven percent of the AAS group reported lifetime use of all 15 non-AAS substances while only three percent in the non-AAS substance group reported lifetime use of 15 non-AAS substances.

3.3. Non-AAS substance use during incarceration

More of the AAS group reported any substance use including AAS use during current or previous incarceration (62.2%), than the non-AAS substance group (43.5%), see Table 3. The AAS group also reported an average of 2.3 non-AAS substances during incarceration compared to 1.3 for the non-AAS substance use group. All substances, except for LSD and Ritalin, were used by more of the AAS group than the non-AAS substance group. As seen prior to incarceration, cannabis was the most commonly used substance during incarceration, followed by meth/amphetamines, prescription opioids, and benzodiazepines. Meth/amphetamines and prescription opioids were used by twice as many in the AAS group than the substance group, while benzodiazepines were used by four times as many in the AAS group.

3.4. Patterns of AAS use related to imprisonment

Among the 120 individuals who reported AAS use during the six months prior to incarceration, 110 (92%) reported no AAS use during current imprisonment. Table 4 reports on AAS use in relation to imprisonment in the lifetime AAS group (n = 427). The majority began

Table 1
Sociodemographic and background characteristics for all participants (N = 1499) categorized in three mutually exclusive groups: lifetime AAS use (n = 427), lifetime non-AAS substance use (n = 593), and the no substance use group (n = 479).

	AAS group (427) A	Non-AAS substance group (593) B	No substance use group (479) C	Missing	Post-hoc
	n (%)	**n (%)**	**n (%)**	**n**	
Age	31.5 (8.5)	33.7 (10.4)	38.7 (13.3)	31	A < B < C
Women	6 (1.4)	54 (9.2)	36 (7.5)	7	A < B, A < C,B > C
Born in Nordic country	353 (85.7)	436 (75.3)	257 (56.0)	49	A > B > C
Single	314 (74.2)	433 (73.9)	258 (44.5)	22	A > C,B > C
Less than high school education	194 (46.3)	244 (41.6)	119 (25.3)	23	A > B > C
Unstable housing situation before prison	119 (29.3)	137 (23.8)	78 (17.6)	73	A > C,B > C
Upbringing with substance use and/or serious mental illness among parents	163 (39.5)	221 (38.6)	73 (16.1)	61	A > C,B > C

The letters below group names refer to the letters used illustrating directions in statistically significant differences, $p < 0.05$.

Table 2
: AAS and non-AAS substance use during the six months prior to current prison stay and debut age for the AAS group (n = 427) and the non-AAS substance group (593).

	AAS group (n = 427)			Non-AAS Substance group (n = 593)		
	n (%)[a]	Debut age[b] Mean (SD)	Missing[c]	n (%)	Debut age Mean (SD)	Missing[c]
Any use	358 (83.8)	–	69	449 (75.7)	–	114
Cannabis	303 (71.0)**	14.8 (3.4) *	54	374 (63.1)	16.6 (4.7)	74
Meth/amphetamines	260 (60.9) ***	17.1 (4.3) *	82	230 (38.8)	19.4 (5.6)	163
Benzodiazepines[d]	257 (60.2) ***	NR	97	233 (39.3)		170
Cocaine	193 (45.2) ***	18.5 (4.2) *	97	172 (29.0)	20.5 (5.5)	168
GHB	145 (34.0) ***	23.5 (7.8) *	119	81 (13.7)	26.8 (8.8)	210
Methadone/buprenorphine[d]	124 (29.0) ***	23.4 (6.0) *	127	93 (15.8)	26.6 (8.3)	209
AAS	120 (28.1)	21.3 (6.4)	123	–	–	–
Morphine, other opioids[d]	106 (24.8) **	19.3 (4.5) *	126	84 (14.2)	21.1 (6.3)	225
LSD	62 (14.5) ***	19.6 (4.3) *	140	42 (7.1)	21.8 (6.3)	220
Ecstasy	97 (22.7) ***	18.8 (4.6) *	126	66 (11.1)	21.1 (6.2)	211
Heroin	92 (21.5) ***	20.4 (4.9) *	138	76 (12.8)	21.7 (6.9)	217
Methylphenidate[d]	57 (13.3) ***	17.5 (3.8) *	141	47 (7.9)	18.9 (5.2)	217
Synthetic cannabinoids	63 (14.8) **	25.5 (8.0)	165	56 (9.4)	25.0 (8.6)	232

* p < .05, **p < 0.01, ***p < 0.001, NR: not reported.
[a] Refer to chi squares between AAS group and non-AAS group.
[b] Refer to t-tests between debut ages of the two groups.
[c] Amount of participants in the AAS group and non-AAS substance group, who were missing each variable.
[d] Non-prescribed use.

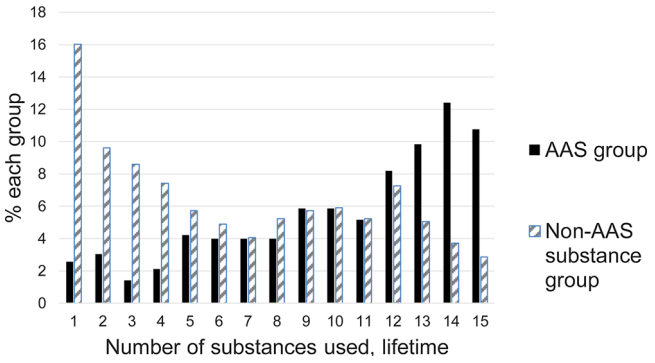

Fig. 1. Percentages of AAS group (n = 427) and non-AAS substance group members (n = 593) who reported lifetime use of 1-15 substances.

Table 3
Substance use in any prison stay for the AAS group (n = 427) and non-AAS substance group (n = 593).

	AAS grp (n = 427) n n(%)	Non-AAS substance grp (n = 593) n (%)
Any drug use***	266 (62.2)	258 (43.5)
No of drugs used*** (mean, SD)	2.3 (2.7)	1.3 (2.1)
Cannabis***	232 (54.3)	221 (37.3)
Meth/amphetamines***	122 (28.6)	88 (14.8)
Benzodiazepines***	155 (36.6)	106 (7.9)
Cocaine***	52 (12.2)	24 (4.0)
GHB***	38 (8.9)	17 (2.9)
Methadone/buprenorphine**	155 (36.3)	110 (18.5)
AAS	61 (14.3)	–
Morphine, other opioids***	47 (11.0)	50 (6.7)
LSD	10 (2.3)	7 (1.2)
Ecstasy**	22 (5.2)	11 (1.9)
Heroin**	66 (15.5)	52 (8.8)
Ritalin	57 (13.3)	42 (7.1)
Synthetic cannabinoids***	56 (13.1)	27 (4.6)

*p < .05, **p < 0.01, ***p < 0.001.

using AAS before their first prison stay (61.6%). About one fourth began using between prison stays, and one tenth initiated first time AAS use during incarceration, referring to either their current stay or a previous one.

Table 4
AAS use before, between and during incarceration (n = 427).

	n (%)
Debut of AAS	
Before first prison stay	263 (61.6)
Between prison stays	95 (23.3)
In prison (current or previous)	40 (9.4)
Missing (n, %)	29 (6.8)
Post-debut use of AAS	
AAS use in current prison stay	24 (5.6)
AAS use in previous stay, not current	64 (15.0)
AAS use only outside prison	325 (76.1)
Missing	14 (3.3)

Three out of four reported using AAS only outside of prison and only 5.6% of the AAS group reported AAS use in their current prison stay, while 15.0% reported using in a previous stay but not in their current stay. In the total study sample of 1499, 88 (5.8%) reported AAS use during any imprisonment.

3.5. Patterns of AAS use and non-AAS substance use

Figure 2 displays average debut ages of substances for the AAS group and the substance use group. The general order was similar in both groups: cannabis was the first substance used, while synthetic cannabinoid was the last. However, while the order of substances initiated was the same, the AAS group initiated nearly all substances earlier.

4. Discussion

In this first national prison study to explore pre-prison and in-prison use of AAS and non-AAS substances among 1499 participants, lifetime AAS use was reported by 30.0% of male and 6.4% of female prisoners. Compared to the non-AAS substance use group, the AAS group reported higher mean number of non-AAS substances used, younger debut ages for nearly all substances, and higher prevalence of use of almost all substances six months prior to and during incarceration. Among the 120 participants who used AAS during the six months prior to current incarceration, 110 (92%) reported no AAS use during current

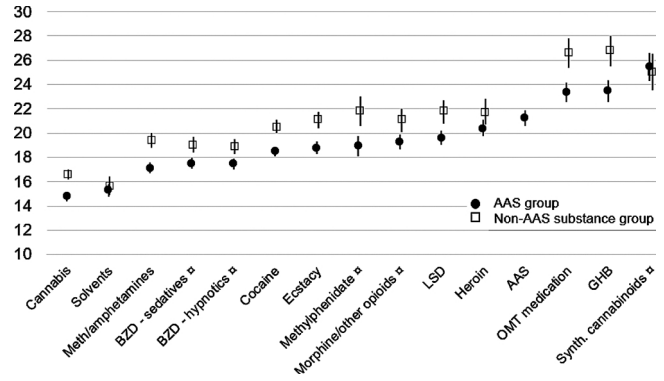

Fig. 2. Debut ages of substance use in the AAS group (n = 427) and the non-AAS substance group (n = 593) (mean, 95% CI).
BZD: benzodiazepine. LSD: lysergic acid diethylamide. OMT: opioid maintenance treatment. GHB: gamma hydroxybutyric acid.
¤ Non-prescribed.

imprisonment. Most of the AAS group initiated AAS prior to first imprisonment and used AAS only when not incarcerated, and prison was the arena for first-time use for 2.7% of all prisoners.

Imprisoned AAS users appear to be a subset of substance users who report earlier debuts and use of more drug types. Lifetime AAS use among inmates may therefore be an indicator of more complex substance use.. This finding is in line with a recent Norwegian study among 563 patients in SUD treatment reporting that AAS lifetime users were younger at debut of first substance, diagnosed with SUDs earlier, and reported shorter times between first time substance use and SUD diagnoses than SUD-patients without AAS exposure (Havnes et al., 2020b). However, a Swedish study among arrestees with substance use problems found an almost similar pattern of preferred substances among participants with and without lifetime AAS use in the year prior to being arrested (Lundholm et al., 2010).

Lifetime prevalence of AAS use in this national Norwegian prison survey was ten times higher than estimates in the general population (Sagoe et al., 2015). Although prevalence estimates in the current study originate from a prison sample not selected by substance use, they are similar to findings from a Swedish study among remand prisoners with substance use problems (Lundholm et al., 2010), but lower than a sample of prisoners with diagnosed SUDs (Klötz et al., 2010). The estimates of the current study are similar to a recent Norwegian study of patients with SUDs (Havnes et al., 2020b), suggesting a stronger link between SUD and AAS use than AAS use and prison. The estimated lifetime prevalence of the current study is higher than two previous prison studies (Korte et al., 1998; Pope et al., 1996), but these two studies are significantly older and the latter is from the United States, a country with a much higher incarceration rate than Norway and therefore likely a different prison population (WBF, 2020).

We found that 110 (92%) of the 120 participants who used AAS during the six months prior to current imprisonment did not report any use during current imprisonment, meaning they ceased AAS use at incarceration. It is easy to automatically consider cessation a positive phenomenon, but more nuance is required. Drug use is generally much less common in prison than outside, due to several factors; most immediately, prisons are highly controlled environments and therefore the supply of most drugs is limited. If AAS is ceased, males may experience temporary hypogonadism with symptoms of androgen deficiency, namely depression, fatigue, sexual dysfunction and sleep disorders after a few weeks (Rahnema et al., 2014; Rasmussen et al., 2016). This condition may last from a few months and up to a year, and in some cases longer or permanently (Coward et al., 2013; Kanayama et al., 2015; Rahnema et al., 2014). Treatment strategies attempt to relieve withdrawal symptoms, find other rewarding activities, and treat premorbid mental health conditions (Kanayama et al., 2009, 2010). An endocrine model to restart the endogenous testosterone production at withdrawal has been suggested to alleviate symptoms of androgen deficiency, but has not yet been tested among AAS users (Rahnema et al., 2014).

For most of the inmates with lifetime AAS use, prison is not where they began use. Most of the AAS group initiated AAS prior to first imprisonment and used AAS only when not incarcerated. However, prison was the arena for first time use for almost 3% of all prisoners. In total, 5.9% of all inmates reported AAS use during current or previous imprisonment. AAS users are a heterogeneous group whether imprisoned or not, and there is variation in motivations for use (Christiansen et al., 2017; Dawson, 2001; Murray et al., 2016; Santos and Coomber, 2017; Zahnow et al., 2018). Studies among SUD patients therefore provide important and relevant sources of information about AAS use. One qualitative study found that patients in SUD treatment used AAS because they wanted to become more muscular and healthier looking due to having emaciated bodies after long-term substance use (Nøkleby and Skårderud, 2013). A recent study found that this motivation was the case for 44.5% of male SUD patients with AAS experience (Havnes et al., 2020b). In addition, there is a growing evidence for body image disorder as a motivation for AAS use (Kanayama et al., 2020). AAS has traditionally been understood to be exercise-related, and the stereotype of the over-exercising and AAS-using prisoner remains. However, an earlier publication from the NorMA study found that AAS use during current incarceration was not associated with exercise (Muller et al., 2018). Motivation for initiation and use of AAS during imprisonment should be explored further, as do the likely complicated relationships between AAS, exercise, substance use, and body image in prison.

Of note, in the lifetime AAS group, 60.9% used amphetamines and 45.2% used cocaine, during the six months prior to imprisonment. It is estimated that 20-50% of AAS users develop AAS dependence (Bjørnebekk et al., 2017; Brower et al., 1991; Griffiths et al., 2018; Kanayama et al., 2009, 2010), and men with AAS dependence are found to have structural brain changes partly similar to other dependencies (Hauger et al., 2019b) that may suggest a shared vulnerability for dependencies. AAS and substance use are each separately associated with increased health risks, for example related to the cardiovascular system (Baggish et al., 2017; Fischbach, 2017; Morentin et al., 2014; Rasmussen et al., 2018; Westover et al., 2008), brain (Bjørnebekk et al., 2017; Bjørnebekk et al., 2019; Hauger et al., 2019a; Hauger et al., 2020; Hauger et al., 2019b; Kaufman et al., 2019; Mackey et al., 2019), and the endocrine system (Coward et al., 2013; Kanayama et al., 2015; Rahnema et al., 2014). Concurrent use of AAS and other substances is common (Dodge and Hoagland, 2011; Ljungdahl et al., 2019; Lundholm et al., 2015) and may increase the health risks further. For example, current use of central stimulants (Westover et al., 2008) among AAS users may lead to increased risk of vasospasm and myocardial infarction. In addition, prisoners as a group are burdened with substance use and SUDs, low socioeconomic status, and mental and physical health problems prior to entering prison (Fazel and Baillargeon, 2011; Fazel et al., 2016; Fazel et al., 2017). Therefore, physical and mental health examination and screening for lifetime and pre-prison AAS and substance use at incarceration is needed to be able to tailor treatment for inmates. For those who have used AAS prior to imprisonment, AAS dependence and previous experience with withdrawal symptoms after cessation of AAS should be explored. Information about AAS use, physical and mental side effects as well as withdrawal symptoms should be available for inmates (Havnes et al., 2019).

4.1. Strengths and limitations

Participants in the NorMA study were found to be representative of the national prison population regarding proportion of women, proportion of inmates with a Norwegian citizenship, and country of birth (Bukten et al., 2015). Furthermore, the study is the first national prison survey that included lifetime, pre-prison and prison use of AAS and

other substances. The limitations of the NorMA study have been discussed in detail in previous publications (Bukten et al., 2020; Bukten et al., 2015; Muller et al., 2018). As the data collected were self-reports of both substance and AAS use, participants may over- or under-report previous and current use. AAS use among female prisoners may be under-reported as stigma and secrecy is associated with women's use of AAS (Börjesson et al., 2016; Havnes et al., 2020a). Language barriers, mental health problems, impaired memory, reading difficulties and reduced cognitive function may have been sources of selection bias or participants not responding to parts of the questionnaire. For this paper, the participants were categorized into mutually exclusive groups according to lifetime use of AAS, non-AAS substances and no substance use. Therefore, participants who only tried one or a few substances earlier in life but had not used any substances the last years would be placed in the lifetime substance use group. Furthermore, the study does not have a measure of dependence of AAS or other forms of severity of AAS use as the study does not distinguish between cyclic or continuous use, weekly doses, specific substances used, or accumulated time used since debut of AAS use.

Generalizability outside Norway is an important consideration. Norway has a low incarceration rate and a high proportion of inmates with substance use problems, which may weaken the generalizability of the study findings to countries with high incarceration rates. Still, a significant number of individuals are imprisoned in Norway because of their illicit substance use and crimes to support their drug habits. Our findings may therefore be particularly relevant to countries with similar lifetime prevalence of AAS in the general population and similar incarceration rates, such as North-European countries, or in countries with similar proportion of inmates with comparable non-AAS substance use history.

4.2. Conclusions

Lifetime AAS use among male prisoners in Norway is common and seem to involve a history of polysubstance use, and may be an indicator of more severe substance use. Information about AAS use, adverse consequences, and treatment should be made available for inmates. There is a need to identify previous and current AAS use as well as substance use at entry to prison, for example by use of Drug Use Disorder Identification Test (DUDIT) (Berman et al., 2005), as the period following is a high-risk time for mental distress. This has implications for treatment programs for prisoners as well as for the training of health professionals and prison staff to increase their capacity to addressing the physical and mental health needs of inmates, including dependence of AAS and/or various psychoactive substances, both during imprisonment and after release from prison.

Author disclosures

The authors whose names are listed immediately below have nothing to disclose.

Contributors

AB is Principal Investigator of and designed the NorMA study. AB and EBR collected the data. IAH, AEM and AB designed the statistical analysis plan. AEM conducted the data analysis. IAH and AEM wrote the manuscript. AB and EBR provided critical feedback on the manuscript and analyses. All authors have read and approved the final manuscript.

Funding

No funding.

Declaration of Competing Interest

No conflict declared.

Acknowledgements

The authors would like to thank all inmates for participating in the study, and prison staff for their assistance in data collection.

References

Aydogan, U., Aydogdu, A., Akbulut, H., Sonmez, A., Yuksel, S., Basaran, Y., Uzun, O., Bolu, E., Saglam, K., 2012. Increased frequency of anxiety, depression, quality of life and sexual life in young hypogonadotropic hypogonadal males and impacts of testosterone replacement therapy on these conditions. Endocr. J., E J12–0134.

Baggish, A.L., Weiner, R.B., Kanayama, G., Hudson, J.I., Lu, M.T., Hoffmann, U., Pope Jr, H.G., 2017. Cardiovascular Toxicity of Illicit Anabolic-Androgenic Steroid Use. Circulation. 135 (21), 1991–2002.

Berman, A.H., Bergman, H., Palmstierna, T., Schlyter, F., 2005. Evaluation of the Drug Use Disorders Identification Test (DUDIT) in criminal justice and detoxification settings and in a Swedish population sample. Eur. Addict res 11 (1), 22–31.

Bjørnebekk, A., Walhovd, K.B., Jørstad, M.L., Due-Tønnessen, P., Hullstein, I.R., Fjell, A.M., 2017. Structural Brain Imaging of Long-Term Anabolic-Androgenic Steroid Users and Nonusing Weightlifters. Biol. Psychiatry. 82 (4), 294–302.

Bjørnebekk, A., Westlye, L.T., Walhovd, K.B., Jørstad, M.L., Sundseth, Ø.Ø., Fjell, A.M., 2019. Cognitive performance and structural brain correlates in long-term anabolic-androgenic steroid exposed and nonexposed weightlifters. Neuropsychology. 33 (4), 547–559.

Brower, K.J., Blow, F.C., Young, J.P., Hill, E.M., 1991. Symptoms and correlates of anabolic-androgenic steroid dependence. Br. J. Addict. 86 (6), 759–768.

Bukten, A., Lund, I.O., Kinner, S.A., Rognli, E.B., Havnes, I.A., Muller, A.E., Stavseth, M.R., 2020. Factors associated with drug use in prison–results from the Norwegian offender mental health and addiction (NorMA) study. Health & Justice. 8, 1–10.

Bukten, A., Lund, I.O., Rognli, E.B., Stavseth, M.R., Lobmaier, P., Skurtveit, S., Clausen, T., Kunøe, N., 2015. The Norwegian offender mental health and addiction study—design and implementation of a national survey and prospective cohort study. Subst. Abuse. 9 (2), 59–66.

Börjesson, A., Gårevik, N., Dahl, M.-L., Rane, A., Ekström, L., 2016. Recruitment to doping and help-seeking behavior of eight female AAS users. Subst. Abuse Treat. Prev. Policy. 11 (1), 11.

Christiansen, A.V., Vinther, A.S., Liokaftos, D., 2017. Outline of a typology of men's use of anabolic androgenic steroids in fitness and strength training environments. Drugs: Educ., Prev. and Policy. 24 (3), 295–305.

Christoffersen, T., Andersen, J.T., Dalhoff, K.P., Horwitz, H., 2019. Anabolic-androgenic steroids and the risk of imprisonment. Drug Alcohol Depend. 203, 92–97.

Coward, R.M., Rajanahally, S., Kovac, J.R., Smith, R.P., Pastuszak, A.W., Lipshultz, L.I., 2013. Anabolic steroid induced hypogonadism in young men. J Urol. 190 (6), 2200–2205.

Dawson, R.T., 2001. Drugs in sport - the role of the physician. J Endocrinol. 170, 55–61.

Dodge, T., Hoagland, M.F., 2011. The use of anabolic androgenic steroids and polypharmacy: A review of the literature. Drug Alcohol Depend. 114 (2-3), 100–109.

Fazel, S., Baillargeon, J., 2011. The health of prisoners. Lancet. 377 (9769), 956–965.

Fazel, S., Hayes, A.J., Bartellas, K., Clerici, M., Trestman, R., 2016. Mental health of prisoners: prevalence, adverse outcomes, and interventions. Lancet Psychiatry. 3 (9), 871–881.

Fazel, S., Yoon, I.A., Hayes, A.J., 2017. Substance use disorders in prisoners: an updated systematic review and meta-regression analysis in recently incarcerated men and women. Addiction. 112 (10), 1725–1739.

Fischbach, P., 2017. The role of illicit drug use in sudden death in the young. Cardiol Young. 27 (S1), S75–S79.

Garevik, N., Rane, A., 2010. Dual use of anabolic-androgenic steroids and narcotics in Sweden. Drug Alcohol Depend. 109 (1-3), 144–146.

Griffiths, S., Jacka, B., Degenhardt, L., Murray, S.B., Larance, B., 2018. Physical appearance concerns are uniquely associated with the severity of steroid dependence and depression in anabolic-androgenic steroid users. Drug Alcohol Rev. 37 (5), 664–670.

Hakansson, A., Mickelsson, K., Wallin, C., Berglund, M., 2012. Anabolic androgenic steroids in the general population: User characteristics and associations with substance use. Eur. Addict. Res. 18 (2), 83–90.

Hall, R.C., Hall, R.C., Chapman, M.J., 2005. Psychiatric Complications of Anabolic Steroid Abuse. Psychosomatics. 46 (4), 285–290.

Hauger, L.E., Sagoe, D., Vaskinn, A., Arnevik, E.A., Leknes, S., Jørstad, M.L., Bjørnebekk, A., 2019a. Anabolic androgenic steroid dependence is associated with impaired emotion recognition. Psychopharmacology. 236, 2667–2676.

Hauger, L.E., Westlye, L.T., Bjørnebekk, A., 2020. Anabolic androgenic steroid dependence is associated with executive dysfunction. Drug Alcohol Depend. 208, 107874.

Hauger, L.E., Westlye, L.T., Fjell, A.M., Walhovd, K.B., Bjørnebekk, A., 2019b. Structural brain characteristics of anabolic-androgenic steroid dependence in men. Addiction. 114 (8), 1405–1415.

Havnes, I.A., Jørstad, M.L., Innerdal, I., Bjørnebekk, A., 2020a. Anabolic-androgenic steroid use among women–A qualitative study on experiences of masculinizing, gonadal and sexual effects. in Press. Int. J Drug Policy, 102876. https://doi.org/10.

1016/j.drugpo.2020.102876.
Havnes, I.A., Jørstad, M.L., McVeigh, J., Van Hout, M.-C., Bjørnebekk, A., 2020b. The anabolic androgenic steroid treatment gap: a national study of substance use disorder treatment. Subst Abuse. 14 1178221820904150.
Havnes, I.A., Jørstad, M.L., Wisløff, C., 2019. Anabolic-androgenic steroid users receiving health-related information; health problems, motivations to quit and treatment desires. Subst. Abuse Treat., Prev. Policy. 14 (1), 20.
Hope, V.D., McVeigh, J., Marongiu, A., Evans-Brown, M., Smith, J., Kimergård, A., Croxford, S., Beynon, C.M., Parry, J.-V., Bellis, M.A., Ncube, F., 2013. Prevalence of, and risk factors for, HIV, hepatitis B and C infections among men who inject image and performance enhancing drugs: a cross-sectional study. BMJ Open. 3 (9), e003207. https://doi.org/10.1136/bmjopen-2013-003207.
Horwitz, H., Andersen, J., Dalhoff, K., 2019. Health consequences of androgenic anabolic steroid use. J. Intern. Med. 285 (3), 333–340.
Ip, E.J., Barnett, M.J., Tenerowicz, M.J., Perry, P.J., 2011. The Anabolic 500 survey: Characteristics of male users versus nonusers of anabolic-androgenic steroids for strength training. Pharmacotherapy. 31 (8), 757–766.
Kanayama, G., Brower, K.J., Wood, R.I., Hudson, J.I., Pope Jr, H.G., 2009. Anabolic–androgenic steroid dependence: an emerging disorder. Addiction. 104 (12), 1966–1978.
Kanayama, G., Brower, K.J., Wood, R.I., Hudson, J.I., Pope Jr, H.G., 2010. Treatment of anabolic–androgenic steroid dependence: Emerging evidence and its implications. Drug Alcohol Depend. 109 (1-3), 6–13.
Kanayama, G., Cohane, G.H., Weiss, R.D., Pope, H.G., 2003. Past anabolic-androgenic steroid use among men admitted for substance abuse treatment: An underrecognized problem? J. Clin. Psychiatry. 64 (2), 156–160.
Kanayama, G., Hudson, J.I., DeLuca, J., Isaacs, S., Baggish, A., Weiner, R., Bhasin, S., Pope Jr, H.G., 2015. Prolonged hypogonadism in males following withdrawal from anabolic-androgenic steroids: an under-recognized problem. Addiction. 110 (5), 823–831.
Kanayama, G., Hudson, J.I., Pope Jr, H.G., 2020. Anabolic-Androgenic Steroid Use and Body Image in Men: A Growing Concern for Clinicians. Psychother. Psychosom. 89 (2), 65–73.
Kaufman, M.J., Kanayama, G., Hudson, J.I., Pope Jr, H.G., 2019. Supraphysiologic-dose anabolic-androgenic steroid use: A risk factor for dementia? Neurosci. Biobehav. Rev. 100, 180–207.
Keene, J.J.A.r., 1997. Drug use among prisoners before, during and after custody. Addiction research 4 (4), 343–353.
Klötz, F., Petersson, A., Hoffman, O., Thiblin, I., 2010. The significance of anabolic androgenic steroids in a Swedish prison population. Compr. Psychiatry. 51 (3), 312–318.
Korte, T., Pykäläinen, J., Seppälä, T., 1998. Drug abuse of Finnish male prisoners in 1995. Forensic Sci. Int. 97 (2-3), 171–183.
Kristoffersen, R., 2014. Correctional Statistics of Denmark, Finland, Iceland, Norway and Sweden 2009-2013. Correctional Service of Norway Staff Academy, Oslo, Norway.
Ljungdahl, S., Ehrnborg, C., Eriksson, B., Lindqvist Bagge, A., Moberg, T., 2019. Patients who Seek Treatment for AAS Abuse in Sweden: Description of Characteristics. J Addict. Med. Ther. 3 (11).
Lood, Y., Eklund, A., Garle, M., Ahlner, J., 2012. Anabolic androgenic steroids in police cases in Sweden 1999–2009. Forensic Sci. International. 219 (1-3), 199–204.
Lundholm, L., Frisell, T., Lichtenstein, P., Langstrom, N., 2015. Anabolic androgenic steroids and violent offending: confounding by polysubstance abuse among 10 365 general population men. Addiction. 110 (1), 100–108.
Lundholm, L., Kall, K., Wallin, S., Thiblin, I., 2010. Use of anabolic androgenic steroids in substance abusers arrested for crime. Drug Alcohol Depend. 111 (3), 222–226.
Mackey, S., Allgaier, N., Chaarani, B., Spechler, P., Orr, C., Bunn, J., Allen, N.B., Alia-Klein, N., Batalla, A., Blaine, S., Brooks, S., Caparelli, E., Chye, Y.Y., Cousijn, J., Dagher, A., Desrivieres, S., Feldstein-Ewing, S., Foxe, J.J., Goldstein, R.Z., Goudriaan, A.E., Heitzeg, M.M., Hester, R., Hutchison, K., Korucuoglu, O., Li, C.R., et al., 2019. Mega-Analysis of Gray Matter Volume in Substance Dependence: General and Substance-Specific Regional Effects. Am. J. Psychiatry. 176 (2), 119–128.
Morentin, B., Ballesteros, J., Callado, L.F., Meana, J.J., 2014. Recent cocaine use is a significant risk factor for sudden cardiovascular death in 15-49-year-old subjects: a forensic case-control study. Addiction. 109 (12), 2071–2078.
Muller, A.E., Havnes, I.A., Rognli, E.B., Bukten, A., 2018. Inmates with harmful substance use increase both exercise and nicotine use under incarceration. Int. J. Environ. Res. Pub. Health. 15 (12), 2663.
Murray, S.B., Griffiths, S., Mond, J.M., Kean, J., Blashill, A.J.J.D., 2016. Anabolic steroid use and body image psychopathology in men: delineating between appearance-versus performance-driven motivations. Drug Alcohol Depend. 165, 198–202.
Nieschlag, E., Vorona, E., 2015. Medical consequences of doping with anabolic androgenic steroids: effects on reproductive functions. Eur. J. Endocrinol. 173 (2), 47.
Norwegian Correctional Service, 2020a. About the Norwegian Correctional Service. Accessed on [August 10 2020]. https://www.kriminalomsorgen.no/index.php?cat=265199.
Norwegian Correctional Service, 2020b. Rusmestringsenheter (Substance Use Disorder treatment units). Accessed on [August 10 2020]. https://www.kriminalomsorgen.no/rusmestringsenheter.253069.no.html.
Nøkleby, H., 2013. Use of doping agents and symptoms of eating disorders among male and female patients in drug addiction treatment. Nord. Stud. Alcohol Drugs. 30, 313–345.
Nøkleby, H., Skårderud, F., 2013. Body practices among male drug abusers. Meanings of workout and use of doping agents in a drug treatment setting. Int. J. Ment. Health Addict. 11 (4), 490–502.
Petersson, A., Garle, M., Granath, F., Thiblin, I., 2006a. Morbidity and mortality in patients testing positively for the presence of anabolic androgenic steroids in connection with receiving medical care: a controlled retrospective cohort study. Drug Alcohol Depend. 81 (3), 215–220.
Petersson, A., Garle, M., Holmgren, P., Druid, H., Krantz, P., Thiblin, I., 2006b. Toxicological findings and manner of death in autopsied users of anabolic androgenic steroids. Drug Alcohol Depend. 81 (3), 241–249.
Piacentino, D., Kotzalidis, G.D., del Casale, A., Aromatario, M.R., Pomara, C., Girardi, P., Sani, G., 2015. Anabolic-androgenic steroid use and psychopathology in athletes. A systematic review. Curr. Neuropharmacology. 13 (1), 101–121.
Pope Jr, H.G., Wood, R.I., Rogol, A., Nyberg, F., Bowers, L., Bhasin, S., 2014. Adverse health consequences of performance-enhancing drugs: an Endocrine Society scientific statement. Endocr. Rev. 35 (3), 341–375.
Pope Jr, H.G., Kouri, E.M., Powell, K.F., Campbell, C., Katz, D.L., 1996. Anabolic-androgenic steroid use among 133 prisoners. Compr. Psychiatry. 37 (5), 322–327.
Rahnema, C.D., Lipshultz, L.I., Crosnoe, L.E., Kovac, J.R., Kim, E.D., 2014. Anabolic steroid–induced hypogonadism: diagnosis and treatment. Fertil. Steril. 101 (5), 1271–1279.
Rasmussen, J.J., Schou, M., Madsen, P.L., Selmer, C., Johansen, M.L., Hovind, P., Ulriksen, P.S., Faber, J., Gustafsson, F., Kistorp, C., 2018. Increased blood pressure and aortic stiffness among abusers of anabolic androgenic steroids: potential effect of suppressed natriuretic peptides in plasma? J. Hypertens. 36 (2), 277–285.
Rasmussen, J.J., Selmer, C., Ostergren, P.B., Pedersen, K.B., Schou, M., Gustafsson, F., Faber, J., Juul, A., Kistorp, C., 2016. Former Abusers of Anabolic Androgenic Steroids Exhibit Decreased Testosterone Levels and Hypogonadal Symptoms Years after Cessation: A Case-Control Study. PloS one 11 (8), e0161208.
Sagoe, D., Molde, H., Andreassen, C.S., Torsheim, T., Pallesen, S., 2014. The global epidemiology of anabolic-androgenic steroid use: a meta-analysis and meta-regression analysis. Ann. Epidemiol. 24 (5), 383–398.
Sagoe, D., Torsheim, T., Molde, H., Andreassen, C.S., Pallesen, S., 2015. Anabolic-androgenic steroid use in the Nordic countries: A meta-analysis and meta-regression analysis. Nord. Stud. Alcohol Drugs. 32 (1), 7–20.
Santos, H.G., Coomber, R., 2017. The risk environment of anabolic-androgenic steroid users in the UK: Examining motivations, practices and accounts of use. Int. J. Drug Policy. 40, 35–43.
Thiblin, I., Garmo, H., Garle, M., Holmberg, L., Byberg, L., Michaëlsson, K., Gedeborg, R., 2015. Anabolic steroids and cardiovascular risk: a national population-based cohort study. Drug Alcohol Depend. 152, 87–92.
Thiblin, I., Runeson, B., Rajs, J., 1999. Anabolic androgenic steroids and suicide. Ann. Clin. Psychiatry. 11 (4), 223–231.
WBF, 2020. World Prison Brieaf. Highest to Lowest - Prison Population Rate. Accessed on [August 10 2020]. https://www.prisonstudies.org/highest-to-lowest/prison_population_rate?field_region_taxonomy_tid=All&=Apply.
Westover, A.N., Nakonezny, P.A., Haley, R.W., 2008. Acute myocardial infarction in young adults who abuse amphetamines. Drug Alcohol Depend. 96 (1-2), 49–56.
Zahnow, R., McVeigh, J., Bates, G., Hope, V., Kean, J., Campbell, J., Smith, J., 2018. Identifying a typology of men who use anabolic androgenic steroids (AAS). Int. J. Drug Policy. 55, 105–111.