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Psychopathology among anabolic-androgenic steroid using and non-using female athletes in Norway

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ABSTRACT

Anabolic-androgenic steroids (AAS) are primarily used to improve physical appearance and increase lean muscle mass. Due to their masculinizing properties, the majority of people using AAS are men; however, AAS use among females may increase with changing body ideals trending towards a more muscular appearance. AAS use among males have been associated with risk-taking behavior, and increased prevalence of personality disorders and psychopathology. As a result of low perceived prevalence and stigma among females who use AAS, the relationship between AAS use and psychopathology in this population is not well-known. AAS using women (n = 16) and weight-lifting controls (WLC) (n = 16) completed questionnaires regarding AAS use, health and training information. Psychopathology was evaluated using the Millon Clinical Multiaxial Inventory-III (MCMI-III). Group differences on demographic variables and scores on MCMI-III scales were evaluated with Mann-Whitney U tests. The clinical cut-off was then applied to all MCMI-III scales and groups were compared using Fisher's exact test. AAS consumers demonstrated significantly greater psychopathology than WLC on several scales. Externalizing personality disorder scales were elevated among those who use AAS relative to controls, such as borderline ($p < 0.001$), antisocial ($p = 0.007$) and sadistic ($p = 0.002$), and in addition depressive ($p = 0.012$), negativistic ($p = 0.001$) and masochistic ($p = 0.029$) personality disorders scales. Furthermore, all clinical syndromes were elevated among AAS consumers. AAS consumers thus demonstrated multi-pathology, and 56% (n = 9) of the group met the clinical criteria for six or more disorders. Females who use AAS experience in general increased levels of psychopathology compared to WLC. Clinicians should be aware of these traits and the challenges they present in providing care to this population.

1. Introduction

Anabolic-androgenic steroids (AAS) include the hormone testosterone, and synthetic analogues (Kicman, 2008). These substances are most frequently used by professional and recreational athletes for their effects on muscle size and strength, often in doses far exceeding natural male production (Bhasin et al., 1996; Brower, 2002). Patterns of AAS administration vary, though these substances are often used in cycles, with periods of use lasting 6–18 weeks, followed by some periods without use. Lifetime prevalence of AAS use is approximately 3.3% globally, though estimates vary by country or region, and use is more common among athletes and males (Abrahin et al., 2014; Pereira et al., 2019; Pope et al., 2014; Sagoe et al., 2014; Selk-Ghaffari et al., 2021). The prevalence of use among women is far more uncertain, as women may underreport due to the stigma and secrecy surrounding AAS use (Börjesson et al., 2016a; Havnes et al., 2020a). A meta-analysis estimated a 1.6% global lifetime prevalence of AAS use among females, although this is likely to be higher among certain populations including women in prison (6.4%) and competitive bodybuilders (24.2%) (Angoorani et al., 2018; Havnes et al., 2020b; Sagoe et al., 2014). Recent

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studies indicate that AAS use may be increasing among adolescent females (2.4%), suggesting that the prevalence may increase in the future (Schneider et al., 2022). However, as a result of perceived low prevalence, AAS use in women remains an under-researched area.

Endogenous levels of testosterone are markedly lower in females than males, meaning females are more vulnerable to high-dose exogenous AAS and may experience greater endocrine disruptions and side effects as a result (Ip et al., 2010). The health risks associated with AAS use in women include sex-specific somatic side effects, such as voice change (deepening), clitoromegaly and hirsutism (Gruber and Pope, 2000; Havnes et al., 2020a) in addition to other serious side effects such as cardiovascular pathology (Baggish et al., 2017), cognitive deficits and brain structural and functional abnormalities (Bjørnebekk et al., 2017, 2021; Westlye et al., 2017). Mental health problems such as anxiety, paranoia, depression, irritability, aggression, hostility, and body image disturbances have been associated with AAS use (Chegeni et al., 2021; Hauger et al., 2021; Malone et al., 1995; Pagonis et al., 2006; Piacentino et al., 2015; van Amsterdam et al., 2010; Yates et al., 1990). However, only a handful of studies typically from the fitness or bodybuilding sports environment are covering female AAS use (Abrahin et al., 2017; Börjesson et al., 2016a; Ip et al., 2010), where the somatic adverse side effects (Abrahin et al., 2017; Börjesson et al., 2016b; Havnes et al., 2020a) are covered to a greater extent than the psychiatric side effects (Gruber and Pope, 2000; Onakomaiya and Henderson, 2016).

Males using AAS have previously been found to have an increased prevalence of personality disorders and psychopathology relative to controls (Cooper et al., 1996; Pagonis et al., 2006). In particular, cluster B personality disorders, which comprise antisocial, histrionic, borderline and narcissistic personality disorders, have been found to be more prevalent among males who use AAS compared to those that do not (Cooper et al., 1996; Hauger et al., 2021; Perry et al., 2003; Porcerelli and Sandler, 1995; Yates et al., 1990). Cluster B personality disorders are typically characterized by unpredictable and overly emotional traits, contributing to both inter- and intra-personal challenges, and are prevalent among those with substance use disorder (Langås et al., 2012; Moran et al., 2006). In addition, AAS consumers may exhibit neurotic and impulsive traits (Garcia-Argibay, 2019), which may contribute to, or result from, AAS use. A minority of this population has also reported mania and/or hypomania, occasionally associated with psychotic symptoms (Malone et al., 1995; Pope and Katz, 1988, 1994) during AAS exposure, and major depression, occasionally associated with suicidal ideation during AAS withdrawal (Malone et al., 1995; Thiblin et al., 1999).

The current study aims to investigate differences in personality and psychopathology between females who use AAS, and a group of female weightlifting controls (WLC). A better understanding of the personality and characteristics of the AAS-using female population will contribute clinically relevant knowledge of a population largely unexplored.

2. Methods

2.1. Participants and data collection

The study sample included 32 female weight-lifting athletes. Athletes were approached through social media, on hidden and open user forums, and through flyers, posters and snowball sampling. Participants were included if they were above 18 years of age. Participants were categorized as AAS consumers if they reported current or previous AAS use, or had used previously, and had completed at least one cycle of AAS, and as WLC if they reported no experience with AAS or other image and performance enhancing substances. Sixteen AAS-using females and 17 non-using (WLC) female athletes were included in the study. Six of the AAS consumers were currently using AAS, while the remaining 10 were previous consumers. One WLC was excluded due to use of performance enhancing substances (not AAS) listed on the World Anti-Doping Agency (WADA) list of prohibited substances.

2.2. Procedures and materials

Demographic data, information regarding weight-lifting training and records, health-related information and previous pharmacological treatment for medical or psychiatric conditions were collected with semi-structured interviews conducted by trained researchers within medicine (psychiatry), or psychology with several years of experience with the population. Furthermore, the interview covered the characteristics of AAS use, specifically: age of onset of use, motivation for use, types of AAS used, dosage, frequency of use, number and duration of cycles and experienced side effects.

Urine samples were collected to confirm AAS use status. Samples were analyzed at the WADA accredited Norwegian Doping Laboratory at Oslo University Hospital (Hullstein et al., 2015). Criteria to determine exogenous androgen use were: 1) urine samples positive for AAS compounds 2) a testosterone to epitestosterone ratio (T/E) $>$ 15 equivalent to previous work (Bjørnebekk et al., 2017, 2021; Hullstein et al., 2015).

The Millon Clinical Multiaxial Inventory-III (MCMI-III) (Millon, 2006) is a 175-item, true– false, self-report inventory for diagnosing personality disorders and identifying existing syndromes, and was administered using the paper format (Jankowski, 2002). The 175 items comprise 14 personality disorder scales, 10 clinical syndrome scales, a validity scale, and three scales to detect response bias. These scales closely parallel the classification of Axis I and Axis II disorders in the Diagnostic and Statistical Manual of Mental Disorders, 4th edition: American Psychiatric Association, 1994 (DMS-IV) (American Psychiatric Association, 1994). The raw data is used to calculate a base rate (BR) score for each scale, with possible scores ranging from 0 to 115. A score of BR $=$ 60 represents the median score in a clinical population, while a score of BR $\geq$ 75 indicates the presence of a specific personality trait, and BR $\geq$ 85 suggests the diagnostic presence of a personality characteristic. The MCMI was originally developed for clinical purposes, where 15% are expected to score below 35 on the disclosure scale (Millon, 2006). In this study, participants were not excluded based upon low disclosure scale scores, as our sample does not represent a clinical population.

2.3. Statistical analysis

All analyses were completed with R Studio version 4.1.3 (R Core Team, 2022). Differences between the AAS and the WLC group in background information and BR scores on MCMI-III scales were evaluated with Mann-Whitney U tests, to account for the non-normal distribution and small sample size. Fisher's exact tests were used to test for potential group differences on categorical data (e.g. scores above the clinical cut-off BR $>$ 75). Findings were considered significant at $p <$ 0.05, and p-values were adjusted using Benjamini-Hochberg procedure to control for the false discovery rate.

2.4. Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics South East Norway (approval #2013/601) and all research was carried out in accordance with the Declaration of Helsinki. All participants received a written description of the study prior to participation and written formal consent was obtained from all participants. The participants were compensated with 1000 NOK (~100 Euro) for their contribution to the study.

3. Results

3.1. Sample characteristics

The AAS group and the WLC did not differ significantly with respect to age, but the WLC had significantly longer education. There were no significant differences in tobacco use or weekly alcohol consumption. The groups were comparable in both height and weight, as well as IQ

score. The majority of the AAS group classified themselves as recreational athletes. Bodybuilding/fitness was the most common competitive sport in both groups. The AAS group comprised slightly more previous consumers than current consumers. All AAS consumers used more than one compound, and the most commonly used were Anavar (oxandrolone), clenbuterol, Winstrol (stanozolol) and Primobolan (metenolone). The experience with AAS ranged from one cycle, to use over 25 years. Urine samples were available for 29 participants (WLC n = 16, AAS n = 13). All samples from WLC indicated no AAS use, and among those reporting AAS use, there were five positive tests and eight negative, representing participants who had used AAS previously. The heterogeneity within the AAS group with regard to duration of use and time since last use should be noted. T/E ratios were in the normal range for all participants. Women who used AAS spent more minutes per week on endurance training, although no statistically significant differences were identified between groups regarding time spent training and current or lifetime maximum lift records. Full sample characteristics are described in Table 1.

Table 1
Sample characteristics.

	WLC	AAS	t	p
n	16	16		
Age (mean (SD))	28.44 (4.50)	31.00 (7.68)	−1.15	0.259
Education (years)	15.97 (2.09)	14.41 (2.06)	2.13	0.042
Alcohol units/week (mean (SD))	0.66 (0.91)	1.73 (2.73)	−1.43	0.146
Height (cm)	167.22 (7.80)	166.41 (6.51)	0.32	0.751
Weight (kg)	65.48 (9.76)	65.91 (9.81)	−0.12	0.903
Positive test (n (%))	0 (0.0)	5 (38)[a]		0.01[d]
T/E ratio (mean (SD))	1.09 (0.67)	1.25 (1.11)		0.627
Training type (n(%))				0.659[d]
Bodybuilding	7 (43.8)	5 (31.2)		
Powerlifting	2 (12.5)	1 (6.2)		
Combat sports	1 (6.2)	2 (12.5)		
Recreational sports	5 (31.2)	8 (50.0)		
Other	1 (6.2)	0 (0.0)		
Training intensity (mean (SD))				
Minutes strength/week	356.17 (214.69)	357.14 (299.90)	−0.01	0.992
Minutes endurance/week	116.00 (115.56)	170.00 (140.18)	−1.07	0.283
Squat record	98.25 (20.69)	112.73 (33.64)	−1.23	0.223
Squats current max	96.64 (17.56)	81.25 (35.33)	1.13	0.226
Bench record	72.65 (9.61)	77.71 (24.85)	−0.65	0.552
Bench current max	62.00 (23.14)	63.81 (29.05)	−0.15	0.878
Deadlift record	117.14 (30.30)	106.36 (24.09)	0.99	0.345
Deadlift current max	108.36 (40.25)	85.62 (34.38)	1.40	0.195
Characteristics of AAS use				
Debut age (years) (median (IQR))		22.00 [20.75, 26.25]		
Total years AAS use		1.50 [1.00, 4.00]		
Number of cycles[b]		3.00 [1.50, 4.25]		
Weekly dose (mg)[b]		240.00 [190.00, 420.00]		
Cycle duration (weeks)[b]		9.00 [7.00, 17.00]		
Current/previous AAS (n (%))				
Previous consumer		9 (56.2)		
Months since quitting (median [IQR])[a]		16 [7.50, 41.00]		
Current consumer		7 (43.8)		
Number of compounds[c]		7 (4.75)		
Compounds used (n (%))[c]		12 (80)		
Anavar (Oxandrolone)				
Clenbuterol		11 (73.3)		
Winstrol (Stanozolol)		10 (66.7)		
Primobolan (Metenolone)		10 (66.7)		
Growth hormone		8 (53.3)		
Nandrolone		7 (46.7)		

[a] 3 missing.
[b] 5 missing.
[c] 1 missing.
[d] Fisher's exact test.

3.2. MCMI results

The AAS group demonstrated significantly higher scores than the WLC group on a wide range of the MCMI-III scales. Personality disorder scales where the AAS group score significantly higher relative to WLCs included depressive, antisocial, sadistic, negativistic, masochistic/self-defeating, and borderline. All of the ten clinical syndromes scales were significantly elevated in the AAS group compared to WLCs. Full results of Mann-Whitney U tests are found in Table 2 and Fig. 1.

After applying the clinical cut-off of BR $\geq$ 75 on all scales, the AAS group demonstrated a greater proportion of pathology, as 56.25% of the group were above the clinical cut-off for six or more scales. Relative to WLCs, a greater number of AAS consumers scored above the clinical cut-off for dysthymia. The number of elevated scales per individual within the groups are shown in Fig. 2. Full results of Fisher's exact test are found in Table 2.

4. Discussion

In the current study AAS use was associated with a high level of psychopathology in weight-lifting women, which is consistent with previous research. The findings suggest multi-pathology, as a large proportion of AAS consumers reported scores above the clinical cut-off on several scales. As there is significant heterogeneity within the AAS group with regard to use patterns and duration, group differences may indicate vulnerabilities for ever using AAS rather than a result of prolonged use. It has been previously reported that relative to abstainers and males who use AAS, females who use AAS have an increased prevalence of psychiatric disorders (Ip et al., 2010). AAS use among females has been associated with increased risk behaviors, mood changes, and depression (Börjesson et al., 2016a; Elliot et al., 2007). The prevalence of psychopathology in the present study appears high, and seemingly higher than what is typically reported in males using AAS (Piacentino et al., 2015). This may reflect the anomalous nature of AAS use among females, which is arguably a more atypical behavior than use among men, and is consistent with higher psychopathology associated with abnormal behavior in general (American Psychiatric Association, 2013). An earlier study suggests that AAS-using females more often report lifetime psychiatric disorders including substance misuse, mood, eating and anxiety disorders, however women in the bodybuilding community more broadly may experience more pathology in these areas relative to the general population (Gruber and Pope, 2000).

Thus, psychopathology among the entire study population may be partially explained by certain aspects of the fitness/weightlifting environment, regardless of AAS use. In the current sample, there appear to be few training differences between those who used AAS and those who did not, however this may be a result of the retrospective self-reporting. While regular physical activity and exercise in females has been associated with several positive mental health outcomes including increased self-esteem and decreased anxiety and depression symptoms (McMahon et al., 2017; Tikac et al., 2022), the type of exercise and environment may influence these relationships. For example, athletes participating in individual sports may experience more anxiety and depression symptoms relative to those in team sports (Pluhar et al., 2019). Personality features such as perfectionism likely contribute to athletic success, but are also associated with obsessive-compulsive tendencies (Bratland-Sanda and Sundgot-Borgen, 2013), and women in the bodybuilding and

Table 2
MCMI-III base rate medians, interquartile range, number and percent of group members above the clinical cut-off, followed by results of the Mann-Whitney U tests for the continuous scales and Fisher's exact test for the dichotomized MCMI-III scales (i.e. number of individuals above the clinical cut-off). Tests compare WLC (n=16) versus all AAS (n=16). Significant ($p<0.05$) results are marked (*). P-values are adjusted using Benjamini-Hochberg procedure to control for the false discovery rate.

	WLC (n = 6)		AAS (n = 16)		U	p (MW)	p (Fisher's)
Personality disorder scales	Median (IQR)	n(%) ≥75	Median (IQR)	n(%) ≥75			
Schizoid	54.00 [21.00, 64.00]	2 (12.5)	62.00 [33.00, 72.50]	2 (12.5)	103	0.37	1.00
Avoidant	42.00 [12.00, 48.00]	2 (12.5)	55.00 [33.00, 80.25]	7 (43.8)	88	0.15	0.27
Depressive	64.00 [0.00, 75.00]	5 (31.2)	82.50 [64.75, 90.50]	11 (68.8)	61	0.02*	0.26
Dependent	50.00 [27.50, 78.00]	5 (31.2)	76.50 [58.75, 87.50]	11 (68.8)	79	0.09	0.26
Histrionic	38.00 [34.00, 40.50]	0 (0.0)	42.00 [39.00, 44.50]	0 (0.0)	77	0.08	1.00
Narcissistic	52.00 [46.00, 57.00]	0 (0.0)	58.00 [42.00, 73.50]	4 (25.0)	102.5	0.37	0.27
Antisocial	15.00 [8.00, 46.75]	1 (6.2)	63.50 [34.00, 75.25]	5 (31.2)	56	0.01*	0.38
Sadistic	17.00 [6.75, 43.00]	0 (0.0)	62.00 [43.00, 63.50]	1 (6.2)	44	0.01*	1.00
Compulsive	44.00 [39.00, 46.25]	0 (0.0)	41.50 [36.00, 47.00]	0 (0.0)	128	1.00	1.00
Negativistic	18.50 [0.00, 33.75]	0 (0.0)	66.00 [41.25, 81.50]	6 (37.5)	39.5	0.01*	0.14
Masochistic	30.00 [0.00, 60.00]	3 (18.8)	76.00 [35.00, 77.25]	10 (62.5)	70	0.05*	0.15
Schizotypal	30.00 [0.00, 40.00]	1 (6.2)	50.00 [20.00, 67.00]	3 (18.8)	86.5	0.14	0.90
Borderline	10.00 [0.00, 35.00]	0 (0.0)	71.00 [37.50, 88.00]	6 (37.5)	31.5	0.01*	0.14
Paranoid	24.00 [0.00, 51.00]	0 (0.0)	48.00 [21.00, 64.00]	2 (12.5)	84	0.12	0.77
Clinical syndrome scales							
Anxiety	20.00 [0.00, 78.00]	5 (31.2)	78.50 [71.25, 88.00]	12 (75.0)	58.5	0.01*	0.15
Somatoform	15.00 [0.00, 60.50]	0 (0.0)	62.50 [22.50, 70.00]	2 (12.5)	73	0.05*	0.77
Bipolar	30.00 [0.00, 61.00]	0 (0.0)	66.00 [57.00, 71.50]	3 (18.8)	46.5	0.01*	0.45
Dysthymia	10.00 [0.00, 60.00]	0 (0.0)	75.50 [40.00, 81.00]	9 (56.2)	49.5	0.01*	0.02*
Alcohol dependence	22.50 [0.00, 30.00]	0 (0.0)	60.00 [45.00, 65.00]	1 (6.2)	50	0.01*	1.00
Drug dependence	15.00 [15.00, 33.75]	0 (0.0)	62.50 [30.00, 70.75]	2 (12.5)	47.5	0.01*	0.77
PTSD	0.00 [0.00, 60.00]	0 (0.0)	67.00 [54.00, 72.75]	4 (25.0)	49	0.01*	0.27
Thought disorder	15.00 [0.00, 60.25]	1 (6.2)	63.50 [62.25, 68.50]	2 (12.5)	52	0.01*	1.00
Major depression	0.00 [0.00, 25.00]	0 (0.0)	62.00 [20.00, 67.00]	2 (12.5)	48.5	0.01*	0.27
Delusional disorder	0.00 [0.00, 0.00]	0 (0.0)	42.50 [18.75, 60.00]	0 (0.0)	58.5	0.01*	0.26

WLC: weight-lifting controls, AAS: anabolic-androgenic steroids, IQR: inter-quartile range, MW: Mann-Whitney.

fitness communities may experience more psychopathology associated with extreme fitness and dieting regiments (Mathisen and Sundgot-Borgen, 2019; Money-Taylor et al., 2021). Additionally, eating disorders, particularly those that are restrictive in nature, have been associated with obsessive-compulsive, neurotic, and avoidant traits (Cassin and von Ranson, 2005; Lilenfeld et al., 2006; Sansone and Sansone, 2010), characteristics which were not significantly different between the groups in this study. Both the AAS consumers and WLC represent a unique population with psychological features that may reflect the specific environment of strength training, which likely differs from the general population.

While the current study may have lacked sufficient statistical power to detect differences in number of participants meeting clinical criteria, the results indicate increased multipathology among women who use AAS relative to WLC. A large proportion of women using AAS demonstrated scores over the clinical cut off (>75) on six or more BR-scales (56.25%, n = 9). This is in line with findings from clinical practice for other substance dependencies, showing high comorbidity between personality disorders and substance use disorders (Korsgaard et al., 2016; Parmar and Kaloiya, 2018). Although distinct from those that use psychoactive drugs, with clear differences in the motivation for use, there is some overlap between these groups (Sagoe et al., 2015). In addition, it is important to note that many personality disorders and clinical syndromes share underlying risk factors, including genetics (Kendler et al., 2019; Wesseldijk et al., 2018), and that a general factor of personality disorder may account for substance use disorder comorbidity (Jahng et al., 2011), which is likely relevant for people using AAS as well.

Additionally, BR of antisocial personality disorder was significantly higher among AAS consumers. Interestingly, borderline and antisocial are often highly prevalent among people with substance use disorder (González et al., 2019; Rosenström et al., 2021). Furthermore, previous research indicates that antisocial personality traits are elevated in male AAS consumers (Hauger et al., 2021), which our results suggest may also be true in females. However, it does not appear that there is a clear psychiatric profile of female who use AAS, as this sample exhibits elevated scores on both externalizing (antisocial, alcohol/drug dependence) and internalizing (dysthymia, depressive disorder, anxiety) scales. It is notable that prevalence of internalizing pathology does appear to be much higher in females than their male counterparts (Piacentino et al., 2015), which may reflect pre-existing sex differences in addition to increased sensitivity to exogenous androgens for females (Onakomaiya and Henderson, 2016).

While relatively little is known about the causal effects of AAS use on psychopathology and personality in females, it is possible that increased testosterone may contribute to certain traits. Elevated testosterone levels have been observed in female borderline personality disorder patients relative to controls (Dettenborn et al., 2016). Exogenous testosterone has also been associated with a decrease in empathetic behaviour, which may explain some of the current findings, particularly related to sadistic and antisocial traits among women who have used AAS (Hermans et al., 2006; van Honk et al., 2011). However, considering the variation in duration of use and time since last use within our study population, it is not possible to determine the direction of the relationships identified in the present study.

It is important to note that there may be shared risk factors for AAS use and mental health problems. Psychopathology may precede AAS use, as a previous study in male AAS consumers demonstrated an increase in psychiatric illness and symptoms during and shortly after AAS use (Pagonis et al., 2006). Furthermore, some females may commence AAS use as a defence following sexual assault (Gestsdottir et al., 2021; Gruber and Pope, 1999), which is a strong risk factor for psychopathology, including borderline personality disorder, anxiety, depression and PTSD (Chen et al., 2010; de Aquino Ferreira et al., 2018; Dworkin et al., 2017). Furthermore, some women in the current sample report taking AAS to combat existing mental health problems, including anxiety and body-image issues (Havnes et al., 2020a). It is thus possible that the current findings may be partially explained by common underlying risk factors.

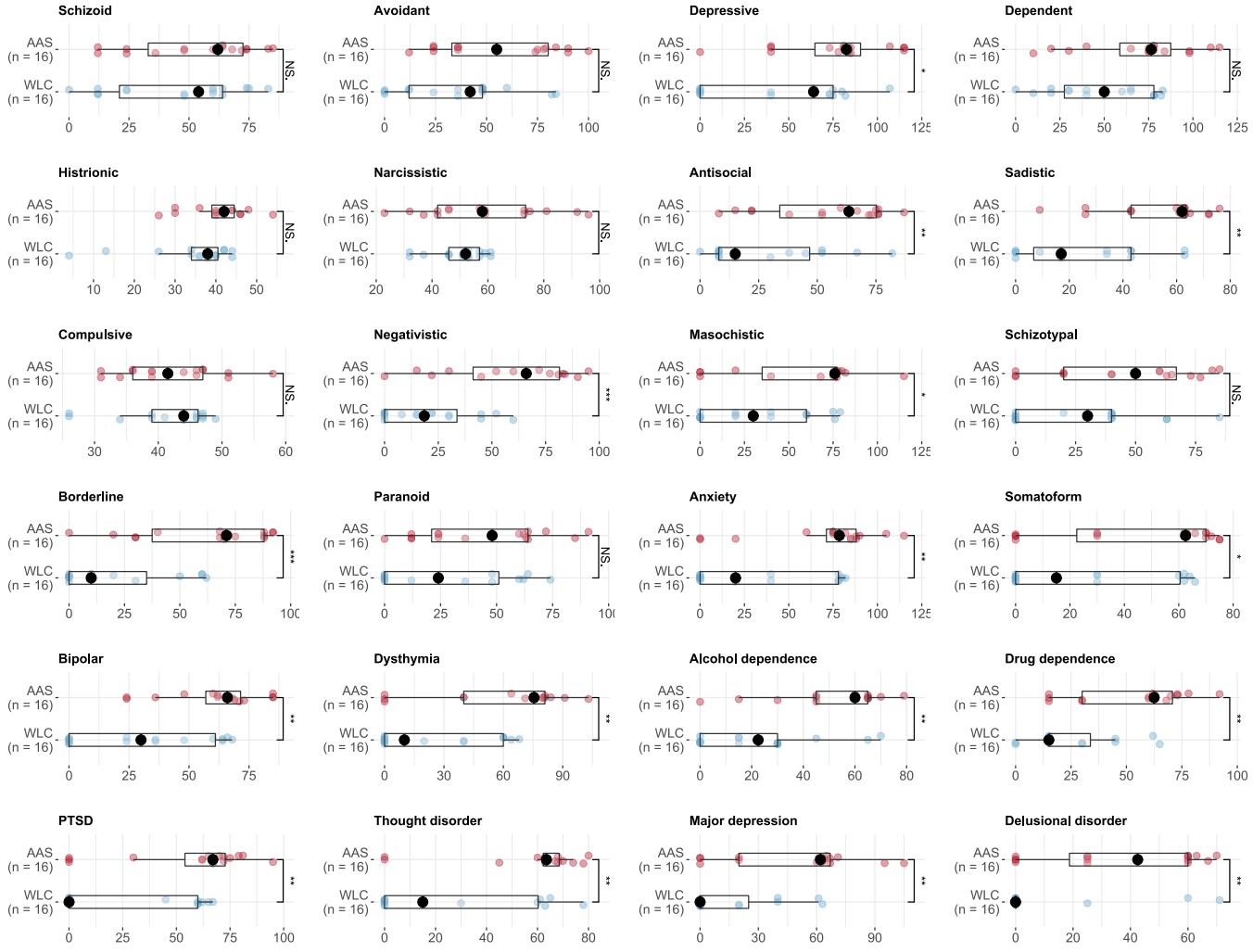

Fig. 1. Distribution of base rate scores of each MCMI-III scale in AAS (red) and WLC (blue) groups. Median and inter-quartile range are depicted in black and results of Mann-Whitney test is marked as follows: *NS: not significant, *: p≤0.05, **: p≤0.01, ***: p≤0.00.*

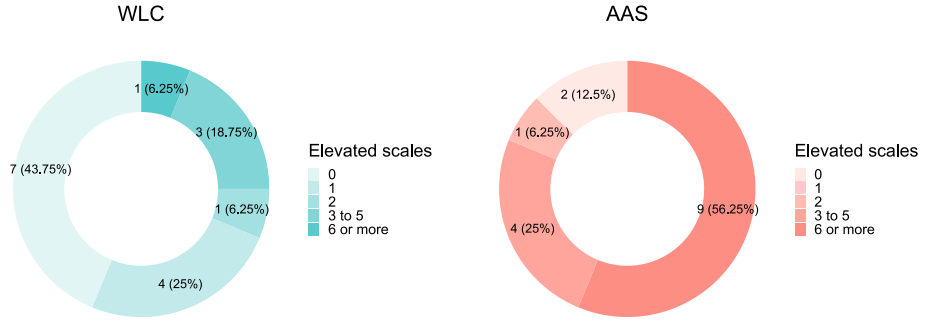

Fig. 2. Donut chart illustrating frequency and percentage of elevated MCMI-III scores (BR ≥ 75) within WLC (n = 16) and AAS (n = 16).

4.1. Limitations

Due to the cross sectional nature of this study, it is not possible to establish causality between AAS-usage and psychopathology. Furthermore, the study sample may not be representative, particularly since the sample is relatively small, and includes only females located in Norway. The small sample size also leads to a lack of power, increasing the probability of type II error in group comparisons of both demographics and psychopathology. In addition, the findings are based on self-report questionnaires, which may be subject to recall and information bias. However, the groups appear to differ greatly, such that the results are unlikely to be significantly impacted by these potential biases. The AAS group also includes women who have previously used AAS, who may exhibit psychiatric and hormonal differences which could influence the current findings, however the sample size is not sufficient to make comparisons between these two subgroups. In addition, there is large variation within the group with regard to use patterns including duration and dose. Future studies in larger samples should investigate the

role of these factors on mental health.

Another important note is that the MCMI-III was designed and standardized for usage in clinical populations, though it has been proven useful in research settings. Nevertheless, findings of reported elevated scales found in research settings should not be considered diagnoses, but an indicator of pathology in the respective populations.

5. Conclusion

Similar to findings among male, females who use AAS demonstrate higher levels of psychopathology than WLC. Many characteristics are reflective of substance use disorder patients, indicating potential shared psychiatric characteristics, including those associated with increased impulsivity and emotional instability, such as borderline personality disorder.

It is critical that clinicians be aware of both the somatic and psychiatric effects of AAS use. Female who use AAS are a particularly vulnerable group, as prevalence of AAS use is perceived to be extremely low, and many experience that their medical provider does not inquire regarding androgen use, or lacks knowledge and experience in this area. This can make adequate and proper care difficult to obtain. Psychopathology presents an additional obstacle to medical care, and may make cessation or treatment more challenging (Papamalis et al., 2021).

Additional studies are needed to establish the role of dose and duration of use of AAS in psychopathology, and longitudinal studies are required to understand possible causation. Female AAS consumers are a hard-to-reach group due to stigma, posing a significant challenge to obtaining large study samples. Creative solutions and international collaboration are required in order to better understand this population and the challenges they face, in order to provide optimal care.

Author statement

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Declaration of competing interest

None.

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