Title: The association between the non-medical use of anabolic-androgenic steroids (AAS) and interpersonal violence: a meta-analysis

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Abstract

The non-medical use of anabolic-androgenic steroids (AAS) by athletes and the general population is a public health concern. One particular concern relates to the link between AAS use and violence. Although there is a growing body of research on the association between AAS and violence, results as to what the relationship is seem to be mixed. The aim of this meta-analysis is to improve our understanding of what the current evidence base indicates regarding the relationship between the use of AAS and interpersonal violence. Fourteen studies with a total of 16 samples met the inclusion criteria, comprising a total sample size of 137,055 participants. The findings show that there is a significant association between AAS use and interpersonal violence ($r = .21$ [95% CI .15, .27], $p < .00001$), although small. It is however unclear what the direction of this relationship is as almost all studies failed to demonstrate if AAS use occurred prior or subsequent to the violent behavior. Risk of bias for most studies was moderate or high. Three potential moderators, AAS use via self-report or testing, interpersonal violence via self-report or criminal records of violent behavior, and proportion of males, were non-significant. Although a meta-analytic relationship between AAS use and interpersonal violence was found, it is unclear to what extent AAS causes violent acts. We need to carefully consider the role of mediating factors, and that the relationship between the two could be part of a broader context as opposed to AAS being the cause of violence.

Keywords

Anabolic-androgenic steroids; interpersonal violence; meta-analysis; performance and image enhancing drugs

Introduction

The non-medical use of anabolic-androgenic steroids (AAS) (e.g. for muscle enhancement) by athletes and the general population is common, with a meta-analysis showing that 3.3% of the world's population has used AAS at least once in their life (Sagoe et al., 2014). Although the use of AAS has been associated with a range of health problems (e.g., cardiovascular disease) and psychiatric side-effects (e.g., dependence) (Pope et al., 2014), often-cited adverse effects of the non-medical use of AAS are aggression and violence (Pope et al., 2021). The public assumption of this relationship is also often fueled by media coverage of single events of extreme violence. For example, the use of AAS by Anders Behring Breivik in Norway in preparation of his terrorist attack in 2011, and the London Bridge terror attack newspaper headlines despite toxicologist's report stating that AAS played no significant role in the atrocity (Mulrooney et al., 2019).

The link between AAS use, aggression and violent behavior

A meta-analysis on the link between AAS and aggression found evidence of an increase, although small, in self-reported aggression in healthy males following AAS administration in randomized controlled trials (Chegeni et al., 2021). Aggression in this meta-analysis was however mainly focused on non-physical aggression (e.g. increased feelings of hostility,

verbal aggression). In only three of the twelve studies a physical aggression (i.e. violence) measure was included but even for these studies the main focus was on non-physical aggression. In addition, although the included studies have value in their experimental method, they did not pertain directly to violent behavior and did not involve behavior in day-to-day life (e.g. testing aggression in a gaming setting). It is therefore unknown to what extent AAS use leads to violent behavior. This is important as experiencing increased feelings of aggression does not necessarily mean that someone will engage in violent behavior. Indeed, aggression does not equal violence. Studies even show that some people who use AAS consider the increased aggression as something positive, for example, benefitting their gym training or aiding in some forms of competitive sport (e.g. see Bates & McVeigh, 2016).

There is growing evidence on the link between AAS use and different types of violence (e.g., physical fighting, violent crimes, and intimate partner violence) (Pope et al., 2021). Findings regarding the relationship however seem to be mixed. For example, some studies have reported that people who use AAS are more likely to engage in physical fighting (Miller et al., 2002) and are more commonly arrested for violent crimes (Lundholm et al., 2010), whereas other studies have failed to demonstrate a significant relationship between people who use AAS and physical violence perpetration (Ganson et al., 2023) and being convicted for a violent crime (Klotz et al., 2006; van de Ven et al., 2023). Whether the use of AAS poses an increased risk for violence behavior therefore remains a topic of contention (Mulrooney et al., 2019). Understanding the link between AAS use and violence is however important as there are significant social costs associated with substance-related violence (e.g. see Black, 2021).

Mediating factors, aggression and violent behavior

The link between aggression, violence and substance use is complex (e.g. see Ingram et al., 2022; Katerndahl et al., 2021), and there are several mediating factors. First of all, a meta-meta-analysis showed that there is a positive relationship between substance use and violence (Duke et al., 2018). Although alcohol often is an important component, the meta-meta-analysis study showed that the combination of alcohol and drugs may be more detrimental than alcohol alone. Poly-drug use is highly prevalent amongst AAS-using populations (Sagoe et al., 2015), with alcohol, prescription drugs and cocaine being the most common psychoactive substances used in addition to AAS. It can therefore be questioned whether the use of AAS itself poses an increased risk for violent acts, or if it is the concomitant use of AAS and other substances. Second, personality traits seem to be another important factor to consider in the link between AAS and violence. For example, studies suggest that the effects of AAS on aggression and violence seems to be dependent on high dominance and low self-control (Geniole et al., 2019), antisocial personality traits (Hauger et al., 2021), and risk-taking behaviors (Zahnow et al., 2018). These traits seem to be more represented in people who use AAS, particularly those dependent on AAS, compared to people in weight-lifting communities who do not use AAS (e.g. see Hauger et al., 2019).

With a growing body of research examining AAS use and violent behavior, it is both timely and important to get a better understanding of what the current evidence indicates in relation to this public health, sociological and criminological issue. This meta-analysis will examine to what extent people who use AAS actually engage in violent behaviors. For this meta-analysis we will focus on interpersonal violence. Interpersonal violence in this article is defined as involving '*the intentional use of physical force or power against other persons by an individual or small group of individuals. Interpersonal violence may be physical, sexual,*

or psychological (also called emotional violence), and it may involve deprivation and neglect' (Mercy et al., 2017).

Methods

The study is reported in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) (Moher et al., 2009). The protocol for this meta-analysis was pre-registered in PROSPERO (removed to ensure anonymity). We reviewed studies that examined the relationship between AAS use and interpersonal violence (as defined above). The search and screening were conducted in October through December, 2022

Study eligibility

Studies were initially screened based on title and abstract. Longitudinal, retrospective, and cross-sectional observational studies, as well as randomized clinical trials, were considered. Publications were included if they are written in English, and if they focused on AAS and violent behaviors. Non-English articles were considered but were excluded if they could not adequately be translated into English. Excluded study designs include mathematical modelling reports, literature reviews, systematic reviews, and meta-analyses. Quantitative studies of descriptive-only statistics, experimental studies and non-human studies were also excluded. All studies that met the inclusion criteria were included, regardless of the start date of the published study.

Search strategy

Studies were identified using the following major databases: PubMed; EBSCOhost; Scopus; PsychINFO; and ProQuest. We also searched reference lists from retrieved manuscripts and contacted corresponding authors of included articles if they had unpublished relevant results.

The following search terms were used: ‘anabolic-androgenic steroid*’ OR ‘anabolic steroid*’ OR ‘anabolic agents’ OR ‘performance enhancing drug*’ OR ‘performance enhancing substance*’ OR ‘image enhancing drug*’ OR ‘image enhancing substance*’ OR ‘androgen abuse’ OR doping. We did not include the term ‘testosterone’ as an initial search revealed that most publications related to the medical use of testosterone and not its non-medical use. The term ‘steroids’ has been removed as an initial search showed that many publications related to corticosteroids as opposed to AAS. Furthermore, in general publications in the first instance will use the term ‘anabolic steroids’ or ‘anabolic-androgenic steroids’ before shortening it to steroids, resulting in these publications being picked up in our search anyway. The search strategies were developed with input from all authors and the help of a specialist librarian.

Study selection and data extraction

The initial search of databases yielded 1,568 papers, leaving 884 records after all duplications were removed. See Figure 1.

INSERT FIGURE 1 HERE

The reference management software Endnote was used to record all publications. One author (removed to ensure anonymity) conducted the database searches and screened the titles and abstracts of all publications obtained by the search strategy, with the third author (removed to ensure anonymity) screening a sub-sample of the articles (10%). Thirty-four full text papers were retrieved and reviewed, which were all examined by two authors (removed to ensure anonymity). Both the initial screening and the full-text examination were followed by a rigorous discussion between the two authors to compare the results and discuss discrepancies.

Twenty-one records were excluded for various reasons (e.g. not all required data available for meta-analysis). A total of 14 studies met our inclusion criteria. Two of the studies reported individually on female and male AAS use and interpersonal violence, creating a total of 16 samples.

The following data were extracted: (1) study author and publication year, (2) nation of study, (3) population, (4) percentage male, (5) measure of AAS use, (6) whether the study report presented evidence that the use measure has evidence of reliability and (7) validity, (8) whether the use measure was self-report or biochemical test, (9) whether the study report presented evidence that the violence measure has evidence of reliability and (10) validity, and (11) whether the violence measure was self-report. Ganson provided us by email with key data for the study of Ganson et al. (2023). For Klötz et al. (2007), we used results for the first three years after the first conviction, and we combined all the AAS positive participants and compared them to the AAS negative control.

Risk of bias assessment

We adopted the 10-item risk of bias instrument used in the study of Allami et al. (2021) focused on problem gambling to assess the quality of each included study. Although this assessment tool is originally designed for observational studies, all items could be applied in our context. Two people (removed to ensure anonymity) independently reviewed the quality of the studies. Results were then compared and discrepancies discussed.

Data analysis

We used Comprehensive Meta-Analysis software, version 3.3.070 (Borenstein et al., 2014). We used the random effects model to aggregate study effect sizes into an overall weighted *r*

and reported results with 95% confidence intervals (CI). We used the random effects model over the fixed effects model because we expected effect sizes between studies to vary due to differences in samples and interventions. We used *r* because it is a widely understood measure of association.

We searched for potential outliers by inspecting the forest plot of effect sizes of both neutral and bona fide comparison conditions. We assessed heterogeneity across studies using Q, I^2 and Tau^2 statistics. The Q statistic tests the null hypothesis that true homogeneity is present across all study effect sizes (Huedo-Medina et al., 2006). The I^2 statistic indicates the percentage of total variability in effect sizes across studies that is due to true heterogeneity, rather than sampling error (Huedo-Medina et al., 2006). The Tau^2 statistic provides an estimate of true between-studies heterogeneity of effects in a random effects meta-analysis (Deeks et al., 2022).

We used four methods to analyze publication bias: visual inspection of a funnel plot, Begg and Mazumdar (1994) rank correlation, Egger's regression test (Egger et al., 1997), test, and Duval and Tweedie (2000) trim and fill test. A funnel plot displays the relationship between the effect size and the standard error (SE) of included studies (Sterne & Egger, 2001). Symmetrical distribution of studies in a funnel plot indicates an absence of publication bias (Borenstein et al., 2009). Both Begg and Mazumdar's rank correlation test and Egger's regression test assess publication bias via significance testing, with a significant *p*-value indicating publication bias (van Enst et al., 2014). Duval and Tweedie's trim and fill test imputes studies into an asymmetric funnel plot in order to achieve symmetry (Borenstein et al., 2009). The imputing corrects for publication bias by creating a new adjusted effect size that includes the imputed studies (Borenstein et al., 2014).

Results

Description of included studies

Sixteen study samples, with a total of 137,055 participants, met the criteria for inclusion in the meta-analysis. The publication dates ranged from 1995 to in press. Six studies were conducted in the United States (Borowsky et al., 1997; Dukarm et al., 1996; Ganson & Cadet, 2019; Ganson et al., 2022; Middleman et al., 1995; Miller et al., 2002), six in Sweden (Klotz et al., 2006; Klötz et al., 2010; Klötz et al., 2007; Lundholm et al., 2015; Lundholm et al., 2010), and one each in Denmark (Christoffersen et al., 2019), Canada (Ganson et al., 2023) and Norway (Hauger et al., 2021). In ten of the sixteen study samples the population included all or nearly all men.

Interpersonal violence was measured in the majority of studies via self-report (Borowsky et al., 1997; Dukarm et al., 1996; Ganson & Cadet, 2019; Ganson et al., 2023; Ganson et al., 2022; Hauger et al., 2021; Klötz et al., 2010; Middleman et al., 1995; Miller et al., 2002) but in some cases it was also measured via recorded violent crime arrest or conviction rates (Christoffersen et al., 2019; Klotz et al., 2006; Klötz et al., 2007; Lundholm et al., 2015; Lundholm et al., 2010). The interpersonal violence measures used were diverse and included violent crime convictions, physical fighting, teen dating violence, perpetrated physical violence, intimate partner violence, sexual violence, and being arrested for a violent crime. The time period to measure interpersonal violence ranged from past month to past year and lifetime. No validated tools were used to measure interpersonal violence.

AAS use in general was measured via self-report (Borowsky et al., 1997; Dukarm et al., 1996; Ganson & Cadet, 2019; Ganson et al., 2023; Ganson et al., 2022; Hauger et al., 2021; Klötz et al., 2010; Lundholm et al., 2015; Lundholm et al., 2010; Middleman et al.,

1995; Miller et al., 2002) with three studies using biochemical testing to measure AAS use (Christoffersen et al., 2019; Klotz et al., 2006; Klötz et al., 2007). The time periods to measure AAS ranged from past month to past year and lifetime. No validated tools were used to measure AAS use. For only one study was it clear that AAS use occurred before the violent act (Christoffersen et al., 2019) and for one study is occurred after the violent act occurred (Klötz et al., 2007). In all other studies it was unclear whether AAS use occurred before, during or after the violent event. See Table 1 for more detail on the AAS use and violence measures used in the included studies.

Association of AAS use with interpersonal violence

The overall association between AAS use and interpersonal violence for the included studies was significant, with $r = .21$ [95% CI .15, .27], $p < .00001$. The study effect sizes were highly heterogeneous, with Q(15) = 700, $p < .00001$, *I*-squared = 98. Table 1 shows the effect size and descriptive information for each study. Figure 2 provides a graphic display of effect sizes for each sample.

INSERT TABLE 1 HERE

INSERT FIGURE 2 HERE

Risk of bias

Table 2 shows our analysis of the quality of the included studies. When assessed on the 10-item criteria, we found that the risk of bias was low for one study, moderate for eight studies and high for five studies. The most commonly observed risks for the moderate to high-risk studies were not using validated instruments to measure AAS use and interpersonal violence

(item 7; 100% of studies), the prevalence period not being appropriate (item 9; 93% of all studies), no reporting of the response rate (item 4; 64% of studies), the sample not being representative (item 1; 57% of studies), and the sample not being randomized (item 3; 57% of studies).

INSERT TABLE 2 HERE

We evaluated publication bias in four ways. First, we examined the funnel plot. The plot, shown in Figure 3, showed symmetry, suggesting no bias. We also calculated Egger's regression coefficient, intercept = 0.75, which was nonsignificant at $t(14) = 0.29$, $p = .78$, and the Begg and Mazundear rank correlation, which showed a nonsignificant tau^2 of .0006, $p = .89$. Both results showed indicated no bias. Finally, we applied Duval and Tweedie's trim and fill, and it suggested adjusting no values for bias.

INSERT FIGURE 3 HERE

Moderator analysis

We examined three potential moderators that we thought might be of interest: (1) whether AAS use was measured by self-report or by a biochemical test and (2) whether interpersonal violence was measured by self-report or by being charged with or convicted of a violent crime, and (3) proportion of males in the sample. Table 3 shows the results of the moderator analyses. All the potential moderators were nonsignificant, but there was a nonsignificant trend for predominantly male samples to have a higher association between AAS use and interpersonal violence. See Table 3.

INSERT TABLE 3 HERE.

Discussion

This meta-analysis has examined to what extent people who use AAS engage in interpersonal violence. A summary of the critical findings from this meta-analysis are shown in Table 4. Our findings show, across 16 study samples including a total of 137,055 participants, a significant association between AAS use and interpersonal violence. The association, $r = .21$, is a small one according to the standards of Cohen (1988). The moderator analyses were nonsignificant, but they had low power due to the relatively small number of samples in each category. The moderator analyses did show nonsignificant trends in favor of higher associations for males and with self-report measures of AAS use and interpersonal violence. A significant association was found for both males and females, for both self-reports and records assessing interpersonal violence, and for self-report of AAS use. Biochemical tests of use, used in only three studies, showed a nonsignificant trend toward association with interpersonal violence.

INSERT TABLE 4 HERE

An issue however is that it is unclear what the direction of the relationship is between AAS use and interpersonal violence. In twelve of the fourteen studies it is unknown whether AAS use occurred before, during or after the violent act. For one study AAS use was even measured after the violent act occurred (Klötz et al., 2007). For instance, the study of Ganson et al. (2023) measured whether participants engaged in AAS use within the past 12 months,

and whether the participants had perpetrated physical violence in the past 12 months. They did not control for when exactly the AAS use occurred in respect to the violent act. It is therefore unclear whether AAS may have influenced the violent acts. Evidence is particularly lacking that AAS use leads to acute triggers of uncontrolled violence (e.g., "roid rage") (Lundholm et al., 2010). If AAS use causes violent behavior, it seems more likely that it leads to long-lasting central effects that potentially lower the threshold for engaging in violence behavior (Lundholm et al., 2010).

We however also need to consider that AAS does not cause violent behavior but simply is part of a larger (risk-taking) lifestyle by some sections of the AAS using communities. A particular type of AAS consumer that comes to mind is the group which in research has been classed as "the Y.O.L.O." (i.e., You Only Live Once) user (Christiansen et al., 2017; Zahnow et al., 2018). The Y.O.L.O. user is considered a risk-taker who also uses other substances in addition to AAS use. For this group, AAS use largely tends to be unplanned and is mainly used to achieve quick improvements in their physique (Zahnow et al., 2018). For some Y.O.L.O. users, AAS use is not necessarily associated with muscularity or fitness but instead occurs within the context of a high-risk, experimental lifestyle, including alcohol and poly-drug use, unsafe sex, and impulsivity (Zahnow et al., 2018). This Y.O.L.O consumer type might therefore be at higher risk of engaging in violence behavior due to these various risk-taking lifestyle aspects such as engaging in poly-drug use and having less impulse control, as opposed to being directly related to the use of AAS. Research has also shown that men are more likely to engage in risk-taking behavior (which the majority of AAS consumers are) and that those risk-takers using substances are more likely to report being involved in violent acts, either as victim or perpetrator (Coid et al., 2016).

As noted in the introduction, there seem to be several mediating factors that influence the relationship between AAS use and violence (e.g., poly-drug use and personality traits). For example, In the study of Lundholm et al. (2015) involving 10,365 male twins a strong association between self-reported AAS use and conviction of a violent crime was found. The relationship however lost statistical power when adjusting for other substance use. Future studies should therefore examine factors that might moderate the effects of AAS on violence, particularly poly-drug use, personality traits, and AAS administration (e.g., type of AAS and duration of use), ideally focusing on populations not prone to violence, and accounting for when AAS use and the violent act occurred.

We also need to consider that the studies included in the meta-analysis originated from North America and the Scandinavian countries, all states which have criminalized the personal possession of AAS (Havnes et al., 2020). In Denmark they identified a 9 fold increased risk of conviction (not necessarily a violent crime) (Christoffersen et al., 2019) and for those incarcerated in the potentially volatile and violent environment of the prison system there is the increased risk of them becoming perpetrators of violence. Caution is also required in interpreting the findings of this meta-analysis due to the inclusion of high numbers of high school students and adolescents. Young men's hormones, specifically testosterone, are surging at this stage of their development and they are at a higher risk of engaging in antisocial behaviour (Peper & Dahl, 2013; White et al., 2022). They therefore may not be representative of the wider AAS using population. Importantly, while much of the policy attention focuses on young males (ACMD, 2010; GAO, 2007), there is growing evidence of older males utilising AAS (Begley et al., 2017; Hearne et al., 2022).

Another important issue is that no validated instruments were being used to measure AAS use or violent behavior; most studies relied on self-report. In five of the fourteen studies

the violent measure was not even defined. Research shows that for self-reported (violent) crimes both under- and over-reporting occurs (Gomes et al., 2019; Krohn et al., 2013). Under- or over-reporting seems to be dependent on the type of violence reported on. For instance, young men tend to over-report physical fighting as it can increase their peer status (Staff & Kreager, 2008), whereas intimate partner violence (both physical and sexual violence) is more likely to be under-reported by perpetrators because of social desirability and shame and guilt (Chan, 2011). Research findings on the validity of self-reported substance use also show that drug use tends to be underreported compared to when biological markers are used (Khalili et al., 2021). An issue however with studies that identify AAS use by testing blood and/or urine samples are that there is the risk that there are unidentified AAS consumers who are temporarily on an off-cycle (i.e., not using AAS for a certain period of time) and as a result end up in the control group (i.e. the non-using group) (Klotz et al., 2006). Not using validated instruments for both AAS use and interpersonal violence may therefore have influenced the accuracy of our findings.

Nevertheless, as AAS use may increase the risk of engaging in interpersonal violence, it is important to educate people who use AAS, health professionals and others on this issue. However, as the direction of the relationship is unclear, we recommend focusing on the context of the above-noted mediating factors as opposed to focusing on AAS use itself. For example, considering poly-drug use is high within AAS-using communities, and as we know that poly-drug use increases the risk of violence (Duke et al., 2018), harm reduction messages could focus on how the combined use of drugs increases the risk of violence (e.g. using alcohol and/or stimulants while using AAS may increase feelings of aggression).

Importantly, to reduce this risk (and other health and social risks), it is key that barriers to accessing health services are reduced for people who use AAS. There is, for

example, significant stigma and discrimination around AAS use (Griffiths et al., 2016), which may lead to individuals concealing their use when presenting to health professionals, or deter them from seeking help. Adding to this is that discourses of AAS historically have been framed around a "narrative of harm" (Mulrooney et al., 2019), labelling illicit AAS use as a crime as opposed to a health problem, and not recognizing the pleasurable and functional reasons for using these substances. These stereotypical ideas around AAS use, including around violence, will therefore need to be dismantled in order to improve engagement with health professionals before, during and after AAS use. Improving engagement with health professional plays a key role in ensuring that people who are using AAS non-medically (and are currently not able to stop) are informed about how to use these substances in the safest manner (i.e. harm reduction), as this potentially may reduce risk such as engaging in violent behavior. For example, a health professional could inform consumers that using high dosages without taking breaks may increase the risk of experiencing feelings of aggression, which potentially may increase the risk of engaging in violent behavior.

In addition, in a recent study of van de Ven et al. (2023) it is noted that treatment programs are needed that support violent offenders (including those who use AAS) to address their drug-related behaviors and their criminal offending. Violent offenders are however often excluded from police, court and prison diversion programs, despite this having additional benefits for improving public safety (Saum & Hiller, 2008). As such, alternative strategies need to be put in place to support violent offenders, including those who use AAS.

Strengths and limitations of the meta-analysis

The main strength of the meta-analyses is its large number of participants, the varied nature of the participants, the different methods used to assess AAS use and interpersonal violence, and the different research teams doing the research.

The main limitation of this meta-analysis is that the correlational nature of the findings cannot support causal conclusions. In addition, the generally unknown reliability and validity of the measures used creates doubt about what was measured and how well. In addition, despite having conducted an extensive search, there most likely will be some studies missing from our meta-analysis. We also had to exclude 21 studies for various reasons (e.g. not having a control group, not separating for interpersonal violence). Although authors of these studies have been contacted for additional information, the vast majority did not respond to our request. There is also the issue that the included studies have their own methodological issues. For example, many of the included studies are limited by methodological issues such as low statistical power, not using validated instruments, and failure to control for other poly-drug use and other mediating factors. Another limitation is that the included studies generally did not account for the dosage and longevity of AAS use, or the type of AAS used. Future studies should take this into consideration when examining the link between AAS use and interpersonal violence. Finally, we would also like to note that in ten of the sixteen samples all or the majority of participants were male. Although the majority of AAS consumers are men, research is showing that AAS use and other enhancement drug use amongst women is a growing phenomenon but remains understudied (Fomiatti et al., 2023). This will therefore need to be considered in the interpretation of the findings.

Conclusion

Table 5 summarizes some of the implications of this review for practice, policy and future research. The findings of this meta-analysis are consistent with the view that violent behavior is more likely to be identified amongst those reporting the use of AAS, when compared to the general population, however this does not necessarily demonstrate causality. We currently do not know what the direction of this relationship is as the vast majority of the studies did not control for when AAS use occurred (before, during and/or after the violent act). Furthermore, there is limited evidence to AAS use leading to acute triggers of uncontrolled violence, as promulgated by sections of the news media, referred to as 'roid rage' (Mulrooney et al., 2019). When examining the link between AAS use and violent behavior, we need to carefully consider (1) the role of mediating factors (e.g. poly-drug use), and (2) that the relationship between the two could be part of a broader context (e.g. a risky lifestyle) as opposed to AAS use being a cause for interpersonal violence on its own. Future research should focus on examining violent behavior before and after a person starts using AAS, using assessment methods that have evidence of reliability and validity. This meta-analysis however forms an important foundation for addressing this issue and could be used in the development of educational and harm reduction messages around AAS use.

INSERT TABLE 5 HERE

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