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## Performance-Enhancing Substance Use and Sexual Risk Behaviors among U.S. Men: Results from a Prospective Cohort Study

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### Abstract

Performance-enhancing substance (PES) use is common among young men and prior research has documented cross-sectional associations between anabolic-androgenic steroid (AAS) use and sexual risk behaviors. However, this relationship remains understudied among a longitudinal cohort of young adult men, and research on prospective associations between legal PES (e.g., creatine) use and sexual risk behaviors is lacking. The current study addresses these oversights using data from the National Longitudinal Study of Adolescent to Adult Health (N=5,451). AAS use and legal PES use were assessed at Wave III (ages 18-26) and 10 indicators of sexual risk behavior were assessed at seven-year follow up (Wave IV; ages 24-32). Linear and logistic regression analyses were conducted adjusting for demographic and behavioral confounders. Participants who reported AAS use and legal PES use had significantly higher number of one-time sexual partners and higher odds of multiple sex partners around the same time in the past 12 months. Participants who reported AAS use had higher odds of any STI in the past 12 months. These results extend prior research on the risk behaviors and adverse effects of PES use. Health care professionals should assess for PES use among young adult men and provide guidance on healthful sexual behaviors.

### Keywords

steroids; creatine; men; sex; sex behaviors

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## Introduction

Performance-enhancing substances (PES) are commonly used among young men for the purpose of increasing muscle-mass, strength, and athletic performance. PES can include dietary supplements and substances that are sold legally “over the counter,” such as creatine monohydrate, and illegal substances, when not used for medical purposes, such as anabolic-androgenic steroids (AAS; Ganson et al., 2019; Nagata et al., 2019). Given the continued emphasis on the muscular body ideal for young men, it is not surprising that between 16-35% report use of legal PES and 3-5% report AAS use (Eisenberg et al., 2012; Nagata, Ganson, Griffiths, et al., 2020). Research focusing on PES use has detailed significant adverse health and social outcomes associated with use of both legal PES and AAS. Problematic alcohol use (Calzo et al., 2016; Ganson et al., 2020), severe medical events (e.g., hospital visits, disability), death (Or et al., 2019), and criminal offending (Ganson et al., 2021) have been shown to be associated with legal PES use, while mental health (e.g., mood disorders; Kanayama et al., 2008; Pope et al., 2014) and physiological health (Ahlgrim & Guglin, 2009; Bispo et al., 2009; Daly et al., 2003; Nikolopoulos et al., 2011) problems are associated with AAS use. Still, associations between PES use, particularly legal PES, and sexual risk behaviors are understudied.

To date, the few studies that have examined the associations between PES use and sexual risk behaviors have focused predominately on AAS users (Ip et al., 2016). This research emphasizes that AAS users may engage in sexual risk behaviors, including reporting a greater number of sexual partners and unprotected sex (Blashill et al., 2014; Goldman et al., 2019; Hope et al., 2013; Ip et al., 2019), which may explain the higher prevalence of sexually transmitted infections (STIs) among AAS users (Hope et al., 2013; Ip et al., 2016, 2019; Pope et al., 2014). However, much of the research that has investigated AAS use and sexual risk behaviors is limited to cross-sectional study designs and small sample sizes that are not representative of the U.S. population. Additionally, gaps remain in the knowledge base on whether legal PES use is associated with sexual risk behaviors, despite legal PES use occurring at a much higher prevalence compared to AAS use.

PES use and sexual risk behaviors among men could be connected via multiple mechanisms. Within the context of the muscular body ideal, men may experience benefits from presenting as more muscular. For example, there is evidence that muscularity is more attractive to potential partners (Frederick & Haselton, 2007; Gray & Frederick, 2012; Varangis et al., 2012). Relatedly, college-aged men frequently report wanting to be more muscular to be sexier (95%), more attractive (90%), and feel more masculine (74%; Frederick et al., 2007). This aligns with a second mechanism in that muscularity and masculinity ideology are linked among men (Frederick et al., 2017; Luciano, 2007); indeed, endorsement of masculine cultural norms, including attitudes about socially constructed normative sexual behavior (e.g., high risk sexual behavior, sexual conquests; Courtenay, 2000), is associated with AAS use (Kanayama et al., 2006). Finally, research has shown that AAS use can alter neurological structure (Hauger et al., 2019; Westlye et al., 2017). This includes areas of executive functioning (Hauger et al., 2020) and emotion regulation (Hauger et al., 2019), which may result in risk behaviors, including sexual behaviors. Relatedly, research among

rodents, a commonly used subject for identifying the effects of AAS use, has shown that adolescent exposure to AAS can alter brain development in ways that may increase sexual engagement (Cunningham et al., 2013).

The present study aims to quantify potential prospective associations between PES use, including both legal PES and AAS, and 10 indicators of sexual risk behavior. We hypothesize that AAS use and PES use will be associated with subsequent sexual risk behaviors over time.

## Methods

Prospective cohort data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) were analyzed. The baseline sample was recruited using systematic sampling methods and implicit stratification to ensure that the high schools (n=80) and middle schools (n=52) selected were representative of US schools with respect to region of country, urbanicity, size, type, and ethnicity. Participants were enrolled in grades 7-12 (ages 11-18) from public, private, and parochial schools in the United States during the 1994-1995 academic year. Since then, four follow-up interviews have been conducted. Written informed consent was obtained from the parent of the participant if they were under age 18 (with child assent), or from the participant if 18 or older. This study included male participants who completed interviews and had full data for all variables of interest at Wave I (1994-1995; ages 11-18), Wave III (2001-2002; ages 18-26) and Wave IV (2008-2009; ages 24-32; N=5,451; Harris, 2013; Harris et al., 2019). The University of North Carolina Institutional Review Board approved all Add Health study procedures.

## Measures

**Dependent Variables: Sexual Risk Behaviors at Ages 24-32 Years (Wave IV)—***Total number of sexual partners* was assessed using the question, “Considering all types of sexual activity, with how many male [or female] partners have you ever had sex?” Number of sexual partners was the sum of the total number of male and female partners (Nagata, Palar, et al., 2020; Tabler & Geist, 2016).

*Number of sexual partners in the past 12 months* was assessed using the question, “Considering all types of sexual activity, with how many male [or female] partners have you had sex in the past 12 months, even if only one time?”

*Number of one-time sexual partners* was assessed using the question, “Considering all types of sexual activity, with how many partners, male or female, have you had sex on one and only one occasion?” (Nagata, Palar, et al., 2020).

*Multiple sex partners around the same time in the past 12 months* was assessed using the question, “In the past 12 months, did you have sex with more than one partner at around the same time?” (0 = no; 1 = yes; Nagata, Palar, et al., 2020).

*STIs in the past 12 months* was assessed using the question, “In the past 12 months, have you been told by a doctor, nurse, or other health professional that you had the following sexually transmitted disease?” Positive responses to chlamydia, gonorrhea, trichomonas,

syphilis, herpes, human papillomavirus, human immunodeficiency virus (HIV), or other sexually transmitted diseases were coded as having any STI in the past 12 months. Due to the high prevalence in young adulthood (Kreisel, Spicknall, et al., 2021; Kreisel, Weston, et al., 2021), we also analyzed chlamydia, gonorrhea, and HIV individually.

*Exchanging sex for money in the past 12 months* was assessed using the question, “In the past 12 months, how many times have you paid someone to have sex with you or has someone paid you to have sex with them?” (0 = none; 1 = 1 time; Nagata, Palar, et al., 2020; Zeglin, 2014).

*Condom use in the past 12 months* was assessed using the question, “In the past 12 months, did you or your partner(s) use any of these methods for birth control or disease prevention: condoms (rubbers)?” Positive responses were coded as condom use present (Fergus et al., 2019; Nagata, Palar, et al., 2020) and were limited to sexually active participants.

**Independent Variables: Performance-Enhancing Substance Use at Ages 18-26 Years (Wave III)**—*Legal PES use* was assessed using the question, “In the past year, have you used a legal performance-enhancing substance for athletes (such as creatine monohydrate or andro)?” (0 = no; 1 = yes).

*AAS use* in the past seven years (since Wave I) was assessed using the question, “Since June 1995, have you taken any of the following drugs without a doctor’s permission: steroids or anabolic steroids?” (0 = no; 1 = yes).

**Confounding Variables**—Age, race/ethnicity, sexual orientation (Wave IV), household income (Wave I), body mass index (BMI; kg/m<sup>2</sup>, Wave III), alcohol use (< 2 days in the past month, yes/no, Wave III), and depression score (CED-S; Wave I) were based on self-report. Gaussian normal regression imputation models were used to impute income for 1,638 participants with missing income data at Wave I. These confounders were included in line with prior research (Eisenberg et al., 2012; Goldman et al., 2019; Hope et al., 2013; Ip et al., 2016, 2019; Kanayama et al., 2008; Nagata, Ganson, Griffiths, et al., 2020; Pope et al., 2014).

### Statistical Analysis

Descriptive statistics were conducted to characterize the sample using means and standard deviations (SD) and percentages. Differences between PES users and non-users were determined using chi-square tests for categorical variables and independent samples *t* tests for continuous variables. Linear regressions were used to determine the associations between AAS use and legal PES use as the independent variables and the discrete count measures of sexual risk behaviors (total number of sexual partners, number of sexual partners in the past 12 months, number of one-time sexual partners). Logistic regressions were used to determine the associations between AAS use and legal PES use as the independent variables and the dichotomous measures of sexual risk behaviors (multiple sex partners around the same time in the past 12 months, STIs in the past 12 months, exchanging sex for money in the past 12 months, condom use in the past 12 months). All regression analyses were adjusted for the previously described confounders (age, race/ethnicity, sexual orientation,

household income, BMI, alcohol use, and depression score), as well as the corresponding sexual risk behavior at Wave I (ages 11-18). All analyses utilized Add Health's nationally representative sample weights and were conducted in 2021 using Stata 16.1.

## Results

Among the diverse sample of 5,451 men, the mean age was 21.9 (standard deviation 1.9) years and 68.3% identified as White, 14.7% Black, 12.3% Hispanic/Latino, 3.3% Asian/Pacific Islander, 0.9% Other race/ethnicity, and 0.6% American Indian/Native American. A majority of men identified as Heterosexual (93.4%). More men reported legal PES use (15.9%) than AAS use (2.7%). Several significant differences in sexual risk behaviors between PES users and non-users were found. See Table 1 for full results.

Results from linear and logistic regression analyses revealed significant prospective associations between PES use at ages 18-26 years and sexual risk behaviors at ages 24-32 years while adjusting for potential confounders (Table 2). Participants who reported AAS use had significantly higher number of one-time sexual partners ( $B$  5.20, 95% confidence interval [CI] 1.73-8.66,  $p = 0.004$ ) and higher odds of multiple sex partners around the same time in the past 12 months (adjusted odds ratio [AOR] 1.95, 95% CI 1.17-3.24,  $p = 0.010$ ), any STI in the past 12 months (AOR 3.08, 95% CI 1.40-6.77,  $p = 0.006$ ), and chlamydia diagnosis in the past 12 months (AOR 4.39, 95% CI 1.37-14.08,  $p = 0.013$ ) while adjusting for potential confounders. Participants who reported legal PES use had significantly higher number of sexual partners in the past year ( $B$  0.36, 95% CI 0.05-0.66,  $p = 0.024$ ), higher number of one-time sexual partners ( $B$  2.48, 95% CI 1.09-3.88,  $p = 0.001$ ) and higher odds of multiple sex partners around the same time in the past 12 months (AOR 1.53, 95% CI 1.23-1.91,  $p < 0.001$ ) while adjusting for potential confounders.

## Discussion

This study is among the first to identify prospective associations between PES use, including both AAS use and legal PES use, and sexual risk behaviors among a nationally representative sample of young adult men in the U.S. We find that use of AAS is associated with a greater number of one-time sexual partners, as well as nearly two-fold, three-fold, and four-fold higher odds of reporting multiple sex partners around the same time, any STI diagnosis in the past 12 months, and chlamydia diagnosis in the past 12 months, respectively. Similarly, we find that legal PES use is associated with a greater number of sexual partners in the past 12 months and one-time sexual partners, as well as higher odds of reporting multiple sex partners around the same time. These findings are salient as they are independent of several known confounding factors, including prior engagement in sexual risk behaviors. Taken together, these results confirm the study hypothesis.

The findings from this study align with prior research showing that AAS use is associated with several sexual risk behaviors, including a higher prevalence of STIs (Hope et al., 2013; Ip et al., 2016, 2019; Pope et al., 2014). However, there were discrepant findings compared to prior research showing a greater number of sexual partners and higher prevalence of unprotected sex among AAS users (Blashill et al., 2014; Goldman et al., 2019; Hope et al.,

2013; Ip et al., 2019), which in part may be due to differences in measures and sample populations. Notwithstanding, it is likely that the associations between number of one-time sexual partners and multiple sexual partners around the same time explain the higher odds of STIs and chlamydia, as has been shown in prior research (Copen et al., 2019). Additionally, our results extend prior research by showing that legal PES use is associated with similar sexual risk behaviors, including number of sexual partners in the past year, number of one-time sexual partners, and multiple sexual partners around the same time. This is a novel finding that adds to a growing literature on the adverse effects of legal PES use (Calzo et al., 2016; Ganson et al., 2020; Nagata, Ganson, Gorrell, et al., 2020; Or et al., 2019), particularly among men, and indicates that further exploration of legal PES use is warranted.

The associations between both AAS use, legal PES use, and sexual risk behaviors likely have similar theoretical explanations grounded in the socially constructed norms of masculinity that emphasize toughness, dominance, and strength (Connell & Messerschmidt, 2005; Courtenay, 2000; Levant, 1996; Mahalik et al., 2003). The intended purpose of PES is to increase muscularity, which is seen as the ideal male body (Murray et al., 2017), and is associated with notions of strength, dominance, and confidence among both men and women (Frederick et al., 2007; Frederick & Haselton, 2007). Research has shown that men who are more muscular report a greater number of short-term and/or one-time sexual partners (Frederick & Haselton, 2007) and men whose masculinity is threatened, as described by precarious manhood (Vandello et al., 2008), often over-emphasize their strength (Frederick et al., 2017) and may engage in risky behaviors (e.g., sexual; Vandello & Bosson, 2013), indicating the overlap between muscularity and masculinity (Frederick et al., 2017; Luciano, 2007).

The associations between AAS use and sexual risk behaviors may also be explained by the neurological effects of AAS use, namely reduced capacity for executive functioning (Hauger et al., 2020) and emotion regulation (Hauger et al., 2019). In the context of sexual risk behaviors, number of one-time sexual partners and multiple sexual partners around the same time may be seen as mechanisms for emotion regulation and/or the effects of poor decision making and impulsivity. Additionally, there is evidence that legal PES can be contaminated with various substances, including steroids and stimulants (Abe et al., 2015; Cohen et al., 2018; Van Wagoner et al., 2017), which may impact behavioral functioning. Thus, future research on the neurological effects of legal PES is needed.

There are several strengths to be noted of this study, including the large, diverse, and nationally representative sample and the prospective cohort study design. However, there are also limitations to be noted. First, the use of retrospective self-report may increase reporting bias. Additionally, the terminology of the dependent variables broadly focuses on “all types of sexual activity.” Future research that includes questions asking about specific sexual behaviors, as well as nuanced details related to sexual behaviors (e.g., consistency of condom use), would be useful in capturing greater precision about engagement in an array of sexual behaviors. Second, there is the potential for unmeasured confounders that may influence the relationship between key variables; however, we adjusted for the corresponding sexual risk behavior at Wave I in our analyses. Third, the overall sample of men was primarily White and heterosexual. Given the continued diversification of the U.S.,



future research should aim to include participants that represent the changing demographics. Lastly, the legal PES use variable conflates several substances, which limits the ability to analyze the nuances of each substance as it relates to sexual risk behaviors.

## Conclusion

The results from this study show that both AAS use and legal PES use are prospectively associated with several key indicators of sexual risk behavior among U.S. young adult men. Health care professionals should assess for sexual risk behaviors among young adult men who report PES use and provide appropriate guidance as necessary. This includes education on the adverse correlates of PES use and healthful techniques to increase musculature and athletic performance, as well as information on safe sexual activity practices. Additionally, health care professionals should consider the influence of socially constructed norms of masculinity and pressures to adhere to the muscular male body ideal, which may underpin both PES use and sexual risk behaviors, when treating men. Public health prevention and intervention efforts should consider the impact of PES use on sexual risk behaviors and provide education and awareness campaigns targeted toward young adult men where use may be common (e.g., gyms and sports teams). Policymakers should consider strengthening regulation and oversight of PES, particularly legal PES, as has been proposed by multiple state legislatures across the U.S. (see for example Dietary Supplements for Weight Loss and Over-the-Counter Diet Pills, 2021; An Act Protecting Children from Harmful Diet Pills and Muscle-Building Supplements, 2021). Lastly, given the international use of PES (Sagoe et al., 2014, 2015; Sandvik et al., 2018; Tahtamouni et al., 2008; Tavares et al., 2020) country-specific health promotion initiatives should consider the findings of this study to promote the health and well-being of men globally.

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## Data Availability Statement:

Add Health data is available to researchers. Please visit <https://addhealth.cpc.unc.edu/> for more information.



## References

- Abe AM, Hein DJ, & Gregory PJ (2015). Regulatory alerts for dietary supplements in Canada and the United States, 2005-13. *American Journal of Health-System Pharmacy*, 72(11), 966–971. 10.2146/ajhp140574 [PubMed: 25987692]
- Ahlgrim C, & Guglin M (2009). Anabolics and cardiomyopathy in a bodybuilder: Case report and literature review. *Journal of Cardiac Failure*, 15(6), 496–500. 10.1016/j.cardfail.2008.12.014 [PubMed: 19643360]
- Bispo M, Valente A, Maldonado R, Palma R, Gloria H, Nóbrega J, & Alexandrino P (2009). Anabolic steroid-induced cardiomyopathy underlying acute liver failure in a young bodybuilder. *World Journal of Gastroenterology*, 15(23), 2920–2922. 10.3748/wjg.15.2920 [PubMed: 19533818]
- Blashill AJ, Gordon JR, & Safren SA (2014). Anabolic-androgenic steroids and condom use: Potential mechanisms in adolescent males. *Journal of Sex Research*, 51(6), 690–695. 10.1080/00224499.2013.766823 [PubMed: 23718635]
- Calzo JP, Horton NJ, Sonnevile KR, Swanson SA, Crosby RD, Micali N, Eddy KT, & Field AE (2016). Male eating disorder symptom patterns and health correlates from 13 to 26 years of age. *Journal of the American Academy of Child and Adolescent Psychiatry*, 55(8), 693–700.e2. 10.1016/j.jaac.2016.05.011 [PubMed: 27453083]
- Cohen PA, Travis JC, Keizers PHJ, Deuster P, & Venhuis BJ (2018). Four experimental stimulants found in sports and weight loss supplements: 2-amino-6-methylheptane (octodrine), 1,4-dimethylamylamine (1,4-DMAA), 1,3-dimethylamylamine (1,3-DMAA) and 1,3-dimethylbutylamine (1,3-DMBA). *Clinical Toxicology*, 56(6), 421–426. 10.1080/15563650.2017.1398328 [PubMed: 29115866]
- Connell RW, & Messerschmidt JW (2005). Hegemonic masculinity rethinking the concept. *Gender and Society*, 19(6), 829–859. 10.1177/0891243205278639
- Copen CE, Leichter JS, Spicknall IH, & Aral SO (2019). Sexually transmitted infection risk reduction strategies among US adolescents and adults with multiple opposite-sex sex partners or perceived partner nonmonogamy, 2011–2017. *Sexually Transmitted Diseases*, 46(11), 722–727. 10.1097/OLQ.0000000000001067 [PubMed: 31644500]
- Courtenay WH (2000). Constructions of masculinity and their influence on men's well-being: A theory of gender and health. *Social Science & Medicine*, 50(10), 1385–1401. 10.1016/S0277-9536(99)00390-1 [PubMed: 10741575]
- Cunningham RL, Lumia AR, & McGinnis MY (2013). Androgenic anabolic steroid exposure during adolescence: Ramifications for brain development and behavior. *Hormones and Behavior*, 64(2), 350–356. 10.1016/j.yhbeh.2012.12.009 [PubMed: 23274699]
- Daly RC, Su TP, Schmidt PJ, Pagliaro M, Pickar D, & Rubinow DR (2003). Neuroendocrine and behavioral effects of high-dose anabolic steroid administration in male normal volunteers. *Psychoneuroendocrinology*, 28(3), 317–331. 10.1016/S0306-4530(02)00025-2 [PubMed: 12573299]
- Eisenberg ME, Wall M, & Neumark-Sztainer D (2012). Muscle-enhancing behaviors among adolescent girls and boys. *Pediatrics*, 130(6), 1019–1026. 10.1542/peds.2012-0095 [PubMed: 23166333]
- Fergus KB, Copp HL, Tabler JL, & Nagata JM (2019). Eating disorders and disordered eating behaviors among women: Associations with sexual risk. *International Journal of Eating Disorders*, 52(11), 1310–1315. 10.1002/eat.23132 [PubMed: 31267548]
- Frederick DA, Buchanan GM, Sadehgi-Azar L, Peplau LA, Haselton MG, Berezovskaya A, & Lipinski RE (2007). Desiring the muscular ideal: Men's body satisfaction in the United States, Ukraine, and Ghana. *Psychology of Men and Masculinity*, 8(2), 103–117. 10.1037/1524-9220.8.2.103
- Frederick DA, & Haselton MG (2007). Why is muscularity sexy? Tests of the fitness indicator hypothesis. *Personality and Social Psychology Bulletin*, 33(8), 1167–1183. 10.1177/0146167207303022 [PubMed: 17578932]
- Frederick DA, Shapiro LM, Williams TR, Seoane CM, McIntosh RT, & Fischer EW (2017). Precarious manhood and muscularity: Effects of threatening men's masculinity on reported

strength and muscle dissatisfaction. *Body Image*, 22, 156–165. 10.1016/j.bodyim.2017.07.002 [PubMed: 28802199]

- Ganson KT, Mitchison D, Murray SB, & Nagata JM (2020). Legal performance-enhancing substances and substance use problems among young adults. *Pediatrics*, 146(3), e20200409. 10.1542/peds.2020-0409 [PubMed: 32868471]
- Ganson KT, Murray SB, & Nagata JM (2019). A call for public policy and research to reduce use of appearance and performance enhancing drugs and substances among adolescents. *The Lancet Child & Adolescent Health*. [https://doi.org/10.1016/S2352-4642\(19\)30345-1](https://doi.org/10.1016/S2352-4642(19)30345-1)
- Ganson KT, Testa A, Jackson DB, & Nagata JM (2021). Performance-enhancing substance use and criminal offending: A 15-year prospective cohort study. *Drug and Alcohol Dependence*, 226(June), 108832. 10.1016/j.drugalcdep.2021.108832 [PubMed: 34186290]
- Goldman AL, Pope HG, & Bhasin S (2019). The health threat posed by the hidden epidemic of anabolic steroid use and body image disorders among young men. *Journal of Clinical Endocrinology and Metabolism*, 104(4), 1069–1074. 10.1210/jc.2018-01706 [PubMed: 30239802]
- Gray PB, & Frederick DA (2012). Body image and body type preferences in St. Kitts, Caribbean: A cross-cultural comparison with U.S. samples regarding attitudes towards muscularity, body fat, and breast size. *Evolutionary Psychology*, 10(3), 631–655. 10.1177/147470491201000319 [PubMed: 22995446]
- Harris KM (2013). *The Add Health study: Design and accomplishments*. Carolina Population Center.
- Harris Kathleen Mullan, Halpern CT, Whitsel EA, Hussey JM, Killeya-Jones LA, Tabor J, & Dean SC (2019). Cohort profile: The national longitudinal study of adolescent to adult health (Add Health). *International Journal of Epidemiology*, 48(5), 1415–1415K. 10.1093/ije/dyz115 [PubMed: 31257425]
- Hauger LE, Westlye LT, & Bjørnebekk A (2020). Anabolic androgenic steroid dependence is associated with executive dysfunction. *Drug and Alcohol Dependence*, 208(October 2019), 107874. 10.1016/j.drugalcdep.2020.107874 [PubMed: 31972519]
- Hauger LE, Westlye LT, Fjell AM, Walhovd KB, & Bjørnebekk A (2019). Structural brain characteristics of anabolic-androgenic steroid dependence in men. *Addiction*, 114(8), 1405–1415. 10.1111/add.14629 [PubMed: 30955206]
- Hope VD, McVeigh J, Marongiu A, Evans-Brown M, Smith J, Kimergård A, Croxford S, Beynon CM, Parry JV, Al Bellis M, & 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), 1–11. 10.1136/bmjopen-2013-003207
- Ip EJ, Doroudgar S, Shah-Manek B, Barnett MJ, Tenerowicz MJ, Ortanez M, & Pope HG (2019). The CASTRO study: Unsafe sexual behaviors and illicit drug use among gay and bisexual men who use anabolic steroids. *American Journal on Addictions*, 28(2), 101–110. 10.1111/ajad.12865 [PubMed: 30724428]
- Ip EJ, Yadao MA, Shah BM, & Lau B (2016). Infectious disease, injection practices, and risky sexual behavior among anabolic steroid users. *AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV*, 28(3), 294–299. 10.1080/09540121.2015.1090539
- Kanayama G, Barry S, Hudson JI, & Pope HG (2006). Body image and attitudes toward male roles in anabolic-androgenic steroid users. *American Journal of Psychiatry*, 163(4), 697–703. 10.1176/ajp.2006.163.4.697 [PubMed: 16585446]
- Kanayama G, Hudson JI, & Pope HG (2008). Long-term psychiatric and medical consequences of anabolic-androgenic steroid abuse: A looming public health concern? *Drug and Alcohol Dependence*, 98(1–2), 1–12. 10.1016/j.drugalcdep.2008.05.004 [PubMed: 18599224]
- Kreisel KM, Spicknall IH, Gargano JW, Lewis FMT, Lewis RM, Markowitz LE, Roberts H, Johnson AS, Song R, St Cyr SB, Weston EJ, Torrone EA, & Weinstock HS (2021). Sexually transmitted infections among US women and men: Prevalence and incidence estimates, 2018. *Sexually Transmitted Diseases*, 48(4), 208–214. 10.1097/OLQ.0000000000001355 [PubMed: 33492089]
- Kreisel KM, Weston EJ, St Cyr SB, & Spicknall IH (2021). Estimates of the prevalence and incidence of chlamydia and gonorrhea among US men and women, 2018. *Sexually Transmitted Diseases*, 48(4), 222–231. 10.1097/OLQ.0000000000001382 [PubMed: 33492094]

- Levant RF (1996). The new psychology of men. *Professional Psychology: Research and Practice*, 27(3), 259–265. 10.1037/0735-7028.27.3.259
- Luciano L (2007). Muscularity and masculinity in the United States: A historical overview. In *The muscular ideal: Psychological, social, and medical perspectives*. (pp. 41–65). American Psychological Association. 10.1037/11581-002
- Mahalik JR, Locke BD, Ludlow LH, Diemer MA, Scott RPJ, Gottfried M, & Freitas G (2003). Development of the Conformity to Masculine Norms Inventory. *Psychology of Men & Masculinity*, 4(1), 3–25. 10.1037/1524-9220.4.1.3
- Murray SB, Nagata JM, Griffiths S, Calzo JP, Brown TA, Mitchison D, Blashill AJ, & Mond JM (2017). The enigma of male eating disorders: A critical review and synthesis. *Clinical Psychology Review*, 57(August), 1–11. 10.1016/j.cpr.2017.08.001 [PubMed: 28800416]
- Nagata JM, Brown TA, Lavender JM, & Murray SB (2019). Emerging trends in eating disorders among adolescent boys: Muscles, macronutrients, and biohacking. *The Lancet Child & Adolescent Health*, 4642(19), 19–20. 10.1016/S2352-4642(19)30147-6
- Nagata JM, Ganson KT, Gorrell S, Mitchison D, & Murray SB (2020). Association between legal performance-enhancing substances and use of anabolic-androgenic steroids in young adults. *JAMA Pediatrics*, E1–E2. 10.1001/jamapediatrics.2020.0883
- Nagata JM, Ganson KT, Griffiths S, Mitchison D, Garber AK, Vittinghoff E, Bibbins-Domingo K, & Murray SB (2020). Prevalence and correlates of muscle-enhancing behaviors among adolescents and young adults in the United States. *International Journal of Adolescent Medicine and Health*. <https://doi.org/10.1515/ijamh-2020-0001>
- Nagata JM, Palar K, Gooding HC, Garber AK, Tabler JL, Whittle HJ, Bibbins-Domingo K, & Weiser SD (2020). Food insecurity, sexual risk, and substance use in young adults. *Journal of Adolescent Health*. 10.1016/j.jadohealth.2020.05.038
- Nikolopoulos DD, Spiliopoulou C, & Theocharis SE (2011). Doping and musculoskeletal system: Short-term and long-lasting effects of doping agents. *Fundamental and Clinical Pharmacology*, 25(5), 535–563. 10.1111/j.1472-8206.2010.00881.x [PubMed: 21039821]
- Or F, Kim Y, Simms J, & Austin SB (2019). Taking stock of dietary supplements' harmful effects on children, adolescents, and young adults. *Journal of Adolescent Health*, 1–7. 10.1016/j.jadohealth.2019.03.005
- Pope HG, Wood RI, Rogol A, Nyberg F, Bowers L, & Bhasin S (2014). Adverse health consequences of performance-enhancing drugs: An endocrine society scientific statement. *Endocrine Reviews*, 35(3), 341–375. 10.1210/er.2013-1058 [PubMed: 24423981]
- Sagoe D, Molde H, Andreassen CS, Torsheim T, & Pallesen S (2014). The global epidemiology of anabolic-androgenic steroid use: A meta-analysis and meta-regression analysis. *Annals of Epidemiology*, 24(5), 383–398. 10.1016/j.annepidem.2014.01.009 [PubMed: 24582699]
- Sagoe D, Torsheim T, Molde H, Andreassen CS, & Pallesen S (2015). Attitudes towards use of anabolic-androgenic steroids among Ghanaian high school students. *International Journal of Drug Policy*, 26(2), 169–174. 10.1016/j.drugpo.2014.10.004 [PubMed: 25465347]
- Sandvik MR, Bakken A, & Loland S (2018). Anabolic–androgenic steroid use and correlates in Norwegian adolescents. *European Journal of Sport Science*, 18(6), 903–910. 10.1080/17461391.2018.1459869 [PubMed: 29635967]
- Dietary supplements for weight loss and over-the-counter diet pills, Pub. L. No. Assembly Bill No. 3041 (2021). [https://leginfo.ca.gov/faces/billNavClient.xhtml?bill\\_id=202120220AB1341](https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1341)
- Tabler J, & Geist C (2016). Young women with eating disorders or disordered eating behaviors. *Socius: Sociological Research for a Dynamic World*, 2, 237802311664870. 10.1177/2378023116648706
- Tahtamouni LH, Mustafa NH, Alfaouri AA, Hassan IM, Abdalla MY, & Yasin SR (2008). Prevalence and risk factors for anabolic-androgenic steroid abuse among Jordanian collegiate students and athletes. *European Journal of Public Health*, 18(6), 661–665. 10.1093/eurpub/ckn062 [PubMed: 18603598]

- Tavares ASR, Serpa S, Horta L, Carolino E, & Rosado A (2020). Prevalence of performance-enhancing substance use and associated factors among Portuguese gym/fitness users. *Substance Use and Misuse*, 55(7), 1059–1067. 10.1080/10826084.2020.1726392 [PubMed: 32068479]
- An act protecting children from harmful diet pills and muscle-building supplements, Pub. L. No. Bill H. 2331 (2021). <https://malegislature.gov/Bills/192/HD1309>
- Van Wagoner RM, Eichner A, Bhasin S, Deuster PA, & Eichner D (2017). Chemical composition and labeling of substances marketed as selective androgen receptor modulators and sold via the internet. *JAMA - Journal of the American Medical Association*, 318(20), 2004–2010. 10.1001/jama.2017.17069 [PubMed: 29183075]
- Vandello JA, & Bosson JK (2013). Hard won and easily lost: A review and synthesis of theory and research on precarious manhood. *Psychology of Men and Masculinity*, 14(2), 101–113. 10.1037/a0029826
- Vandello JA, Bosson JK, Cohen D, Burnaford RM, & Weaver JR (2008). Precarious manhood. *Journal of Personality and Social Psychology*, 95(6), 1325–1339. 10.1037/a0012453 [PubMed: 19025286]
- Varangis E, Lanzieri N, Hildebrandt T, & Feldman M (2012). Gay male attraction toward muscular men: Does mating context matter? *Body Image*, 9(2), 270–278. 10.1016/j.bodyim.2012.01.003 [PubMed: 22342537]
- Westlye LT, Kaufmann T, Alnæs D, Hullstein IR, & Bjørnebekk A (2017). Brain connectivity aberrations in anabolic-androgenic steroid users. *NeuroImage: Clinical*, 13, 62–69. 10.1016/j.nicl.2016.11.014 [PubMed: 27942448]
- Zeglin RJ (2014). Participation in prostitution: Associated outcomes within familial relationships. *Sexuality Research and Social Policy*, 11(1), 50–62. 10.1007/s13178-013-0143-4

Characteristics of 5,451 men from the National Longitudinal Study of Adolescent to Adults Health, by performance-enhancing substance (PES) use

Table 1.

	No AAS Use n=5,306	AAS Use n=145	No legal PES Use n=4,583	Legal PES Use n=868
	M (SD) / %	M (SD) / %	M (SD) / %	M (SD) / %
			P	P
Demographics				
Age	21.9 (1.9)	21.8 (1.9)	21.9 (1.9)	21.8 (1.8)
Race/Ethnicity			0.371	<b>0.001</b>
White	68.0%	78.7%	66.5%	77.8%
Latino	12.3%	12.8%	12.8%	9.6%
Black	14.9%	8.0%	15.8%	8.8%
American Indian	0.6%	0.0%	0.6%	0.5%
Asian/Pacific Islander	3.3%	0.5%	3.4%	2.4%
Other race/ethnicity	0.9%	0.0%	0.9%	1.0%
Sexual orientation (Wave IV; aged 24-32 years)			0.806	0.157
Heterosexual	93.5%	93.1%	93.1%	95.5%
Mostly heterosexual	3.4%	2.9%	3.6%	2.4%
Gay, bisexual, or asexual	3.1%	4.0%	3.3%	2.1%
Household income, thousands of dollars (Wave I; aged 11-18 years)	45.5 (39.5)	46.7 (31.9)	44.2 (36.7)	52.6 (36.2)
Body mass index, kg/m <sup>2</sup> (Wave III; aged 18-26 years)	26.4 (5.9)	27.7 (5.7)	26.5 (6.0)	26.3 (5.1)
Alcohol use, 2 days past 30 days (Wave III; aged 18-26 years)	54.8%	56.8%	51.9%	70.2%
Depression score, CED-S (Wave I, aged 11-18)	10.0 (6.7)	9.8 (6.3)	10.2 (6.7)	9.0 (6.3)
Sexual Risk Behaviors (Wave IV; aged 24-32 years)				
Total number of sexual partners	14.4 (28.9)	20.7 (37.5)	13.9 (28.6)	18.5 (31.9)
Number of sexual partners, past 12 months	1.8 (3.1)	2.4 (5.0)	1.8 (3.1)	2.1 (3.5)
Number of one-time sexual partners	5.0 (13.7)	10.3 (20.5)	4.7 (11.9)	7.5 (21.7)
Multiple sex partners around the same time, past 12 months	16.5%	27.1%	15.9%	21.5%
Any sexually transmitted infection, past 12 months <sup>a</sup>	4.7%	11.8%	4.7%	5.9%
Chlamydia, past 12 months	1.6%	5.1%	1.7%	1.5%
Gonorrhea, past 12 months	0.70	1.7%	0.7%	1.0%
HIV, past 12 months	0.001%	0.0%	0.001%	0.001%

	No AAS Use n=5,306		AAS Use n=145		No legal PES Use n=4,583		Legal PES Use n=868	
	M (SD) / %	M (SD) / %	M (SD) / %	P	M (SD) / %	M (SD) / %	P	
Exchanging sex for money, past 12 months	3.0	4.9%	0.241	0.241	3.0	3.3%	0.764	
Condom use, past 12 months <sup>b</sup>	59.8%	53.6%	0.221	0.221	60.2%	57.1%	0.219	

Note: All means and percentages are calculated with weighted data to reflect the representative proportion in the target U.S. population.

**Boldface** indicates statistical significance  $P < 0.05$ .

Differences between PES users and non-users was determined using chi-square tests for categorical variables and independent samples *t* tests for continuous variables.

<sup>a</sup>Includes chlamydia, gonorrhea, syphilis, HIV, herpes, trichomonas, and human papillomavirus

<sup>b</sup>Among sexually active participants

**Table 2**

Associations between performance-enhancing substance (PES) use at Wave III (aged 18-26 years) and sexual risk behaviors at Wave IV (aged 24-32 years) among men from the National Longitudinal Study of Adolescent to Adults Health (N=5,451)

	AAS Use		Legal PES Use	
	Coef. <sup>a</sup> (95% CI)	P	Coef. <sup>a</sup> (95% CI)	P
Total number of sexual partners	-0.51 (-7.00-5.99)	0.876	0.99 (-1.46-3.43)	0.426
Number of sexual partners, past 12 months	0.68 (-0.34-1.60)	0.145	<b>0.36 (0.05-0.66)</b>	<b>0.024</b>
Number of one-time sexual partners	<b>5.20 (1.73-8.66)</b>	<b>0.004</b>	<b>2.48 (1.09-3.88)</b>	<b>0.001</b>
	AAS Use		Legal PES Use	
	AOR <sup>a</sup> (95% CI)	P	AOR <sup>a</sup> (95% CI)	P
Multiple sex partners around the same time, past 12 months	<b>1.95 (1.17-3.24)</b>	<b>0.010</b>	<b>1.53 (1.23-1.91)</b>	< <b>0.001</b>
Any sexually transmitted infection, past 12 months <sup>b</sup>	<b>3.08 (1.40-6.77)</b>	<b>0.006</b>	1.43 (0.88-2.34)	0.150
Chlamydia, past 12 months	<b>4.39 (1.37-14.08)</b>	<b>0.013</b>	1.17 (0.50-2.75)	0.718
Gonorrhea, past 12 months	4.11 (0.94-18.05)	0.061	2.16 (0.86-5.44)	0.102
HIV, past 12 months		-	1.46 (0.20-10.79)	0.711
Exchanging sex for money, past 12 months	1.84 (0.77-4.40)	0.171	1.29 (0.64-2.61)	0.477
Condom use, past 12 months <sup>c</sup>	0.84 (0.55-1.30)	0.441	0.91 (0.73-1.13)	0.384

Note: All effect sizes are calculated with weighted data to reflect the representative proportion in the target U.S. population.

**Boldface** indicates statistical significance  $P < 0.05$ .

<sup>a</sup> Adjusted for age, race/ethnicity, sexual orientation (Wave IV), household income (Wave I), body mass index (Wave III), alcohol use (Wave III), depression (Wave I), and the corresponding sexual behavior at Wave 1.

<sup>b</sup> Includes chlamydia, gonorrhea, syphilis, HIV, herpes, trichomonas, and human papillomavirus.

<sup>c</sup> Among sexually active participants.