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**Appearance and performance-enhancing drugs and supplements (APEDS): Lifetime use and associations with eating disorder and muscle dysmorphia symptoms among cisgender sexual minority people**

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## **Abstract**

**Purpose:** Appearance and performance-enhancing drugs and supplements (APEDS) are used to enhance muscle growth, athletic performance, and physical appearance. The aim of this study was to examine the lifetime use of APEDS and associations with eating disorder and muscle dysmorphia symptoms among cisgender sexual minority people.

**Methods:** Participants were cisgender sexual minority people (1,090 gay men, 100 bisexual plus men, 564 lesbian women, and 507 bisexual plus women) recruited from The PRIDE Study in 2018 who reported lifetime APEDS use and completed the Eating Disorder Examination-Questionnaire (EDE-Q) and the Muscle Dysmorphic Disorder Inventory (MDDI). Regression analyses stratified by gender and sexual orientation examined associations of any APEDS use with EDE-Q and MDDI scores.

**Results:** Lifetime APEDS use was common across four groups of cisgender sexual minority people (44% of gay men, 42% of bisexual plus men, 29% of lesbian women, and 30% of bisexual plus women). Protein supplements and creatine supplements were the most commonly used APEDS. Any APEDS use was associated with higher EDE-Q scores on one or more subscales in all sexual minority groups. Further, any APEDS use was associated with higher MDDI Total Scores in all groups; any APEDS use was associated with all MDDI subscale scores in cisgender gay men only.

**Discussion:** APEDS use is common and associated with eating disorder and muscle dysmorphia symptoms in sexual minority men and women, thus highlighting the importance of assessing for these behaviors and symptoms among these populations in clinical settings.

**Keywords:** LGBTQ, steroids, creatine, protein, supplements, eating disorder

## 1. Introduction

Appearance and performance-enhancing drugs and supplements (APEDS) are a class of substances used to improve muscle growth, athletic performance, and/or physical appearance (Hildebrandt et al., 2007, 2011). Such substances are either legal (e.g., protein supplements and creatine supplements) or illicit (e.g., anabolic-androgenic steroids not prescribed for medical purposes) across national contexts, including in the United States (US), Canada, and Australia (Australian Criminal Intelligence Commission, 2017; Controlled Drugs and Substances Act, 1996; Anabolic Steroids Control Act, 1990). The use or misuse of various APEDS has been linked to serious medical complications including increased risk of death and adverse cardiovascular, endocrine, hepatic, and renal outcomes (Or et al., 2019; Pope et al., 2014). Further, APEDS use has been associated with various psychological and behavioral concerns, including body shame, eating disorder (ED) symptoms, sexual risk behaviors, and alcohol use (Bolding et al., 2002; Castro et al., 2019; Nagata, Peebles, et al., 2020; Strübel & Petrie, 2019). Stemming from societal pressures to achieve a lean and muscular body ideal (Griffiths et al., 2013), APEDS use and related muscularity-oriented behaviors are more common among men than women (Nagata et al., 2019; Nagata, Peebles, et al., 2020). However, the sociocultural body ideal for women increasingly emphasizes toned muscularity and a ‘fit’ body (Girard et al., 2018). While some APEDS may be used to reduce weight or body fat (e.g., fat-burning substances, diet pills), the current study focuses on muscularity-oriented APEDS.

With parallel findings indicating elevated disordered eating and body image concerns (Diemer et al., 2015; Kamody et al., 2020; Nagata, Ganson, & Austin, 2020; Parmar et al., 2021), cisgender (i.e., gender aligning with sex assigned at birth) sexual minorities (i.e., non-heterosexual people, based on identity, attractions, and/or sex/gender of partners) may face heightened risk for APEDS use. In the minority stress theory (Meyer, 2003), sexual minority people disproportionately experience social stressors related to their minority status (e.g., discrimination, victimization) that may explain disparities in health behaviors and outcomes. Emerging evidence supports this theory in relation to APEDS use. Victimization experiences were uniquely associated with anabolic-androgenic steroid use among adolescent sexual minority boys (Blashill & Safren, 2014), and internalized homophobia, sexual orientation concealment, and heterosexist discrimination were independently associated with APEDS use in cisgender sexual minority young adults (Convertino et al., 2021). Other psychosocial and behavioral factors also may contribute to elevated risk for APEDS use among sexual minority people (Blashill et al., 2015; Bolding et al., 2002; Ip et al., 2019).

Although not universally consistent (e.g., Strübel & Petrie, 2019), evidence suggests elevated muscularity-oriented behaviors among cisgender sexual minority (relative to cisgender heterosexual) boys and men, including anabolic-androgenic steroid use (Blashill & Safren, 2014; Calzo et al., 2019; Ganson & Cadet, 2019; Mor et al., 2014), drive for muscularity (Mor et al., 2014), and protein supplement use (Mor et al., 2014). In contrast, limited research on sexual minority girls and women suggests no significant sexual orientation disparities in anabolic-androgenic steroid use or other muscularity-oriented behaviors (Calzo et al., 2019; Nagata et al., 2019). However, a recent study found positive associations between drive for muscularity and APEDS use among sexual minority men and women (Klimek et al., 2021).

The extent of APEDS use among cisgender bisexual plus individuals (i.e., those with bisexual, pansexual, or polysexual identities) is unclear, as these individuals are often either excluded from analysis (e.g., Bolding et al., 2002) or combined with gay men or lesbian women to form a single sexual minority category (e.g., Blashill & Safren, 2014; Calzo et al., 2016). This is of concern given unique stressors (e.g., biphobia) and elevated experiences of other factors (e.g., sexual identity concealment) faced by bisexual plus communities (Friedman et al., 2014; Mohr et al., 2017; Roberts et al., 2015). After adjusting for asthma (for which steroids may be prescribed), bisexual boys (12.4%) and boys unsure of their sexual orientation (10.7%) were more likely to report steroid use compared to heterosexual boys (2.3%); there were no significant differences for bisexual girls (4.7%) and girls unsure of their sexual orientation (2.8%) compared to heterosexual girls (1.5%) (Calzo et al., 2019).

There remain critical gaps in our understanding of the nature of APEDS use and associations with theoretically salient variables such as ED and muscle dysmorphia (MD) symptoms across different sexual minority populations (American Psychiatric Association, 2013). Gay and bisexual men who reported (versus denied) using anabolic-androgenic steroids showed greater ED symptoms (Griffiths et al., 2017), and another study, using a mixed sample of gay and heterosexual men (presumably primarily cisgender), found that APEDS use was associated with greater MD symptoms (Strübel & Petrie, 2019). Although lifetime APEDS use and disordered eating behaviors were found to be associated among college women, sexual orientation was not assessed (Nagata, Peebles, et al., 2020), and literature involving samples of cisgender sexual minority women is lacking. In one study, cisgender sexual minority women had greater ED symptoms, a lower drive for muscularity, and a lower proportion reporting APEDS

use versus cisgender sexual minority men; however, associations of APEDS use with ED symptoms and MD symptoms were not assessed (Gonzales & Blashill, 2021).

Many studies on APEDS use among sexual minorities have utilized specialized samples, such as gym attendees (Bolding et al., 1999, 2002; Ip et al., 2017; Ip et al., 2019; Mor et al., 2014) or dating application users (Brady et al., 2019; Griffiths et al., 2017). Prior findings have been based on samples of younger age cohorts, including high school (Blashill & Safren, 2014; Calzo et al., 2019; Ganson & Cadet, 2019; Nagata et al., 2019; Parent & Bradstreet, 2018) or university (Strübel & Petrie, 2019) students. As such, we must improve our understanding of APEDS use among cisgender sexual minorities of all ages. This is critical for public health surveillance and the development of clinical interventions tailored to meet unique needs of diverse populations. The purpose of this study was to characterize lifetime APEDS use and associations with ED and MD symptoms among four groups of cisgender sexual minority adults: gay men, bisexual plus men, lesbian women, and bisexual plus women. We hypothesized that any lifetime APEDS use would be positively associated with ED symptoms and MD symptoms across these sexual minority groups.

## **2. Methods**

### **2.1. Study Population**

The Population Research in Identity and Disparities for Equality (PRIDE) Study is a large-scale, national (US), longitudinal cohort study of sexual and/or gender minority adults which include, but are not limited to, people who identify as lesbian, gay, bisexual, transgender, and/or queer (LGBTQ). Specific inclusion criteria were: age  $\geq 18$  years, living in the US or its territories, and ability to read and respond to questionnaires in English. Additional details about The PRIDE Study recruitment, research platform, and design are described elsewhere (Lunn,

Lubensky et al., 2019; Lunn, Capriotti et al., 2019). All participants of The PRIDE Study were invited to complete the ‘Eating and Body Image’ survey between April 2018 and August 2018.

For this analysis, we included cisgender gay men, cisgender bisexual plus men, cisgender lesbian women, and cisgender bisexual plus women. We excluded individuals with non-binary or transgender gender identities as these populations are distinct and heterogeneous from sexual minorities and warrant their own separate study. Participants were asked about their current gender identity (with the option to indicate more than one), the sex assigned to them at birth (“What sex were you assigned at birth on your original birth certificate?”), and their sexual orientation (“What is your current sexual orientation?”), with the option to indicate more than one. Supplemental Table 1 describes classification rules applied to form the final samples. Of the 4,285 participants who completed the ‘Eating and Body Image’ survey, the final sample included 2,260 participants who were classified as cisgender gay men (n=1,090), cisgender bisexual plus men (n=100), cisgender lesbian women (n=564), and cisgender bisexual plus women (n=507).

This study was approved by the University of California, San Francisco and Stanford University Institutional Review Boards, as well as The PRIDE Study’s Research Advisory Committee and Participant Advisory Committee. Participants provided written informed consent, and there was no compensation for survey completion.

## **2.2. Measures**

See Table 1 for a description of the measures.

## **2.3. Data Analysis**

Analyses were conducted in Stata 15.1 (StataCorp, College Station, TX). Summary statistics and regression models were stratified by cisgender sexual minority group (gay men, bisexual plus men, lesbian women, bisexual plus women). Comparisons of APEDS use by gender (cisgender gay and bisexual plus men vs. cisgender lesbian and bisexual plus women) were calculated using Pearson's chi-square tests. Multiple linear regression analyses were used to examine associations of any lifetime APEDS use with EDE-Q and MDDI scores. Multiple logistic regression analyses were used to examine associations of any lifetime APEDS use with the dichotomized (absent/present) ED behaviors. Additional regression analyses were conducted to examine associations between protein use and, separately, creatine use with MDDI scores, EDE-Q scores, and ED behaviors in all four samples. The same analyses were conducted for androgenic-anabolic steroids and synthetic muscle enhancers except in samples where regressions could not be conducted as no participants reported use. All models adjusted for BMI, race/ethnicity, age, and educational attainment. Assumptions of linear and logistic regression were checked; in logistic regression models, BMI was log transformed to meet the linearity assumption. Statistical significance was evaluated after employing the Benjamini-Hochberg correction.

### 3. Results

Table 2 reports sociodemographic characteristics by sexual minority group. Any lifetime APEDS use was common among cisgender gay men (43.9%), cisgender bisexual plus men (42.0%), cisgender lesbian women (29.1%), and cisgender bisexual plus women (29.8%). Protein and creatine supplements were the most used APEDS across groups. Small proportions of cisgender gay men reported use of anabolic-androgenic steroids (2.9%) and synthetic muscle

enhancers (2.0%), whereas use of these substances was rarer or absent in the other groups.

Cisgender gay and bisexual plus men reported greater lifetime APEDS use (any and each type) than cisgender lesbian and bisexual plus women ( $ps < 0.001$ ).

Table 3 shows associations between any lifetime APEDS use and current ED symptoms and MD symptoms. Among cisgender gay men, any lifetime APEDS use was significantly associated with higher scores on all of the four EDE-Q subscales, as well as with greater odds of binge eating and compelled/driven exercise. For cisgender bisexual plus men, any lifetime APEDS use was significantly associated with higher EDE-Q Weight & Shape Concern scores, as well as with greater odds of binge eating. Among cisgender lesbian women, any lifetime APEDS use was significantly associated only with a higher EDE-Q Dietary Restraint score and higher odds of driven/compelled exercise. Finally, for cisgender bisexual plus women any lifetime APEDS use was significantly associated with higher EDE-Q Weight & Shape Concern, Dietary Restraint, and Eating Shame subscales as well as with greater odds of binge eating and compelled/driven exercise.

Regarding MD symptoms, among cisgender gay men, any lifetime APEDS use was significantly associated with higher MDDI Total and all subscale scores. For cisgender bisexual plus men, any lifetime APEDS use was significantly associated only with higher MDDI Total and Drive for Size scores. Among cisgender lesbian women, any lifetime APEDS use was significantly associated only with higher MDDI Total and Functional Impairment scores. Finally, for cisgender bisexual plus women, any lifetime APEDS use was significantly associated with higher MDDI Total, Functional Impairment, and Appearance Intolerance subscale scores.

Supplemental Tables 2-4 present parallel regression results for models examining each of the four types of APEDS separately. Among cisgender gay men, protein and creatine use was

associated with higher MDDI (Total and all subscales) and most EDE-Q subscale scores.

Anabolic-androgenic steroid and synthetic performance-enhancing substance use was associated with higher MDDI Total and Drive for Size scores, while synthetic performance-enhancing substances was associated with higher Functional Impairment score. Among cisgender bisexual plus men, protein use was associated with higher EDE-Q Weight and Shape Concern, and higher MDDI Total and Drive for Size scores. Creatine use was associated with higher MDDI Drive for Size score. Among cisgender lesbian women, protein use was associated with higher EDE-Q Dietary Restraint score. Protein and creatine use was associated with higher MDDI Total and Functional Impairment scores. Among cisgender bisexual plus women, protein and synthetic performance-enhancing substance use was associated with most MDDI and EDE-Q subscales.

#### **4. Discussion**

In a large, national sample of cisgender sexual minority men and women in the US, we found that approximately two out of five cisgender gay and bisexual plus men (44% and 42%, respectively) reported lifetime APEDS use. Approximately three out of ten cisgender lesbian and bisexual plus women (29% and 20%, respectively) reported lifetime APEDS use. Protein supplements were the most commonly used APEDS, likely due to their widespread availability and acceptability (Samal & Samal, 2018). Consistent with the overall hypothesis, lifetime APEDS use was significantly associated with certain ED symptoms and MD symptoms across all four cisgender sexual minority groups, although the specific use and association patterns varied somewhat across groups. Most notably, any lifetime APEDS use was significantly associated with overall MD symptoms in all four cisgender sexual minority groups.

##### **4.1. Lifetime APEDS use**

The results pattern mirrors findings from the general population showing that boys/men are more likely than girls/women to endorse the use of protein powder, anabolic-androgenic steroids, and other muscle-enhancing supplements (Eisenberg et al., 2012; Nagata et al., 2019; Nagata, Ganson, Griffiths, et al., 2020). Cisgender sexual minority men reported protein supplement use comparable to cisgender (sexual orientation unspecified) college men (46.3%), whereas cisgender sexual minority women reported approximately double the rate of protein use compared to cisgender (sexual orientation unspecified) college women (14.4%) (Nagata, Peebles, et al., 2020). Creatine supplements were the second most commonly used APEDS; use among cisgender sexual minority men was roughly equivalent to use among cisgender (sexual orientation unspecified) college men (21.8%); use in cisgender sexual minority women was approximately double that in (sexual orientation unspecified) college women (1.6%) (Nagata, Peebles, et al., 2020). Anabolic-androgenic steroid and synthetic muscle-enhancing substance use were infrequent and similar to anabolic-androgenic steroid use in (sexual orientation unspecified) college men (1.0%) and women (0.1%) (Nagata, Peebles, et al., 2020). Notably, prior studies have reported highly variable lifetime use of anabolic-androgenic steroids in sexual minority boys and young men, ranging from approximately 1 out of 100 to nearly 1 out of 4, perhaps due to different assessment methods or subpopulations being studied (e.g., different regions, data collection years; Blashill & Safren, 2014; Ganson & Cadet, 2019; Parent & Bradstreet, 2018). Overall, our findings of APEDS use in sexual minority populations were consistent with prior studies in the general population.

#### **4.2 APEDS and ED symptoms**

Lifetime APEDS use was associated with a broad array of ED attitudes and behaviors among cisgender gay men and bisexual plus women. In cisgender bisexual plus men, lifetime APEDS use was significantly associated with only one EDE-Q subscale (Weight and Shape Concern) and one ED behavior (binge eating). In cisgender lesbian women, lifetime APEDS use was associated with only one EDE-Q subscale (Dietary Restraint) and one ED behavior (compelled/driven exercise). These results are consistent with previous findings in cisgender gay and bisexual men showing greater ED symptoms among anabolic-androgenic steroid users compared to non-users (Griffiths et al., 2017) as well as a positive association found between APEDS use and probable ED diagnosis in sexual minority men and women (Convertino et al., 2021).

Sexual minority stressors (e.g., stigma, discrimination, victimization; Meyer, 2003) alongside broader cultural pressures to pursue a lean physique may contribute to APEDS use and disordered eating in sexual minority people. Additional research is needed to explore how other identities and demographics (e.g., gender identity, race/ethnicity, socioeconomic status) intersect to impact risk for APEDS use among sexual minorities. Results can also be considered in relation to the expanded tripartite theory of eating pathology in sexual minority men (Tylka & Andorka, 2012), which suggests that pressures to pursue a lean, muscular body ideal promote internalization of these standards, which leads to dual pathways of muscularity and body fat dissatisfaction prompting muscularity enhancement behaviors (e.g., APEDS use) and disordered eating. A recent study found support for a combined theoretical framework of the tripartite theory and minority stress theory to explain eating pathology in sexual minorities (Convertino et al., 2021). The present findings provide further support for linking these outcomes in cisgender gay men and extend these results to cisgender bisexual plus women.

Finally, associations between lifetime APEDS use and ED symptoms differed between cisgender lesbian and bisexual plus women despite similar sample sizes and generally similar APEDS use and ED symptom severity. This may reflect additional sexual minority stressors experienced by bisexual plus women, such as anti-bisexual discrimination and internalized biphobia (Brewster et al., 2014; Friedman et al., 2014). Bisexual plus women seeking to attract people of multiple genders may also face unique social stressors, such as a drive to meet multiple appearance standards (Moreno-Domínguez et al., 2019). Additional research will be needed to explore this potential disparity in the associations between cisgender lesbian and bisexual plus women.

#### **4.3 APEDS and MD symptoms**

Lifetime APEDS use was associated with overall MD symptoms across the four sexual minority groups, consistent with the muscularity-enhancing nature of the APEDS assessed in this study. Although data on APEDS use and MD symptoms in cisgender sexual minorities are limited, results are consistent with previous findings of positive associations between APEDS use and MD symptoms in college men and women with unspecified sexual orientation (Hildebrandt et al., 2012), and in a combined sample of heterosexual and gay men (Strübel & Petrie, 2019). Notably, a study in predominantly heterosexual men found that those who endorsed anabolic-androgenic steroid use primarily for appearance had greater MD symptoms than those endorsing use primarily for performance (Murray et al., 2016), thus highlighting the importance of assessing motivations for APEDS use among sexual minorities in future research.

The association between lifetime APEDS use and overall MD symptoms in cisgender gay and bisexual plus men is consistent with the sociocultural body ideal for men. In particular, men

place greater emphasis on the size or ‘bulk’ of muscularity, whereas the muscular ideal for women is toned, thin, fit, and not focused on building muscle mass (Murray et al., 2017). This may in part reflect the nature of the APEDS assessed in this study, which were more muscularity- versus leanness-oriented. Future research examining a broader range of substances related to fitness and appearance (e.g., fat burning supplements) will provide further insights. Lastly, cisgender bisexual plus women showed significant associations between lifetime APEDS use and all MD symptom variables, and these associations were generally higher than the corresponding associations in cisgender lesbian women. Given that a similar pattern was observed for APEDS use in relation to ED symptoms, this further emphasizes the importance of examining lesbian and bisexual plus women as distinct groups in future research in this area.

#### **4.4 Limitations**

Certain limitations of this study should be noted. First, the cross-sectional design precludes prospective and causal determinations. Second, our US-based sample was predominantly White and highly educated, therefore findings may not be generalizable to all cisgender sexual minority populations. Third, a single item was administered to assess APEDS use, which was limited in scope (i.e., assessing only lifetime use, and not dosage, frequency, or duration), omitted fat-burning substances, and was subject to potential self-report bias. Future research could delve deeper into types, dose, frequency, and additional nuances of APEDS use. Fourth, our sample of cisgender bisexual plus men was smaller than other groups, and corresponding analyses may have been comparatively underpowered. Finally, to focus this study on sexual orientation among cisgender people, individuals with non-binary or transgender gender identities were excluded. Given prior research indicating that transgender and gender-expansive

people may experience higher rates of ED pathology relative to cisgender individuals (Coelho et al., 2019), future studies of gender minority people will be needed. Nonetheless, strengths of this study include the large national sample of cisgender sexual minority men and women reflecting a broad age range, as well as the use of well-validated ED and MD symptom measures and an analytic approach that adjusted for numerous conceptually relevant covariates.

## 5. Implications and Conclusions

Lifetime APEDS use was common among cisgender sexual minority populations and was associated with ED symptoms and MD symptoms. Healthcare providers should consider assessing for APEDS use in cisgender sexual minority populations, particularly cisgender gay men, among whom use was most common and consistently associated with ED symptoms and MD symptoms. In particular, anabolic-androgenic steroid use was highest among cisgender gay men, which is of particular concern given the serious medical consequences associated with anabolic-androgenic steroid use (Pope et al., 2014). Cisgender bisexual plus women also showed consistent associations of any lifetime APEDS use with ED symptoms and MD symptoms, suggesting a particular need for further research with this population. Among sexual minorities endorsing APEDS use, providers should consider assessing for ED and MD symptoms. The potential health consequences or benefits of many APEDS, particularly over the long-term, are largely unknown, in part due to the lack of regulation by the US Food and Drug Administration. To inform development of prevention programs, interventions, and general clinical guidelines, additional research is needed to prospectively evaluate APEDS use in relation to mental and physical health and identify biopsychosocial factors associated with APEDS use among sexual minority populations.

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**Availability of data and materials:** Data from The PRIDE Study may be accessed through an Ancillary Study application (details at [pridestudy.org/collaborate](https://pridestudy.org/collaborate)).

**Compliance with ethical standards**

**Ethics approval:** The University of California, San Francisco Institutional Review Board approved this study on 2 February 2018 (#16-21213). All procedures performed in this study were in accordance with the ethical standards of the university's Institutional Review Board and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Consent to participate:** Written informed consent was obtained from all participants.

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Table 1. Description of measures

Measure	Description
Lifetime APEDS use	Participants were asked, “Have you ever used the following drugs/supplements for the purpose of enhancing appearance or performance?”. Response options included: “Anabolic Steroids”, “Other Synthetic Muscle Enhancers (such as clenbuterol, human growth hormone)”, “Protein Supplements (such as whey protein, protein shakes, protein bars)”, and “Creatine Supplements (such as creatine monohydrate, creatine ethyl ester, and others)”. Participants provided a “Yes” or “No” response for each of the items. This question was adapted from the EAT 2010 survey (Eisenberg et al., 2012)
Eating Disorder Examination-Questionnaire (EDE-Q)	The EDE-Q assesses eating disorder symptoms experienced over the previous 28 days (Fairburn & Beglin, 2008). Participants rated items on a 7-point scale, with higher values indicating more severe symptoms. An alternative four-factor structure (Friborg et al., 2013) that was psychometrically validated in sexual minorities (Klimek et al., 2021; Oshana et al., 2020) was used in this study. The four subscales included: Dietary Restraint, Preoccupation and Restriction, Weight and Shape Concern, and Eating Shame. Internal consistency was acceptable for the EDE-Q Global Score and subscales in this study (McDonald’s Omega: cisgender gay men .78-.94, cisgender bisexual plus men .79-.92, cisgender lesbian women .77-.94, cisgender bisexual plus women .78-.94). The EDE-Q also assessed the frequency of specific eating disorder behaviors in the previous 28 days, including dietary restraint, binge eating, vomiting, laxative use, and drive-compelled exercise. In this study, frequencies were re-coded and dichotomized to reflect the absence/presence of each disordered eating behavior, with presence defined as $\geq 1$ episode of a given behavior in the past 28 days, similar to prior studies (Lavender et al., 2010; Luce et al., 2008; Nagata et al., 2021; Nagata, Capriotti, et al., 2020; Nagata, Murray, et al., 2020). Given the community-based sample, the vast majority of participants had 0 for each of the behaviors as expected; thus, disordered eating behavior data were not normally distributed. We were interested in understanding the relationships of APEDS with presence or absence of any disordered eating behavior, as opposed to behavior severity or frequency.
Muscle Dysmorphic Disorder Inventory (MDDI)	The MDDI is a 13-item questionnaire that assesses muscle dysmorphia symptoms (Hildebrandt et al., 2004). Participants rated items on a 5-point Likert-type scale from 1 ( <i>never</i> ) to 5 ( <i>always</i> ) scale. The MDDI includes a Total Score and three subscales: Drive for Size, Appearance Intolerance, and Functional Impairment. Items were summed, and higher scores reflect greater symptoms. Internal consistency was generally acceptable or better for the MDDI Total Score and subscales in this sample (McDonald’s Omega: cisgender gay men .77-.87, cisgender bisexual plus men .76-.87, cisgender lesbian women .66-.87, cisgender bisexual plus women .65-.84). The measure has been validated in multiple populations, including among cisgender gay men and lesbian women (Compte et al., 2021).
Covariates	Sociodemographic information (age, race/ethnicity, educational attainment), weight, and height were self-reported by participants. Body mass index (BMI) was calculated using the standard formula: $\text{weight}(\text{kg})/\text{height}(\text{m})^2$ . These variables were selected as covariates because evidence suggests that they could be possible confounders in the relationships between APEDS use and eating disorder symptoms and/or muscle dysmorphia (Nagata, Ganson, Griffiths, et al. 2020; Nagata, Peebles, et al. 2020).

Table 2. Sociodemographic characteristics of sexual minority participants from The PRIDE Study

	Cisgender gay men <i>n</i> =1,070)	Cisgender bisexual plus men ( <i>n</i> =100)	Cisgender lesbian women ( <i>n</i> =564)	Cisgender bisexual plus women ( <i>n</i> =507)
	Mean ± SD / %	Mean ± SD / %	Mean ± SD / %	Mean ± SD / %
Age, years	42.1 ± 15.1	38.0 ± 12.8	38.0 ± 14.3	31.9 ± 9.6
Race/ethnicity				
White	83.9%	81.7%	84.1%	83.0%
Hispanic/Latino/a	6.5%	3.2%	6.0%	4.7%
Asian/Pacific Islander	3.0%	7.5%	1.2%	3.0%
Black/African American	1.7%	2.2%	1.6%	2.8%
Native American	0.6%	--	0.4%	0.2%
Multiracial/Other	4.2%	5.4%	6.8%	6.4%
Educational attainment				
College degree or higher	79.9%	81.0%	82.8%	79.3%
Body mass index (BMI), kg/m <sup>2</sup>	27.1 ± 6.2	28.0 ± 7.1	29.1 ± 8.1	29.1 ± 8.4
Appearance and performance-enhancing drugs and substances (APEDS)				
Any APEDS	43.9%	42.0%	29.1%	29.8%
Anabolic-androgenic steroids	2.9%	0.0%	0.2%	0.0%
Creatine supplements	16.2%	16.0%	3.7%	2.8%
Synthetic muscle enhancers	2.0%	0.0%	0.0%	0.2%
Protein supplements	42.5%	41.0%	28.9%	29.6%
Eating Disorder Examination-Questionnaire Eating Disorder Attitudes <sup>a</sup>				
EDE-Q Weight & Shape Concern	2.5 ± 1.7	2.4 ± 1.6	2.4 ± 1.6	2.7 ± 1.7
EDE-Q Preoccupation & Restriction	0.6 ± 1.0	0.7 ± 1.1	0.6 ± 1.0	0.8 ± 1.1
EDE-Q Dietary Restraint	2.2 ± 2.0	2.0 ± 2.0	2.1 ± 2.0	1.9 ± 2.0
EDE-Q Eating Shame	0.6 ± 1.0	0.6 ± 0.9	0.8 ± 1.1	1.0 ± 1.2
Disordered eating behaviors				

Dietary restraint	19.2%	24.0%	13.5%	18.7%
Binge eating	10.7%	12.0%	8.7%	10.5%
Vomiting	0.6%	0.0%	0.4%	1.6%
Laxative misuse	1.1%	1.0%	0.4%	0.4%
Compelled/driven exercise	9.4%	5.0%	5.3%	4.1%
Muscle Dysmorphic Disorder Inventory				
MDDI Total Score	27.4 ± 7.7	26.4 ± 6.4	24.2 ± 5.9	24.5 ± 5.4
MDDI Drive for Size	9.9 ± 4.7	8.9 ± 4.2	6.4 ± 2.5	6.4 ± 2.4
MDDI Appearance Intolerance	11.5 ± 4.3	11.1 ± 4.1	11.8 ± 4.1	12.1 ± 3.9
MDDI Functional Impairment	6.1 ± 3.0	6.4 ± 2.8	6.0 ± 2.9	6.1 ± 2.9

<sup>a</sup> Friborg et al.'s (2013) four-factor structure was used.

Table 3. Associations of any lifetime appearance and performance-enhancing drugs and substances (APEDS) use with eating disorder symptoms and muscle dysmorphia symptoms among cisgender sexual minority participants in The PRIDE Study

	Any lifetime APEDS use							
	Cisgender gay men (n=1,090)		Cisgender bisexual plus men (n=100)		Cisgender lesbian women (n=564)		Cisgender bisexual plus women (n=507)	
	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>
<b>Eating disorder symptoms</b>								
Eating Disorder Examination-Questionnaire								
Eating Disorder Attitudes <sup>a</sup>								
EDE-Q Weight & Shape Concern	<b>0.44 (0.25 - 0.63)</b>	<b>&lt;0.001</b>	<b>0.77 (0.17 - 1.37)</b>	<b>0.012</b>	0.23 (-0.06 - 0.51)	0.126	<b>0.43 (0.13 - 0.74)</b>	<b>0.005</b>
EDE-Q Preoccupation & Restriction	<b>0.17 (0.05 - 0.28)</b>	<b>0.006</b>	0.35 (-0.09 - 0.80)	0.114	0.07 (-0.11 - 0.24)	0.466	0.23 (0.01 - 0.44)	0.038
EDE-Q Dietary Restraint	<b>0.61 (0.36 - 0.86)</b>	<b>&lt;0.001</b>	0.75 (-0.11 - 1.60)	0.085	<b>0.64 (0.26 - 1.01)</b>	<b>0.001</b>	<b>0.77 (0.39 - 1.16)</b>	<b>&lt;0.001</b>
EDE-Q Eating Shame	<b>0.16 (0.04 - 0.28)</b>	<b>0.007</b>	0.20 (-0.13 - 0.52)	0.232	0.11 (-0.08 - 0.31)	0.263	<b>0.25 (0.03 - 0.47)</b>	<b>0.026</b>
Disordered eating behaviors								
	aOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>
Dietary restraint	1.42 (1.03 - 1.95)	0.032	2.06 (0.70 - 6.04)	0.190	0.75 (0.43 - 1.31)	0.317	1.63 (1.01 - 2.64)	0.048
Binge eating	<b>1.64 (1.08 - 2.49)</b>	<b>0.020</b>	<b>11.75 (1.45 - 95.42)</b>	<b>0.021</b>	0.78 (0.40 - 1.54)	0.475	<b>2.00 (1.08 - 3.69)</b>	<b>0.027</b>
Vomiting	2.78 (0.49 - 15.76)	0.248	--	--	--	--	1.25 (0.29 - 5.37)	0.766
Laxative misuse	1.97 (0.59 - 6.56)	0.269	--	--	1.92 (0.12 - 31.51)	0.649	8.17 (0.14 - 430.43)	0.314

Compelled/driven exercise	<b>3.81 (2.36 - 6.15)</b>	<b>&lt;0.001</b>	2.40 (0.21 - 28.02)	0.484	<b>2.97 (1.36 - 6.48)</b>	<b>0.006</b>	<b>7.14 (2.55 - 20.01)</b>	<b>&lt;0.001</b>
<b>Muscle Dysmorphia symptoms</b>								
Muscle Dysmorphic Disorder Inventory	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>	<i>B</i> (95% CI)	<i>p</i>
MDDI Total Score	<b>5.51 (4.60 - 6.41)</b>	<b>&lt;0.001</b>	<b>5.09 (2.62 - 7.56)</b>	<b>&lt;0.001</b>	<b>1.91 (0.82 - 2.99)</b>	<b>0.001</b>	<b>3.60 (2.61 - 4.59)</b>	<b>&lt;0.001</b>
MDDI Drive for Size	<b>2.88 (2.39 - 3.38)</b>	<b>&lt;0.001</b>	<b>2.82 (1.32 - 4.31)</b>	<b>&lt;0.001</b>	0.12 (-0.31 - 0.55)	0.580	0.46 (0.03 - 0.89)	0.034
MDDI Functional Impairment	<b>1.90 (1.54 - 2.25)</b>	<b>&lt;0.001</b>	1.10 (-0.10 - 2.29)	0.073	<b>1.44 (0.91 - 1.97)</b>	<b>&lt;0.001</b>	<b>2.04 (1.51 - 2.57)</b>	<b>&lt;0.001</b>
MDDI Appearance Intolerance	<b>0.68 (0.20 - 1.16)</b>	<b>0.005</b>	1.18 (-0.31 - 2.66)	0.118	0.36 (-0.34 - 1.06)	0.311	<b>1.12 (0.45 - 1.78)</b>	<b>0.001</b>

Note. Analyses are adjusted for baseline BMI (log transformed in logistic regression analyses to meet linearity assumption), race/ethnicity, age, and education. *B* = Estimated unstandardized coefficient from linear regression. CI = Confidence interval. aOR = Adjusted odds ratio from logistic regression. **Bold** indicates statistical significance after the Benjamini-Hochberg procedure.

<sup>a</sup> Friberg et al.'s (2013) four-factor structure was used.

**Conflicts of Interest**

Dr. Obedin-Maliver has consulted for Sage Therapeutics (5/2017) in a one-day advisory board, Ibis Reproductive Health (a non-for-profit research group; 3/2017-5/2018, 2020-present), and Hims Inc. (2019 - present). Dr. Lunn has consulted for Hims Inc. (2019 - present) and Folx, Inc. (2020). Dr. Flentje has consulted for Hopelab (2020). None of these roles present a conflict of interest with this work as described here. The other authors have no conflicts of interest to report.

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**Author Statement:**

Jason M. Nagata: conceptualization, analysis, methodology, writing original draft, review, and editing. Hunter McGuire, Jason M. Lavender, Tiffany A. Brown, Stuart B. Murray: writing original draft, critical review, and editing. Emilio J. Compte, Chloe J. Cattle: critical review, and editing. Annesa Flentje, Micah E. Lubensky, Juno Obedin-Maliver, Mitchell R. Lunn: conceptualization, methodology, review, and editing.

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## Highlights

- We examined appearance and performance-enhancing drugs and supplements (APEDS) use
- Participants were cisgender sexual minority populations from The PRIDE Study
- Lifetime APEDS use was common across sexual minority groups
- APEDS use was associated with eating disorder and muscle dysmorphia symptoms

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