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Appearance and performance-enhancing drugs and supplements, eating disorders, and muscle dysmorphia among gender minority people

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Abstract

Objective: Appearance and performance-enhancing drugs and supplements (APEDS) can be 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 gender minority people.

Method: Participants were 1653 gender minority individuals (1120 gender-expansive [defined as a broad range of gender identities that are generally situated outside of the woman–man gender binary, e.g., genderqueer, nonbinary] people,

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352 transgender men, and 181 transgender women) recruited from The Population Research in Identity and Disparities for Equality Study in 2018. Regression analyses stratified by gender identity examined associations of any APEDS use with eating disorder and muscle dysmorphia symptom scores.

Results: Lifetime APEDS use was common across groups (30.7% of gender-expansive people, 45.2% of transgender men, and 14.9% of transgender women). Protein supplements and creatine supplements were the most commonly used APEDS. Among gender-expansive people and transgender men, lifetime use of any APEDS was significantly associated with higher eating disorder scores, dietary restraint, binge eating, compelled/driven exercise, and muscle dysmorphia symptoms. Any APEDS use was additionally associated with laxative use among gender-expansive people. Among transgender women, use of any APEDS was not significantly associated with eating disorder or muscle dysmorphia symptoms.

Discussion: APEDS use is common and associated with eating disorder and muscle dysmorphia symptoms in gender-expansive people and transgender men, thus highlighting the importance of assessing for these behaviors and symptoms among these populations, particularly in clinical settings.

Public Significance: This study aimed to examine APEDS use among gender minority people. We found that 30.7% of gender-expansive (e.g., nonbinary) people, 45.2% of transgender men, and 14.9% of transgender women reported lifetime APEDS use, which was associated with eating disorder and muscle dysmorphia symptoms in transgender men and gender-expansive people. Clinicians should assess for these behaviors in gender minority populations.

KEYWORDS

creatine, eating disorder, muscle dysmorphia, nonbinary, protein, sexual and gender minorities, steroids, supplements, transgender persons

1 | INTRODUCTION

Appearance and performance-enhancing drugs and supplements (APEDS) include a range of over-the-counter (e.g., protein and creatine supplements) or illicit (e.g., anabolic-androgenic steroids not prescribed for medical purposes) substances used for improving athletic performance and/or increasing muscularity (Hildebrandt et al., 2007; Hildebrandt et al., 2011). In the United States, dietary supplement manufacturers are not required to collect or report product safety information (Scott, 2002), and as such, there is limited empirical evidence relating to the potential benefits, side effects, and long-term health outcomes associated with legal APEDS use (Pomeranz et al., 2015). Concerns have been raised about the safety and quality of legal APEDS with reports of unlabeled steroids and steroid-like substances found in muscle-building dietary supplements marketed to US consumers (Tucker et al., 2018). In contrast with legal APEDS, illicit APEDS use has been associated with more severe health effects, including adverse cardiovascular, neuroendocrine, renal, and hepatic outcomes (Lehmann et al., 2019; Pope, Wood, et al., 2014). Regardless of the potential safety of some over-the-counter APEDS, evidence suggests that their use is prospectively associated with illicit APEDS use (Nagata, Ganson, Gorrell, et al., 2020), and recent findings indicate the use of any form of APEDS is associated with symptoms of eating disorders and muscle dysmorphia (Nagata, Peebles, Hill, et al., 2021; Strübel & Petrie, 2019). Thus, understanding how APEDS use varies across subpopulations is critical for public health surveillance and identifying potential disparities.

Pooled data from nine US-based studies found that approximately 3–4 million US residents reported lifetime use of anabolic-androgenic steroids with the vast majority of users presumed to be predominantly cisgender men (i.e., gender identity or transgender status were not reported) (Pope, Kanayama, et al., 2014). Moreover, disparities in APEDS use have been documented across marginalized communities, including higher usage among presumed to be predominantly cisgender sexual minority men and men of color (Blashill et al., 2017; Blashill & Safren, 2014; Gonzales & Blashill, 2021). Emerging evidence suggests that gender minority populations (i.e., transgender and gender-expansive) are at increased risk for illicit APEDS use (Guss et al., 2017). Transgender individuals have a gender identity or expression that differs from the sex assigned to them at birth, whereas gender-expansive comprises a broad range of gender identities (e.g., genderqueer, nonbinary) situated outside of the woman-man

gender binary. While some APEDS can be prescribed and used safely as part of routine clinical care (e.g., testosterone as gender-affirming hormone therapy for transgender men; Coleman et al., 2012), transgender adolescent boys had over 26 times the odds of lifetime nonprescription steroid use relative to cisgender adolescent boys (Guss et al., 2017). Transgender boys/men may be driven to use nonprescription steroids due to structural barriers preventing access to or continued engagement in gender-affirming care (Puckett et al., 2018).

Other research suggests that certain gender minority groups are at elevated risk for experiencing symptoms of eating disorders and muscle dysmorphia (i.e., extreme preoccupation with insufficient muscularity). In a national sample of US college students, transgender students had greater odds of past-year self-reported eating disorder diagnosis, past-month purging (i.e., vomiting or laxatives), and past-month diet pill use compared to cisgender heterosexual women (Diemer et al., 2015). For muscle dysmorphia symptoms, transgender men scored similarly to cisgender men on drive for size but higher on appearance anxiety/avoidance compared to other groups (Amodeo et al., 2022; Nagata, Compte, McGuire, et al., 2021).

Although associations between APEDS use and symptoms of eating disorders and muscle dysmorphia have been found in other populations (Nagata, Peebles, Hill, et al., 2021; Strübel & Petrie, 2019), characterizing this relationship among gender minority individuals may guide future research and enhance awareness of these concerns among healthcare providers. Moreover, there are limited data on over-the-counter and nonprescription/illicit APEDS use in gender minority communities. The current study sought to address these gaps by characterizing: (a) lifetime APEDS use among transgender men, transgender women, and gender-expansive adults, and (b) the association of APEDS use with recent (previous 4 weeks) eating disorder symptoms and typical muscle dysmorphia symptoms. We hypothesized that APEDS use would be positively associated with eating disorder symptoms and muscle dysmorphia symptoms across gender minority populations.

2 | METHODS

2.1 | Study population

Data for this study were from The Population Research in Identity and Disparities for Equality (PRIDE) Study, which is a national (United States), longitudinal cohort study of sexual and/or gender minority adults including, but not limited to, people who identify as a sexual and/or gender minority person which includes but is not limited to those who are lesbian, gay, bisexual, transgender, and/or queer (LGBTQ+). A national network of organizations and individuals (PRIDEnet) was created to engage sexual and gender minority communities. Participants were recruited through PRIDEnet constituents, social media advertising, digital communications (newsletters, blog posts), distribution of study-branded promotional items, in-person outreach at conferences and events, and word-of-mouth. Specific inclusion criteria were: age ≥18 years, living in the United States or its territories, and ability to read and answer questionnaires in English. Data were collected on a secure, cloud-based, web-responsive platform. Additional study details are described elsewhere (Lunn, Capriotti, et al., 2019; Lunn, Lubensky, 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.

Participants were asked about their current gender identity (with the option to indicate more than one) and sex assigned at birth ("What sex were you assigned at birth on your original birth certificate?"). For this analysis, we included gender-expansive people, transgender men, and transgender women (see Appendix S1 for detailed description of classification rules). Of the 10,665 participants from The PRIDE Study at the time, 4285 completed the "Eating and Body Image" survey (response rate 40.2%). Sociodemographic characteristics of participants who completed the "Eating and Body Image" survey were similar to those of the overall sample from The PRIDE Study (Lunn, Lubensky, et al., 2019). Of these, 1653 identified as a gender-expansive person ($n = 1120$), a transgender man ($n = 352$), or a transgender woman ($n = 181$). There was no compensation for survey completion.

This study was approved by the University of California, San Francisco, and Stanford University Institutional Review Boards, and The PRIDE Study's Research Advisory Committee and Participant Advisory Committee. Participants provided written informed consent.

2.2 | Measures

2.2.1 | Lifetime APEDS use

Participants were asked if they had ever used the following drugs/supplements for the purpose of enhancing appearance or performance: anabolic-androgenic steroids, synthetic muscle enhancers (such as clenbuterol or human growth hormones), creatine supplements (such as creatine monohydrate, creatine ethyl ester, or others), or protein supplements (such as whey protein, protein shakes, or protein bars). Participants provided a "Yes" or "No" response for each item. Participants who responded "Yes" to one or more of the four APEDS types were coded as having any lifetime APEDS use. This question was adapted from the EAT 2010 survey (Eisenberg et al., 2012).

2.2.2 | Eating Disorder Examination-Questionnaire 6.0

The Eating Disorder Examination-Questionnaire (EDE-Q) assesses eating disorder attitudes and behaviors experienced over the previous 28 days (Fairburn & Beglin, 2008). Participants responded to items on a 7-point scale with higher values indicating greater symptoms and reported frequencies of specific behaviors (i.e., binge eating, compelled/driven exercise, vomiting, laxative use). The Global score was calculated as the average of four subscale scores (i.e., Restraint, Eating Concern, Shape Concern, and Weight Concern). We examined the EDE-Q Global score as a continuous variable; we are not aware of

clinical cutoffs validated in gender minority populations. The EDE-Q also assesses the frequency of specific behaviors in the previous 28 days, including dietary restraint, binge eating, vomiting, laxative use, and compelled/driven exercise. We combined vomiting and laxative use into a single "purging" variable. Raw frequencies were dichotomized to reflect absence/presence of each behavior, with presence defined as ≥1 episode, consistent with prior studies (Lavender et al., 2010; Luce et al., 2008; Nagata, Capriotti, Murray, et al., 2020; Nagata, Compte, Murray, et al., 2021; Nagata, Murray, Flentje, et al., 2020). This approach aligned with our interest in understanding associations of APEDS use with the presence, versus severity, of specific eating disorder behaviors.

2.2.3 | Muscle Dysmorphic Disorder Inventory

The Muscle Dysmorphic Disorder Inventory (MDDI) is a 13-item self-report questionnaire that assesses muscle dysmorphia symptoms, and participants rated items on a 5-point scale in reference to their typical (i.e., "how you typically think, feel, or behave") experience (Hildebrandt et al., 2004). Items were summed, with higher scores reflecting greater symptoms, to form a Total and three subscale scores (i.e., Drive for Size, Appearance Intolerance, and Functional Impairment). Participants rate items on a 5-point Likert-type scale from 1 (*never*) to 5 (*always*) scale, and items are summed such that higher scores reflect greater muscle dysmorphia symptoms.

2.2.4 | Covariates

Sociodemographic information (age, race/ethnicity, and educational attainment), height, and weight were self-reported by participants. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$. These variables were included as covariates given evidence that they could be confounders in the relationships between APEDS use and

TABLE 1 Sociodemographic characteristics of gender minority populations from The PRIDE Study

	Gender-expansive people ($n = 1120$) Mean ± *SD* (%)	Transgender men ($n = 352$) Mean ± *SD* (%)	Transgender women ($n = 181$) Mean ± *SD* (%)
Age (years)	30.0 ± 9.8	30.9 ± 9.8	41.2 ± 15.0
Race/ethnicity			
White	79.8%	86.7%	89.6%
Hispanic/Latino	3.8%	3.4%	3.5%
Asian/Pacific Islander	2.9%	.3%	.6%
Black/African American	1.1%	2.8%	–
Native American	.3%	.3%	–
Mutiracial/other	12.1%	6.5%	6.4%
Educational attainment			
College degree or higher	66.0%	63.6%	59.1%
Body mass index (BMI), kg/m^2	28.7 ± 8.4	28.8 ± 7.4	28.0 ± 6.4
Appearance and performance-enhancing drugs and substances (APEDS)			
Any APEDS	30.7%	45.2%	14.9%
Protein supplements	29.9%	43.8%	14.4%
Creatine	4.7%	10.2%	5.0%
Anabolic-androgenic steroids	.7%	1.7%	1.1%
Synthetic performance-enhancing substances	.5%	.3%	.6%
Eating Disorder Examination-Questionnaire (EDE-Q)			
Eating disorder attitudes			
EDE-Q Global score	1.8 ± 1.3	1.7 ± 1.3	2.0 ± 1.3
Eating disorder behaviors			
Dietary restraint	21.9%	23.6%	28.2%
Binge eating	11.9%	10.2%	13.8%
Compelled/driven exercise	6.8%	7.7%	7.7%
Purging (vomiting or laxative use)	2.3%	1.4%	2.2%
Muscle Dysmorphic Disorder Inventory (MDDI)			
MDDI Total score	27.2 ± 6.7	30.4 ± 7.5	24.5 ± 5.7

Abbreviation: PRIDE, Population Research in Identity and Disparities for Equality.

symptoms of eating disorders and/or muscle dysmorphia (Nagata, Ganson, Griffiths, et al., 2020; Nagata, Peebles, Hill, et al., 2021).

2.3 | Data analysis

Stata 15.1 (StataCorp, College Station, TX) was used to conduct analyses. Summary statistics and regression models were stratified by gender minority group. Multiple linear regression was used to examine associations of lifetime use of any APEDS with the EDE-Q Global and MDDI Total scores. Multiple logistic regression was used to examine associations of lifetime use of any APEDS with the dichotomized (absent/present) eating disorder behaviors. In exploratory sensitivity analyses, additional linear and logistic regression models were run separately for each APEDS type (protein, creatine, anabolic-androgenic steroids, and synthetic performance-enhancing substances) as independent variables and for EDE-Q and MDDI subscale scores as dependent variables. Covariate adjustment for all models included BMI, race/ethnicity, age, and educational attainment. Linear and logistic regression assumptions were checked and met; BMI was log transformed to meet the linearity assumption of logistic regression.

3 | RESULTS

Lifetime use of any APEDS was 30.7% among gender-expansive people, 45.2% among transgender men, and 14.9% among transgender women (see Table 1). Protein supplement use was reported in 29.9% of gender-expansive people, 43.8% of transgender men, and 14.4% of transgender women. Creatine use was reported in 4.7% of gender-expansive people, 10.2% of transgender men, and 5.0% of transgender women. Anabolic-androgenic steroid use was reported in .7% of gender-expansive people, 1.7% of transgender men, and 1.1% of transgender women. Use of synthetic performance-enhancing substances was reported in .5% of gender-expansive people, .3% of transgender men, and .6% of transgender women. Correlations between EDE-Q Global score and MDDI Total score were .52 in gender-expansive people, .43 in transgender men, and .71 in transgender women (Appendix S1).

Among gender-expansive people and transgender men, lifetime use of any APEDS was significantly associated with higher EDE-Q Global score, higher MDDI Total score, and a greater odds of engaging in binge eating, compelled/driven exercise, and dietary restraint (see Table 2). Lifetime use of any APEDS was significantly associated with greater odds of purging for gender-expansive people only. There were no significant associations found among transgender women. Tables S6–S9 present parallel results for regression models that separately examine each type of APEDS and include EDE-Q and MDDI subscales.

4 | DISCUSSION

In a large, national sample of gender minority adults in the United States, lifetime use of any APEDS was reported by approximately four out of nine transgender men, three out of 10 gender-expansive individuals, and one out of seven transgender women. This

TABLE 2 Associations of any lifetime appearance and performance-enhancing drugs and substances (APEDS) use with eating disorder symptoms and muscle dysmorphia symptoms among gender minority participants in The PRIDE Study

	Appearance and performance-enhancing drugs and substances								
	Gender-expansive people ($n = 1120$)			**Transgender men ($n = 352$)**			**Transgender women ($n = 181$)**		
Eating disorder symptoms									
Eating Disorder Examination-Questionnaire (EDE-Q)	***B* (95% CI)**	***p***	***R*²**	***B* (95% CI)**	***p***	***R*²**	***B* (95% CI)**	***p***	***R*²**
Eating disorder attitudes									
EDE-Q Global score	**.61 (.45–.78)**	**<.001**	**.18**	**.57 (.30–.83)**	**<.001**	**.16**	.47 (−.06 to 1.00)	.084	.16
Eating disorder behaviors	**aOR (95% CI)**	***p***		**aOR (95% CI)**	***p***		**aOR (95% CI)**	***p***	
Dietary restraint	**1.75 (1.28–2.39)**	**<.001**		**2.07 (1.21–3.56)**	**.008**		1.21 (.49–2.99)	.674	
Binge eating	**2.05 (1.38–3.05)**	**<.001**		**2.11 (1.01–4.43)**	**.048**		1.22 (.39–3.81)	.731	
Compelled/driven exercise	**4.02 (2.43–6.64)**	**<.001**		**2.67 (1.10–6.47)**	**.030**		3.24 (.97–10.88)	.057	
Purging (vomiting or laxative use)	**3.61 (1.58–8.22)**	**.002**		.68 (.11–4.36)	.686		1.65 (.15–17.93)	.681	
Muscle dysmorphia symptoms									
Muscle Dysmorphic Disorder Inventory (MDDI)	***B* (95% CI)**	***p***	***R*²**	***B* (95% CI)**	***p***	***R*²**	***B* (95% CI)**	***p***	***R*²**
MDDI Total score	**4.88 (4.04–5.72)**	**<.001**	**.13**	**5.10 (3.51–6.68)**	**<.001**	**.14**	1.96 (−.30 to 4.23)	.089	.13

Note: Analyses are adjusted for baseline BMI (log transformed in logistic regression analyses to meet linearity assumption), race/ethnicity, age, and education. Bold indicates $p < .05$.

Abbreviations: aOR, adjusted odds ratio from logistic regression; *B*, estimated coefficient from linear regression; CI, confidence interval; PRIDE, Population Research in Identity and Disparities for Equality.

pattern of findings across transgender men and women is generally consistent with results from presumed to be predominantly cisgender samples with boys/men being more likely than girls/women to endorse using protein and muscle-enhancing supplements and anabolic-androgenic steroids (Eisenberg et al., 2012; Pope, Kanayama, et al., 2014). Regarding specific APEDS types, lifetime use of anabolic-androgenic steroids or synthetic muscle enhancers was relatively infrequent across all study groups. In contrast, use of creatine and protein supplements, particularly the latter, was more common across groups, likely given their greater accessibility and acceptability (Samal & Samal, 2018). As hypothesized, lifetime use of any APEDS was significantly associated with most eating disorder and muscle dysmorphia symptoms among gender-expansive people and transgender men, although there were no significant associations among transgender women.

4.1 | Lifetime APEDS use

Lifetime APEDS use in transgender men were similar to those previously reported in cisgender gay (43.9%) and bisexual plus (42.0%) men, while use in transgender women was qualitatively lower than previously reported in cisgender lesbian (29.1%) and bisexual plus (29.8%) women in The PRIDE Study (Nagata et al., 2022). Overall, protein supplements were the most commonly endorsed type of APEDS. Proportions of lifetime use in transgender men and women were similar to those found in presumed to be predominantly cisgender college men (46.3%) and women (14.4%) in the United States (Nagata, Peebles, Hill, et al., 2021). A similar pattern of differences in protein supplement use between men and women has been documented in gym-attendant samples from Italy, Turkey, the United Kingdom, and Lebanon (El Khoury & Antoine-Jonville, 2012; Ewan et al., 2019). The proportion of gender-expansive individuals that reported lifetime protein supplement use was intermediate between transgender men and women. Creatine supplements were the second most endorsed type of APEDS. A smaller proportion of transgender men reported lifetime creatine use compared to presumed to be predominantly cisgender heterosexual college men (21.8%) (Nagata, Peebles, Hill, et al., 2021). Smaller proportions of gender-expansive individuals and transgender women reported lifetime creatine use compared to transgender men in the present sample, but higher rates than presumed to be predominantly cisgender heterosexual college women (1.6%) (Nagata, Peebles, Hill, et al., 2021). Finally, lifetime use of anabolic-androgenic steroids and synthetic muscle-/performance-enhancing substances was similar across the three gender minority groups and was comparable to those found in presumed to be predominantly cisgender college men (1.0%) but greater than those found in presumed to be predominantly cisgender college women (.1%) (Nagata, Peebles, Hill, et al., 2021). Use among transgender men was greater than general population estimates in the United Kingdom, which ranged between .1% and .2% from 2007 to 2018 (Mullen et al., 2020) although the timeframe of these estimates is past-year rather than lifetime in the current study. Further, lifetime anabolic-androgenic steroid use within groups in this study was lower than estimates of lifetime nonprescription steroid use reported in seven of 18 transgender adolescents; data for specific gender identities were not reported (Guss et al., 2017).

4.2 | Eating disorder symptoms

Across eating disorder symptoms, transgender women tended to have higher scores compared to transgender men and gender-expansive individuals. Consistent with prior research supporting greater eating disorder symptoms in transgender individuals (Diemer et al., 2015), global eating disorder symptoms across all gender minority groups were elevated compared to normative data for presumed to be predominantly cisgender heterosexual college men ($M = 1.09$, $SD = 1.00$) (Lavender et al., 2010) and comparable or higher than presumed to be predominantly cisgender heterosexual college women ($M = 1.74$, $SD = 1.30$) (Luce et al., 2008).

4.3 | APEDS and eating disorder symptoms

Lifetime use of any APEDS was significantly associated with greater eating disorder attitudes (with medium effect sizes) and behaviors among transgender men and gender-expansive individuals (excepting purging in the latter) but not among transgender women. Although the literature in this area is scarce (Uniacke et al., 2021), certain relevant theories and models may inform the interpretation of our findings. For example, the tripartite influence model of eating pathology (originally centered on thin body ideals) has been adapted to muscularity-oriented attitudes and behaviors (Schaefer et al., 2021; Thompson et al., 1999; Tylka, 2011). This model posits that social influences from peers, parents, and media promote a muscular body ideal that leads to internalization of muscularity-oriented attitudes and appearance standards. This internalization may promote engagement in muscularity-oriented behaviors (e.g., APEDS use). A recent investigation found significant, positive associations between muscularity-ideal internalization and body shame among transgender men and transgender women, respectively (Strübel et al., 2020). The current study extends prior findings by providing evidence of a potential pathway between eating disorder attitudes and APEDS use among gender minority populations, particularly transgender men and gender-expansive people.

Another potentially relevant model is the gender minority stress framework (Meyer, 2003), which proposes that stress induced by stigma, discrimination, prejudice, and victimization experienced by gender minority individuals may contribute to mental and behavioral health disparities (Hendricks & Testa, 2012; Testa et al., 2015). There may be an association between gender dysphoria and eating disorder symptoms, and that receipt of gender-affirming care may help reduce eating disorder symptoms (Feder et al., 2017; Nowaskie et al., 2021). These stressors, alongside broader sociocultural appearance pressures, may contribute to disordered eating behaviors and related APEDS use in certain gender minority groups. However, given we did

not measure minority stress in this study, we note that APEDS use has been associated with eating disorder symptoms in presumed to be predominantly cisgender populations (Nagata, Peebles, Hill, et al., 2021).

Finally, the absence of significant associations between APEDS use and eating disorder symptoms among transgender women is notable. This may be partially due to a smaller sample size, yet the magnitude of the associations suggests that this may not be the only explanation. Although eating disorder symptom severity was generally comparable across all groups, lifetime use of any APEDS use was substantially lower among transgender women. This aligns with traditionally gendered sociocultural body ideals that emphasize a thin or "fit" body with toned muscularity for women versus an emphasis on muscle size or "bulk" for men (Rodgers et al., 2018). This likely reflects the muscular size-enhancing nature of the specific APEDS assessed in this study (e.g., anabolic-androgenic steroids, protein, and creatine), whereas other types of APEDS (e.g., fat burning supplements) may have greater salience for transgender women or other gender minority individuals with body ideal attitudes that are less muscularity-oriented.

4.4 | APEDS and muscle dysmorphia symptoms

Lifetime use of any APEDS was significantly associated with muscle dysmorphia symptoms with medium effect sizes in transgender men and gender-expansive people but not transgender women. This is consistent with results showing that muscle dysmorphia symptom scores across groups paralleled proportions of lifetime APEDS use. Namely, transgender men reported the highest scores and greatest proportion of any APEDS use, transgender women the lowest, and scores and APEDS use for gender-expansive people were in between. These results align with those found in cisgender sexual minority men and women showing associations between APEDS use and probable body dysmorphic disorder; however, this was not specific to muscularity-oriented concerns (Convertino et al., 2021). Findings are consistent with those indicating associations between APEDS use and muscle dysmorphia symptoms in college men and women (Hildebrandt et al., 2012) and heterosexual and gay men (Strübel & Petrie, 2019).

Some gender minority individuals may use APEDS to promote body changes consistent with their gender identity (Murray et al., 2013), in place of or in addition to prescribed gender-affirming hormone therapy. Similarly, gender minority individuals with symptoms of muscle dysmorphia who experience gender dysphoria may use APEDS as a strategy for coping or managing gender dysphoria. The link between muscle dysmorphia symptoms and APEDS use may be stronger among gender minority people with higher degrees of gender dysphoria. Thus, this potential moderating effect should be investigated in future research.

Eating disorder and muscle dysmorphia symptoms were significantly correlated with medium to large effect sizes. Therefore, the overlap in participants reporting both eating disorder and muscle dysmorphia symptoms could account for associations with APEDS use.

4.5 | Strengths and limitations

Strengths of this investigation include the large, nationwide sample of gender minority adults representing a broad age range, use of well-validated eating disorder and muscle dysmorphia symptom measures, and a conservative analytic approach that adjusted for numerous conceptually relevant covariates. However, certain limitations should be noted. First, data were cross-sectional, precluding definitive interpretations of the temporal nature of the identified associations. Second, data on dosage, frequency, and duration of APEDS use were not available; moreover, APEDS were measured for lifetime use, whereas eating disorder and muscle dysmorphia measures assessed current symptomatology, which may have attenuated the associations. Third, differing sample sizes for gender minority groups resulted in variable statistical power, and supplemental analyses with anabolic-androgenic steroid and synthetic performance-enhancing substance use should be interpreted with caution due to small sample sizes. Nonetheless, our generally large sample may help yield statistically significant results. Fourth, survey questions did not distinguish between APEDS use with/without a prescription, so some participants may have endorsed using specific APEDS as part of gender-affirming hormone therapy. Fifth, our community-based sample from the United States was predominantly White and highly educated; thus, the current results may not generalize to all gender minority populations. Participants with particular interest in eating or body image issues may also have been more likely to complete the "Eating and Body Image" survey from which the current data were drawn, which could have led to sampling bias. Finally, although we adjusted for potential confounding variables including BMI, race/ethnicity, age, and education, other unassessed variables could have influenced the results. For instance, we did not assess other forms of psychopathology or gender minority stress. Future research could examine APEDS use and associations with eating disorder and muscle dysmorphia symptoms within specific BMI and age categories.

4.6 | Implications and conclusions

The present study found that APEDS use was significantly associated with eating disorder and muscle dysmorphia symptoms among transgender men and gender-expansive people but not transgender women. Healthcare providers should be aware of the likelihood of these attitudes and behaviors among gender minorities. Screening and, if needed, counseling for individuals endorsing such attitudes or behaviors is recommended. Assessing motivations for APEDS use is warranted given that those with appearance- versus performance-based reasons for using specific APEDS (i.e., anabolic-androgenic steroids) have been found to report greater muscle dysmorphia symptoms (Murray et al., 2016). Additional research is needed to inform the long-term health-related impacts of APEDS use among gender minority individuals, including its relation to gender-affirming healthcare and long-term use of gender-affirming hormone therapy. Further investigation of peer, parental, and media influences on

eating- and body image-related concerns among gender minorities is warranted. Finally, the differential pattern of findings for transgender women in this study highlights the importance of identifying factors associated with APEDS use in this population.

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CONFLICT OF INTEREST

Dr. Obedin-Maliver has consulted for Sage Therapeutics (May 2017) in a one-day advisory board, Ibis Reproductive Health (a not-for-profit research group; March 2017–May 2018, 2020–present), Folx, Inc. (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, 2022). 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.

AUTHOR CONTRIBUTIONS

F. Hunter McGuire: Investigation; writing – original draft; writing – review and editing. **Jason M. Lavender:** Methodology; writing – original draft; writing – review and editing. **Tiffany A. Brown:** Methodology; writing – original draft; writing – review and editing. **Stuart B. Murray:** Conceptualization; methodology; writing – review and editing. **Richard E. Greene:** Investigation; writing – original draft; writing – review and editing. **Emilio J. Compte:** Methodology; writing – review and editing. **Annesa Flentje:** Conceptualization; investigation; writing – review and editing. **Micah E. Lubensky:** Conceptualization; investigation; project administration; writing – review and editing. **Juno Obedin-Maliver:** Conceptualization; investigation; methodology; project administration; resources; writing – review and editing. **Mitchell R. Lunn:** Conceptualization; investigation; methodology; project administration; resources; writing – review and editing.

DATA AVAILABILITY STATEMENT

Data from The PRIDE Study may be accessed through an Ancillary Study application (details at pridestudy.org/collaborate).

ETHICS STATEMENT

The University of California, San Francisco Institutional Review Board approved this study on February 2, 2018 (#16-21213) and the Stanford University School of Medicine Review Board on February 1, 2019 (#48707). 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. Written informed consent was obtained from all participants.

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SUPPORTING INFORMATION

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