Original Research Article

The intersection of autistic traits, ADHD traits, and gender diversity in disordered eating and drive for muscularity within the general population

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Abstract

Neurodivergent and gender diverse people are overrepresented among individuals with eating disorders. There also appears to be an epidemiological overlap between autism, ADHD, and gender diversity, making it difficult to disentangle their possible contributions to eating behaviours and body image, including restrictive eating and muscle-building behaviours. We examined the unique associations between neurodivergent traits, dimensional gender diversity, disordered eating (DE), and drive for muscularity in a UK general population sample ($N = 492$; 324 assigned female at birth; 98.6% cisgender; M age = 41.44 years), using correlations and hierarchical multiple regressions. We found higher levels of autistic traits, ADHD traits, and gender diversity were associated with elevated DE. Nonbinary gender diversity, when one's gender identity exists between or outside of the gender binary, was associated with higher levels of drive for muscularity in people assigned female at birth, but with elevated DE in people assigned male at birth. Notably, ADHD traits were the only independent predictor of DE and drive for muscularity when controlling for co-occurring internalising symptoms. The study highlights an association between ADHD traits and both DE and drive for muscularity, even after controlling for internalising symptoms. Additionally, it demonstrates the crucial role of internalising symptoms when examining the associations between autistic traits, gender diversity, and DE.

Lay Abstract

Certain groups within society are more likely to develop eating disorders, including neurodivergent and gender diverse people. Gender diverse people identify with a gender that does not match their sex assigned at birth. Neurodivergence and gender diversity are found to commonly co-occur in the same individuals, making it challenging to determine whether neurodivergent and gender diverse traits are associated with eating disorder symptoms and body image concerns. We wanted to understand whether specific types of neurodivergent and gender diverse traits were associated with eating disorder symptoms and body image concerns in the general population. In total, 492 people completed an online questionnaire about their experience of eating disorder symptoms, such as dieting behaviours and concerns about weight, muscle building behaviours, gender diverse traits, and levels of autistic and ADHD traits. We found people with higher levels of autistic traits, ADHD traits, and gender diversity also had higher levels of eating disorder symptoms. When we accounted for levels of anxiety and depressive symptoms, we found ADHD traits had a stronger influence on eating disorder symptoms and muscle building behaviours than gender diverse or autistic traits. Our findings suggest that people who have high levels of neurodivergent traits or greater gender diversity may be particularly at risk of developing eating disorder symptoms and body image concerns.

Keywords

Disordered eating, gender diversity, autistic traits, ADHD traits, drive for muscularity

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Introduction

Eating disorders are complex mental health conditions that can have negative consequences on physical, psychological, and socio-emotional health (Arcelus et al., 2011; Santomauro et al., 2021; van Hoeken & Hoek, 2020). For example, people with eating disorders are more likely to experience cardiac complications, anxiety and depressive disorders, suicidal ideation, and social isolation (Godart et al., 2007; Joiner et al., 2022; Makri et al., 2022; Pallister & Waller, 2008; Swinbourne et al., 2012; Tith et al., 2020). Furthermore, eating disorders have the highest mortality rate of any psychiatric illness (Smink et al., 2012) and affect approximately 1–6% of the population (Micali et al., 2013). The prevalence of eating disorders is particularly elevated in certain groups, such as gender diverse people (gender identity does not match their assigned sex at birth) and people who are neurodivergent, particularly autistic people and people with attention-deficit hyperactivity disorder (ADHD; Amodeo et al., 2022; Christensen et al., 2019; Diemer et al., 2015; Huke et al., 2013; Jones et al., 2016; Nagata et al., 2022).

Recent research suggests an epidemiological overlap between gender diversity, autism, and ADHD (Antshel et al., 2013; Cooper et al., 2018; Goetz & Adams, 2022; van der Miesen et al., 2018), with evidence suggesting both autism and ADHD are around 2–6 times more common in gender diverse individuals compared to cisgender individuals (people whose gender identity aligns with their sex assigned at birth; Warrier et al., 2020). People who are both autistic and gender diverse are found to be at increased risk of developing mental health conditions, such as anxiety and depression, compared to individuals who identify as either autistic or gender diverse (Bungert et al., 2024; Clyde et al., 2024; Simpson et al., 2024). There is emerging evidence to suggest that eating disorder symptoms and diagnoses are also elevated in people who are both autistic and gender diverse (Sedgewick et al., 2021; Strauss et al., 2021). There has been much less research attention on the overlap between ADHD and gender diversity, with examinations of mental health difficulties limited to one study. In this study, Dawson et al. (2017) found gender diverse adults were more likely to report having ADHD and co-occurring anxiety and/or depression than cisgender adults. Research has not yet considered the overlap between ADHD, autism, and gender diversity. Furthermore, current eating disorder studies focus on comparing eating disorder symptoms in gender diverse and cisgender individuals with or without an autism diagnosis (Sedgewick et al., 2021). There is now considerable evidence demonstrating both autism and ADHD can be conceptualised and measured as dimensional traits in the general population (Happé & Frith, 2020, 2021; Stanton et al., 2020; Thapar et al., 2017). By investigating traits in larger general population samples, we are able to retain a level of detail that is often lost through categorical classification approaches (Lyall, 2023). Trait-based approaches have been successfully used to examine neurodivergence in adults in previous studies (Hargitai et al., 2023; Waldren et al., 2024). They can help overcome some of the limitations of research with people who have a neurodivergent diagnosis only, such as small and homogenous samples. This will be particularly useful in the current study, enabling us to investigate nuanced relationships between autism, ADHD, gender diversity, and eating pathology.

The type of eating pathology may also be important when considering the overlap with neurodivergence and gender diversity. Disordered eating (DE) typically encompasses behaviours and cognitions, including dietary restriction, fear of weight gain, purging, and body dissatisfaction (Murray, Griffiths et al., 2017). These behaviours and cognitions are focused on attaining the thin ideal, a consistently reported body ideal in cisgender women (Thompson & Stice, 2001). Evidence suggests that neurodivergent characteristics and gender diversity may have a causal and maintaining role in the development of DE. For gender diverse people, self-reported drive for thinness is comparable across trans men and trans women, and similar to levels reported by cisgender women (Witcomb et al., 2015). However, the motivations driving these behaviours may differ greatly between gender diverse and cisgender people. For example, DE behaviours in gender diverse people may function as a way of controlling pubertal development, including menstruation cessation and interruption of secondary sex characteristic development (e.g. Coelho et al., 2019; Diemer et al., 2018; Kamody et al., 2020; Romito et al., 2021). In addition, these behaviours may be used to achieve body characteristics that are more aligned with their gender identity and alleviate symptoms of gender dysphoria (Algars et al., 2012; Ewan et al., 2014; Gordon et al., 2016; Murray et al., 2013; Winston et al., 2004). Autistic traits such as rigid thinking, routinised behaviours, and sensory sensitivities are also thought to be key to the development of DE, particularly restrictive-type eating disorders like anorexia nervosa (Brede et al., 2020). For people with ADHD, research has reported elevated rates of eating disorders characterised by binge and/or purge type symptoms, such as bulimia nervosa and binge eating disorder (Bleck & DeBate, 2013). Impulsivity is thought to be an important driver of these eating behaviours in people with ADHD (Kaisari et al., 2017; Martin et al., 2022). Taken together, these findings suggest that elevated neurodivergent and gender diverse traits may uniquely contribute to higher levels of DE.

In addition to traditional DE behaviours, research has started to explore the relations between drive for muscularity and both gender diversity and neurodivergence. Drive for muscularity encompasses muscularity-oriented body image concerns and behaviours, such as preoccupation

Table 1. Sample characteristics (n = 492).

	Frequency	% of the sample
Sex assigned at birth		
Female	324	65.9
Male	166	33.7
Prefer not to say	2	0.4
Gender identity[a]		
Cisgender	485	98.6
Trans/Gender diverse	6	1.2
Genderqueer	1	
Nonbinary	2	
Trans woman	1	
Trans man	1	
Not specified	1	
Ethnicity		
White	434	88.2
Mixed or multiple ethnic groups	11	2.2
Asian or Asian British	24	4.9
Black, Black British, Caribbean or African	21	4.3
Other ethnic group	1	0.2
Prefer not to say	1	0.2
Highest level of qualification[b]		
No formal qualifications	6	1.2
GCSE passes, apprenticeships, or equivalent	85	17.3
A level or equivalent	85	17.3
Bachelor's degree, Higher National Certificate/Diploma	204	41.5
Master's level and above	111	22.6
Prefer not to say	1	0.2
Sexual orientation		
Straight or heterosexual	434	88.2
Gay or lesbian	16	3.3
Bisexual	28	5.7
Pansexual	4	0.8
Asexual	4	0.8
Other sexual orientation	1	0.2
Prefer not to say	5	1.0
Eating disorder diagnosis[c]		
Yes	22	4.5
Binge eating disorder	8	
Bulimia nervosa	7	
Anorexia nervosa	4	
Excessive exercise	1	
Rumination disorder	1	
Not specified	1	
No	467	94.9
Prefer not to say	3	0.6
Status of eating disorder		
Current	9	1.8
Historical	8	1.6
Unsure	5	1.0
Autism diagnosis[c]		
Yes	8	1.6
No	479	97.4
Prefer not to say	5	1.0

(continued)

(continued)

Table 1. Continued.

	Frequency	% of the sample
ADHD diagnosis[c]		
Yes	5	1.0
No	487	99.0
Prefer not to say	0	0.0
Mental health diagnoses[c]		
Yes	145	29.5
Depressive disorders	97	
Anxiety disorders	104	
Borderline personality disorder	3	
No	333	67.7
Prefer not to say	14	2.8

Note: [a] Participants were asked to indicate whether their gender identity aligned with their sex assigned at birth. If their sex and gender identity matched, they were labelled 'cisgender'; whereas, if their sex and gender identity did not match, they were labelled 'trans/gender diverse'. For individuals in the latter group, they were asked to specify their gender identity using an open-text box.
[b] Eight categories, based on the categories used by the UK Office for National Statistics in the Census 2021 (Office for National Statistics, 2023), were collapsed into six for presentation in this table.
[c] Participants were asked whether they had received a formal diagnosis of an eating disorder of any type, autism, ADHD, or diagnosis of a mental health condition. If participants responded 'Yes' to either an eating disorder or mental health diagnosis, they were given the option to specify this diagnosis using a free text response.

with caloric intake, overconsumption of protein-based foods, and elimination of certain food groups (Murray, Nagata et al., 2017). Research suggests the thinness-oriented appearance ideal reported in cisgender women is shifting towards an 'athletic ideal', characterised by a toned and thin body shape (Karazsia et al., 2017; Krug et al., 2020; Tiggemann & Zaccardo, 2015). For cisgender men, a lean and muscular body has been a long held appearance ideal in Western cultures (Blond, 2008; Buote et al., 2011; Lavender et al., 2017; Leit et al., 2002). Although limited in number, recent research has highlighted some gender diverse people report elevated levels of drive for muscularity (Amodeo et al., 2022; Nagata, Compte et al., 2021; Nagata, McGuire et al., 2022; Roberts et al., 2021). For example, trans men report higher levels of muscularity-orientated body concerns compared to cisgender women, with levels comparable to cisgender men (Amodeo et al., 2022; Strübel et al., 2020). Often these behaviours function as a way of achieving a more lean and muscular body, as well as suppressing curves that reflect a stereotypically feminine body (Amodeo et al., 2022; Duffy et al., 2016; Nagata et al., 2020). There is also emerging evidence that muscularity-oriented behaviours and attitudes are associated with elevated autistic traits (Galvin et al., 2022), although the association with ADHD remains unexplored. Although the mechanism underlying the link between drive for muscularity and autistic traits is mostly unclear, one explanation may be that people with higher levels of autistic traits are more likely to negatively evaluate their body. For some individuals, these negative evaluations may be driven by internalisation of thin body ideals; whereas others may internalise muscular body ideals (Longhurst et al., 2024).

The current study aimed to examine whether autistic traits, ADHD traits, and gender diversity (levels of binary and nonbinary gender diversity measured dimensionally) uniquely contributed to levels of DE and drive for muscularity in the general population. In addition, we aimed to investigate whether there was an interaction between gender diversity and neurodivergent traits, given research demonstrates people who are both neurodivergent and gender diverse experience more mental health difficulties than individuals who are either neurodivergent or gender diverse (Bungert et al., 2024; Clyde et al., 2024; Simpson et al., 2024). Anxiety and depressive symptoms were controlled for based on their frequent co-occurrence with eating disorders (Swinbourne et al., 2012; Wade et al., 2000), neurodivergence (Hollocks et al., 2019; Uljarević et al., 2020), and gender diversity (Bouman et al., 2017; Budge et al., 2013). We hypothesised that: (1) DE would be positively correlated with levels of autistic traits, ADHD traits, and gender diversity; (2) drive for muscularity would be positively correlated with gender diversity; however, analyses with neurodivergent traits were exploratory due to the limited prior research; (3) autistic traits, ADHD traits, and gender diversity would independently predict DE, but analyses involving drive for muscularity as the dependent variable were exploratory; (4) greater gender diversity and neurodivergent traits would interact to predict increased DE. Given the different socio-cultural norms for eating behaviours and body image in people assigned male compared to female sex at birth (Lavender et al., 2017; Thompson & Stice, 2001), we also explored assigned sex at birth differences in our general population sample.

Methods

Participants

A total of 541 participants were recruited through Prolific, a participant recruitment website (www.prolific.co). All participants were required to be aged 18 years or older,

currently based in the UK, and fluent in English. Twenty-six participants were excluded due to incomplete questionnaires (>10% missing items), whilst 23 participants were excluded due to failure of both attention checks. This resulted in a final sample size of 492 participants (*M* age = 41.44 years, SD = 13.11, ranged from 19 to 81 years). A power analysis performed using G*Power (Faul et al., 2007) suggested a minimum sample size of 160 for a multiple linear regression with eight predictors, assuming a medium effect size (f = 0.15), alpha of 0.05, and power of 0.95. Demographics and self-reported mental health history are presented in Table 1.

The project received approval from the University's School of Psychology Ethics Committee (EC.23.03.07.6760RA2). Informed consent was obtained online from participants before completing the questionnaires.

Procedure

The study was hosted on an online platform (Qualtrics, 2020; version July 2023). Participants provided demographic information (Table 1) before completing self-report questionnaires, presented in a randomised order. An attention check was randomly placed within the order of the questionnaires and read: 'Please ignore the question below and select both "yes" and "unsure". This way, we can be more confident that you are reading the questions carefully and will pay attention throughout the study. Do you frequently get less than 7 hours of sleep?'. This question was presented twice within the series of questionnaires and response options were 'Yes', 'No', or 'Unsure'. Participants were compensated for their time.

Measures

Eating Disorder Examination Questionnaire (EDE-Q). The EDE-Q (Fairburn & Beglin, 1994) assesses eating disorder behaviours and cognitions over the previous 28 days (e.g. on how many of the past 28 days have you had a definite fear that you might gain weight?), with responses captured on a 7-point scale ranging from 0 ('no days') to 6 ('every day'). Averaging the scores of relevant items is used to capture four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. These subscale scores are averaged to create a Global EDE-Q score (ranging from 0 to 6), which was used in the current study analyses. Higher scores indicate greater endorsement of eating disorder symptoms. Prior studies have used a cut-off of ≥4 as a marker of clinical significance (Lavender et al., 2010; Mond et al., 2006). The EDE-Q has good internal consistency, temporal stability, and construct validity (Berg et al., 2012; Mond et al., 2004). Cronbach's α in the current study were: global, α = .948; restraint, α = .842; eating concern, α = .849; shape concern, α = .914; weight concern, α = .857.

Drive for Muscularity Scale (DMS). The DMS (McCreary & Sasse, 2000) is a 15-item self-report measure used to capture behaviours and cognitions related to the desire to increase muscularity (e.g. I lift weights to build muscle; I wish that I were more muscular). Participants respond on a 6-point scale from 1 ('Always') to 6 ('Never'). All items are reverse scored before an average score is calculated (ranging from 1 to 6). Higher scores indicating a higher drive for muscularity. Previous psychometric validation of DMS total scores in cisgender males and females has demonstrated good internal consistency and evidence of convergent validity with body mass index and DE (de Carvalho et al., 2019; McCreary et al., 2004). Cronbach's α for DMS total score in the current study was α = .914.

Autism Spectrum Quotient (Aq). The AQ (Baron-Cohen et al., 2001) is a commonly used self-report measure of autistic traits in the general population (Ruzich et al., 2015). Participants respond on a 4-point scale to 50 items (e.g. I tend to notice details that others do not), from 'definitely agree' to 'definitely disagree', with each coded as either a 0 or 1 (specified for each item). Only the total score was used in the current study, which ranges from 0 to 50. Higher scores indicate greater endorsement of autistic traits. A threshold of ≥32 is recommended for general population samples (Baron-Cohen et al., 2001; Woodbury-Smith et al., 2005). Internal consistency of total AQ scores is good (Austin, 2005). Cronbach's α for AQ total score in the current study was α = .870.

Adult ADHD Self-Report Scale (ASRS). The ASRS (Kessler et al., 2005) is an 18-item self-report measure of ADHD-like traits over the past six months. The items are consistent with the DSM-IV (American Psychiatric Association, 1994) criteria for ADHD. For each item (e.g. how often do you have problems remembering appointments or obligations?), the participant is asked to respond on a 5-point Likert scale ('Never' to 'Very often'), based on how they have felt/behaved over the past six months. Depending on the item, responses are either scored as 0 or 1. Only total ASRS score was used in the current study, which ranges from 0 to 18. Higher scores indicate higher levels of current ADHD traits, while the cut-off score is ≥14 (Kessler et al., 2007). Cronbach's α for ASRS total score in the current study was good (α = .866), in line with previous research (Adler et al., 2006).

Gender Self-Report (GSR). The GSR (Strang et al., 2023) is a community-developed multidimensional gender characterisation tool. The GSR has been calibrated and validated in autistic and non-autistic adults and youth, as well as gender diverse and cisgender individuals. This self-report tool can capture continuous binary and nonbinary gender identity traits across 30 items (responses are captured on a

4-point scale from 'never true' to 'always true'). Three subscales are computed and linearly transformed to a 0–1 scale: female-male continuum, binary gender diversity, and nonbinary gender diversity. As endorsement of female vs male traits were not of interest in the current study, only binary gender diversity and nonbinary gender diversity were used as outcome measures. Higher values on the binary gender diversity subscale indicate greater binary distance from assigned sex at birth e.g. greater endorsement of female items when sex assigned at birth is male. Higher values on the nonbinary gender diversity subscale indicate greater nonbinary gender diversity, e.g. greater endorsement of items such as 'overall, I feel that deep down my true gender is neither male nor female'. Cronbach's α for the GSR scores were: binary gender diversity, α = .992, nonbinary gender diversity, α = .865.

Hospital anxiety and depression scale (HADS). The HADS (Zigmond & Snaith, 1983) assesses anxiety and depressive symptoms over the previous two weeks. Each of the 14 items are scored on a 0–3 scale, with response options varied across items. Anxiety and depression scores are computed based on seven corresponding items for each (e.g. anxiety: worrying thoughts go through my mind; depression: I feel as if I am slowed down). Anxiety and depression subscales range from 0–21. Higher scores indicate greater severity of symptoms, with scores of ≥11 indicating clinical significance (Zigmond & Snaith, 1983). Cronbach's α for HADS scores in the current study were as follows: anxiety, α = .863, depression, α = .822.

Statistical analysis

All statistical analyses were conducted using SPSS (version 27.0; IBM, 2020). Missing values were low across all measures (< 0.14%) and mean imputation was used to replace these. Thirteen participants met the outlier criterion for completion time (mean ± 3 SDs); however, removal of these participants had no impact on results, so they were included in the sample. Preliminary analyses tested for potential demographic covariates of DE behaviours and cognitions and the drive for muscularity; any significant demographic covariates were controlled for in the regression analyses.

To examine our hypotheses, Pearson's correlations were followed by four hierarchical multiple linear regressions to examine the unique contributions of each independent variable on EDE-Q and DMS scores. Sex, age, and sexuality were added as covariates into the model predicting EDE-Q scores at Step 1. When predicting DMS scores, education level was added into Step 1 as an additional covariate alongside sex, age, and sexuality. Mean-centred interaction terms (gender diversity × autism traits, gender diversity × ADHD traits) were added as independent variables. Binary and nonbinary gender diversity were examined in separate models due to their conceptual overlap. In addition to these multiple regressions, we conducted regressions in people assigned female and male at birth separately to examine sex differences (Tables S1–S8 in Supplemental Materials).

Results

Most participants in our sample scored below threshold scores for the questionnaires (Table 2).

Correlations examined the associations between the questionnaires (Table 3). In line with our hypotheses, DE (EDE-Q) was significantly positively correlated with autistic traits (AQ), ADHD traits (ASRS), and binary gender diversity. Nonbinary gender diversity was not significantly correlated with DE, which contradicted our hypothesis, but we did find DE was significantly positively correlated with both anxiety and depressive symptoms (HADS). Drive for muscularity (DMS) was significantly positively correlated with autistic traits, ADHD traits, and anxiety symptoms, but not with depressive symptoms. In contrast to our hypothesis, binary and nonbinary gender diversity were not significantly positively correlated with drive for muscularity.

Exploratory correlations were performed for people assigned female at birth and male at birth separately (Table 3). Both groups displayed comparable positive correlations between DE and both autistic and ADHD traits. However, the groups differed in their associations between DE, drive for muscularity, and gender diversity. For people assigned male at birth, higher nonbinary gender diversity (i.e. more endorsement of nonbinary traits, such as identifying with a gender that is neither male nor female) was associated with higher levels of DE. Whereas, for people assigned female at birth, higher nonbinary gender diversity was associated with higher levels of drive for muscularity.

Separate hierarchical multiple regressions determined whether gender diversity and neurodivergent traits were unique predictors of DE and drive for muscularity, whilst controlling for relevant demographic covariates in step 1, and anxiety and depressive symptoms at step 2.

The first model predicting DE was significant (Table 4). At step 1, higher levels of ADHD traits and autistic traits were significant independent variables, in line with our hypotheses. In contrast to our hypotheses, we found binary gender diversity was not a significant independent variable in the model, and greater gender diversity and neurodivergent traits did not significant interact to predict increased DE. Female sex assigned at birth was the only other significant independent variable in the model. However, autistic traits were no longer significant once anxiety and depression scores were at step 2. The same pattern of findings was found when binary gender diversity was replaced by nonbinary gender diversity in the model (Table 5).

Table 2. Descriptive statistics for the questionnaires (n = 492).

	Min-Max	Available scores	Mean (SD)	Frequency (%) above threshold
Disordered eating (EDE-Q)	0–5.75	0–6	1.94 (1.38)	55 (11.2)
Restraint	0–6	0–6	1.58 (1.56)	-
Eating Concern	0–6	0–6	1.05 (1.34)	-
Shape Concern	0–6	0–6	2.74 (1.76)	-
Weight Concern	0–6	0–6	2.40 (1.68)	-
Drive for muscularity (DMS)	1–5.21	1–6	1.97 (0.88)	-
Autistic traits (AQ)	0–44	0–50	20.39 (8.45)	54 (11.0)
ADHD traits (ASRS)	0–18	0–18	5.97 (4.50)	38 (7.7)
Anxiety (HADS)	0–21	0–21	7.96 (4.61)	139 (28.3)
Depression (HADS)	0–18	0–21	5.28 (4.07)	62 (12.6)
Gender diversity (GSR)				
Binary	0–1	0–1[a]	0.19 (0.17)	-
Nonbinary	0–0.74	0–1[b]	0.18 (0.21)	-

Note: EDE-Q: Eating Disorder Examination Questionnaire; DMS: Drive for Muscularity Scale; AQ: Autism Spectrum Quotient; ADHD: Attention-deficit Hyperactivity Disorder; ASRS: Adult ADHD Self-Report Scale; HADS: Hospital Anxiety and Depression Scale; GSR: Gender Self-Report.
[a] 0: identity closely aligned with sex assigned at birth, 1: identity closely aligned with sex opposite to that assigned at birth.
[b] 0: no endorsement of nonbinary gender identity, 1: strong endorsement of nonbinary gender identity.

Table 3. Correlations between questionnaire measures for the total sample (n = 492), people assigned female at birth (n = 324), and male at birth (n = 166), separately.

	Disordered eating (EDE-Q)	Drive for muscularity (DMS)	Autistic traits (AQ)	ADHD traits (ASRS)	Binary gender diversity (GSR)	Nonbinary gender diversity (GSR)
Total sample						
Drive for muscularity	.188***					
Autistic traits	.257***	.141**				
ADHD traits	.437***	.223***	.445***			
Binary gender diversity	.104*	−.076	.170***	.142**		
Nonbinary gender diversity	.081	.079	.167***	.184***	.488***	
Anxiety (HADS)	.430***	.115**	.471***	.556***	.123**	.134**

(continued)

Table 3. Continued.

	Disordered eating (EDE-Q)	Drive for muscularity (DMS)	Autistic traits (AQ)	ADHD traits (ASRS)	Binary gender diversity (GSR)	Nonbinary gender diversity (GSR)
Depression (HADS)	.356***	.083	.506***	.404***	.137**	.146***
Assigned female at birth						
Drive for muscularity	.272***					
Autistic traits	.289***	.147**				
ADHD traits	.412***	.225***	.440***			
Binary gender diversity	−.020	.070	.188***	.093		
Nonbinary gender diversity	.010	.160**	.247***	.175**	.489***	
Anxiety	.412***	.138*	.482***	.516***	.010	.111*
Depression	.411***	.057	.473***	.383***	.090	.142*
Assigned male at birth						
Drive for muscularity	.431***					
Autistic traits	.217**	.135				
ADHD traits	.424***	.443***	.477***			
Binary gender diversity	.112	.003	.160*	.105		
Nonbinary gender diversity	.173*	.095	−.015	.160*	.443***	
Anxiety	.390***	.285***	.474***	.611***	.178*	.119
Depression	.294***	.133	.590***	.481***	.230**	.129

Note: EDE-Q: Eating Disorder Examination Questionnaire; DMS: Drive for Muscularity Scale; AQ: Autism Spectrum Quotient; ASRS: Adult ADHD Self-Report Scale; GSR: Gender Self-Report; HADS: Hospital Anxiety and Depression Scale; ADHD: Attention-deficit hyperactivity disorder.
*$p < .05$, **$p < .01$, ***$p < .001$.

These models were repeated in people assigned female and male at birth separately. For people assigned female at birth (Tables S1 and S2 in Supplemental Materials), results were consistent with those reported in Tables 4 and 5. For people assigned male at birth (Tables S3 and S4), ADHD traits were the only significant predictor of DE across Step 1 and 2 in both models.

The first model predicting drive for muscularity was significant (Table 6). Higher levels of ADHD traits, male sex assigned at birth, younger age, and higher level of education were significant independent variables. In addition, a significant interaction between ADHD traits and binary gender diversity was negatively related to drive for muscularity. The pattern of findings remained when anxiety and depression scores were added at step 2.

Table 4. Hierarchical multiple regression of neurodivergent traits, binary gender diverse (GD) traits, interactions between neurodivergent traits and gender diversity, and relevant covariates on disordered eating (EDE-Q).

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
Step 1							
Constant	.173	1.285	2.221	.238		7.355	<.001
ADHD traits	.107	.079	.135	.014	.351	7.485	<.001
Autistic traits	.019	.004	.034	.008	.114	2.475	.014
Binary GD	−.174	−.888	.541	.364	−.022	−.478	.633
Sex[a]	.645	.396	.893	.126	.220	5.099	<.001
Age	−.003	−.012	.005	.004	−.032	−.769	.442
Sexuality	−.067	−.207	.074	.071	−.041	−.934	.451
ADHD traits × Binary GD	−.070	−.227	.088	.080	−.039	−.868	.386
Autistic traits × Binary GD	.024	−.056	.104	.041	.027	.592	.554
R^2	.244						
F	19.01						<.001
Step 2							
Constant	1.047	.526	1.569	.266		3.945	<.001
ADHD traits	.078	.049	.108	.015	.256	5.182	<.001
Autistic traits	.000	−.016	.016	.008	−.001	−.022	.983
Binary GD	−.277	−.974	.421	.355	−.035	−.780	.436
Sex[a]	.625	.379	.872	.125	.214	4.983	<.001
Age	−.003	−.011	.006	.004	−.026	−.632	.528
Sexuality	−.029	−.166	.109	.070	−.018	−.409	.682
ADHD traits × Binary GD	−.040	−.193	.113	.078	−.023	−.513	.608
Autistic traits × Binary GD	.024	−.053	.102	.039	.028	.622	.534
Anxiety	.041	.006	.076	.018	.138	2.328	.020
Depression	.059	.022	.097	.019	.174	3.118	.002
R^2	.292						
F	19.43						<.001

(continued)

Table 4. Continued.

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
ΔR^2	.049						
ΔF	16.213						<.001

Note: EDE-Q: Eating Disorder Examination Questionnaire; ADHD: Attention-deficit Hyperactivity Disorder.
[a] Male = 0, female = 1. Steps were defined in the same hierarchical regression analysis; *B*: unstandardised regression coefficient; CI: confidence interval; *LL*: lower limit; *UL*: upper limit; *SE B*: standard error of the coefficient; **β**: standardised coefficient; R^2: coefficient of determination; ΔR^2: *R* square change; ΔF: *F* value change.

Table 5. Hierarchical multiple regression of neurodivergent traits, nonbinary gender diverse (GD) traits, interactions between neurodivergent traits and gender diversity, and relevant covariates on disordered eating (EDE-Q).

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
Step 1							
Constant	1.770	1.310	2.230	.234		7.558	<.001
ADHD traits	.108	.080	.136	.014	.353	7.543	<.001
Autistic traits	.018	.003	.033	.008	.111	2.393	.017
Nonbinary GD	−.102	−.649	.446	.278	−.016	−.365	.715
Sex[a]	.614	.377	.850	.120	.210	5.101	<.001
Age	−.003	−.012	.006	.004	−.029	−.691	.490
Sexuality	−.069	−.207	.068	.070	−.043	−.990	.323
ADHD traits × Nonbinary GD	−.131	−.265	.004	.069	−.092	−1.905	.057
Autistic traits × Nonbinary GD	.049	−.018	.117	.034	.070	1.438	.151
R^2	.249						
F	19.518						<.001
Step 2							
Constant	1.073	.559	1.588	.262		4.102	<.001
ADHD traits	.079	.049	.109	.015	.258	5.225	<.001
Autistic traits	−.001	−.017	.015	.008	−.006	−.123	.902
Nonbinary GD	−.176	−.708	.356	.271	−.027	−.650	.516
Sex[a]	.580	.346	.814	.119	.198	4.869	<.001

(continued)

Table 5. Continued.

Variable	*B*	95% CI for B		*SE B*	**β**	*t*	*p*
		LL	*UL*				
Age	−.002	−.011	.006	.004	−.023	−.554	.580
Sexuality	−.033	−.167	.101	.068	−.020	−.480	.632
ADHD traits × Nonbinary GD	−.109	−.240	.022	.067	−.076	−1.631	.104
Autistic traits × Nonbinary GD	.053	−.012	.118	.033	.076	1.602	.110
Anxiety	.042	.008	.077	.018	.143	2.420	.016
Depression	.057	.020	.095	.019	.169	3.039	.003
R^2	.297						
F	19.843						<.001
ΔR^2	.048						
ΔF	16.135						<.001

Note: EDE-Q: Eating Disorder Examination Questionnaire; ADHD: Attention-deficit Hyperactivity Disorder.
[a] Male = 0, female = 1. Steps were defined in the same hierarchical regression analysis; *B*: unstandardised regression coefficient; CI: confidence interval; *LL*: lower limit; *UL*: upper limit; *SE B*: standard error of the coefficient; **β**: standardised coefficient; R^2: coefficient of determination; ΔR^2: *R* square change; ΔF: *F* value change.

To explore the significant interaction between ADHD traits and binary gender diversity further, simple slopes for the association between ADHD traits and drive for muscularity were tested for low (−1 SD below the mean), moderate (mean), and high (+1 SD above the mean) levels of binary gender diversity. All tests revealed a significant positive association between ADHD traits and drive for muscularity, but the association was stronger for individuals whose gender identity was more closely aligned with their sex assigned at birth ($B = .059$, SE $B = .010$, $\beta = .305$, $p < .001$), compared to individuals who indicated a moderate ($B = .043$, SE $B = .008$, $\beta = .224$, $p < .001$) or large ($B = .027$, SE $B = .011$, $\beta = .142$, $p = .014$) distance between their gender identity and sex assigned at birth (i.e. more binary gender diversity).

The same pattern was found in the second model, where binary gender diversity was replaced by nonbinary gender diversity (Table 7); however, there were no significant interactions between nonbinary gender diversity and neurodivergent traits.

Additional regression analyses performed separately for people assigned female at birth (Tables S5 and S6) and male at birth (Tables S7 and S8) were generally consistent with those reported in Tables 6 and 7. However, the significant interaction between ADHD traits and binary gender diversity (Table 6) was not present in these samples. Finally, exploratory analyses were conducted to examine correlations between EDE-Q subscales and both neurodivergent traits and gender diversity (Table S9).

Discussion

The present study is the first to examine how neurodivergent and gender diverse traits are associated with DE and drive for muscularity in a general population sample. In line with our expectations, we found higher levels of autistic traits, ADHD traits, and gender diversity were associated with higher levels of DE. For both DE and drive for muscularity, ADHD traits were the only significant independent predictor once internalising symptoms were accounted for. Individuals with higher levels of ADHD traits may engage in DE behaviours and/or drive for muscularity as a way of managing differences in characteristics related to ADHD, such as impulsivity and hyperactivity.

We found positive associations between neurodivergent traits and both DE and drive for muscularity, in line with previous general population studies (Christensen et al., 2019; Galvin et al., 2022; Jacob et al., 2018; Martin et al., 2022). However, our findings that ADHD and autistic traits significantly predicted DE, and ADHD traits significantly predicted drive for muscularity, are novel given previous studies have not examined the unique contributions of different neurodivergent traits on DE or drive for muscularity

Table 6. Hierarchical multiple regression of neurodivergent traits, binary gender diverse (GD) traits, interactions between neurodivergent traits and gender diversity, and relevant covariates on drive for muscularity (DMS).

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
Step 1							
Constant	2.920	2.540	3.299	.193		15.112	<.001
ADHD traits	.038	.021	.055	.009	.199	4.448	<.001
Autistic traits	.005	−.004	.014	.005	.052	1.179	.239
Binary GD	−.038	−.467	.391	.218	−.008	−.175	.861
Sex[a]	−.772	−.921	−.622	.076	−.418	−10.142	<.001
Age	−.018	−.023	−.013	.003	−.271	−6.704	<.001
Sexuality	−.016	−.100	.069	.043	−.015	−.366	.714
Education level	.062	.019	.105	.022	.111	2.826	.005
ADHD traits × Binary GD	−.109	−.205	−.014	.048	−.098	−2.261	.024
Autistic traits × Binary GD	.021	−.028	.069	.025	.037	.841	.401
R^2	.314						
F	23.923						<.001
Step 2							
Constant	2.926	2.511	3.341	.211		13.857	<.001
ADHD traits	.038	.019	.056	.009	.196	4.033	<.001
Autistic traits	.007	−.003	.017	.005	.065	1.333	.183
Binary GD	−.007	−.440	.425	.220	−.001	−.033	.973
Sex[a]	−.789	−.942	−.635	.078	−.428	−10.119	<.001
Age	−.018	−.023	−.012	.003	−.265	−6.515	<.001
Sexuality	−.022	−.107	.063	.043	−.021	−.502	.616
Education level	.062	.019	.105	.022	.112	2.841	.005
ADHD traits × Binary GD	−.109	−.205	−.014	.049	−.098	−2.247	.025
Autistic traits * Binary GD	.020	−.028	.068	.025	.037	.821	.412
Anxiety	.009	−.013	.030	.011	.047	.801	.423
Depression	−.014	−.037	.009	.012	−.065	−1.181	.238

(continued)

Table 6. Continued.

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
R^2	.316						
F	19.680						<.001
ΔR^2	.002						
ΔF	.716						.489

Note: DMS: Drive for Muscularity Scale; ADHD: Attention-deficit Hyperactivity Disorder.
[a] Male = 0, female = 1. Steps were defined in the same hierarchical regression analysis; *B* = unstandardised regression coefficient; CI: confidence interval; *LL*: lower limit; *UL*: upper limit; *SE B*: standard error of the coefficient; β: standardised coefficient; R^2: coefficient of determination; ΔR^2: *R* square change; ΔF: *F* value change.

in the general population. Notably, when we controlled for anxiety and depressive symptoms, only ADHD traits remained a significant predictor. Previous research has proposed several possible explanations for the link between ADHD traits and DE. One hypothesis is that co-occurring anxiety symptoms, which are commonly reported by people with higher levels of ADHD traits (Quenneville et al., 2022), may be driving this association. Indeed, DE has been proposed as a strategy for reducing anxiety symptoms (Godart et al., 2000). However, our findings suggest this association between ADHD traits and DE is still present after controlling for internalising symptoms. An alternative explanation might be that ADHD traits, such as impulsivity and hyperactivity, directly influence DE behaviours. Increased impulsivity, a key characteristic of ADHD (American Psychiatric Association, 2013), has consistently been reported to be positively associated with DE, especially binge eating behaviours, in individuals with and without ADHD (Kaisari et al., 2017; Nickel et al., 2019). Although previous research has not investigated the link between drive for muscularity and ADHD traits, there is evidence to suggest that individuals with ADHD report higher levels of exercise fixation than individuals who not have ADHD, which is associated with higher levels of hyperactivity (Popat et al., 2023). It is possible that individuals with higher levels of ADHD traits engage in exercise as a way of coping with elevated hyperactivity. For some individuals, engaging in these behaviours may become problematic if they develop a dependence on exercise and the resulting body shape changes, such as increased muscularity. However, caution is needed when interpreting these findings as longitudinal research is required to examine these hypothesised causal pathways.

Although we found autistic traits to be positively associated with DE, they were not a significant predictor. This suggests that autistic traits may not directly contribute to the presence of DE once internalising symptoms are controlled for. Instead, autistic traits may have an indirect effect on DE through ADHD traits, depression, anxiety, and/or emotion regulation difficulties, as highlighted in previous general population studies (Giles et al., 2021; Mansour et al., 2016). However, due to our unitary measure of autistic traits, we can only conclude that combined autistic traits do not directly contribute to DE. One possibility is that certain autistic traits are more strongly related to DE than others. For example, sensory sensitivities and rigidity, both found across a range of neurodivergent conditions and mental health diagnoses, have been linked with increased DE (Zickgraf et al., 2022), suggesting these may be potential transdiagnostic markers.

In contrast to our hypothesis, nonbinary gender diverse traits (i.e. endorsement of a gender identity that is neither female nor male) were not a correlate of DE, whereas binary gender diverse traits (i.e. endorsement of a gender identity that is opposite to their sex assigned at birth) were a correlate but not an independent predictor of DE. Previous literature has found gender diverse people to be particularly vulnerable to developing eating disorders (Diemer et al., 2018; Nagata et al., 2022; Uniacke et al., 2021); however, neurodivergence was not controlled for in these studies. Our findings suggest that the presence of gender diverse traits per se do not confer independent risk for DE. However, this does not preclude that difficulties/distress associated with gender diversity (e.g. gender dysphoria: psychological distress resulting from incongruence between one's gender identity and sex assigned at birth; American Psychiatric Association, 2013) may be associated with an increased eating disorder risk. We were specifically interested in recruiting a general population sample to investigate dimensional relationships been gender diversity, neurodivergence, and DE, rather than investigating levels of DE and neurodivergent traits in a purposively recruited sample of gender diverse people. However, this meant that our general population sample largely identified as

Table 7. Hierarchical multiple regression of neurodivergent traits, nonbinary gender diverse (GD) traits, interactions between neurodivergent traits and gender diversity, and relevant covariates on drive for muscularity (DMS).

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
Step 1							
Constant	2.957	1.310	2.230	.194		15.240	<.001
ADHD traits	.039	.080	.136	.009	.200	4.466	<.001
Autistic traits	.004	.003	.033	.005	.043	.956	.340
Nonbinary GD	.206	−.649	.446	.170	.050	1.216	.225
Sex[a]	−.789	.377	.850	.073	−.428	−10.852	<.001
Age	−.018	−.012	.006	.003	−.272	−6.699	<.001
Sexuality	−.038	−.207	.068	.042	−.037	−.909	.364
Education level	.062			.022	.112	2.833	.005
ADHD traits × Nonbinary GD	−.050	−.265	.004	.041	−.056	−1.208	.228
Autistic traits × Nonbinary GD	.023	−.018	.117	.021	.051	1.093	.275
R^2	.311						
F	23.603						<.001
Step 2							
Constant	2.951	.559	1.588	.212		13.941	<.001
ADHD traits	.037	.049	.109	.009	.194	3.978	<.001
Autistic traits	.006	−.017	.015	.005	.055	1.124	.262
Nonbinary GD	.222	−.708	.356	.170	.054	1.303	.193
Sex[a]	−.806	.346	.814	.074	−.437	−10.859	<.001
Age	−.018	−.011	.006	.003	−.265	−6.485	<.001
Sexuality	−.044	−.167	.101	.043	−.043	−1.028	.305
Education level	.062			.022	.112	2.843	.005
ADHD traits × Nonbinary GD	−.052	−.240	.022	.042	−.058	−1.262	.208
Autistic traits × Nonbinary GD	.023	−.012	.118	.021	.052	1.101	.271
Anxiety	.011	.008	.077	.011	.058	.996	.320
Depression	−.015	.020	.095	.012	−.071	−1.299	.194

(continued)

Table 7. Continued.

Variable	*B*	95% CI for B		*SE B*	β	*t*	*p*
		LL	*UL*				
R^2	.313						
F	19.469						<.001
ΔR^2	.003						
ΔF	.907						.405

Note: DMS: Drive for Muscularity Scale; ADHD: Attention-deficit Hyperactivity Disorder.
[a] Male = 0, female = 1. Steps were defined in the same hierarchical regression analysis; *B*: unstandardised regression coefficient; CI: confidence interval; *LL*: lower limit; *UL*: upper limit; *SE B*: standard error of the coefficient; β: standardised coefficient; R^2: coefficient of determination; ΔR^2: *R* square change; ΔF: *F* value change.

cisgender with low levels of variance in gender diverse traits. This may have negatively impacted on the accuracy of the estimated relationship between gender diverse traits and DE in the regression analyses. Purposive sampling of people who have greater variability in gender diverse traits may provide a more accurate picture of this relationship. Given gender diversity may be less prevalent in the general population than neurodivergence (Di Grazia et al., 2021; Goodman et al., 2019; Thomas et al., 2015; Zeidan et al., 2022), future research with people who identify as gender diverse may help disentangle the relations between eating disorders, gender diversity, and neurodivergence.

A strong element of our design is that we additionally looked at the pattern of data for people assigned female or male at birth separately. This is important as the socio-cultural influences on eating behaviours and body image on people who want to appear more gender-neutral or to align with the opposite gender to their assigned sex at birth will be different for these two groups, even if the underlying desire for divergence from sex assigned at birth is the same. We found greater endorsement of a nonbinary gender identity was positively associated with DE in people assigned male at birth, whereas in people assigned female at birth it was positively associated with drive for muscularity. Although our findings differ from the majority of studies with nonbinary people that report similar levels of DE and drive for muscularity in those assigned either male or female at birth (Cusack & Galupo, 2021; Roberts et al., 2021; Zamantakis & Lackey, 2022), it is notable that these studies all include a nonbinary sample that is heavily biased towards those assigned female at birth. When examining nonbinary gender diverse traits, our pattern of findings aligns with expectations based on the socio-cultural norms of body image in Western cultures. For example, for nonbinary people assigned female at birth, an increased drive for muscularity may be expected given that muscularity is attributed with a more masculine physique (Lavender et al., 2017) and would lead to a more gender neutral or androgynous appearance. Similarly, for nonbinary people assigned male at birth, DE has a stronger cultural resonance among females in Western cultures (Thompson & Stice, 2001), so engaging in these behaviours may also reflect socio-cultural influences on someone wishing to distance themselves from a male identity. However, further research is needed to explore the relations between sex assigned at birth and DE within gender diverse populations.

The current study has several other strengths, such as the examination of both DE and drive for muscularity, which are often only considered in isolation but are found to display overlapping behaviours and cognitions (Cunningham et al., 2022; Griffiths et al., 2013; Kelley et al., 2010). By using a multi-dimensional measure of gender diversity, we were able to provide a more nuanced examination of the relations between gender diversity, neurodivergence, and both DE and drive for muscularity. This is important given previous studies with gender diverse people have found differences in DE and eating disorder risk between those who identify with binary trans identities compared to nonbinary trans identities (Diemer et al., 2018; Romano & Lipson, 2022). Notably, given the aim of our study was to examine relations between dimensional traits in the general population, our sample is largely representative of the general population. Specifically, the population is representative in regard to the proportion of individuals reporting a neurodivergent condition (Langley et al., 2023) or ED diagnosis (Beat, n.d.), as well as mean scores on the EDE-Q (Carey et al., 2019), AQ (Ruzich et al., 2015), and ASRS (Silverstein et al., 2017).

Despite a range of strengths, the cross-sectional and correlational design is an important limitation, meaning we are unable to make any causal inferences from the data. Future studies using longitudinal designs would extend these findings and enable us to examine the temporal relations between neurodivergence, gender diversity, and the

development of eating pathology. Additional measures of DE may be useful to include to capture a wider spectrum of eating behaviours. For example, recent studies have reported links between avoidant/restrictive food intake disorder (ARFID) and autism and ADHD (Archibald & Bryant-Waugh, 2023; Bourne et al., 2020). However, it is not clear whether ARFID is also frequently reported in gender diverse individuals. It is also important for future research to consider how different types of eating pathology may be related to autistic and ADHD traits. ADHD traits have been found to be more predictive of binge-purge-type eating behaviours compared to restrictive-type eating behaviours (Kaisari et al., 2017; Nickel et al., 2019); whereas, higher levels of autistic traits are typically reported by individuals with anorexia nervosa and restrictive-type eating behaviours (Dell'Osso et al., 2018; Nickel et al., 2019). This may suggest that ADHD traits and autistic traits are predictive of specific eating behaviours, requiring more nuanced and fine-grained measures of these behaviours and cognitions.

Overall, our findings demonstrate higher levels of autistic traits, ADHD traits, and gender diversity are associated with higher levels of DE in the general population. We found non-binary gender diversity was associated with higher levels of drive for muscularity in people assigned female at birth, but with higher levels of disordered eating in people assigned male at birth. Notably, ADHD traits were the only independent predictor of DE and drive for muscularity, when co-occurring internalising symptoms were accounted for. Our findings highlight the need for research to consider both ADHD and autistic traits when examining relations with gender diversity, disordered eating, and drive for muscularity in the general population. Further, the sex assigned at birth differences highlight the importance of considering these two groups separately. Although further work is needed to replicate our findings and examine underlying mechanisms, our research provides new evidence on the intersections of gender diversity, neurodivergence, and eating and body image pathology in the general population.

Data availability: Data are available at https://osf.io/v5234/.

Consent to participate: Informed consent was obtained online from participants before completing the questionnaires.

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