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Research paper

The classification of body dysmorphic disorder symptoms in male and female adolescents

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ABSTRACT

Background: Body dysmorphic disorder (BDD) was categorised in *DSM-5* within the newly created 'obsessive-compulsive and related disorders' chapter, however this classification remains subject to debate. Confirmatory factor analysis was used to test competing models of the co-occurrence of symptoms of BDD, obsessive-compulsive disorder, unipolar depression, anxiety, and eating disorders in a community sample of adolescents, and to explore potential sex differences in these models.

Methods: Self-report questionnaires assessing disorder symptoms were completed by 3149 Australian adolescents. The fit of correlated factor models was calculated separately in males and females, and measurement invariance testing compared parameters of the best-fitting model between males and females.

Results: All theoretical models of the classification of BDD had poor fit to the data. Good fit was found for a novel model where BDD symptoms formed a distinct latent factor, correlated with affective disorder and eating disorder latent factors. Metric non-invariance was found between males and females, and the majority of factor loadings differed between males and females. Correlations between some latent factors also differed by sex.

Limitations: Only cross-sectional data were collected, and the study did not assess a broad range of *DSM-5* defined eating disorder symptoms or other disorders in the *DSM-5* obsessive-compulsive and related disorders chapter.

Conclusions: This study is the first to statistically evaluate competing models of BDD classification. The findings highlight the unique features of BDD and its associations with affective and eating disorders. Future studies examining the classification of BDD should consider developmental and sex differences in their models.

1. Introduction

The classification of body dysmorphic disorder (BDD) has been the subject of increasing research interest in the past two decades. As BDD is poorly understood and frequently misdiagnosed (Phillips and Feusner, 2010), its classification may have important academic and practical implications, for example, with regard to screening in the presence of related disorders, improved clinical decision making, development of interventions, or understanding of aetiological factors (Abramowitz and Jacoby, 2015; First et al., 2004; Phillips and Stein, 2015; Phillips et al., 2010). Although classified as a somatoform disorder in *DSM-III-R* and *DSM-IV* (American Psychiatric Association, 1987, 1994), BDD has long been conceptualised as related to obsessive-compulsive disorder (OCD) as part of an '*obsessive-compulsive spectrum*' of disorders (Phillips et al., 1995). Studies have found that BDD and OCD share core disorder features, have elevated comorbidity in clinical samples, increased family history, and similarities in treatment response (Abramowitz and Jacoby, 2015; Bienvenu et al., 2012; Kelly and Phillips, 2011; Phillips et al., 2010). Accordingly, in *DSM-5* (American Psychiatric Association, 2013), BDD was included in a new 'obsessive-compulsive and related disorder' (OCRD) category, alongside OCD, hoarding, trichotillomania, excoriation, and several other specified and unspecified OCRD diagnoses.

However, the classification of BDD in DSM-5 has faced criticism. A recent review by Frías et al. (2015) highlighted a number of methodological limitations of studies linking BDD and OCD, including the

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lack of control groups in comorbidity studies, reliance on samples recruited from specialised clinics, and limited information on specific aetiological pathways. Further, the authors concluded that the evidence reviewed might in fact support a closer association between BDD and social anxiety disorder than between BDD and OCD. Abramowitz and Jacoby (2015) argued that BDD and OCD are more meaningfully related to anxiety disorders than to other OCRDs regarding the function of core symptoms, comorbidity, familial disorder patterns, and treatment response. Indeed, BDD is strongly associated with anxiety and unipolar depression across important domains including comorbidity, family history, disorder course, and cognitive biases (Abramowitz and Jacoby, 2015; Fang and Hofmann, 2010; Frías et al., 2015; Kelly et al., 2013; Phillips and Stout, 2006). These studies support an alternate conceptualisation of BDD as part of a broader '*affective spectrum*' that also includes anxiety, OCD, and unipolar depression (Phillips et al., 1995).

Other researchers have focused on the relationship between BDD and eating disorders, as these disorders are associated in their clinical features, onset and course, and cognitive biases (Cororve and Gleaves, 2001; Hartmann et al., 2013; Rosen and Ramirez, 1998). It has thus been proposed that BDD and eating disorders may form a separate '*body image spectrum*' of disorders (Cororve and Gleaves, 2001; Phillipou et al., 2017). However, as OCD and eating disorders are also associated (Phillips and Kaye, 2007), this may instead indicate that BDD, OCD, eating disorders, anxiety, and depression all belong to a single overall '*internalising spectrum*'.

While each of these theories regarding the classification of BDD has some empirical support, no prior study has directly compared competing models of BDD classification. Of the different validators used to guide classification decisions in *DSM-5* (American Psychiatric Association, 2013), comorbidity between BDD and associated disorders has been the most widely examined. Statistical techniques such as confirmatory factor analysis (CFA) of disorder co-occurrence have been used to directly compare the fit of theorised classification models to observed data, and such studies have resulted in significant advances to the understanding of the structure of psychopathology. For example, an influential CFA study by Krueger et al. (1998) identified two stable higher order dimensions (also known as latent factors) across disorders that corresponded with the internalising and externalizing syndromes identified in youth by Achenbach and Edelbrock (1984). Sustained research efforts have expanded such dimensional models of psychopathology to include uncommon mental disorders, thought disorders, and personality disorders (Forbush and Watson, 2013; Markon, 2010), and challenge current models of disorder classification (Kotov et al., 2017). For an overview of conceptual issues and future directions of such research, see Kotov et al. (2017) or Krueger and Markon (2006). Findings from these studies suggest several important issues to consider when using CFA to compare models of BDD classification.

First, some studies indicate the potential for developmental differences in the structure of psychopathology. Lahey et al. (2008) found that a dimensional model of psychopathology was appropriate for children and adolescents, but the factors were more highly correlated among children. Wittchen et al. (2009) reported that a theoretical classification model that fit well in adolescents and young adults did not fit adequately in children and older adults. Waszczuk et al. (2014) found differential associations between symptoms of depression and anxiety in children, adolescents, and young adults. Although further research is needed to establish whether such differences are robust and meaningful, these studies suggest that the structure of psychopathology may differ across developmental groups. As BDD typically begins during adolescence (Bjornsson et al., 2013), the current study will focus on the classification of BDD at this time of peak disorder onset. CFA is an appropriate tool for modelling comorbidity in adolescents, and has supported the inclusion of OCD, anxiety, depression, and eating disorders in an internalising spectrum of disorders (Beesdo-Baum et al., 2009; Blanco et al., 2015; Kessler et al., 2012; Lahey et al., 2008; Wittchen et al., 2009). However, as current theoretical BDD models are primarily derived from adult research, it is unclear how well they will fit in an adolescent sample. The current study will therefore include a novel model, where BDD symptoms form their own factor, correlated with separate affective and eating disorders factors.

Second, most adolescent studies have involved categorical analyses of the diagnostic status of a disorder. This approach relies on the application of validated thresholds to determine disorder status (Carragher et al., 2016). However, measures assessing BDD have rarely been evaluated in adolescents and thus do not have well-validated cut-points. Further, categorical approaches ignore the potential importance of subthreshold disorder presentations (Roberts et al., 2015). The current study will thus examine the relationships between symptoms, not diagnostic status.

Third, sex differences have been observed in child and adolescent studies in the strength of the association between particular disorders and their latent factor (Lahey et al., 2008), and in overall internalising factor scores (Carragher et al., 2016; Caspi et al., 2014). Hence, while sex differences are not part of the theoretical models of BDD, fitting the models separately for males and females may provide sex-specific information about disorder associations.

Fourth, previous CFA studies suggest that models of affective disorders such as anxiety and depression may show the best fit when lower-order fear and distress factors are identified (Beesdo-Baum et al., 2009; Blanco et al., 2015; Kessler et al., 2012; Wittchen et al., 2009). However, as this structure is not always observed (Lahey et al., 2008), the utility of identifying these factors will be assessed prior to fitting the BDD classification models.

Finally, when seeking to model comorbidity between disorders, clinical samples will not be representative of the general population (Angold et al., 1999). This may be particularly true for BDD, where access to appropriate mental health services is low (Buhlmann et al., 2010; Marques et al., 2011; Schneider et al., 2016) and misdiagnosis is common (Grant et al., 2001; Veale et al., 2015). Therefore, the classification of BDD will be examined in a community sample.

1.1. The current study

The aim of the current study was to use CFA to test competing models of the classification of BDD in relation to OCD, anxiety, depression, and eating disorders among adolescents. Fig. 1 presents the models that were selected for CFA testing, though for simplicity of presentation, correlations among factors and item residual variances are not depicted. In *Model 1*, BDD is part of a single unidimensional internalising factor that also includes OCD, anxiety, depression, and eating disorders. In *Model 2*, BDD is part of an affective spectrum of disorders that includes anxiety, depression, and OCD, with a separate correlated eating disorders factor. In *Model 3*, BDD and eating disorders form a body image spectrum of disorders that is correlated with an affective disorders factor that includes anxiety, depression, and OCD. In *Model 4*, BDD and OCD form an obsessive-compulsive spectrum factor that is correlated with separate affective and eating disorders factors. Finally, *Model 5* tests the novel hypothesis that BDD forms a separate factor that is correlated with affective disorders and eating disorders factors. Initial analyses will evaluate the utility of anxiety and depression symptoms being modelled as a single factor, or as separate fear and distress factors. The study will then test the fit of each model of the classification of BDD. As prior adolescent studies have found sex differences in models of psychopathology, models will be fit separately for males and females, and the measurement invariance of model fit parameters will be examined in the best fitting model.

2. Method

2.1. Participants

Participants were adolescents recruited from seven high schools in

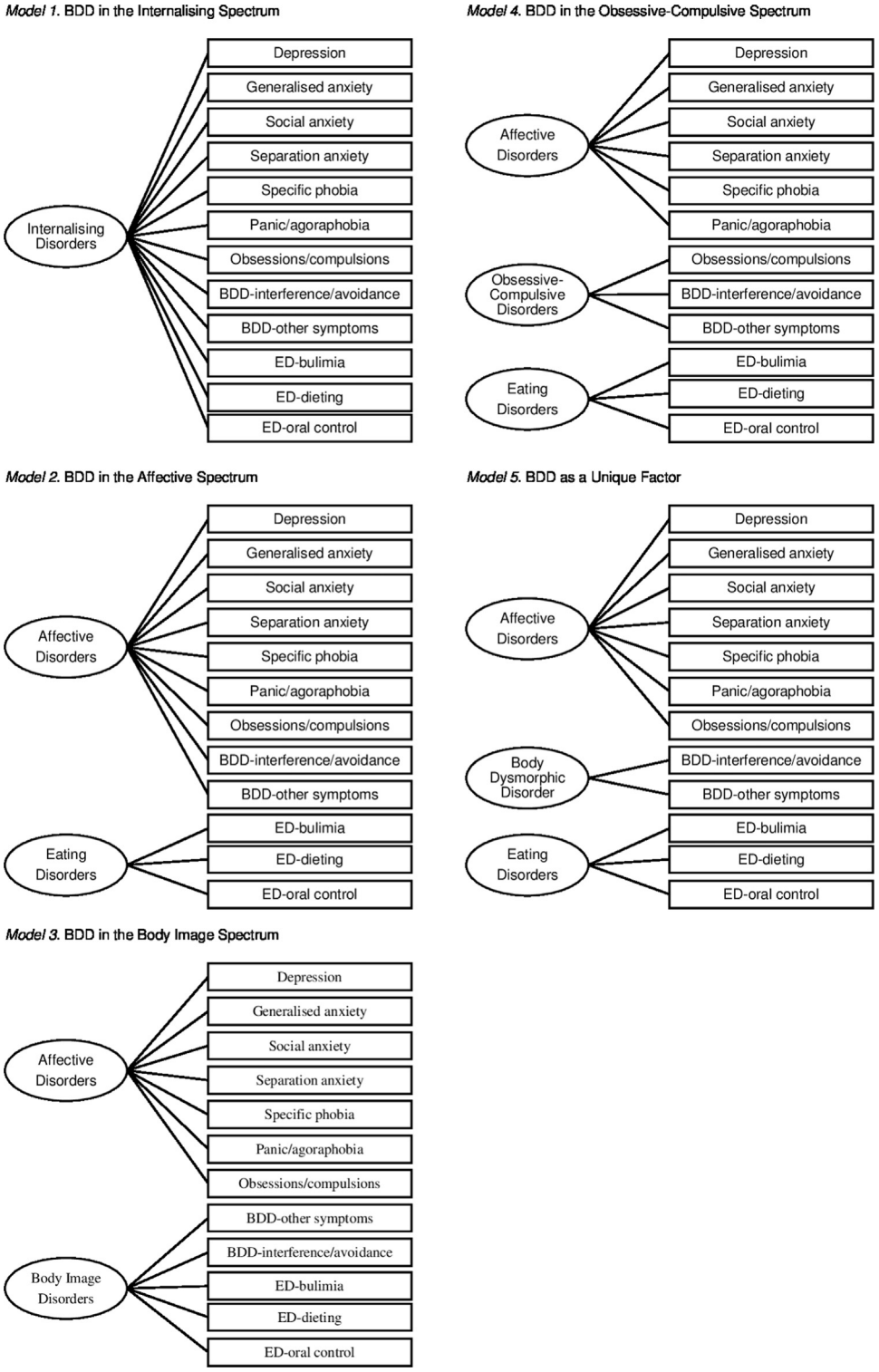

Fig. 1. Models of the classification of BDD symptoms.

the Greater Sydney area of New South Wales, Australia. Four boys' schools were involved in a study examining utilisation of an online treatment program for anxiety and depression, whereas three girls' schools were involved in a different study examining the longitudinal development and prevention of anxiety and depression. Questionnaires were administered in batteries developed for each study. A total of 5005 students were enrolled in eligible school grades at the time of testing, and 3149 (response rate of 62.9%) consented and provided a valid response to the BDD questionnaire. Data from these participants have been reported in previous studies on the prevalence and correlates of BDD (Schneider et al., 2016a; Schneider et al., 2017a, b; Schneider et al., 2016b).

Of the participating students, 2000 were male (63.5%, M_{age} = 14.71, SD = 1.34) and 1149 were female (36.5%, M_{age} = 14.36, SD = 1.39). School-level scores on the index of community socio-educational advantage (ICSEA; Australian Curriculum and Assessment Reporting Authority, 2013) indicated that participants came from schools with above-average socio-educational advantage (ICSEA of all Australian schools; M = 1000.00, SD = 100.00, current study male ICSEA; M = 1048.13, SD = 38.01, range = 1002.00–1105.00, female ICSEA; M =

1169.72, *SD* = 42.86, range = 1092.00–1201.00).

Additional demographic questions were completed by a subset of participants (*n* = 2335, 74.2%). For both males and females, English was the main language spoken at home (91.5/90.5%), most lived in a two-parent home (79.1/80.8%), and the cultural background of their parents was predominantly Oceanian (mothers = 36.9/42.5%, fathers = 37.2/41.8%) or European (mothers = 42.4/34.0%, fathers = 37.2/41.8%). Parents typically worked as managers or skilled professionals (mothers = 46.9/47.8%, fathers = 47.4/72.0%).

2.2. Procedure

Assessment sessions took place in class or year groups during school time, supervised by members of the research team, and teachers where available. Responses were collected confidentially using de-identified alphanumeric codes and participants were informed that confidentiality would be maintained unless their responses indicated serious risk of harm, such as current suicidal ideation or evidence of abuse. The research was approved by the Human Research Ethics Committee of Macquarie University and the governing body of each school. Consent to the current study was provided as part of the larger study of emotional health conducted at each school. Parents received written information and consent forms, and students were informed about the program using presentations to class groups or assemblies. At boys' schools, parents filled in a form to opt out if they did not wish their child to participate. If parents did not opt out, an online consent form was provided to all male students to give active consent. At girls' schools, parents provided written consent to opt in to the research. Students then had the opportunity to opt out of testing verbally.

2.3. Measures

Body dysmorphic disorder symptoms were assessed using an adaptation of the Body Image Questionnaire-Child and Adolescent Version (BIQ-C; Veale, 2009). A previous study by our research team led to the development of a revised 9-item version of the measure assessing two factors: 'interference and avoidance' and 'other symptoms' (Schneider et al., 2016a). This is referred to as the BIQ-C-9 to distinguish it from the original measure. An initial screening item establishes the presence of any appearance concerns. If no concerns were present, the participant did not answer further questions and received a total score of 0. All other participants described up to five body areas of concern and then answered 9 items about BDD symptoms. Each item has a tailored response format scored from 0 to 8, with higher scores indicating greater symptom severity (after reverse-scoring of three items). For example, the item "How much is your feature(s) on your mind? That is, you think about it a lot and it is hard to stop thinking about it?" is scored from 0 (*never on my mind*) to 8 (*always on my mind*). In the current study, internal consistency for males/females for total BIQ-C-9 scores were Cronbach's α = .84/.89, interference and avoidance factor α = .71/.78, and the other symptoms factor α = .76/.84.

Anxiety symptoms were assessed using the Spence Children's Anxiety Scale (SCAS; Spence, 1998). It contains 38 items assessing symptoms of OCD, generalised anxiety disorder, panic and agoraphobia, social anxiety, separation anxiety, and specific phobias (limited to physical injury-related fears). Participants rate the frequency of items such as "I worry about things" from 0 (*never*) to 3 (*always*). The scale has strong psychometric properties, with support found for the six factor model, good internal consistency (total scale α = .92, subscale α = .60–.80), convergent and divergent validity, and modest test-retest reliability (Spence et al., 2003). In this study, internal consistency for males/females for obsessive-compulsive symptoms was α = .78/.80, generalised anxiety α = .79/.82, panic-agoraphobia α = .83/.85, social anxiety α = .77/.77, separation anxiety α = .71/.67, and specific phobia of physical injury α = .60/.49.

Symptoms of depression were measured using the Short Mood and Feelings Questionnaire (SMFQ; Angold et al., 1995). This 13 item measure assesses depressive symptoms (e.g., "I cried a lot") over the over the past two weeks such on a 3-point scale, from 0 (*not true*) to 2 (*true*). The SMFQ correlates well with diagnostic measures of depression and discriminates between depressed and non-depressed individuals (Angold et al., 1995). It has strong internal consistency (α = .84–90; Angold et al., 2002; Rhew et al., 2010). In this study, internal consistency was α = .90 for males and α = .91 for females.

The child version of the 26-item Eating Attitudes Test (ChEAT-26; Maloney et al., 1988) was used to measure disordered eating attitudes and behaviours found in the eating disorders anorexia nervosa and bulimia nervosa. Key attitudes assessed include fear of being fat and food preoccupation e.g., "I am scared about being overweight", whereas key behaviours assessed include dietary restriction and purging. Consistent with the recommendations of Anton et al. (2006), items were scored using a 6-point response scale from 0 (*never*) to 5 (*always*) in order to increase scoring variance and reduce skew. The item 'I enjoy trying new rich foods' was reverse scored (Garner et al., 1982). The internal consistency of the total scale has been found to be good in previous population-based studies of adolescents (α = .86–.87; Rojo-Moreno et al., 2011; Smolak and Levine, 1994). Though alternate factor structures of the ChEAT-26 have been explored in adolescents (Anton et al., 2006; Rojo-Moreno et al., 2011), the original three-factor structure from the adult version of the questionnaire (Garner et al., 1982) was found to perform adequately in preliminary analysis and was therefore employed in the current study. Internal consistency for males/females in the current study were α = .79/.80 for bulimia, α = .90/.93 for dieting, and α = .76/.73 for oral control.

2.4. Data analysis

CFA was conducted using Mplus version 6.12. Each indicator variable was freely estimated, the mean of each latent factor was set at 0, and the factor variance set at 1. As symptom subscale scores were continuous and not normally distributed, robust maximum likelihood (MLR) estimation with Satorra-Bentler scaled chi-square test of model fit (SBχ^2) was used (Rhemtulla et al., 2012). Evaluation of model fit was based on the criteria of Hu and Bentler (1999) supplemented by Brown (2015): root mean-square error of estimation (RMSEA) ≤ .08 indicated adequate fit (≤ .06 good), comparative fit index (CFI) and Tucker-Lewis index (TLI) ≥ .90 indicated adequate fit (≥ .95 good), and standardised root mean-square residual (SRMR) ≤ .08 indicated good fit. The Akaike information criterion and (AIC) and Bayesian information criterion (BIC) were also considered for each model. When comparing models, smaller AIC and BIC values are preferred, a change in BIC > 10 indicates a very strong support for the model with the smaller BIC (Raftery, 1995).

The initial stage of model testing examined the correlations between the proposed affective disorders factors of distress (depression and generalised anxiety scores) and fear (social anxiety, separation anxiety, specific phobias, and panic/agoraphobia scores). Following Brown (2015), a correlation between these factors ≥ .85 supported the use of a single underlying factor, providing that the overall model fit was not substantially poorer for the single factor model.

Competing models of the classification of BDD were then tested. If the same model provided the best fit for males and females, multi-group confirmatory factor analysis was used to assess measurement invariance. This involved placing increasingly restrictive equality constraints on families of parameters and determining whether the addition of each constraint resulted in a model with significantly poorer fit than the previous less constrained model (Brown, 2015). Following the recommendations of Sass et al. (2014) and Chen (2007), measurement invariance was indicated by a non-significant chi-square difference test ($\Delta\chi^2$), change in CFI (ΔCFI) > −.01, change in RMSEA (ΔRMSEA) < .015, change in SRMR (ΔSRMR) < .03 for tests of factor loading invariance, and ΔSRMR < .01 for tests of intercept invariance.

Table 1
Bivariate correlations (Spearman's Rho) between symptom measures for males (above the diagonal) and females (below the diagonal).

	BDD-IA	BDD-OS	Depression	GAD	Social	Separation	Specific	Panic/Ag	OCD	ED-BU	ED-DI	ED-OC
BDD-IA	–	.92	.37	.33	.37	.24	.20	.28	.27	.22	.26	.22
BDD-OS	.87	–	.37	.34	.36	.23	.20	.26	.26	.23	.25	.21
Depression	.50	.50	–	.57	.55	.43	.32	.52	.51	.32	.28	.31
GAD	.42	.43	.62	–	.65	.55	.41	.58	.58	.28	.24	.30
Social	.44	.44	.57	.64	–	.50	.42	.50	.51	.25	.23	.31
Separation	.27	.25	.39	.58	.50	–	.37	.49	.51	.25	.27	.25
Specific	.17	.17	.26	.39	.35	.44	–	.43	.36	.19	.17	.20
Panic/Ag	.35	.34	.57	.69	.53	.52	.44	–	.52	.27	.23	.28
OCD	.31	.32	.55	.64	.52	.52	.33	.60	–	.32	.30	.31
ED-BU	.44	.48	.43	.33	.31	.18	.13	.32	.32	–	.47	.47
ED-DI	.54	.59	.41	.33	.37	.20	.14	.30	.31	.64	–	.45
ED-OC	.29	.30	.33	.31	.28	.21	.21	.32	.34	.39	.45	–

Note. All correlations were significant, p < .001, BDD = Body dysmorphic disorder, IA = Interference and avoidance, OS = Other BDD symptoms, GAD = Generalised anxiety disorder, Social = Social anxiety disorder, Separation = Separation anxiety disorder, Specific = Specific phobia relating to physical injury, Panic/Ag = Panic disorder and agoraphobia, OCD = Obsessive-compulsive disorder, ED = Eating disorder, BU = Bulimia, DI = Dieting factor, OC = Oral control.

3. Results

Bivariate correlations (Spearman's Rho) between study measures, by sex, are given in Table 1.

3.1. Utility of lower-order fear and distress factors

We first examined whether symptoms of anxiety and depression should be divided into fear (social anxiety, separation anxiety, specific phobias, and panic/agoraphobia scores) and distress (depression and generalised anxiety) factors. The correlation between the fear and distress factors was very high (males = .97, females = .98), and model fit was not poorer when employing a single-factor model (see Table S1). These findings supported the use of a single underlying latent affective disorders factor (Brown, 2015), so lower-order fear and distress factors were not identified in subsequent models.

3.2. Evaluation of models of the classification of BDD

Goodness-of-fit parameters for classification models 1–5 (as presented in Fig. 1) are presented in Table 2, and factor loadings are presented in Table 3. Theoretically guided models 1–4 did not provide good fit to the data. Model 5, where BDD formed its own factor, had good model fit and all factor loadings were positive and salient. Model 5 thus represented the best fit to the observed data. Standardised factor loadings and inter-factor correlations of Model 5 are presented in Table 4.

3.3. Cross-sex measurement invariance of model 5

Measurement invariance testing was conducted to explore the equivalence of Model 5 parameters for males and females. The configural invariance model showed adequate fit (SB χ^2 = 813.546, *df* = 102, $p < .0001$, CFI = .951, RMSEA = .067 [90% CI = .062, .071], SRMR = .044.), indicating that males and females had equivalent numbers of factors and patterns of indicator-factor loadings. Metric invariance was then examined; SBχ^2 = 1017.16, *df* = 111, $p < .0001$, CFI = .938, RMSEA = .072 [90% CI = .068, .076], SRMR = .062. The chi-square difference test was significant (ΔSBχ^2 = 183.369, *df* = 9, $p < .0001$) and ΔCFI = −.013, thus constraining the factor loadings to equivalence produced a model with significantly poorer fit. Partial metric models (Byrne et al., 1989) were explored by freeing individual factor loadings with the highest modification indices, but no partial metric model provided adequate fit. Evaluation of the confidence intervals of the model parameters (Table 4) indicated that 8/12 factor loadings and 2/3 factor correlations differed significantly by sex. Females reported higher factor loadings for generalised anxiety, panic and agoraphobia, and eating disorders-dieting, and higher factor correlations between BDD and affective disorders, and between BDD and eating disorders. Males reported higher loadings for BDD-interference and avoidance, separation anxiety, social anxiety, specific phobia, and eating disorders-oral control.

4. Discussion

This is the first study to use CFA to compare different models of the classification of BDD symptoms, and one of few to consider developmental and sex differences in the structure of psychopathology. Prior to

Table 2
Goodness-of-fit evaluation for BDD classification models 1–5.

Model	Sex	SBχ^2	*df*	RMSEA [90% CI]	CFI	TLI	SRMR	AIC	BIC
1. Internalising spectrum	Male	2907.729	54	.163 [.158, .168]	.656	.580	.110	122301.20	122502.83
	Female	1852.598	54	.170 [.164, .177]	.703	.637	.105	76603.97	76785.65
2. Affective spectrum	Male	1887.239	53	.132 [.126, .137]	.779	.725	.079	120998.90	121206.14
	Female	1336.941	53	.145 [.139, .152]	.788	.736	.095	75999.84	76186.57
3. Body image spectrum	Male	1546.790	53	.119 [.114, .124]	.820	.776	.114	120508.49	120715.72
	Female	749.977	53	.107 [.100, .144]	.885	.857	.067	75265.29	75452.02
4. Obsessive-compulsive spectrum	Male	2022.670	51	.139 [.134, .144]	.762	.693	.074	120929.37	121147.80
	Female	901.613	51	.120 [.114, .127]	.860	.818	.109	75458.07	75654.89
5. BDD as a separate factor	Male	428.643	51	**.061 [.056, .066]**	**.954**	**.941**	**.036**	118936.70	119155.14
	Female	381.932	51	**.075 [.068, .082]**	**.945**	**.929**	**.056**	74832.14	75028.96

Note. Bold text indicated acceptable model fit according to the relevant criteria. SBχ^2 = Satorra-Bentler adjusted chi-square, *df* = Degrees of freedom, RMSEA = Root mean-square error of approximation, CI = Confidence interval, CFI = Comparative fit index, TLI = Tucker-Lewis index, SRMR = Standardised root mean-square residual, AIC = Akaike information criterion, BIC = Bayesian information criterion.

Table 3
Standardised factor loadings and factor correlations for models 1–5.

Model	1		2		3		4		5	
Sex	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Standardised factor loading										
Depression	.732	.753	.731	.741	.722	.717	.730	.716	.722	.717
Generalised anxiety disorder	.815	.838	.826	.861	.834	.880	.832	.884	.831	.880
Panic disorder and agoraphobia	.782	.792	.785	.809	.790	.828	.787	.821	.791	.828
Specific phobia (physical injury)	.560	.473	.562	.486	.569	.502	.565	.503	.570	.502
Separation anxiety disorder	.727	.630	.728	.651	.737	.672	.729	.662	.739	.672
Social anxiety disorder	.752	.724	.759	.731	.758	.724	.764	.731	.756	.723
Obsessive-compulsive disorder	.747	.736	.748	.746	.752	.757	**.751**	**.440**	.754	.757
BDD-interference/avoidance	.488	.618	.479	.583	**.918**	**.861**	**.550**	**.881**	**.921**	**.877**
BDD-other symptoms	.493	.625	.484	.588	**.911**	**.889**	**.553**	**.907**	**.918**	**.926**
Eating disorder-bulimia	.398	.532	**.792**	**.805**	**.315**	**.642**	*.790*	*.780*	*.789*	*.780*
Eating disorder-dieting	.394	.543	**.740**	**.854**	**.369**	**.723**	*.746*	*.889*	*.746*	*.890*
Eating disorder-oral control	.403	.447	**.742**	**.588**	**.309**	**.452**	*.739*	*.549*	*.740*	*.549*
Factor correlations										
Factor 1 - Factor 2	–	–	.465	.568	.488	.589	.922	.611	.476	.558
Factor 1 - Factor 3	–	–	–	–	–	–	.436	.496	.446	.498
Factor 2 - Factor 3	–	–	–	–	–	–	.551	.734	.373	.724

Note. Default formatting = loading for factor 1, Bold formatting = loading for factor 2, Italic formatting = loading for factor 3, BDD = body dysmorphic disorder.

fitting models of BDD classification, we examined whether lower-order fear and distress factors should be identified within affective disorders. Consistent with Lahey et al. (2008), these factors were so highly correlated that they indicated a single affective factor across symptoms of anxiety and depression. Each of the theoretical models of the classification of BDD had poor fit to the data. Thus, the data did not support BDD classification as part of a single internalising spectrum (Model 1), a broad affective spectrum (Model 2), or a narrower obsessive-compulsive spectrum (Model 4) or a body image spectrum (Model 3). The novel Model 5 did, however, provide acceptable fit to the data. In this model, BDD symptoms formed a separate factor that was correlated with affective spectrum symptoms and eating disorder symptoms.

Although sex differences were not part of the theoretical models of BDD classification, we compared model parameters between males and females as sex differences have been observed in several previous adolescent and adult CFA studies (Lahey et al., 2008; Mitchell et al., 2014; Prenoveau et al., 2010). Measurement invariance testing of the parameters of Model 5 found metric noninvariance between males and females. That is, whereas the overall model fit was similar in males and females, the loadings of observed scores onto the latent factors differed significantly by sex for a majority of the symptom measures. The relationship between the latent factors also varied by sex; the correlation of the BDD latent factor to both the affective and eating disorder latent factors were stronger in females than in males. Most notably, BDD symptoms were more strongly related to eating disorder symptoms than to affective disorder symptoms in female adolescents, and the opposite pattern was observed in male adolescents. A sex-specific association between BDD and eating disorders has also been observed in a clinical sample of adults with BDD, where lifetime prevalence of eating disorders was significantly higher among females than males (42.3 vs. 11.1%; Phillips et al., 2006). These findings highlight the need to consider sex differences as well as developmental differences in the structure of psychopathology (Wittchen et al., 2009).

Alternatively, the current findings may reflect, in part, the fact that study participants had not yet passed through the typical age of onset for depression, eating disorders, OCD, or panic disorder (Hudson et al., 2007; Kessler et al., 2005). However, associations with earlier-onset disorders such as social anxiety, separation anxiety, and specific phobias were not notably stronger than those for later-onset disorders. Replication of the current findings in samples of both adolescents and adults is needed to determine whether BDD continues to form a unique factor later in life. However, findings from adult twin studies of BDD

Table 4
Model 5 standardised factor loadings and factor correlations.

		Male		Female		
Factor	Measure	Loading	95% CI	Loading	95% CI	CI overlap
Affective disorders	Depression	.722	.700, .744	.717	.699, .735	Yes
	Generalised anxiety disorder	.831	.821, .841	.880	.870, .890	No, F > M
	Panic disorder and agoraphobia	.791	.774, .808	.828	.816, .840	No, F > M
	Specific phobia (physical injury)	.570	.543, .597	.502	.475, .529	No, M > F
	Separation anxiety disorder	.739	.719, .759	.672	.650, .694	No, M > F
	Social anxiety disorder	.756	.743, .769	.723	.707, .739	No, M > F
	Obsessive-compulsive disorder	.754	.740, .768	.757	.742, .772	Yes
BDD	BDD-interference/avoidance	.921	.907, .935	.877	.863, .891	No, M > F
	BDD-other symptoms	.918	.904, .932	.926	.914, .938	Yes
Eating disorders	Eating disorder-bulimia	.789	.767, .811	.780	.761, .799	Yes
	Eating disorder-dieting	.746	.725, .767	.890	.875, .905	No, F > M
	Eating disorder-oral control	.740	.717, .763	.549	.520, .578	No, M > F
Factor correlations		Factor	95% CI	Factor.	95% CI	
Affective Disorders - BDD		.476	.448, .504	.558	.531, .585	No, F > M
Affective Disorders - Eating Disorder		.446	.404, .488	.498	.465, .531	Yes
BDD - Eating Disorder		.373	.341, .405	.724	.701, .747	No, F > M

Note. CI = Confidence interval, BDD = Body dysmorphic disorder, Factor = Factor correlation, M = Male, F = Female.

symptoms may support the value of considering both shared and unique disorder features. Although BDD symptoms shared common genetic liabilities with symptoms of obsessive-compulsive spectrum disorders (Monzani et al., 2014) and combined anxiety and obsessive-compulsive spectrum disorders (López-Solà et al., 2016), BDD was found to have the strongest disorder-specific genetic influences of the disorders assessed.

4.1. Limitations and future directions

This study is novel as it constitutes the first attempt to model the associations between symptoms of BDD and comorbid disorders using CFA. However, limitations of the current research need to be considered when interpreting the findings. The BDD measure used is the first to be psychometrically validated in adolescents (citation removed to allow blind review), however for consistency between measures it may be preferable to use questionnaires with a single symptom severity score in future analyses. Alternately, item-level CFAs may be informative in further understanding the relationships between disorder symptoms. The study did not assess other *DSM-5* OCRDs such as trichotillomania and excoriation, and future studies are needed to explore the classification of these disorders. The eating disorder measure was developed to assess symptoms of anorexia nervosa and bulimia nervosa (Maloney et al., 1988), but BDD may also be associated with other eating disorders (Dingemans et al., 2012), or show associations that are specific to certain eating disorders (Hartmann et al., 2013). Therefore, the association of BDD to a broad range of *DSM-5* eating disorder symptoms should be assessed in future studies. This includes assessment of muscularity-oriented disordered eating, particularly given current debates regarding the classification of muscle dysmorphia (dos Santos Filho et al., 2015; Kanayama and Pope, 2011; Murray and Touyz, 2013) and challenges in the detection of male eating disorders (Mitchison and Mond, 2015; Murray et al., 2017).

As highlighted by Angold et al. (1999), longitudinal research studies are needed in order to understand the sequence of comorbid disorder onset, and to determine common versus specific risk factors for disorders. Further, as comorbidity is only one of the validators used to indicate the relationship between disorders in *DSM-5* (American Psychiatric Association, 2013), future studies of the classification of BDD should span the full range of available validators. While the recruitment of participants from a population-based sample may be considered a strength of the current research (Lahey et al., 2009), particularly given the reliance on highly specialised samples in much previous BDD research, the structure of psychopathology may differ between clinical and non-clinical samples (Kotov et al., 2015). Key questions regarding the classification of BDD should thus be addressed in clinical and non-clinical samples, and involve longitudinal and large-scale epidemiological studies. Further, although CFA is a valuable technique for modelling psychopathology, the classification of BDD should also be explored using alternative statistical approaches such as bifactor models (Carragher et al., 2016), network models of comorbidity (Eaton, 2015), and the Hierarchical Taxonomy of Psychopathology (HiTOP), a new classification of axis 1 and axis 2 disorders (Kotov et al., 2017).

Overall, these findings provide further evidence that BDD is related to, yet meaningfully distinct from, OCD, depression, anxiety, and eating disorders (Abramowitz and Jacoby, 2015; Frías et al., 2015; López-Solà et al., 2016). It is therefore critical that clinicians and healthcare workers have knowledge of BDD and are able to recognize and assess for this disorder in young people. Conceptualising BDD as distinct from other mental health disorders is consistent with current clinical approaches to BDD. Research from related disorders has informed the cognitive-behavioural model of BDD (Fang and Hofmann, 2010; Fang and Wilhelm, 2015; Hartmann et al., 2013), and guided treatment development (National Institute for Health and Clinical Excellence, 2005). However, there is an increasing focus on the unique aspects of BDD that may be translated into clinical approaches to enhance existing treatments, such as by targeting visual processing abnormalities (Beilharz et al., 2017), disorder onset experiences (Weingarden et al., 2017) and aesthetic evaluations (Lambrou et al., 2011). Continued investigation into the classification of BDD is vital in improving understanding of the disorder across the public and mental health professionals, as poor knowledge about BDD is a barrier to seeking treatment (Marques et al., 2011) and may contribute to the under-diagnosis of BDD in clinical practice (Veale et al., 2015).

5. Conclusions

In adolescents, symptoms of BDD appear to form a separate factor that is correlated with symptoms of affective disorders and eating disorders. In both male and female adolescents, BDD is moderately associated with affective disorders, including OCD, anxiety and depression. The association between BDD and eating disorders is strong for females, and weak for males. These findings highlight the need for future studies examining the classification of BDD to consider developmental and sex differences in their models, and to thoroughly assess male presentations of body image problems. Further research is needed in order to establish both the unique and shared features of BDD, and to inform classification schemes, clinical practice and aetiological models.

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Institutional board review

The research was approved by the Human Research Ethics Committee of Macquarie University and the governing body of each school.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jad.2017.08.062.

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