EMPIRICAL ARTICLE

Does Shared Genetic Risk Contribute to the Co-occurrence of Eating Disorders and Suicidality?

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ABSTRACT

Objective: There is a high level of co-occurrence of suicidality with eating disorders (EDs) but the reason for this is unknown. To test the hypothesis that suicidality and EDs share genetic risk contributing to the expression of both phenotypes.

Method: Female twins ($N = 1{,}002$) from the Australian Twin Registry, aged 28–40 years, were interviewed with diagnostic interviews. Lifetime diagnostic information relating to eating disorders [anorexia nervosa (AN), bulimia nervosa (BN), binge eating disorder, and purging disorder (PD)], suicidality (ranging transitory thoughts to suicide attempts), and major depression.

Results: Any suicidal thoughts were reported by 24% of the sample, but prevalence of lifetime suicidality among female twins with EDs was much higher (43%), presence of an ED diagnosis more than doubling likelihood of suicidality (OR = 2.32, 95% CI: 1.63–3.31). AN and BN conveyed greatest risk of suicidality (OR = 2.03, 95% CI: 1.06–3.87; OR = 3.97, 95% CI: 2.01–7.85, respectively). Twin phenotype correlations showed monozygotic twins had uniformly higher estimates than dizygotic counterparts. A trivariate Cholesky model indicated a common genetic influence on suicidality and ED phenotypes (but not depression), and no nonshared environmental source.

Discussion: Both cross twin phenotypic correlations and genetic modeling infer a common genetic pathway for suicidality and EDs, but further investigation is needed to elucidate whether this may constitute emotional dysregulation or other temperament-linked factors. Study findings also indicate that ED clients must be routinely assessed for presence of suicidality, independent of depression status. © 2015 Wiley Periodicals, Inc.

Keywords: genetic risk; eating disorders; suicidality; major depression; twins

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Introduction

People with eating disorders experience significantly higher mortality rates than the general population,[1] and one of the highest mortality rates associated with any psychiatric illness.[2] A proportion of premature death is attributable to medical complications,[3] but suicide is a significant contributory factor. In anorexia nervosa (AN) 1 out of 5 deaths can be attributed to suicide,[1,4,5] and suicide is elevated for all eating disorder diagnoses, including bulimia nervosa (BN), binge eating disorder (BED) and purging disorder (PD).[6] The standardized mortality ratios (SMR) for suicide in AN and BN have recently been reported as high as 31.0 and 7.5, respectively, per 100,000[5] compared with 45 in high income countries for all-cause mortality.[7] Prevalence of nonfatal suicidal behavior (attempts and ideation) is also significantly elevated, with a prevalence ranging from 3 to 30% for AN,[8,9] 15–40% for BN,[9–12] and 12.5% in BED for suicide attempts.[13] Although there is considerable range in prevalence of suicide attempts across studies (influenced by diagnostic subtyping variability and measurement of attempts and ideation), they serve to highlight the co-occurrence of suicidality and eating disorders.

The reasons for this co-occurrence are unclear. Three possibilities exist. The first is that eating disorders cause suicidality; the second is that

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suicidality causes eating disorders; and, the third is that common factors influence both. It is this latter explanation that has received most attention in the literature, with investigation of various factors that may have the capacity to explain the high level of co-occurrence. Variables linked to suicide attempts in AN include greater chronicity of illness; lower body mass index; affective, anxiety and substance use issues.[11,12] For BN, suicide attempts are linked with greater psychopathology; elevated impulsivity; reduced self-directedness; and a familial alcohol abuse.[11,12] Odds of suicidality are also elevated among those with symptoms of depression, anxiety, neuroticism, cigarette smoking, and impulsivity.[10,14,15]

Across this variety of putative common factors, only comorbidity of major psychiatric disorders was robustly associated with attempting suicide among those with eating disorders in a recent study.[6] Pisetsky et al.[6] sought to clarify the relationship between EDs and suicidality using a large national registry database. Consistent with other studies, results showed that lifetime suicide attempt or completion is significantly more prevalent among women with an eating disorder diagnosis than those without: respectively, 12 and 1.74% or 9.13 and 1.56% when employing more broadly defined criteria. However, suicidality was higher in the presence of purging behaviors and where there was increased burden of comorbid psychiatric conditions, seven of which were assessed including major depression. They also examined whether various eating disorder features and temperament (perfectionism, extraversion, neuroticism, and self-directedness) would increase odds of lifetime suicide attempt, but none were significant. Therefore, predominance of suicidality among those with eating disorders—particularly purging subtypes—was explained by greater psychiatric comorbidity.

However, a common factor yet to be investigated with potential to explain increased suicidality in eating disorders is the shared genetic risk between the two phenotypes. Both the eating disorder and suicide literature independently report that these respective conditions appear to be highly heritable.[16–18]. Twin studies identify the additive genetic components account for around 40 to 60% of variance in eating disorder expression.[16] Concordance for suicide and suicidal behavior has also been found to be higher in monozygotic twins over their dizygotic counterparts (14.9 vs. 0.7% and 23.0 vs. 0.7%).[19]

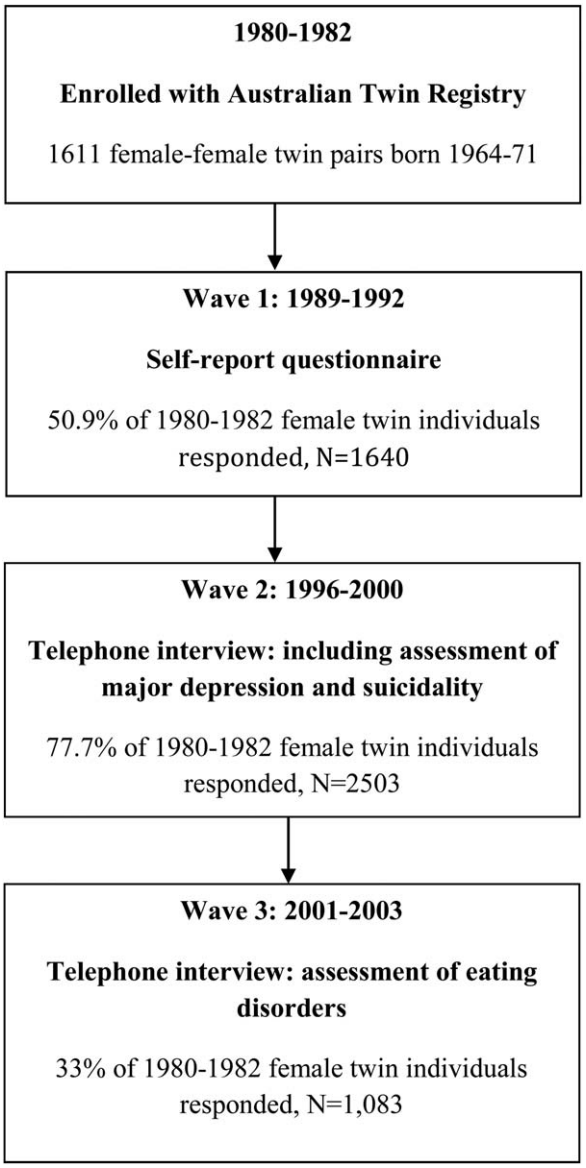
These data are highly suggestive of shared genetic risk factors for both eating disorders and suicidality, consistent with previous research that has found an increased risk of self-directed harm in bulimic females in the presence of MAOAuVNTR high-function alleles.[20] Therefore, this study investigated shared genetic risk between these two phenotypes in a general population sample of Australian female twins while also examining shared risk with lifetime major depression, given this poses a compelling reason as to why there is co-occurrence between eating disorders and suicidality and previous findings which suggest the presence of shared genetic risk between major depression and eating disorders.[21,22] Specifically, the first objective of this study was to identify odds of suicidality and major depression among those with and without eating disorders. Second, we investigated the presence of shared genetic contribution underpinning the covariance of eating disorders, major depression, and suicidality by decomposing the latent risk factors into additive genetic, shared environmental, and nonshared environmental influences.

Method

Participants

As shown in Figure 1, the sample of twins approached to participate in this study was originally derived from a cohort of 8,536 twins (4,268 pairs) born 1964–1971, who were registered as children with the Australian Twin Registry (ATR) over 1980–1982, in response to media appeals and systematic appeals through schools. Female-female twins who had participated in at least one of two waves of data collection (a self-report questionnaire over 1989–1992 when the twins were aged 18–25 years,[23] and a clinical interview over 1996–2000 which assessed major depression and suicidality) were approached to participate in this study. In the third wave of data collection, 2,320 twins (1,140 complete pairs) were approached by the ATR over 2001–2003 to participate in an interview about eating disorders; 1,083 individual twins consented to participate (47%), 568 did not agree to participate (24%), and 669 did not respond (29%). At least one further telephone call or letter was used to contact the nonresponders. The mean age of the women at the time of the third wave of data collection was 35 years (SD = 2.11), ranging from 28 to 40 years. A telephone interview of eating and self-report questionnaire was completed with 1,002 women and 81 women completed only the self-report questionnaire; 315 complete sister-sister pairs (201 MZ pairs and 114 DZ pairs) and 372 incomplete pairs (181 MZ and 191 DZ), where only one twin participated. Zygosity was determined on the basis of responses to standard questions about

FIGURE 1. Waves of assessment of female-female MZ and DZ twins.



physical similarity and confusion of twins by parents, teachers, and strangers, methods that give better than 95% agreement with genotyping.[24] The Flinders University Clinical Research Ethics Committee approved the data collection and written informed consent was obtained after the procedures had been fully explained.

Ascertainment of Clinical Psychopathology

Clinical Interview for Major Depression and Lifetime Suicidality. The semistructured assessment for the genetics of alcohol (SSAGA[25]) was used at Wave 2 to assess lifetime presence of DSM-IV criteria for major depression. The SSAGA is a comprehensive psychiatric interview with excellent inter-rater reliability. The SSAGA also contains a suicidal behaviour section,[18] from which a 4-point scale of lifetime suicidality was derived where 0 = no suicidal ideation; 1 = transient suicidal thoughts only; 2 = persistent suicidal thoughts, plan or minor attempt; and 3 = serious suicide attempt. To maximise power, we developed a variable called any suicidality, which included 0 as one group (no suicidality), and scores 1–3 as the second group (any form of suicidality).

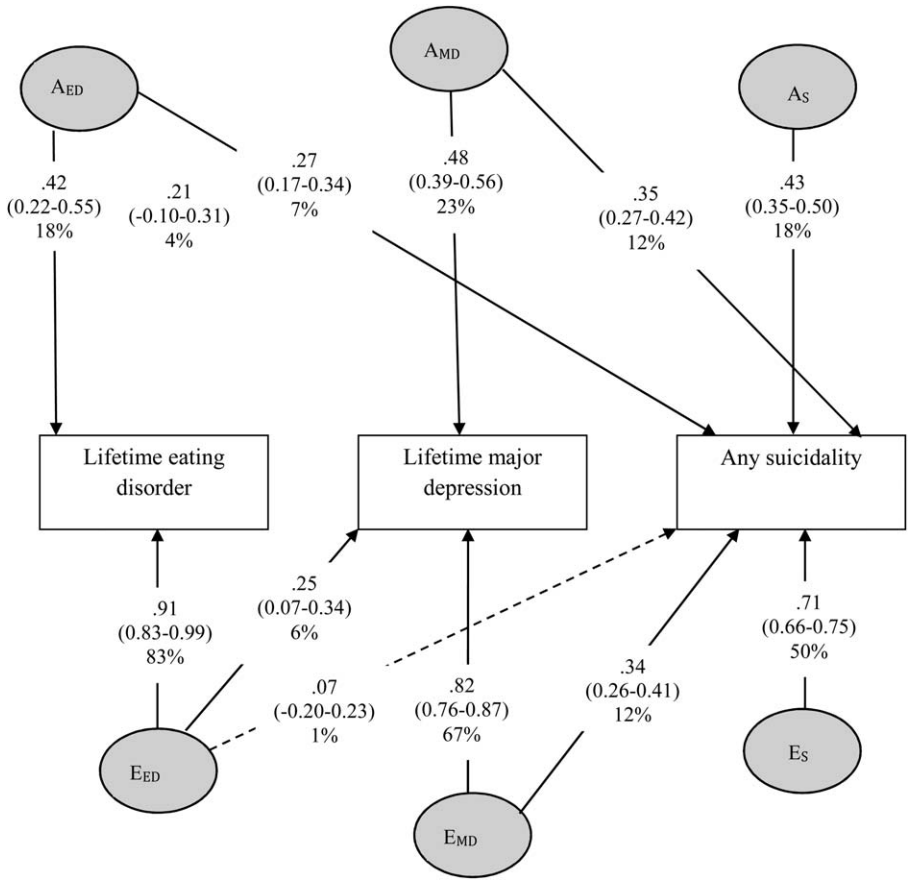
Clinical Interview for Eating Disorders. The telephone interview at the third wave used the Eating Disorder Examination (EDE) 14th edition[26] where all diagnostic questions addressed DSM-IV criteria over a three-month time frame, followed by lifetime questions, including the age range during which the behavior occurred in order to assess the co-occurrence as well as duration of features. As previously reported,[27] 43 (4.3%) women met the criteria for lifetime AN (either full or partial), 18 had restricting type. A total of 29 (2.9%) women met full criteria for BN, 7 of these with a nonpurging BN and 29 (2.9%) women met criteria for binge eating disorder (i.e., objective binge episodes at least twice a week for a 3-month period without a break of more than 2 weeks that was not concurrent with any threshold compensatory behaviors). The criteria for PD, the presence of threshold purging (i.e., vomiting, diuretics, or laxatives) in the complete absence of lifetime objective binge episodes were met by 53 women (5.3%). Thus a total of 154 women (15.4%) met criteria for a DSM-IV eating disorder. The diagnoses are nonoverlapping, with the order of assignment being AN, BN, BED, and PD. The mean age of onset of the eating disorders ranged from 17 to 23 years, and the mean age of this cohort at the second wave interview (when major depression and suicidality was assessed) was 30.59 years (SD = 2.10), ranging from 24 to 37 years. Therefore, the eating disorder would have presented by the time the second wave of data was collected. All interviewers were postgraduate Clinical Psychology trainees ($n = 10$) who had been instructed in use of the EDE. Each of the interviews was taped and corrective feedback was provided until the interviewer had acquired the skills required to complete the interview independently. Monthly group meetings were held to discuss the interview process ensured interview fidelity.

Analyses

Logistic regressions [using generalized estimating equations (GEEs)] were used to address our first aim, differences in suicidality and major depression in our eating disorder and no eating disorder groups. GEEs were used to account for the nesting of the data within the twin pairs. The odds ratio (OR) and 95% confidence intervals (CI) were reported.

To address our second aim we used a trivariate Cholesky decomposition model using Mx software[28] to examine any shared latent risk factors between eating

FIGURE 2. Path diagram showing the standardized parameter estimates (95% CI) and % variance for the trivariate Cholesky decomposition model for lifetime eating disorder diagnosis, lifetime major depression and lifetime suicidality (A: additive genetic influences; E: nonshared environmental influences). The broken lines refer to parameter estimates that are not significant.



disorder status, major depression, and suicidality, as shown in Figure 2 A full information maximum likelihood approach was used where raw data were analyzed thus incorporating complete and incomplete pairs of twins; missing data is addressed by creating the appropriate mean vector and covariance matrix for each observation.[28] We first examined the models where the magnitude of the parameter estimates was allowed to differ across the three phenotypes, starting with a full model (i.e., containing the additive genetic variance [A], shared environment [C], and nonshared environment [E] sources of variance). We then fit a series of nested models to examine whether all sources of variance were required. Twice the difference in the log likelihood (−2lnL) between a higher order and submodel yields a statistic that is asymptotically distributed as chi square, with the degrees of freedom (df) equal to the difference in their number of parameters, and can be used to determine if the submodel is significantly worse fitting than the full model. In this case, the higher order model was the ACE Cholesky. Typically, where models do not differ significantly, the Akaike's Information Criterion (AIC) is used to support the choice of a submodel as the best fitting model, where the lower the value the better the balance between explanatory power and parsimony.

Results

Prevalence and Likelihood Ratios

Of the 1,002 twins who completed an interview with respect to diagnostic eating disorder status, 729 (73%) reported no suicidal ideation, and 137 (14%) reported having transient suicidal thoughts, 88 (9%) reported persistent suicidal thoughts or plan or minor attempt, and 48 (5%) reported a serious suicide attempt. Therefore 273 people were classified as having any suicidality. The frequency and ORs associated with the presence of suicidality in the presence of a lifetime eating disorder is reported in **Table 1**, with no difference between the proportions for the different eating disorders, although this approached significance ($p = 0.07$) for the comparison between BN and binge eating

TABLE 1. Comparison of any suicidality and lifetime major depression between the lifetime eating disorder group (ED) and the referent group without a lifetime eating disorder

	Suicidality Compared with Referent Group			Major Depression Compared with Referent Group[a]		
Diagnosis (*N*)	ED	No ED	OR (95% CI)	ED	No ED	OR (95% CI)
Any eating disorder	66/154 (43%)	207/848 (24%)	2.13 (1.49–3.03)	81/153 (53%)	253/847 (30%)	2.55 (1.79–3.64)
AN	19/43 (44%)		2.03 (1.06–3.87)	22/43 (51%)		2.01 (1.07–3.74)
BN	18/29 (62%)		3.97 (2.01–7.85)	22/28 (79%)		3.75 (1.84–7.64)
Binge eating disorder	10/29 (35%)		1.03 (0.44–2.40)	17/29 (59%)		2.47 (1.24–4.93)
PD	19/53 (36%)		1.29 (0.74–2.25)	25/53 (47%)		1.51 (0.90–2.54)

Note: OR: odds ratio; CI: confidence interval.
[a]Two people had missing data for major depression.

TABLE 2. Maximum likelihood correlations (95% CIs) for dichotomous variables: within and cross twin phenotypes (MZ above diagonal and DZ below diagonal) for twin 1 (t1) and twin 2 (t2); within-trait twin correlations are shown in bold

MZ Twins (583 individuals, 201 complete pairs)						
Phenotype	EDt1	MDt1	St1	EDt2	MDt2	St2
Eating disorder (EDt1)		0.11 (0.004–0.22)	0.20 (0.09–0.31)	**0.16 (0.03–0.28)**	0.03 (−0.09–0.14)	0.17 (0.06–0.28)
Major depression (MDt1)	0.30 (0.17–0.42)		0.35 (0.26–0.43)	0.10 (−0.02–0.21)	**0.22 (0.12–0.31)**	0.14 (0.04–0.24)
Suicidality (St1)	0.10 (−0.03–0.23)	0.47 (0.38–0.55)		0.12 (0.009–0.23)	0.18 (0.09–0.28)	**0.31 (0.22–0.40)**
Eating disorder (EDt2)	**0.03 (−0.13–0.20)**	0.12 (−0.02–0.24)	0.05 (−0.08–0.18)		0.17 (0.05–0.28)	0.08 (−0.03–0.19)
Major depression (MDt2)	0.15 (0.02–0.28)	**0.15 (0.04–0.25)**	0.12 (0.01—0.22)	0.17 (0.04–0.30)		0.28 (0.18–0.37)
Suicidality (St2)	0.04 (−0.10–0.18)	0.04 (−0.09–0.18)	**0.04 (–0.07–0.15)**	0.22 (0.09–0.34)	0.20 (0.09–0.30)	
DZ Twins (419 individuals, 114 complete pairs)						

disorder. A total of 334 (33%) twins reported the presence of lifetime major depression and the frequency and ORs associated with the presence of depression in the presence of a lifetime eating disorder is also reported in **Table 1**. Women with BN had a significantly higher prevalence of major depression compared to women with AN ($p = 0.03$) and PD ($p = 0.009$).

Twin Phenotype Correlations

The maximum likelihood twin correlations for eating disorder, major depression and suicidality status are summarized in **Table 2**, showing that MZ estimates are uniformly higher than those of DZ twins, for eating disorder status (MZ: 0.16; DZ: 0.03), major depression (MZ: 0.22; DZ: 0.15), and suicidality (MZ: 0.31; DZ: 0.04), and cross-twin cross-trait, eating disorder and major depression (MZ: 0.03 − 0.11; DZ: 0.12 − 0.15) and eating disorder and suicidality (MZ: 0.17 − 0.20; DZ: 0.04 − 0.05). Overall this suggests a role of additive genetic factors in associations between eating disorder status and suicidality. We note that higher MZ and DZ correlations for suicidality were reported in an earlier study (MZ: 0.49; DZ: 0.10)[18] of which the current sample is a subset; these estimates may be attenuated by the restricted age range in the current sample, compared with the larger sample that included women aged 27–89 years, with a mean age of 44.5 years.

Trivariate Twin Modeling

The trivariate Cholesky model was run to remove any confounding influences of the relationship among major depression, eating disorder status, and suicidality. The results of the Cholesky model fitting are shown in **Table 3** where all the submodels were significantly worse fitting than the full ACE model with the exception of the AE model, for which the standardized parameters (and percentage variance) are shown in **Figure** 2. Only two pathways were not significant (indicated by dotted paths), those from the latent eating disorder genetic variable to the major depression phenotype and from the latent eating disorder environmental variable to the suicide phenotype. Significant pathways included the latent additive genetic variance contributing to both eating disorder status and suicidality, indicating this shared risk factor accounts for some co-occurrence of the two phenotypes. The correlations between the latent factors in the model are shown in **Table 4**. The correlation

TABLE 3. Model comparisons of the trivariate Cholesky model of lifetime eating disorder diagnosis, lifetime major depression, and any suicidality; preferred model shown in bold.

Model	−2LL	df	AIC	χ^2 (df) p
ACE	4228.01	3805	−3381.99	
AE	**4229.46**	**3811**	**−3392.55**	**1.45 (6) 0.96**
CE	4242.76	3811	−3379.24	14.75 (6) 0.02
E	4296.01	3817	−3337.99	68.00 (12) <0.001

TABLE 4. Correlations (95% CIs) among the latent sources of variance contributing to lifetime eating disorder diagnosis, lifetime major depression, and any suicidality

	Eating Disorder	Major Depression
Genetic Correlations		
Major Depression	0.29 (−0.08–0.69)	
Suicidality	0.60 (0.25–1.00)	0.65 (0.43–0.87)
Nonshared Environment Correlations		
Major depression	0.11 (0.01–0.21)	
Suicidality	0.01 (−0.10–0.12)	0.22 (0.13–0.30)

between latent genetic variables contributing to lifetime eating disorder status and suicidality is strong and significant, whereas the nonshared environmental correlation is negligible and not significant.

Discussion

Suicidality and eating disorders co-occur, perhaps more so than other psychiatric conditions,[2] suggesting some shared underlying risk. In accordance with previous studies, and in terms of addressing our first aim, our results demonstrated significant associations between suicidality (ideation and attempts only) and eating disorders. A unique contribution of this work is that it examined the associations between lifetime eating disorders and both major depression and suicidality. Further, we investigated whether shared genetic risk contributed to the expression of eating disorders, major depression and suicidality phenotypes using a community-based sample of Australian female twins.

The risk of suicidality given any eating disorder is only marginally lower than the risk of major depression, a condition recognized as especially prevalent among those with eating disorders.[29] AN and BN had notable associations with suicidality; odds of BED and PD were elevated but not significant. More investigation is clearly needed with these eating disorder groups to confirm the associations with suicidality. The trend toward higher levels of suicidality in the BN compared to the AN group supports recent work finding elevated suicidality (attempts) predominates in purging subtypes[6] and that adolescent girls using compensatory behaviors (particularly vomiting) have greater likelihood of engaging in self-harming and suicidal behaviors.[30] The chronicity of BN, as indicated by low rates of recovery from bingeing and compensatory behavior,[31] may contribute to elevated suicidality. By modeling depression, the analysis showed that worsening affective symptoms, often argued to be the main driver of suicidality, do not necessarily underpin the relationship between eating disorders and suicidality.

This study focused on a specific hypothesis with potential to partially explain the co-occurrence of eating disorders and suicidality, namely shared genetic risk. Strikingly, we find that the considerable comorbidity of ED and suicidality (in excess of double likelihood of suicidality given any eating disorder) explained by shared genetic risk factors ($r_g = 0.60$ with an upper 95% CI of 1.0), with no contribution from environmental factors. Depression shared genetic risk with suicidality (but not significantly with eating disorders), in addition to shared environmental influences. Further work is required to more specifically identify the source of this shared genetic risk, which is likely to reside in some temperament style rather than the presence of psychiatric comorbidity. Many view temperament as "... critical etiological factors for eating disorders" (p.433[32]), where emotional dysregulation, including lack of emotional awareness and impulse control difficulties, are two factors associated with AN and the binge/purge behaviors occurring within AN, respectively.[33] To date there has been limited investigation of the role of temperament predicting increased risk of suicidality in eating disorders[6] and better measures of candidate phenotypes require investigation.

The nonoverlap of nonshared environment risk factors (i.e., experiences unique to each twin whether objective or effective[34]), between the two phenotypes is also of interest. It has long been known that unique experiences make a critical contribution to behaviors that are influenced by underlying genetic risk factor.[35] It is widely believed that genetic vulnerability and environmental factors work together to increase risk of self-harm and suicidality, perhaps manifested respectively by temperamental characteristics and trauma.[36] The results of the current study suggest we should look elsewhere for key candidate environments for eating disorders that act together with genes to influence risk for both eating disorders and suicidality. Further, several eating disorder studies have proposed that genetic risk for eating

disorders may be exacerbated by puberty,[37] adverse family environments,[38,39] and the socio-cultural environment.[40] It is also plausible that different genetic and environmental factors may influence eating disorder phenotypes over the developmental trajectory, with genetic factors becoming more important as girls mature from early to late adolescence.[37]

The lack of a significant correlation between latent genetic factors contributing to eating disorders and depression was somewhat unexpected given findings in the previous literature. While it is likely that with more power our genetic correlation between lifetime eating disorder and major depression will become significant (i.e., 95% CI > 0), the correlation (0.29) remains lower than those found previously. One study has found a correlation of 0.58 (95% CI: 0.36–0.84) between the genetic sources of variance contributing to both AN and major depression,[21] and another identified a significant correlation of 0.46 between BN and major depression.[22] In contrast, a study of BN in a multivariate analysis with specific phobia, generalized anxiety disorder, panic disorder, major depression, and alcoholism showed that BN primarily shared a genetic factor with only phobia and panic disorder.[41] It may be that comorbidities between eating disorders and other psychiatric states account for more shared variance between genetic risk factors than between major depression, indicating that future examinations of the relationship between eating disorders and major depression should also include important comorbidities such as suicidality.

These findings should be interpreted in the context of a number of limitations. First, the analyses did not adjust for psychiatric conditions other than major depression, or other possible confounders of the relationship between eating disorders and suicidality.[10–13] Second, assessment of suicidality occurred at Wave 2, while the ED diagnostic interview was undertaken at Wave 3. Thus, it is plausible that prevalence of lifetime suicidality may have been underestimated as we did not access any official records as have previous studies[6] to check for deaths from suicide in this sample. Nevertheless, comparisons with other local data[42] were found to be similar to the present study. Third, while the participation rate is considered moderate (46.7%), it approximates other epidemiological studies in Australia.[43] Participation in our third wave of data was not predicted by self-reported problems with disordered eating reported at the Wave 1 or the presence of lifetime major depression at Wave 2.[44] Fourth, our sample of 154 twins meeting heterogeneous eating disorder criteria means that the sample size is modest for this type of analysis, and unable to establish differential effects due to specific eating disorders.

In conclusion, in accordance with a growing body of literature, we find that the presence of eating disorders, chiefly AN and BN, are associated with increased risk for suicidality; individuals with eating disorders are at risk of taking their own lives, regardless of the presence of lifetime major depression. It is imperative that suicidality be assessed routinely in clinical settings with eating disorder patients in order to ensure that appropriate support is provided. While shared genetic risk appears to explain most of this comorbidity, the mechanism by which this works remains unknown. Investigation of temperament styles that may explain this mechanism is needed, including negative emotionality which has been shown to share common genetic influences with a general psychopathology factor in childhood and adolescence.[45]

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References

1. Arcelus J, Mitchell AJ, Wales J, Nielsen S. Mortality rates analysis of 36 studies. Arch Gen Psychiatry 2011;68:724–731.
2. Harris EC, Barraclough B. Excess mortality of mental disorder. Br J Psychiatry 1998;173:11–53.
3. Crow SJ, Swanson SA, Peterson CB, Crosby RD, Wonderlich SA, Mitchell JE. Latent class analysis of eating disorders: Relationship to mortality. J Abnorm Psychol 2012;121:225–231.
4. Pompili M, Mancinelli I, Girardi P, Ruberto A, Tatarelli R. Suicide in anorexia nervosa: A meta-analysis. Int J Eat Disord 2004;36:99–102.
5. Preti A, Rocchi MB, Sisti D, Camboni MV, Miotto PA. Comprehensive meta-analysis of the risk of suicide in eating disorders. Acta Psychiatr Scand 2011; 12:6–17.
6. Pisetsky EM, Thornton LM, Lichtenstein P, Pedersen NL, Bulik CM. Suicide attempts in women with eating disorders. J Abnorm Psychol 2013;122: 1042–1056.
7. Patton GC, Coffey C, Sawyer SM, Viner RM, Haller DM, Bose K, et al. Global patterns of mortality in young people: A systematic analysis of population health data. Lancet 2009;374:881–892.
8. Bulik CM, Thornton L, Pinheiro AP, Plotnicov K, Klump KL, Brandt H, et al. Suicide attempts in anorexia nervosa. Psychosom Med 2008;70:378–383.
9. Franko D, Keel P. Suicidality in eating disorders: Occurrence, correlates, and clinical implications. Clin Psychology Rev 2006;26:769–782.
10. Bulik CM, Sullivan PF, Joyce PR. Temperament, character and suicide attempts in anorexia nervosa, bulimia nervosa and major depression. Acta Psychiatr Scand 1999;100:27–32.
11. Forcano L, Fernandez-Aranda F, Alvarez-Moya E, Bulik C, Granero R, Gratacos M, Jimenez-Murcia S, Krug I, Mercader M, Riesco N, Saus E, Santamaria JJ, Estivill X. Suicide attempts in bulimia nervosa: Personality and psychopathological correlates. Eur Psychiatry 2009;24: 91–97.

12. Favaro A, Santonastaso P. Suicidality in eating disorders: Clinical and psychological correlates. Acta Psychiatr Scand 1997;95:508–514.
13. Carano A, De Berardis D, Campanella D, Serroni N, Ferri F, Di Iorio G, et al. Alexithymia and suicide ideation in a sample of patients with binge eating disorder. J Psychiatr Pract 2012;18:5–11.
14. Fairweather AK, Anstey KJ, Rodgers B, Jorm AF, Christensen H. Age and gender differences among Australian suicide ideators: Prevalence and correlates. J Nerv Ment Dis 2007;195:130–136.
15. Zouk H, Tousignant M, Seguin M, Lesage A, Turecki G. Characterization of impulsivity in suicide completers: Clinical, behavioral and psychosocial dimensions. J Affect Disord 2006;92:195–204.
16. Trace SE, Baker JH, Peñas-Lledó E, Bulik CM. The genetics of eating disorders. Ann Rev Clin Psychol 2013;9:589–620.
17. Brent DA, Mann JJ. Family genetic studies, suicide, and suicidal behavior. Am J Med Genet C Semin Med Genet 2005;13C:13–24.
18. Statham DJ, Heath AC, Madden PAF, Bucholz KK, Bierut LJ, Dinwiddie SH, et al. Suicidal behaviour: An epidemiologic and genetic study. Psychol Med 1998;28:839–855.
19. Roy A, Segal NL. Suicidal behavior in twins: A replication. J Affect Disord 2001;66:71–74.
20. Steiger H, Fichter M, Bruce KR, Joober R, Badawi G, Richardson J, et al. Molecular-genetic correlates of self-harming behaviors in eating-disordered women: Findings from a combined Canadian–German sample. Prog Neuropsychopharmacol Biol Psychiatry 2011;35:102–106.
21. Wade TD, Bulik CM, Neale MC, Kendler KS. Anorexia nervosa and major depression: An examination of shared genetic and environmental risk factors. Am J Psychiatry 2000;157:469–471.
22. Walters EE, Neale MC, Eaves LJ, Heath AC, Kessler RC, Kendler KS. Bulimia nervosa and major depression: A study of common genetic and environmental factors. Psychol Med 1992;22:617–622.
23. Heath AC, Howells W, Kirk KM, Madden PAF, Bucholz KK, Nelson EC, et al. Predictors of non-response to a questionnaire survey of a volunteer twin panel: Findings from the Australian 1989 twin cohort. Twin Res 2001;4:73–80.
24. Eaves LJ, Eysenck HJ, Martin NG, Jardine R, Heath AC, Feingold L, et al. Genes, Culture and Personality: An Empirical Approach. London: Oxford University Press, 1989.
25. Bucholz KK, Cadoret R, Cloninger CR, Dinwiddie SH, Hesslebrook VM, NurnbergerJI, et al. A new, semi-structured psychiatric interview for use in genetic linkage studies: a report on the reliability of the SSAGA. J Stud Alcohol 1994;55:149–158.
26. Fairburn CG, Cooper Z. The eating disorder examination. In Fairburn CG, Wilson GT, editors. Binge Eating: Nature, assessment and treatment. New York: Guilford Press 1993, pp. 317–360.
27. Wade TD, Bergin JL, Tiggemann M, Bulik CM, Fairburn CG. Prevalence and long term course of lifetime eating disorders in an adult Australian twin cohort. Aust N Z J Psychiatry 2006;40:121–128.
28. Neale MC, Boker SM, Xie G, Maes H. Mx: Statistical Modeling, 5th ed. Richmond, VA: Department of Psychiatry, 1999.
29. Hudson JI, Hiripi E, Pope HG Jr., Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. Biol Psychiatry 2007;61:348–358.
30. Laasko E, Hakko H, Raesaenen P, Riala K. The Study-70 Workgroup: Suicidality and unhealthy weight control behaviors among female underaged psychiatric inpatients. Comp Psychiatry 2013;54:117–122.
31. Le Grange D, Crosby RD, Rathouz PJ, Leventhal BL. A randomized controlled comparison of family-based treatment and supportive psychotherapy for adolescent bulimia nervosa. Arch Gen Psychiatry 2007;64:1049–1056.
32. Racine SE, Keel PK, Burt SA, Sisk CL, Neale M, Boker S, et al. Exploring the relationship between negative urgency and dysregulate eating: Etiologic associations and the role of negative affect. J Abnorm Psychol 2013;122:433–444.
33. Racine SE, Wildes JE. Emotion dysregulation and symptoms anorexia nervosa: The unique roles of lack of emotional awareness and impulse control difficulties when upset. Int J Eat Disord 2013;46:713–720.
34. Turkheimer E, Waldron M. Nonshared environment: A theoretical, methodological, and quantitative review. Psychol Bull 2000;126:78–108.
35. Plomin R. Commentary: Why are children in the same family so different? Non-shared environment three decades later. Int J Epidemiol 2011;40:582–592.
36. Favaro A, Ferrara S, Santonastaso P. Self-injurious behaviour in a community sample of young women: Relationship with childhood abuse and other types of self-damaging behaviors. J Clin Psychiatry 2007;68:122–131.
37. Klump KL, Burt SA, McGue M, Iacono WG. Changes in genetic and environmental influences on disordered eating across adolescence: A longitudinal twin study. Arch Gen Psychiatry 2007;64:1409–1415.
38. van Strien T, Snoek HM, van der Zwaluw CS, Engels RCME. Parental control and the dopamine D2 receptor gene (DRD2) interaction on emotional eating in adolescence. Appetite 2010;54:255–261.
39. Suisman JL, Burt SA, McGue M, Iacono WG, Klump KL. Parental divorce and disordered eating: An investigation of a gene-environment interaction. Int J Eat Disord 2011;44:169–177.
40. Wade TD, Hansell NK, Crosby RD, Bryant-Waugh R, Treasure J, Nixon R, et al. A study of changes in genetic and environmental influences on weight and shape concern across adolescence. J Abnorm Psychol 2013;122:119–130.
41. Kendler KS, Walters EE, Neale MC, Kessler RC, Heath AC, Eaves L J. The structure of the genetic and environmental risk factors for six major psychiatric disorders in women: Phobia, generalized anxiety disorder, panic disorder, bulimia, major depression, and alcoholism. Arch Gen Psychiatry 1995;52:374–383.
42. De Leo D, Cerin E, Spathonis K, Burgi S. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behavior. J Affect Disord 2005;86:215–224.
43. Anstey KJ, Christensen H, Butterworth P, Easteal S, Mackinnon A, Jacomb T, et al. Cohort profile: The PATH through life project. Int J Epidemiol 2012;41:951–960.
44. Wade TD, Crosby RD, Martin NG. Use of latent profile analysis to identify eating disorder phenotypes in an adult Australian two cohort. Arch Gen Psychiatry 2006;63:1377–1384.
45. Tackett JL, Lahey BB, van Hulle C, Waldman I, Krueger RF, Rathouz PJ. Common genetic influences on negative emotionality and a general psychopathology factor in childhood and adolescence. J Abnorm Psychol 2013;122:1142–1153.