Factors Associated with Suicide Attempts in Women with Eating Disorders

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department Psychology

Chapel Hill
2013

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ABSTRACT

EMILY M. PISETSKY: Factors Associated with Suicide Attempts in Women with Eating Disorders
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The primary aim of this study was to evaluate whether the prevalence of lifetime suicide attempts/completions (SACs) is greater in women with anorexia nervosa (AN) and women bulimia nervosa (BN) than women with no eating disorder (no ED). Additional aims included identifying eating disorder features, comorbid psychopathology, and temperament features associated with SACs separately in the women with AN and with BN. Women in the Swedish Twin study of Adults: Gene and Environment (STAGE; n = 12,981) and the Screening Across the Lifespan of Twins (SALT; n = 16,281) cohorts completed questionnaires assessing eating disorder behaviors, lifetime history of psychiatric disorders, and temperament. Lifetime SACs were identified using diagnoses from the Swedish National Patient Register and the Cause of Death Register. STAGE and SALT were analyzed separately. General linear models were used to evaluate whether ED category (AN, BN, or no ED) was associated with SACs, and to identify factors associated with SACs. The prevalence of SAC was higher for women in both the AN or BN categories compared with women with no ED in both STAGE and SALT. In STAGE, depression and panic disorder were associated with SACs in women with AN, and vomiting, depression, substance use and panic disorder were associated with SACs in women with BN. In SALT, alcohol abuse/dependence was associated with SACs in women with AN; no factors were identified as associated with SACs in women with BN. All identified factors acted in an additive

manner and did not interact with eating disorder status to differentially increase risk. Results of this investigation may assist with identification of individuals with eating disorders at highest risk for SAC and directly inform treatment and prevention efforts.

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LIST OF ABBREVIATIONS

AN: Anorexia nervosa

ANBP: Bing/purge subtype anorexia nervosa

BMI: Body mass index

BN: Bulimia nervosa

CI: Confidence interval

DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition

ED: Eating Disorder

EPI: Eysenck Personality Inventory

FDR: False discovery date

GAD: Generalized anxiety disorder

GEE: Generalized estimating equations

ICD: International Classification of Diseases

OCD: Obsessive-compulsive disorder

RAN: Restricting subtype anorexia nervosa

SAC: Suicide attempts/completions

SALT: Screening Across the Lifespan of Twins

SMR: Standardize mortality ratio

STAGE: Swedish Twin study of Adults - Genes and Environment

STR: Swedish Twin Registry

Introduction

Eating disorders are serious mental disorders that occur in 1-5% of adolescent and adult women and often have poor long-term outcome (Berkman, et al., 2006; Hudson, Hiripi, Pope, & Kessler, 2007). Of these conditions, anorexia nervosa (AN) is characterized by an inability to maintain healthy body weight, restrictive eating, overvaluation of weight and shape, and in some subtypes, binge eating and purging behaviors (American Psychiatric Association, 2000). Only 30-46% of patients with AN ever fully recover from this condition (Bulik, Sullivan, Fear, & Pickering, 2000; Steinhausen, 2009), and the evidence base for treatment of AN in adults is deficient (Berkman, et al., 2006).

In contrast to AN, bulimia nervosa (BN) is characterized by recurrent binge eating, compensatory behaviors, and overvaluation of weight and shape in the absence of low weight (American Psychiatric Association, 2000). The clinical course of BN is less severe than that of AN, with 70% of patients achieving remission 5-20 years after baseline diagnosis (Keel & Brown, 2010); a growing literature supports the efficacy of both medication and psychotherapy (Berkman, et al., 2006). However, understanding who is at risk for poor outcome and mortality for both AN and BN is of critical importance for psychologists to be able to develop targeted prevention and treatment for these devastating disorders.

Eating Disorder Mortality

The mortality from eating disorders has consistently been shown to be elevated compared to the general population. Standardized mortality ratios (SMR) have varied widely for AN, and have been estimated to be between 0.71-17.8 (Norring & Sohlberg, 1993; Strober, Freeman, & Morrell, 1997). SMR is the observed number of deaths divided by the

expected number of deaths and provides a risk of death compared to the general population of similar age and gender. The wide variation of SMRs may depend partially on the length of follow-up, which ranged from one to 35 years, as well as type of patient population, and number of participants lost to follow-up. The most recent and comprehensive meta-analysis of mortality in eating disorders analyzed data from 36 studies and found that the SMR was 5.86 (95% CI, 4.17; 8.26) for AN and 1.93 (95% CI, 1.44; 2.59) for BN compared to a reference population (Arcelus, Mitchell, Wales, & Nielsen, 2011). Therefore, the existing data on mortality of AN and BN indicate that individuals with either disorder are at increased risk for death compared with their age and gender matched peers. In addition to being at risk compared to the general population, people with AN appear to have the highest mortality of any psychiatric illness (Harris & Barraclough, 1998; Sullivan, 1995). Mortality for AN is 5.6% per decade of follow up (Sullivan, 1995). Approximately half of the deaths of individuals with AN result from physical complications of the disorder, such as malnourishment or heart failure, whereas the second leading cause of death in AN is suicide (Harris & Barraclough, 1998; Sullivan, 1995).

The high rate of death by suicide in both AN and BN is particularly alarming. A recent meta-analysis conducted by Preti and colleagues (2011) analyzed data from 40 studies presenting cause of mortality data and found that, in 16,342 patients with AN followed over a mean of 11.1 years, 245 suicides occurred, yielding an SMR of 31.0. This SMR is comparable to a previous finding of an SMR of 32.4 for suicide in individuals with AN (Harris & Barraclough, 1998). The meta-analysis by Preti and colleagues (2011) also included data from 16 studies on BN and found that four suicides occurred in the 1768 patients, with a mean follow-up of 7.5 years, yielding an SMR of 7.5. Due to the low number

of participants, low number of completed suicides, and the use of continuity correction for studies with zero events, one should interpret this SMR with caution as the results might be inflated. However, a recent study not included in this meta-analysis followed 906 participants seeking outpatient psychotherapy for BN over 8-25 years and found eight completed suicides, yielding an SMR of 6.51 (Crow, et al., 2009). Therefore, these studies provide convergent evidence to suggest that individuals with both AN and BN are at elevated risk for suicide compared to age and gender matched peers.

There are several limitations across the studies examining mortality and suicide in eating disorders. First, the length of follow-up varies widely, ranging from 1-35 years. As longer length of follow-up generally correlates with more deaths due to suicide, the studies with shorter follow-up may be presenting conservative estimates of risk for completed suicide. Second, many of these studies lost a large number of their participants to follow-up and provided no details about these participants. Conceivably, these participants may have been lost to follow-up due to death, which would also lead to conservative estimates. Third, most of the participants came from treatment-seeking populations. Eating disorders often go undetected and untreated in the community, particularly for individuals with BN who have no physical evidence of their disorder (Hoek, 1991; Hudson, et al., 2007). These undetected cases may have been less severe, with people at risk for suicide potentially being more likely to seek treatment. As a result, the proportion of those with an eating disorder who commit suicide may have been inflated due to the reliance on treatment-seeking populations. Therefore, future research investigating suicide in eating disorders should increase follow-up time, examine death records to identify participants considered lost to follow-up, and investigate mortality using population-based samples.

Suicide Attempts: Prevalence

Due to the low prevalence of AN and BN in the population, investigating completed suicide can be difficult due to necessarily large sample size and many years of follow-up. Few studies have the power to examine factors associated with completed suicide. However, one of the best predictors of a death by suicide is a previous suicide attempt, with individuals who have made one attempt having a 30-40 times increased risk of death by suicide compared with those who have never made a suicide attempt (Borges, Angst, Nock, Ruscio, & Kessler, 2008; Borges, et al., 2006). Therefore, studying suicide attempts is one way one to address the sample size problem and obtain information about factors associated with suicide in these low prevalence disorders.

Suicide attempts are common in individuals with AN, with estimates of from 8% to 29.7% attempting suicide (Franko & Keel, 2006; Youssef, et al., 2004). The elevated rate of suicide completion in AN has been hypothesized to be a result of starvation-induced compromised medical conditions (Joiner, Van Orden, Witte, & Rudd, 2009). According to this "fragility hypothesis," people with AN die from attempts that would not be lethal for a healthy individual and may not actually represent suicide attempts where the individual intended to die. Arguing against this hypothesis, suicide attempts in AN are often serious and associated with an intention to die. In a sample of 432 non-treatment seeking participants with AN, 16.9% had attempted suicide at least once in their life. Of those who had attempted suicide, 78.3% wanted to die from their attempt(s), and 56.5% thought that they would die as a result of the attempt(s). Over half of these attempts required medical attention (Bulik, et al., 2008). In another study that examined a sample of patients with AN seeking treatment, 86% of those who had attempted suicide endorsed "definite intent" to die as a result of their

attempt (Bulik, Sullivan, & Joyce, 1999). Therefore, suicide attempts in those with AN are common and often serious.

Clinical studies have yielded contradictory results regarding differences in prevalence of suicide attempts across AN and BN, with some studies finding no difference in prevalence of attempts (Bulik, et al., 1999; Herzog, et al., 1999; Milos, Spindler, Hepp, & Schnyder, 2004), some finding higher prevalence of suicide attempts in individuals with BN than AN (Favaro & Santonastaso, 1996; Favaro & Santonastaso, 1997), and some higher prevalence of suicide attempts in individuals with AN than BN (Franko, et al., 2004). Some of these contradictory data may have resulted from a lack of sub-typing AN. Franko and colleagues (2006) highlighted the importance of distinguishing between patients with binge/purge subtype anorexia nervosa (ANBP) and patients with restricting subtype anorexia nervosa (RAN) when calculating suicide prevalence (Franko & Keel, 2006). When analyses accounted for AN subtypes, consistency emerged with patients with ANBP having elevated rates of suicide attempts compared with RAN. Bulik and colleagues (2008) found that only 7.4% of those with RAN had at least one lifetime suicide attempt compared with over 26% of those with ANBP (Bulik, et al., 2008). Favaro and colleagues (1997) reported similar results, with 5% of those with RAN compared to 16% of those with ANBP having at least one lifetime suicide attempt. Therefore, studies investigating suicide attempts in AN should distinguish between the two subtypes.

Suicide attempts in individuals with BN have received less attention than AN in the literature as it was originally thought that people with BN did not have as high of a risk for suicide attempts and completions. Although evidence suggests that the mortality rate for BN is lower than AN, suicide attempts are common in those with BN, with studies reporting

between 15-40% of participants indicating a lifetime history of at least one suicide attempt (Bulik, et al., 1999; Corcos, et al., 2002; Favaro & Santonastaso, 1997; Franko & Keel, 2006; Milos, Spindler, Hepp, et al., 2004). Of individuals with BN who attempt suicide, 34.1% had a "serious" or "extreme" first attempt; the proportion of "serious" or "extreme" attempts increased as the number of the suicide attempts increased. Over 60% of individuals with BN were hospitalized as a result of their first suicide attempt, and 100% of those who endorsed an "extreme" suicide attempt were hospitalized (Corcos, et al., 2002). Thus, suicide attempts are common in individuals with BN as well as AN, and those attempts often are serious.

Factors Associated with Suicide Attempts

Even though individuals with eating disorders are at elevated risk for suicide attempts, many individuals with eating disorders do not attempt suicide. Therefore, it is important to understand more fully the factors within this population that place individuals at risk for such attempts. Several factors have been identified as being associated with suicide attempts in individuals with an eating disorder. The correlates that have received the most research attention and empirical support are clinical features of the eating disorder itself, psychiatric comorbidity, substance abuse, and certain temperament and personality traits.

Lifetime suicide attempts have been associated with specific clinical features of eating disorders. As described above, several studies indicated that people who purge are more likely to make a suicide attempt than those who do not. In a study of outpatients, Favaro and Santonastaso (1996) divided AN and BN participants separately into groups based on purging behaviors. Of those with AN, the groups of participants who vomited and/or used laxatives had a higher prevalence of suicide attempts than the non-purging group. Among the BN participants, the highest prevalence of suicide attempts was in the group who

engaged in both vomiting and laxative use compared to those who used only one purging method or a non-purging compensatory behavior (Favaro & Santonastaso, 1996). Therefore, across eating disorder diagnoses, purging in some manner is associated with suicide attempts. Other eating disorder features, including lifetime low body weight (Favaro & Santonastaso, 1997), longer duration of illness (Favaro & Santonastaso, 1997), and earlier age of onset (Forcano, et al., 2009) have been associated with suicide attempts in individuals with eating disorders. These later factors might be indicators of more severe psychopathology among these individuals at risk for suicide attempts.

Several psychiatric disorders have been found to be associated with suicide attempts in individuals who have an eating disorder. Individuals with an eating disorder who attempt suicide are more likely to have a lifetime history of depression than individuals with an eating disorder who have not attempted suicide (Anderson, Carter, McIntosh, Joyce, & Bulik, 2002; Bulik, et al., 2008; Corcos, et al., 2002; Favaro & Santonastaso, 1997). Over 80% of individuals with AN who had attempted suicide report that their worst or only attempt occurred during an active major depressive disorder episode (Bulik, et al., 2008). In addition to mood disorders, other axis I and axis II disorders have been associated with suicide attempts in individuals with eating disorders. Individuals with an eating disorder who have attempted suicide are more likely to have an anxiety disorder, including post-traumatic stress disorder, panic disorder, or a broad diagnosis of "any anxiety disorder" (Bulik, et al., 2008; Milos, Spindler, Hepp, et al., 2004), Cluster B personality disorders [disorders characterized as dramatic, emotional, and emotional; (Bulik, et al., 2008; Milos, Spindler, Hepp, et al., 2004; Stein, Lilenfeld, Wildman, & Marcus, 2004)] and Cluster C personality disorders [disorders characterized as anxious or fearful; (Milos, Spindler, Hepp, et al., 2004)].

Therefore, the individuals with an eating disorder who attempt suicide appear to have additional psychopathological difficulties.

Several studies also have found substance and alcohol abuse to be significantly associated with suicide attempts in both AN and BN (Anderson, et al., 2002; Corcos, et al., 2002; Franko, et al., 2004). Even after controlling for depression, Bulik and colleagues (2008) found that substance abuse was significantly associated with a lifetime suicide attempt in individuals with AN. The depression literature suggests that substance use disorder is associated with suicide attempts in individuals with major depressive disorder (Davis, et al., 2005; McDermut, Mattia, & Zimmerman, 2001). The association between substance use and suicide attempts may result from the substance use exacerbating the psychiatric symptoms, the substance use interfering with social functioning, and/or an impulsive personality increasing the likelihood of both using substances and attempting suicide.

To date, research has not disentangled whether these comorbidities are generally responsible for the high risk for suicide attempts or whether they play a unique role within the context of the eating disorder. That is, given that individuals with other psychiatric disorders such as depression and substance use are at high risk for suicide attempts in general, it is important in future investigations to explore whether these comorbid disorders operate independently of the eating disorder in elevating the risk for suicide attempts or whether these disorders and the eating disorder interact in some unique manner that places an individual with both disorders at particularly high risk. Given the frequency of comorbidity in individuals with an eating disorder who attempt suicide, understanding whether these psychiatric comorbidities act in an additive manner or interact in some unique way to

increase the prevalence of suicide attempts may elucidate some of the underlying mechanisms driving this increased suicidal behavior.

In addition to psychiatric comorbidities, temperament and personality characteristics appear to be associated with suicide attempts in individuals with eating disorders. Bulik and colleagues (1999) examined the relation between temperament and character variables and suicide attempts in women with an eating disorder. High persistence (a tendency to continue behavior that is no longer rewarded) was associated with increased odds of suicide attempt in individuals with an eating disorder (Bulik, et al., 1999). Although high persistence is typically considered an adaptive trait related to the ability to persevere, persistence may become maladaptive when contingencies are changeable (Cloninger, Przybeck, Svrakic, & Wetzel, 1994). When faced with disruptive or uncertain life events, individuals with high persistence may find that their previous coping strategies fail, and they lack the flexibility to develop and implement alternative strategies (Bulik, et al., 1999).

Low self-directedness (low resourcefulness and self-acceptance) has also been associated with increased odds for a lifetime suicide attempt in women with AN and women with BN (Bulik, et al., 1999). The association between self-directedness and suicide is more straightforward; a person who does not identify with individually-valued life goals or feel responsibility for their choices may be more susceptible to feel hopeless and therefore be more likely to attempt suicide (Bulik, et al., 1999). Women with borderline personality disorder, a disorder marked by impulsivity and suicidal behavior, have lower self-directedness than controls (Fassino, et al., 2009). Additionally, the association between low self-directedness and suicide attempts has been shown in individuals with mood disorders,

schizophrenia spectrum disorders, and borderline personality disorder (Calati, et al., 2008), indicating that this association is not unique to those individuals with an eating disorder.

Based on these temperament and personality data and the psychiatric comorbidities associated with suicide attempts described above, an anxious-impulsive profile emerges for people with an eating disorder who attempt suicide. Evidence suggests that suicidality is associated with anxiety disorders and anxious personality traits such as a harm avoidance and neuroticism in both psychiatric and community samples (Bulik, et al., 1999; Engstrom, Brandstrom, Sigvardsson, Cloninger, & Nylander, 2004; Renaud, Berlim, McGirr, Tousignant, & Turecki, 2008). Additionally, impulsivity, high novelty seeking, and low self-directedness have been associated with suicide attempts and completions in the general population (McGirr, Paris, Lesage, Renaud, & Turecki, 2007; McGirr, Renaud, et al., 2007; Zouk, Tousignant, Seguin, Lesage, & Turecki, 2006). The co-existence of anxious and impulsive traits may increase suicidal risk in individuals with eating disorders. The presence of these multi-impulsive traits has been noted in BN (Fichter, Quadflieg, & Rief, 1994) and has been associated with suicide attempts in that group (Nagata, Kawarada, Kiriike, & Iketani, 2000). The findings of Bulik and colleagues (2008) that suicide attempts in AN are also associated with a cluster of anxiety disorders, substance abuse, Cluster B personality disorders, and various impulse-control disturbances such as self-harm and stealing, indicate that a similar anxious/impulsive trait might be present in individuals with AN who attempt suicide. Therefore, the logical next step would be to investigate whether an anxious-impulsive profile may predispose to suicide by replicating these findings in a large, population-based sample and, additionally, explore whether these traits work additively or interact to increase the risk of suicide.

A large body of research has examined factors associated with suicide attempts in individuals with eating disorders and has established several psychopathological, temperament, and personality correlates of suicide attempts in this population. However, clinical studies assessing prospective risk factors for suicide attempts and completions are scarce. Huas and colleagues (2011) reviewed the literature for prospective risk factors for mortality of eating disorders broadly and noted that, with one exception, the sample sizes were small (less than 14 deaths) and studies therefore had limited power. Additionally, the risk factors were not consistently tested across these studies, making comparisons and generalizations difficult. Furthermore, these studies did not separate out mortality resulting from suicide (Huas, et al., 2011). Clinically, there is an important distinction between those who die of physical complications of their eating disorder and those who commit suicide.

Identifying those individuals at risk for suicide attempts or completion would allow researchers, clinicians, and family to target prevention and treatment resources on those at risk for poor outcome. Franko and colleagues (2004) assessed suicidality in an eight year prospective longitudinal study of individuals with both AN and BN. For individuals with AN, a history of a suicide attempt prior to the intake for the study, severity of substance use during the study, participation in individual therapy, use of neuroleptic medication and age of onset of eating disorder predicted time to first suicide attempt after admission to the study. For individuals with BN, participation in therapy, diagnosis of paranoid personality disorder at intake, and laxative use during the study predicted time to first suicide attempt after admission to the study (Franko, et al., 2004). These results should be interpreted with caution, as the participants were from a treatment-seeking population and therefore not only already had a diagnosis of an eating disorder, but many had already made one suicide

attempt. The lack of prospective risk factors for suicide attempts and completions in individuals with an eating disorder is a major gap in the research literature.

Present Study

A growing body of literature indicates that risk for both suicide attempts and completed suicides is elevated among those individuals with eating disorders relative to individuals without eating disorders. This risk for suicide completion appears to be particularly high for individuals with AN compared to BN; however, these results have been discrepant due to the inconsistency of sub-typing AN into RAN and ANBP. Clinical correlates associated with suicide attempts in individuals with eating disorders include several clinical features of the eating disorder, psychiatric comorbidities, and temperament and personality traits. However, previous research has not focused on understanding whether these psychiatric comorbidities and temperament and personality traits act in an additive manner or interact in some unique way to increase the risk of suicide attempts. Therefore, the underlying mechanisms driving the increased suicidal behavior in this population remain unclear and future research should therefore begin to attempt to disentangle these factors.

The information gained from small clinical samples serves to support initial hypotheses and indicate future directions for research. However, these studies have typically been underpowered and the findings are not generalizable outside of a treatment-seeking population. In order to assist clinicians and families in developing reliable risk profiles to assist with appropriate diligence, detection, and prevention of suicide in this high-risk population, population-based studies must be conducted and are the next logical extension of this body of literature. No comprehensive population-based study exists that explores

prospective risk factors and correlates of suicide attempts/completions in an eating disorder population.

The present study is the first population-based study of suicide risk in women with eating disorders that includes a prospective measure. The present study uses data from two cohorts of the population-based Swedish Twin Registry (STR) in conjunction with the Swedish National Patient Register and the National Cause of Death Register. These datasets provide a unique opportunity to investigate areas not extensively studied in the suicide literature. The participants were drawn from the general population, rather than a treatment seeking or convenience sample, and detailed information about eating disorder symptoms and full diagnoses are available on the sample. With a sample size of 29,662 across the two cohorts, the present study has more power to investigate factors associated with suicide attempts/completions than the majority of the published literature.

By linking to the Swedish National Patient Register and the National Cause of Death Register, the present study is able to investigate suicide attempts without relying on potentially biased self-report. Moreover, gathering data from national registers decreases the likelihood that participants will be lost to follow-up, as all deaths and hospitalization in Sweden are captured in these databases. Therefore, the present study assesses whether suicide attempts/completions are more prevalent in individuals with eating disorders than in individuals without eating disorders in a population-based sample and identifies psychopathological, temperament, and personality features associated with suicide attempts/completions, including a prospective temperament feature. We also investigate whether the factors associated with suicide in eating disorders are differentially associated

with suicide attempts/completions in individuals with eating disorders as compared to individuals without an eating disorder.

The present study has 1 descriptive aim (Aim 1), 3 primary aims (Aims 2, 3, and 4), and 1 exploratory aim (Aim 5):

Aim 1: After linking the two cohorts of the STR with the Swedish National Patient Register and the National Cause of Death Register, to identify all cases of attempted and completed suicide and assesses type of suicide attempts, age at first suicide attempt, and number of attempts within the full sample and across eating disorder diagnoses.

Aim 1 is a descriptive aim.

Aim 2: To evaluate whether the prevalence of suicide attempts/completions is greater in women with AN and with BN than individuals without an eating disorder, and to evaluate whether there are differences in prevalence of suicide attempts/completions across eating disorder sub-types, including RAN, ANBP, and BN.

Hypothesis: The prevalence of suicide attempts/completions will be higher in individuals with AN and with BN than those without an eating disorder, with the risk in individuals with AN being higher than in those with BN. When eating disorder categories are sub-categorized, suicide attempts/completions will be more prevalent in individuals with ANBP and BN than RAN.

Aim 3: To identify eating disorder features, including lowest illness related body mass index (BMI), lifetime presence of various inappropriate compensatory behaviors, binge eating, age of eating disorder onset, and amenorrhea, associated with suicide attempts/completions in AN and in BN relative to individuals with AN and BN who have never attempted suicide.

Hypothesis: Lowest illness related BMI and age of eating disorder will be negatively associated with suicide attempts/completions and the lifetime prevalence of various inappropriate compensatory behaviors will be positively associated with suicide attempts/completions in individuals with AN and in individuals with BN.

Aim 4: To identify, separately within AN and within BN groups, psychiatric comorbidity and personality features associated with suicide attempts/completions.

Hypothesis: Suicide attempts/completions will be positively associated with lifetime major depression, lifetime anxiety disorders, lifetime alcohol abuse/dependence, lifetime substance use, and low self-directedness in all eating disorder groups. Low extraversion will be a prospective risk factor for suicide attempts/completions in individuals with eating disorders. The factors associated with suicide attempts/completions will not differ between AN and BN groups.

Aim 5: To determine whether significant factors identified in Aims 3 and 4 are differentially associated with suicide attempts/completions in individuals with AN and BN compared with individuals without eating disorders.

Aim 5 is an exploratory aim.

Method

Participants:

This study included women from two cohorts of the Swedish Twin Registry (STR). The STR is a large, population-based sample of Swedish twins comprising over 170,000 individuals in approximately 85,000 twin pairs. Participants included in this study are female twins born between 1959-1985 assessed as part of the Swedish Twin study of Adults: Gene and Environment [STAGE; n = 12,981; (Furberg, et al., 2008; Lichtenstein, et al., 2006)] and females twins born between 1935-1958 assessed as part of the Screening Across the Lifespan of Twins study [SALT; n = 16,281; (Lichtenstein, et al., 2002; Pedersen, Lichtenstein, & Svedberg, 2002)]. These non-overlapping cohorts are described below. Only women with complete eating disorder diagnostic information were included. Women with a lifetime diagnosis of binge eating disorder but no other lifetime diagnosis of an eating disorder were excluded from the analyses.

Swedish Twin study of Adults: Genes and Environment (STAGE): The data for STAGE were collected in 2005 using web-based questionnaires and phone interviews. Questionnaires assessed demographic information; medical history; presence of psychiatric disorders including detailed information on eating disorders, alcohol and illicit substance use; and personality variables included neuroticism, extraversion, perfectionism and self-directedness. The response rate was 59.6%. Participants were between 20 and 47 years of age at the time of assessment.

Determination of zygosity was based on responses to standard twin similarity questions, which were validated with a panel of 47 single-nucleotide polymorphisms in a

random sample of 198 twin pairs. Ninety five percent (n = 188) were correctly classified. This zygosity algorithm has also previously been validated with similar results (Lichtenstein, et al., 2002). Of the twins included in the present study, 42.5% are from monozygotic twin pairs, 30.0% are from same-sex dizygotic twin pairs, 25.2% are from opposite-sex twin pairs, and 2.3% have unknown zygosity.

Screening Across the Lifespan of Twins (SALT): The cohort of Swedish twin births from 1935-1958 was originally compiled and assessed from 1970-1973. The information gathered in the 1970-1973 data collection primarily consisted of demographic, medical and life-style information and also included a short form of the Eysenck Personality Inventory (Floderus-Myrhed, Pedersen, & Rasmuson, 1980; Lichtenstein, et al., 2002; Pedersen, et al., 2002). Between 1998 and 2002, all willing and able, living and contactable twins from this birth cohort were interviewed. Trained interviewers with a medical background conducted interviews using a computer-based data collection system and assessed the presence of several diseases, psychiatric disorders including detailed information on eating disorders, and alcohol consumption. The response rate for the full sample was 75.7%. Women in SALT who participated in the 1998-2002 wave of data collection are included in the present study. Of the SALT participants, 10,213 also participated in the 1970-1973 assessment; therefore, prospective personality data are available for a large subset of this cohort. Detailed information on procedures and data sources has been published previously (Lichtenstein, et al., 2002; Pedersen, et al., 2002).

Zygosity information for same-sexed pairs was obtained at the time of register compilation on the basis of questions about childhood resemblance. For those with uncertain zygosity, this information was updated during the most recent screening. Four separate

validation studies using serology and/or genotyping have shown that these items correctly classify the zygosity of 98% of twin pairs (Lichtenstein, et al., 2002). Of the twins included in this study, 20.5% are from monozygotic twin pairs, 29.5% are from same-sex dizygotic twin pairs, 36.9% are twins from opposite-sex dizygotic twin pairs, and 13.1% have unknown zygosity.

Identification of Attempted and Completed Suicide

All Swedish citizens since 1947 and, hence, each participant in STAGE and SALT, has an assigned unique personal identification number (national registration number). Via this number, the STAGE and SALT databases can be linked to any Swedish National Register. In order to identify all recorded suicide attempts and completions, the two STR databases were linked with following registers:

National Patient Register: The Centre for Epidemiology at the National Board of Health and Welfare maintains a register that covers all public, inpatient and outpatient hospitalizations in Sweden. Each record contains admission and discharge dates, primary discharge diagnosis, and up to eight secondary diagnoses using the International Classification of Diseases (ICD) 8, ICD-9, or ICD-10 depending on the year of hospitalization (World Health Organization, 1967, 1978, 1992). The attending physician documented the diagnoses. This register captures all psychiatric care in Sweden since 1973. The register also routinely captures suicide attempts using ICD codes (codes E950-E959 in ICD-8 and ICD-9, and X60-X84 in ICD-10, see Table 1 for full list). This register was searched for any discharge diagnoses indicating suicide attempts.

The Cause of Death Register: All deaths in Sweden from 1958-2009 are contained in the Cause of Death Register. The diagnoses and causes of death are coded according to ICD.

The register routinely codes suicide as a cause of death. This database was searched to identify all cases of death by suicide (ICD-10 X60-X84, see Table 1).

Suicide Attempts/Completions: Information on suicide attempts was extracted from the National Patient Register for the years 1969-2009. Therefore, all suicide attempts not resulting in death prior to participating in STAGE and SALT in addition to suicide attempts after participation in STAGE and SALT were captured. Information on completed suicides was available from 2005-2009 for STAGE and from 1998-2009 for SALT. Due to the short follow-up time to capture completed suicides, the prevalence of completed suicides was hypothesized a priori to be too small to have sufficient power to conduct analyses across groups. Therefore, suicide attempts and completions were collapsed into one variable. The presence or absence of suicide attempts/completions is the main outcome variable.

Eating Disorder Diagnosis:

The STAGE and SALT databases are overlapping but not identical. In all instances where questions are isomorphic across databases, variables in SALT were renamed to match those in STAGE. For composite variables such as AN and BN diagnosis, variables were created to harmonize these composites as closely as possible. Table 2 lists the items used for AN diagnoses for STAGE and SALT. A broad definition of AN was used, which was defined as the Diagnostic and Statistical Manual for Psychiatric Disorders Fourth Edition (DSM-IV) criteria for AN with broadened criterion for A, B, and C, and excluding Criterion D, amenorrhea (American Psychiatric Association, 1994). Amenorrhea is an unreliable diagnostic criteria for AN (American Psychiatric Association, 1994; Bulik, Sullivan, & Kendler, 2000) and will not be included in the DSM-5 definition of AN ("DSM-5: The

Future of Psychiatric Diagnosis," 2012). This broad definition has been used elsewhere (Bulik, et al., 2010).

Additionally, AN was subtyped into RAN (absence of both lifetime binge eating and purging) and ANBP (presence of lifetime binge eating and or purging) for secondary analyses. For both STAGE and SALT, a broad definition of BN was used and is defined as meeting DSM-IV criteria for BN with a reduced frequency of binge eating of four or more times per month. This broad definition has been used previously (Root, et al., 2010) and has been shown to improve the detection of binge eating behavior without significantly increasing the prevalence of the disorder (Trace, et al., In Press). Table 3 lists the items used for BN diagnoses for STAGE and SALT.

The eating disorder categories used in analyses were non-overlapping and included those with no lifetime diagnosis of an eating disorder (no ED), those with a lifetime diagnosis of AN, and those with a lifetime diagnosis of BN. For any participants who had a lifetime history of both AN and BN (STAGE, n = 103; SALT, n = 28), they were categorized as BN (Monteleone, Di Genio, Monteleone, Di Filippo, & Maj, 2011).

For Aim 2, the AN group was further subtyped. Individuals with a lifetime diagnosis of AN who had never engaged in binge eating and never purged at least once a week were categorized as RAN. Individuals with a lifetime diagnosis of AN who had binged and/or purged were categorized as ANBP. Individuals with a lifetime diagnosis of AN and BN were categorized as BN.

Eating Disorder Features:

Binge Eating: To assess lifetime prevalence of binge eating in STAGE and SALT, participants were asked, “Have you ever had binges when you ate what most people would

regard as an unusually large amount of food in a short period of time?" with response options *yes, no,* and *don't know/refuse*. Those persons who answered yes to this question were then asked, "When you were having eating binges, did you feel your eating was out of control?" Response options for STAGE were: *not at all, slightly, moderately, very much, extremely,* and *don't know/don't wish to answer*. Response options for SALT were: *yes, no,* and *don't know/refuse*. To be scored positively for binge eating, participants had to answer 1) *yes* to the first question, and 2) *slightly, moderately, very much,* or *extremely* to the second question in STAGE or *yes* to the second question in SALT.

Inappropriate Compensatory Behaviors: The purging behaviors, including vomiting and laxative misuse, were evaluated in STAGE and SALT by asking the respondents who had endorsed binge eating if they engaged in any purging behaviors to counteract binge eating. If they answered "yes," they were scored positive for the respective purging methods. In addition, in STAGE, participants were asked about lifetime diet pill and diuretic use. STAGE participants who did not endorse binge eating were asked whether they had ever engaged in any of these behaviors to control their shape or weight with response options of never, once or twice, weekly, or daily. Those who responded weekly or daily were scored as positive for the respective purging method.

Each participant in STAGE and SALT was asked whether she ever fasted to control her shape or weight or had not eaten for 24 hours of more. Those who answered "never" were scored as absent for fasting; otherwise fasting was considered present. Excessive exercise was similarly assessed: each participant was asked whether she exercised more than 2 hours per day to control her shape and weight. Those who endorsed "daily" in STAGE or answered "yes" in SALT were scored positive for excessive exercise; for all other responses,

excessive exercise was considered absent. Participants in both cohorts were asked whether they had engaged in any "other" compensatory behaviors not previously listed.

Total number of inappropriate compensatory behaviors: A variable was created that was the sum of the number of inappropriate compensatory behaviors in which an individual had engaged over her life. For STAGE, this variable ranged from 0-7 (including all of the compensatory behaviors listed above) and for SALT, this variable ranged from 0-5 (including vomiting, laxative use, fasting, excessive exercise and "other"). Individuals with BN had a range of 1-7 for STAGE and 1-5 for SALT because engaging in at least one compensatory behavior is required to meet diagnostic criteria for BN.

Lowest BMI: For both STAGE and SALT, each participant reported lowest weight in kilograms (kg) since age 18 and current height in meters (m). For women who did not have a history of AN, lowest adult BMI (kg/m^2) was calculated. For women with a history of AN, lowest BMI was calculated from lowest weight during AN and height at the time of low weight.

Age of Onset: In STAGE and SALT, age of onset of AN was defined as age at low weight. In STAGE, age of onset of BN was assessed by asking the participant how old they were when they first began to binge eat or engage in any of the inappropriate compensatory behaviors. Age of onset of BN in SALT was defined as age at first episode of binge eating. For participants who had lifetime diagnoses of both AN and BN, the age of onset of first diagnosis was used.

Amenorrhea: To assess amenorrhea, women in both STAGE and SALT were asked the age at which they experienced menarche. Women who got their first period at age 16 or older were classified as having amenorrhea. In addition, women were asked if their periods

had already started prior to AN symptoms. Those who responded 'no' were also classified as having amenorrhea. Those that responded 'yes' were then asked if the periods stopped and for how long. Individuals who responded that her period had stopped for at least 3 months were classified as having amenorrhea.

Psychiatric Comorbidity

Other psychiatric disorders were assessed using detailed self-report questionnaires in STAGE and questions from the interview in SALT, both based on the Structured Clinical Interview for DSM-IV [SCID; (First, Spitzer, Gibbon, & Williams, 2002)]. For both STAGE and SALT, depression was coded as present if Criterion A (five symptoms of depression associated with a change of functioning) and Criterion C (significant impairment caused by the symptoms) were met. Generalized anxiety disorder (GAD) was considered present if DSM-IV-TR (American Psychiatric Association, 2000) Criteria A (excessive anxiety and worry) and C (at least three symptoms resulting from anxiety and worry) were met. Alcohol abuse/dependence diagnosis was assigned based on DSM-IV criteria (American Psychiatric Association, 1994). Substance use was measured in STAGE only and was defined as using marijuana/hash, opioids, stimulants, hallucinogens, sedatives and/or hormones 10 times or more in one month, which is Criterion 1 of drug dependence in DSM-IV-TR (American Psychiatric Association, 2000). In STAGE, lifetime prevalence of specific phobias obsessive-compulsive disorder (OCD), and panic disorder were assessed with the question "have you ever had any of the following problems." Response options were "yes" and "no."

Temperament and Personality

In STAGE, several temperament and personality variables were assessed in 2005. Concern over mistakes, personal standards, and doubts about actions were each evaluated

using four items from the subscales from the Frost Multidimensional Perfectionism Scale (Frost, Marten, Lahart, & Rosenblate, 1990). Extraversion and neuroticism were evaluated using nine items and 18 items, respectively, of the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975). Self-directedness was measured using five items from the Temperament and Character Inventory (TCI) (Cloninger, 1994). Cronbach's alpha for the self-directedness subscale in a normative Swedish population is .81 (Brandstrom, et al., 1998). For all temperament and personality scales, items were scored and summed according to their respective criteria.

In SALT, extraversion was assessed in 1973 using a short form of the Eysenck Personality Inventory (Eysenck & Eysenck, 1964; Floderus-Myrhed, et al., 1980). Therefore, the SALT cohort presents a unique situation in which a prospective personality risk factor can be assessed. This short form has been widely used in Scandinavian twin studies (Pedersen, Plomin, McClearn, & Friberg, 1988; Viken, Rose, Kaprio, & Koskenvuo, 1994). The scaled score is based on the sum of 0/1 (no/yes) responses to nine items. Mean imputation was used if one item for a particular scale is missing. Individuals with more than one missing item for a particular scale were excluded.

Because conceptual design differences exist between the two cohorts, all analyses were run separately for STAGE and SALT. Conducting analyses separately allowed for a partial replication. STAGE was considered the discovery dataset. Because the SALT assessment included only a subset of the information obtained in the STAGE assessment, the SALT dataset was used as a partial replication dataset. Additionally, due to the low prevalence of eating disorders in the SALT cohort, power to detect significant results in the SALT dataset was limited. Full models are presented for STAGE and the *p*-values for the full

models were used to determine significance. Additionally, unadjusted models are presented for STAGE. The unadjusted models are used to compare the results to those from the SALT cohort to assess whether patterns of findings are replicated across the two datasets. All data management and analyses were conducted using SAS 9.2 (SAS Institute Inc., 2004).

Statistical Analyses – STAGE Cohort

Aims 1 and 2: To identify all cases of attempted and completed suicide and assesses type of suicide attempts, age at first suicide attempt, and number of attempts within the full sample and across eating disorder diagnoses. To evaluate whether the prevalence of suicide attempts/completions is higher in women with AN and with BN than individuals without an eating disorder and to evaluate whether there are differences in prevalence of suicide attempts/completions across eating disorder sub-types, including RAN, ANBP, and BN.

The STAGE database was first linked with the Swedish National Patient Register and the Swedish National Cause of Death Register. These linkages were done via the national identification number assigned to all Swedish Nationals, described above. For each individual, the total number of lifetime suicide attempts resulting in hospitalization was based on the number of unique dates of hospital discharge entries into the Swedish National Patient Register with a suicide attempt code. Individuals who died as a result of a suicide attempt were identified from a cause of death code for suicide in the Swedish National Cause of Death Register. Identified completed suicides were added to the number of suicide attempts generated from the Swedish Hospital Discharge Register if the date of the death was different from the last Swedish National Patient Register entry.

From the date of the entries, each individual's age at first attempt was calculated. The method used for each attempt was determined by analyzing the ICD codes for each entry. The method(s) used to attempt suicide were classified as "violent" (e.g., gunshot, stabbing, hanging, jumping from a high place) and "non-violent" (see Table 1). Any participant who had more than one suicide attempt and at least one attempt was classified as violent was

grouped with those with violent attempts. The prevalence of at least one lifetime suicide attempt/completion and of violent suicide attempts/completion among those who had ever attempted suicide were computed for those with no ED, AN, and BN. Means and standard deviations for number of attempts and age at first attempt were calculated for the no ED, AN, and BN groups. Additionally, the number and percentage of lifetime suicide attempts/completions was calculated across the eating disorder subtypes, RAN, ANBP, and BN.

Logistic regression analyses (using PROC GENMOD in SAS) with generalized estimating equations (GEE) were applied to assess differences in the prevalence of suicide attempts/completion across the no eating disorder (ED), AN, and BN groups. GEE was used to account for the nesting of the data within twin pairs in this and all subsequent full model analyses. GEE generates means adjusted for cluster relationships as well as model covariates. Exchangeable correlation matrices were used for all analyses except where noted. The dependent variable was the presence/absence of a suicide attempt/completion and the independent variable was eating disorder category (no ED, AN, and BN). Age at assessment was entered as a covariate in this and all subsequent full model analyses. Type 3 score statistics were used to determine the significance of the independent variable in the models. Post hoc contrasts, which use these adjusted means, were requested to assess pairwise group differences. The score statistics are presented as χ^2 for all analyses. Unadjusted models (age not included as a covariate and GEE for non-independence not applied) were also run and results are presented for both models.

To determine whether the prevalence of violent suicide attempts among those who ever attempted/complete suicide differed across eating disorder category, a logistic

regression analysis using GEE was conducted with eating disorder category as the independent variable (no ED, AN, and BN) and presence of a violent suicide attempt as the dependent variable.

To determine whether eating disorder category was associated with age at first suicide attempt, a general linear model was applied (using PROC GENMOD) with GEE corrections. In this model, age at first suicide attempt was entered as the dependent variable and eating disorder category was the independent variable. To determine whether eating disorder category is associated with the total number of lifetime suicide attempts, a Poisson regression with GEE corrections was conducted. In this model, total number of suicide attempts was the dependent variable and eating disorder category was the independent variable.

To determine whether prevalence of suicide attempts/completions differs across RAN, ANBP, and BN, a logistic regression analysis using GEE corrections was conducted with eating disorder subtype as the independent variable (RAN, ANBP, and BN) and presence/absence of at least one suicide attempt/completion as the dependent variable.

Aim 3: To identify eating disorder features associated with suicide attempts/completions in individuals with AN and BN relative to individuals with AN and BN who have never attempted suicide.

Analyses were conducted separately with AN and BN groups to determine whether any specific eating disorder features are significantly associated with the prevalence of at least one suicide attempt/completion. The potential factors associated with suicide attempts/completions included the lifetime prevalence of binge eating (for AN only as all individuals with BN engage in binge eating), vomiting, laxative use, diet pill use, diuretic use, excessive exercise, fasting, other inappropriate compensatory behaviors, and

amenorrhea. Additionally, logistic regression models were applied to assess whether lifetime lowest BMI, age of onset of eating disorder, and total number of inappropriate compensatory behaviors in which the individual engaged were associated with the presence of a suicide attempt/completion. Each of these variables was individually entered into logistic regression models as the independent variable with the presence of a suicide attempt/completion as the dependent variable.

For some models, the sparse data and low event rate made it impossible to use an exchangeable covariance structure. Within the full sample, an independent covariance structure was used to apply GEE to the analysis examining total number of suicide attempts. In the BN sample, an independent covariance structure was used to apply GEE to the analyses examining the association between suicide attempt/completion and diet pill use, fasting, other eating disorder behaviors, amenorrhea, lowest BMI, and total number of inappropriate compensatory behaviors.

Aim 4: To identify separately in AN and in BN groups, psychiatric comorbidity and personality features associated with suicide attempts/completions.

Logistic regression analyses were conducted to examine whether lifetime psychiatric comorbidity is associated with suicide attempts/completions. These models were run separately in the AN sample and in the BN sample. The comorbid disorders assessed included lifetime diagnosis of depression, GAD, alcohol abuse/dependence, substance use, specific phobias, OCD, and panic disorder. These variables were individually entered as the independent variable into logistic regression models with GEE corrections; the presence/absence of at least one suicide attempt/completion was the dependent variable.

The associations between personality traits, including concern over mistakes, personal standards, doubts about actions, extraversion, neuroticism, and self-directedness and suicide attempts/completions were investigated using logistic regression models with GEE corrections.

In the BN sample, models assessing the association between suicide attempts/completions and alcohol abuse/dependence, substance use, phobia, OCD, panic disorder, concern over mistakes, personal standards, doubts about actions, extraversion, and neuroticism were conducted using an independent covariance structure to conduct the GEE.

Each risk factor variable was analyzed individually in Aims 3 and 4. Therefore, due to the large number of analyses conducted using the same sample, corrections for multiple testing were made using the methods of False Discovery (Benjamini & Hochberg, 1995) prior to analysis of Aim 5.

Aim 5: To determine whether significant factors identified in Aims 3 and 4 are differentially associated with suicide attempts/completions in individuals with AN and BN compared with individuals without eating disorders.

Results from Aim 3 indicated that vomiting was associated with suicide attempts/completions in the BN sample. Results from Aim 4 indicated that within the AN sample, depression and panic disorder were associated with suicide attempts/completions and that within the BN sample, depression, substance use, and panic disorder were associated with suicide attempts/completions.

Separate logistic regression models were conducted to assess whether the factors that emerged as significant in Aim 4 were differentially associated with suicide attempts/completions in individuals with AN compared with individuals without an eating

disorder. Suicide attempts/completions was the dependent variable in these models and the main effects were the factors of interest (depression and panic disorder) and the presence/absence of AN (AN status). An interaction term, the factor of interest by AN status, was initially included in both of the models. Because neither of the interaction terms was significant, they were dropped from the models and the models were reapplied including the main effects (the factors and AN status). Age was entered as a covariate in both models and GEE corrections were applied.

Logistic regression models were used to assess whether the factors that emerged in Aims 3 and 4 were differentially associated with suicide attempts/completions in individuals with BN compared with individuals without an eating disorder. Suicide attempts/completions was the dependent variable in these models and the main effects were the factor of interest (vomiting, depression, substance use and panic disorder) and the presence/absence of BN (BN status). An interaction term, the factor of interest by BN status, was initially included in each of the models. As none of these interaction terms were significant, the interaction terms were dropped from the models and the models were reapplied including the main effects of the respective factor and BN status. Age was entered as a covariate and GEE corrections were applied.

Results: STAGE Cohort

Prevalence of Suicide Attempts/Completions

At least one lifetime suicide attempt/completion was identified in 266 individuals out of the 12,981 (2.05%) individuals in the STAGE cohort. Three individuals who had died by suicide were identified. Of these three individuals, one had a diagnosis of BN and the other two had no eating disorder diagnosis.

Table 4 presents the lifetime prevalence of suicide attempts/completions across the no ED, AN, and BN groups. Lifetime prevalence of suicide attempts/completions was significantly different across these three groups ($\chi^2 = 39.62$, df = 2, $p < .01$). Post hoc analyses revealed that significantly fewer persons with no ED [1.65%; (202/12,248) attempted suicide than those with AN [5.80%; (22/379), $p < .01$) and than those with BN [11.86%; (42/354), $p < .01$]. Suicide attempts/completions were less prevalent in AN than in BN ($p < .01$). There were no significant differences in prevalence of suicide attempts/completions across the eating disorder subtypes, with 3.95% (8/203) of individuals with RAN, 7.95% (14/176) of individuals with ANBP and 11.85% (42/354) of individuals with BN having at least one suicide attempt/completion ($\chi^2 = 11.69$, df = 2, $p > .05$).

The prevalence of violent attempts among those who attempted/completed suicide is presented in Table 5. No significant differences in the prevalence of violent suicide attempts across the no ED [16.43%; (23/202)], AN [33.33% (5/22)], and BN [23.33%; (7/42)] groups were observed.

The age at first attempt for all persons with at least one suicide attempt was between 13-50 years. The mean age at first suicide attempt by eating disorder category is presented in

Table 5. Age at first attempt did not differ by eating disorder category. The total number of suicide attempts ranged from 1-43. The average number of suicide attempts across eating disorder category is presented in Table 5; the total number of suicide attempts did not differ by eating disorder category.

Eating Disorder Features Associated with Suicide Attempts/Completions:

The prevalence of eating disorder features in the AN sample in those with at least one suicide attempt/completion (n = 22) and those without a suicide attempt/completion (n = 357) are presented in Table 6. None of these features were significantly associated with the lifetime prevalence of at least one suicide attempt/completion. The mean lifetime lowest BMI, age of onset, and number of lifetime compensatory behaviors are also presented in Table 6. None of these variables were significantly associated with the lifetime prevalence of at least one suicide attempt/completion.

Table 7 presents the prevalence of the eating disorder features in the BN sample in the group with at least one suicide attempt/completion (n = 42) and in the group without a suicide attempt/completion (n = 312). The lifetime presence of vomiting was significantly associated with a suicide attempt/completion ($\chi^2 = 8.38$, df = 2, $p < 0.03$). Vomiting was more prevalent in the group with a suicide attempt/completion [92.86%, (39/42)] than the group without a suicide attempt/completion [79.81%, (249/312), adjusted OR = 1.02, 95% CI = 1.00; 1.03]. There was no difference in the prevalence of any of the other eating disorder features between the two groups. The mean lifetime lowest BMI, age of onset, and number of lifetime compensatory behaviors are also presented in Table 7. None of these variables were significantly associated with suicide attempt/completion.

Comorbid Psychiatric Diagnoses and Personality Features Associated with Suicide Attempts/Completions:

The prevalence of comorbid psychiatric diagnoses in the AN sample with at least one suicide attempt/completion and in the AN sample without a suicide attempt/completion are presented in Table 8. The lifetime presence of depression was significantly associated with suicide attempt/completion ($\chi^2 = 12.30$, df = 2, $p < .01$). Depression was more prevalent in the group with a suicide attempt/completion [86.36%, (19/22)] compared with the group without a suicide attempt/completion [49.07%, (159/324), adjusted OR = 6.85, 95% CI = 2.00; 23.43]. The lifetime presence of panic disorder was significantly associated with suicide attempt/completion ($\chi^2 = 10.05$, df = 2, $p < .02$). Panic disorder was more prevalent in the group with a suicide attempt/completion [76.47%, (13/17)] than the group without a suicide attempt/completion [28.66%, (88/307), adjusted OR = 8.48, 95% CI = 2.72; 26.49]. No other comorbid psychiatric diagnoses differed between the two groups. The means of the personality feature variables are presented in Table 8. None of the personality feature variables were significantly associated with suicide attempt/completion.

The prevalence of comorbid psychiatric diagnoses in the BN sample with at least one suicide attempt/completion and in the BN sample without a suicide attempt/completion are presented in Table 9. A lifetime diagnosis of depression was associated with suicide attempt/completion ($\chi^2 = 15.87$, df = 2, $p < .01$). Depression was more prevalent in the group with at least one suicide attempt/completion [87.50%, (35/40)] than the group without a suicide attempt/completion [56.74%, (160/282), adjusted OR = 1.01, 95% CI = 1.00; 1.01]. Lifetime substance use was significantly associated with suicide attempt/completion ($\chi^2 = 10.85$, df = 2, $p < .01$). The prevalence of substance use was higher in those with at least one

suicide attempt/completion [33.33%, (14/42)] than those without a suicide attempt/completion [6.41%, (20/312), OR = 7.26, 95% CI = 3.26; 15.68]. Lifetime panic disorder was significantly associated with suicide attempt/completion ($\chi^2 = 8.24$, df = 2, $p < .01$). Panic disorder was more prevalent in those with a suicide attempt/completion [65.63%, (21/32)] than those without a suicide attempt/completion [35.57%, (90/253, OR = 3.68, 95% CI = 1.64; 8.25]. No other comorbid psychiatric diagnosis was significantly associated with suicide attempt/completion. The means of the personality feature variables are also presented in Table 9. None of the personality features were significantly associated with suicide attempt/completion.

Analyses of Factors Associated with Suicide in Individuals with Eating Disorders: Differentially Associated with Suicide in Individuals Without EDs

Two factors from the analyses in Aim 3 and 4, lifetime prevalence of depression and panic disorder, were significantly associated with suicide attempts/completions in women with AN. These associations were then compared among women with AN and women with no ED to assess whether these factors act in an additive manner with AN status or interact (See Table 10). In the first model, the interaction of depression and AN was not significant and was, therefore, dropped from the final model. In the final model, both depression ($\chi^2 = 68.45$, df = 1, $p < .01$) and AN status ($\chi^2 = 8.53$, df = 1, $p < .01$) were associated with suicide attempts/completions. Even when accounting for the effects of depression, women with a lifetime diagnosis of AN were more likely to attempt/complete suicide (OR = 2.75, CI = 1.70; 4.41) than those without AN. Depression and AN do not interact but rather act in an additive manner to increase risk of suicide attempts/completions.

In the second model, the interaction of panic disorder and AN status (AN vs. no ED) was not significant and was, therefore, dropped from the final model. In the final model, both panic disorder ($\chi^2 = 59.58$, df = 1, $p < .01$) and AN status ($\chi^2 = 5.74$, df = 1, $p < .02$) were associated with suicide attempts/completions. Even when accounting for the effects of panic disorder, women with a lifetime diagnosis of AN were more likely to attempt/complete suicide (OR = 2.44, CI = 1.44; 4.13) compared with those without AN. Panic disorder and AN do not interact but rather act in an additive manner to increase risk of suicide attempts/completions.

Four factors, lifetime prevalence of vomiting, depression, substance use, and panic disorder, emerged from the analyses in Aim 3 and 4 as being associated with suicide attempts/completions in women with BN. These associations were then compared among women with BN and women with no ED to assess whether these factors act in an additive manner with BN status or interact (See Table 11). In all four models, the interaction of the factor and BN status was not significant and was dropped from the model. In each model, both the factor of interest and BN status were associated with suicide attempts/completions (See Table 11).

Statistical Analyses – SALT Cohort

To use the SALT cohort as a partial replication study, the methodology used was identical to the methodology used in the STAGE wherever possible. However, due to the low prevalence of AN and BN in SALT, unadjusted models were used in order to preserve statistical power.

Aims 1 and 2: To identify all cases of attempted and completed suicide and assesses type of suicide attempts, age at first suicide attempt, and number of attempts within the full sample and across eating disorder diagnoses. To evaluate whether the prevalence of suicide attempts/completions is greater in women with AN and with BN than individuals without an eating disorder and to evaluate whether there are difference in prevalence of suicide attempts/completions among eating disorder subtypes, including RAN, ANBP, and BN.

The SALT database was first linked with the Swedish National Patient Register and the Swedish National Cause of Death Register. These linkages were done via the national identification number assigned to all Swedish Nationals, described above. For each individual, the total number of lifetime suicide attempts resulting in hospitalization was determined based on the number of unique date of hospital discharge entries into the Swedish National Patient Register for a suicide attempt code. Individuals who died as a result of a suicide attempt were identified in the Swedish National Cause of Death Register from a cause of death code for suicide. Identified completed suicides were added to the count generated from the Swedish Hospital Discharge Register if the date of the death was different from the last Swedish National Patient Register entry.

From the date of the entries, each individual's age at first attempt was calculated. The method used for each attempt was determined by analyzing the ICD codes for each entry. The method(s) used to attempt suicide were classified as "violent" (e.g., gunshot, stabbing, hanging, jumping from a high place) and "non-violent" (see Table 1). Any participant who had more than one suicide attempt and at least one attempt that was classified as violent was grouped with those with violent attempts. The prevalence of at least one lifetime suicide attempt/completion and of violent suicide attempts/completion among those who had ever attempted suicide were computed for those with no ED, AN, and BN. Means and standard deviations for number of attempts and age at first attempt were calculated for the no ED, AN, and BN groups. Additionally, the number and percentage of lifetime suicide attempts/completions was calculated across the eating disorder subtypes, RAN, ANBP, and BN.

Logistic regression analyses (using PROC GENMOD in SAS) were used to assess differences in the prevalence of suicide attempts/completion across the no ED, AN, and BN groups. The dependent variable was the presence/absence of a suicide attempt/completion and the independent variable was eating disorder group (no ED, AN and BN). Type 3 score statistics were used to identify significant associations. For models with significant associations, post hoc contrasts were requested to assess pairwise group differences. The score statistics are presented as χ^2 for all analyses.

To determine whether the prevalence of violent suicide attempts differed across eating disorder groups, a logistic regression analysis was conducted with eating disorder group as the independent variable (no ED, AN, and BN) and presence of a violent suicide attempt as the dependent variable.

To determine whether eating disorder category was associated with the age at first attempt, a general linear model was applied (using PROC GENMOD). In this model, age at first attempt was entered as the dependent variable and eating disorder category was the independent variable. To determine whether eating disorder category is associated with the total number of lifetime suicide attempts, a Poisson regression was conducted. In this model, total number of suicide attempts was the dependent variable and eating disorder category was the independent variable.

To determine whether prevalence of suicide attempts/completions differs across ED subtypes a logistic regression analysis was conducted with eating disorder subtype as the independent variable (RAN, ANBP, and BN) and presence/absence of at least one suicide attempt/completion as the dependent variable.

Aim 3: To identify eating disorder features associated with suicide attempts/completions in individuals with AN and in BN relative to individuals with AN and BN who have never attempted suicide.

Analyses were conducted separately in the AN and BN groups to assess whether eating disorder features are associated with the prevalence of at least one suicide attempt/completion. The factors assessed included the lifetime prevalence of binge eating (for AN only), vomiting, laxative use, excessive exercise, fasting, other inappropriate compensatory behaviors, amenorrhea. Additionally, logistic regression models were applied to assess whether lifetime lowest BMI, age of onset of eating disorder, and total number of inappropriate compensatory behaviors were associated with the presence of a suicide attempt/completion. Each of these variables was individually entered into logistic regression

models as the independent variable with a dependent variable of the presence of a suicide attempt/completion.

In both the AN and BN samples, none of the individuals who had attempted/completed suicide endorsed using "other inappropriate compensatory behaviors." Due to this zero cell, the analysis would not run and a χ^2 value could not be calculated.

Aim 4: To identify separately in AN and in BN groups, psychiatric comorbidity and personality features associated with suicide attempts/completions.

Logistic regression analyses were conducted to examine whether lifetime psychiatric comorbidity are associated with suicide attempts/completions. These models were conducted separately within the AN sample and the BN samples. The factors evaluated included a lifetime diagnosis of depression, GAD, and alcohol abuse/dependence. Each of these variables was evaluated individually and was entered as the independent variable into logistic regression models. The dependent variable was suicide attempt/completion.

A logistic regression analysis was applied to assess whether the score on the Eysenck Personality Inventory (EPI) administered in 1973 was associated with lifetime prevalence of suicide attempt/completion. The EPI score was the independent variable and presence/absence of suicide attempts/completions was the dependent variable.

Each risk factor variable was analyzed individually in Aims 3 and 4. Therefore, due to the large number of analyses being conducted using the same sample, corrections for multiple testing were made using the methods of False Discovery (Benjamini & Hochberg, 1995).

Aim 5: To determine whether significant factors identified in Aims 3 and 4 are differentially associated with suicide attempts/completions in individuals with AN and BN compared with individuals without eating disorders.

Results from Aim 4 indicated that, within the AN sample, a lifetime diagnosis of alcohol abuse/dependence was associated with suicide attempts/completions. A logistic regression model was used to assess whether a lifetime diagnosis of alcohol abuse/dependence is differentially associated with suicide attempts/completions in individuals with AN compared with individuals without an eating disorder. Suicide attempts/completions was the dependent variable in this models and the main effects were the lifetime diagnosis of alcohol abuse/dependence and the presence/absence of AN (AN status). An interaction term, alcohol abuse/dependence with AN status, was initially included in the model. Because the interaction term was not significant, the interaction term was dropped from the model and the model was reapplied including the main effects of the respective factor and AN status.

Results: SALT Cohort

Prevalence of Suicide Attempts/Completions

Lifetime suicide attempts/completions were identified in 333 of the 16,281 (2.05%) individuals in the SALT cohort. Nine individuals were identified who had died by suicide. Of these individuals, eight did not have an eating disorder diagnosis and one had a diagnosis of BN.

Table 12 presents the lifetime prevalence of suicide attempts/completions across the no ED, AN, and BN groups. Eating disorder category was significantly associated with the lifetime prevalence of suicide attempts/completions ($\chi^2 = 20.91$, df = 2, $p < .01$). Post hoc pairwise analyses revealed that significantly fewer individuals with no ED [1.97%, (317/16,705) attempted/completed suicide than those with AN [6.67%, (9/135)] and than those with BN [9.86%, (7/71)]. There was no significant difference in the prevalence of suicide attempts/completions between AN and BN or across the eating disorder subtypes, including RAN [6.80%, (7/103)], ANBP [6.25%, (2/32)] and BN [9.86%, (7/71)].

The prevalence of violent attempts among those who attempted suicide is presented in Table 11. There were no significant differences in the prevalence of violent suicide attempts across the no ED [9.46%, (30/317)], AN [33.33%, (3/9)], and BN [28.57%, (2/7)] groups.

The age at first attempt for all individuals with at least one suicide attempt ranged from 16-70. The mean ages at first suicide attempt by eating disorder category are presented in Table 13. Age at first attempt did not differ significantly across eating disorder category. The total number of suicide attempts/completions ranged from 1-35. The average numbers of suicide attempts/completions across eating disorder category are presented in Table 13; there

were no significant differences in number of attempts/completions by eating disorder category.

Eating Disorder Features Associated with Suicide Attempts/Completions

The prevalence of eating disorder features in the AN sample with at least one suicide attempt/completion (n = 9) and without a suicide attempt/completion (n = 126) are presented in Table 14. None of the eating disorder features were associated with suicide attempts/completions. The means for lifetime lowest BMI, age of onset, and number of lifetime compensatory behaviors are also presented in Table 14. None of these variables were significantly associated with the lifetime prevalence of at least one suicide attempt/completion.

The prevalence of eating disorder features in the BN sample with at least one suicide attempt/completion (n = 7) and without a suicide attempt/completion (n = 64) are presented in Table 15. None of the eating disorder features were associated with suicide attempts/completions. The means for lifetime lowest BMI, age of onset, and number of lifetime compensatory behaviors are also presented in Table 15. None of these variables were significantly associated with the lifetime prevalence of at least one suicide attempt/completion.

Psychiatric Comorbidity and Personality Features Associated with Suicide Attempts/Completions:

The prevalence of comorbid psychiatric diagnoses in the AN sample with at least one suicide attempt/completion and without a suicide attempt/completion are presented in Table 16. The lifetime presence of alcohol abuse/dependence was significantly associated with suicide attempt/completion ($\chi^2 = 10.63$, df = 1, $p < .04$). Alcohol abuse/dependence was more

prevalent in the group with a suicide attempt/completion [44.44%, (4/9); OR = 15.87, CI = 3.40; 74.72] than the group without a suicide attempt/completion [4.80%, (6/125)]. None of the other psychiatric disorders were associated with suicide attempts/completions. Table 14 also presents the mean value of the EPI assessment from the 1972 administration. The EPI score was not significantly associated with suicide attempts/completions.

The prevalence of comorbid psychiatric diagnoses in the BN sample with at least one suicide attempt/completion and without a suicide attempt/completion are presented in Table 17. None of the psychiatric disorders were associated with suicide attempts/completions. Because every individual with BN who attempted suicide had a lifetime diagnosis of depression, an odds ratio could not be calculated for that model. Table 17 also presents the mean value of the extraversion assessment from the 1973 administration. The EPI extraversion score was not significantly associated with suicide attempts/completions.

Analyses of Factors Associated with Suicide in Individuals with Eating Disorders: Differentially Associated with Suicide in Individuals Without Eating Disorders

One factor, lifetime prevalence of alcohol abuse/dependence, emerged from the analyses in Aim 3 and 4 as being associated with suicide attempts/completions in women with AN. This factor was further explored within a sample of women with AN and with no ED. In the first model, the interaction of alcohol abuse/dependence and AN was not significant and was therefore dropped from the final model. In the final model, both alcohol abuse/dependence ($\chi^2 = 209.49$, df = 1, $p < .01$) and AN status ($\chi^2 = 6.18$, df = 1, $p < .02$) were associated with suicide attempts/completions. Even when accounting for the effect of alcohol abuse/dependence (OR = 12.61, CI = 9.52; 16.70), women with AN were more likely to

attempt/complete suicide (OR = 2.81, CI = 1.36; 5.84) compared to those without AN. These factors act in an additive manner.

Discussion

Prevalence of Suicide Attempts/Completions

The present study evaluated the prevalence of suicide attempts/completions among women with eating disorders in two population-based samples. Consistent with findings in previous research, the prevalence of suicide attempts/completions was significantly elevated in women with AN compared to women with no eating disorder. Of the women with AN, 5.80% of the STAGE sample and 6.67% of the SALT sample had been hospitalized for a suicide attempt at least once in their lives, resulting in unadjusted odds ratios of 3.67 (95% CI = 2.34; 5.78) and 3.55 (95% CI = 1.79; 7.05), respectively. The prevalence of suicide attempts was lower than previously reported estimates of 8-29.7% from treatment-seeking samples (Bulik, et al., 1999; Franko & Keel, 2006; Franko, et al., 2004; Youssef, et al., 2004).

Likewise, the prevalence of suicide attempts/completions was higher among women with BN than women with no eating disorder. Of women with BN, suicide attempts/completions were identified in 11.86% of the STAGE sample and 9.86% of the SALT sample, resulting in unadjusted odds ratios of 8.03 (95% CI = 5.65; 11.40) and 5.43 (95% CI = 2.47; 11.96), respectively. The prevalence of suicide attempts was lower than previously reported prevalence estimates of 15-40% from treatment-seeking samples (Bulik, et al., 1999; Corcos, et al., 2002; Favaro & Santonastaso, 1997; Franko & Keel, 2006; Milos, Spindler, Schnyder, et al., 2004).

Suicide attempts in the current study were identified through hospital discharge registries rather than self-report, and this manner of assessing suicide attempts might help to

account for the seemingly lower rate of attempts reported in the current investigation. In a non-treatment seeking sample of participants with AN, only approximately 50% of those who reported a suicide attempt had ever sought medical treatment for a suicide attempt (Bulik, et al., 2008). In a treatment-seeking sample of both AN and BN, approximately 60% of those who reported a suicide attempt had sought medical treatment for their attempt (Corcos, et al., 2002). Therefore, many individuals who attempt suicide are not hospitalized as a result of their attempt. The lower prevalence of identified suicide attempts/completions in the present study may be due to the conservative nature of the suicide attempt/completion definition. Additionally, the use of a population-based sample may also contribute to the lower prevalence, as undetected cases may be less severe and people at risk for suicide are potentially more likely to seek treatment.

Completed suicides have consistently been shown to be more prevalent in individuals with AN than those with BN (Preti, Rocchi, Sisti, Camboni, & Miotto, 2011). However, previous research has yielded inconsistent results regarding differences in prevalence of suicide attempts across individuals with AN and BN, with some studies reporting no difference in prevalence of attempts (Bulik, et al., 1999; Herzog, et al., 1999; Milos, Spindler, Hepp, et al., 2004); some finding higher prevalence of suicide attempts in individuals with BN than AN (Favaro & Santonastaso, 1996; Favaro & Santonastaso, 1997) and some higher prevalence of suicide in individuals with AN than BN (Franko, et al., 2004). The present study revealed a higher prevalence of suicide attempts/completions in individuals with BN than AN in the STAGE sample (unadjusted OR = 2.18, 95% CI = 1.28; 3.74, $p < .001$). The SALT sample showed a similar pattern, with 9.86% of women with BN

having a lifetime suicide attempt compared to 6.67% of women with AN; however, this finding failed to reach significance.

Franko and Keel (2006) highlighted the importance of subtyping AN into RAN and ANBP when assessing the prevalence of suicide attempts, noting that the contradictory results may be due to combing RAN and ANBP into the same sample. When prevalence of suicide is reported across AN subtypes, individuals with RAN appear to have a lower prevalence compared to individuals with both ANBP and BN, who have similar prevalence of suicide attempts. In the present study, no significant differences emerged in either STAGE or SALT across RAN, ANBP, and BN. However, the data show the same pattern of findings with individuals with RAN having a lower prevalence than those with ANBP and BN but may have failed to reach significance due to limited power.

The above findings might also have been affected by the decision to include individuals with a lifetime diagnosis of both AN and BN in the BN category. The existing literature on suicide in eating disorders typically uses the participant's diagnosis at study onset as the defining category for all analyses. Diagnostic crossover is frequent, both from AN to BN [8%-54%; (Eddy, et al., 2008; Tozzi, et al., 2005)] and from BN to AN [4%-27%; (Bulik, PF, Fear, & Pickering, 1997; Tozzi, et al., 2005)]. However, no studies in the suicide literature were identified that addressed the issue of diagnostic crossover. The present study had information about lifetime diagnosis for both disorders, and a subset of the sample had lifetime diagnoses of both AN and BN. In order to preserve power, the groups with a lifetime diagnoses of both AN and BN were not analyzed separately in STAGE or SALT. As individuals with a lifetime diagnoses of both AN and BN typically resemble BN groups both in terms of personality characteristics, such as higher novelty-seeking, and Axis I

comorbidity (Monteleone, et al., 2011), the decision was made to include this subgroup in the BN category. However, it is important to note the manner in which this decision may have affected results.

The null findings might also have been affected by the limited power of the study and may reflect Type II error. This study is the largest, population based study investigating the prevalence of suicide attempts/completions and factors associated with attempts in women with AN and BN compared to a referent group without eating disorders. However, given the low base rate of eating disorders and the even lower base rate of suicide attempts/completions, power was still limited to adequately address all of the aims. Therefore, it is worthwhile to examine the data closely to identify patterns that may indicate a finding that failed to reach significance due to limited power as these findings can provide hypotheses for future investigations. The power of each analysis was further limited by the presence of missing data (as noted in the tables). The data were either missing from the assessment completely (i.e., failure to respond to a question) or the participant was missing an item key to a diagnostic algorithm. The data are assumed to be missing at random, but the large amounts of missing data also constrain power.

Suicide in Individuals with Eating Disorders: Application of the Interpersonal Theory of Suicide

The present study adds to a growing literature that demonstrates that individuals with an eating disorder have a higher prevalence of suicide attempts/completions than individuals without an eating disorder. In his interpersonal theory of suicide [IPTS; (Joiner, 2005)], Joiner posits that in order for an individual to attempt suicide, the individual must have both the desire and the capability for suicide. The desire for suicide emerges when an individual

experiences both thwarted belongingness ("I am alone") and perceived burdensomeness ("I am a burden"). Individuals with AN and BN have smaller social networks and, therefore, conceivably less social support than individuals without eating disorders (Tiller, et al., 1997). Individuals with both AN and BN report high levels of loneliness, associated with both actual difficulties in interpersonal relationships and skewed perceptions of these relationships (Levine, 2012). Within BN samples, individuals also appear to be dissatisfied with the support that they receive (Rorty, Yager, Buckwalter, & Rossotto, 1999). Further, the effectiveness of interpersonal therapy in BN (Agras, Walsh, Fairburn, Wilson, & Kraemer, 2000; Fairburn, Jones, Peveler, Hope, & O'Connor, 1993) indicates that interpersonal difficulties may be common in this population. There are currently no data assessing the exact construct of thwarted belongingness in individuals with eating disorders. However, the limited and dissatisfying social support individuals with eating disorders have may lead to an experience of thwarted belongingness, which could contribute to a higher desire for suicide.

From an interpersonal perspective, the desire for suicide comes from the intersection of thwarted belongingness and perceived burdensomeness (Joiner, 2005). Individuals with eating disorders are often dependent on their families, both financially and emotionally, as eating disorders have been associated with loss of employment and underemployment (Whitney, Haigh, Weinman, & Treasure, 2007). Although there are no data on the experience of perceived burdensomeness in individuals with eating disorders, caregivers of both individuals with AN (Treasure, et al., 2001) and BN (Perkins, Winn, Murray, Murphy, & Schmidt, 2004) endorse high levels of caregiver distress and burden. Caregivers of individuals with AN experience as much caregiver burden as caregivers of individuals with schizophrenia (Graap, et al., 2008). Individuals with eating disorders might well perceive

their caregivers' levels of distress and burden, and, therefore experience a high level of perceived burdensomeness.

Individuals with many forms of psychopathology experience thwarted belongingness and perceived burdensomeness yet do not attempt suicide. The high prevalence of suicide attempts/completions in individuals with eating disorders has been hypothesized to be associated with the necessary acquired capability for suicide. IPTS posits that highly lethal suicide attempts are made only by those who have both (1) an increased physical pain tolerance and (2) a reduced fear of death. Acquired capability for suicide comes from "habituation and activation of opponent processes in response to repeated exposure to physically painful and/or fear-inducing experience" (Van Orden, et al., 2010). In this model, through repeated exposure to physically painful and/or fear-inducing experiences, individuals will habituate to the physical pain (i.e., exhibit increased pain tolerance) and habituate to the idea of their own death (i.e., reduced fear of death).

Based on opponent process theory (Solomon & Corbit, 1974), IPTS indicates that over time, exposure to these painful and/or fear-inducing experiences will result in decreases in the primary process (i.e., fear) and increases in the opponent process (i.e., relief). Therefore, acquired capability is conceptualized as a multi-dimensional variable that reaches a threshold level. Based on IPTS, individuals with eating disorders should have a high level of acquired capability for suicide due to the painful experiences of habitual starvation and inappropriate weight control behaviors as well as the habituation and opponent processes that develop over time.

Neurobiology of Suicide

Although the act of attempting suicide may be triggered by an interpersonal experience or environmental event, a large body of literature indicates a neurobiological diathesis for suicidal behavior [For a review see (Currier & Mann, 2008)]. Family studies indicate that suicidal behavior runs in families, even after controlling for the effects of psychopathology (Kim, et al., 2005); twin studies yield heritability estimates of between 30 and 50% (Statham, et al., 1998; Voracek & Loibl, 2007)}. As a complex trait, it is assumed that suicide is influenced by multiple genetic and environmental factors as well as their interactions and epigenetic effects (Currier & Mann, 2008).

In terms of neurobiology, the role of serotonin appears to be particularly important in the diathesis of suicidal behavior and relevant to the finding of elevated prevalence of suicidal behavior in women with eating disorders. The serotonergic system (5-HT) has been widely investigated and abnormalities of the serotonin system are associated with both completed suicide and nonfatal suicidal behavior (Currier & Mann, 2008; Ernst, Mechawar, & Turecki, 2009; Mann, 2003). Serotonin is involved in a broad range of biological, physiological, and behavioral functions (Serretti, Calati, Mandelli, & De Ronchi, 2006). Notably, serotonin is associated with impulsivity and emotion regulation (Davidson, Putnam, & Larson, 2000), both of which are associated with suicidal behavior (Anestis & Joiner, 2011; McGirr, Paris, et al., 2007; McGirr, Renaud, et al., 2007). Suicidal behavior is associated with both low serotonin transporter binding (Anguelova, Benkelfat, & Turecki, 2003) and greater receptor binding (Pandey, et al., 2002). Specifically, an association between a low-expressing short allele on the promoter region of the serotonin transporter (5-

HTTLPR) and suicidal behavior has been widely demonstrated (Lin & Tsai, 2004), providing evidence for genetic determination of these features.

Notable for the findings from the present study, the serotonergic system is also associated with body weight regulation and eating behaviors, and has been associated with the development of eating disorders (Kaye, 1997; Weltzin, Fernstrom, & Kaye, 1994). Brain imaging studies show that, when compared to healthy individuals, individuals with or having recovered from AN (Bailer, et al., 2005; Frank, et al., 2002; Frank, et al., 2001; Galusca, et al., 2008) and BN (Pichika, et al., 2012; Tiihonen, et al., 2004) exhibit altered serotonin measures, including binding potential of postsynaptic 5-HT_{1a} receptors and 5-HT_{2A} receptors. Binding potential of both 5-HT_{1a} and 5-HT_{2A} receptors has been associated with harm-avoidance and anxiety and may contribute to dysphoric mood (Frank, et al., 2001; Kaye, et al., 2003).

A small but growing body of literature has aimed to identify genes in the serotonergic pathway that are associated with eating disorders (Hildebrandt, Alfano, Tricamo, & Pfaff, 2010; Kiezebrink, et al., 2010). Although results from molecular genetic studies investigating the serotonergic system have mostly been negative or equivocal (Hinney, Friedel, Remschmidt, & Hebebrand, 2004), one exception should be noted. A recent meta-analysis indicates that frequency of a short allele on the promoter region of the serotonin transporter (5-HTTLPR) is associated with AN (Lee & Lin, 2010). Therefore, the 5-HTTLPR short allele has been associated with both suicidal behavior and eating disorders.

The mechanism by which the 5-HTTLPR short allele may contribute to the liability to develop suicidal behavior or an eating disorder is unclear. However, when healthy individuals with this short allele are presented with negative stimuli, they show increased

amygdala functioning compared to healthy individuals without the short allele (Brown & Hariri, 2006); this finding suggests some amygdala dysfunction. Additionally, this short allele has also been associated with violent behavior and impulsivity (Retz, Retz-Junginger, Supprian, Thome, & Rosler, 2004). This short allele may therefore contribute to disturbance in emotion regulation (Davidson, et al., 2000), which has been associated with both eating disorders (Corstorphine, Mountford, Tomlinson, Waller, & Meyer, 2007) and suicidal behavior (Anestis & Joiner, 2011). The finding that the 5-HTTLPR short allele is associated with both suicidal behavior and eating disorders indicates that abnormalities or disruptions in the serotonergic system could contribute to both eating disorders and suicide risk. Given the complexity of both eating disorders and suicidal behavior, it is likely that other neurobiological pathways are also be involved.

Eating Disorder Features Associated with Suicide Attempts/Completions

According to IPTS, individuals who engage in inappropriate weight control behaviors should have a higher acquired capability for suicide and, therefore, higher prevalence of suicide attempts/completions. Previous research has indicated that the presence of any purging has been associated with suicide attempts in both AN (Favaro & Santonastaso, 1996; Selby, et al., 2010) and BN samples (Favaro & Santonastaso, 1996). In the present study, within the BN group, self-induced vomiting was associated with suicide attempts/completions in the STAGE sample but not the SALT sample. Vomiting was not associated with suicide attempts/completions in the AN group across either STAGE or SALT sample.

Vomiting is an initially unpleasant physiological experience and can have long-term painful physical effects, such as tooth decay, gum damage, and esophageal tears. Therefore,

vomiting may increase an individual's acquired capability for suicide through increasing pain tolerance. Furthermore, many people report not only habituating to the unpleasantness of vomiting, but express eventually experiencing it as a stress-relieving behavior (Broussard, 2005). In addition to increasing one's pain tolerance, vomiting may also contribute to increased acquired capability by engaging opponent processes and pairing an originally fear-inducing behavior with emotional relief (Joiner, 2005).

In the long-term, several of the inappropriate compensatory behaviors, such as laxative use or fasting, could contribute to increased pain tolerance (Papezova, Yamamotova, & Uher, 2005). However, vomiting uniquely allows an individual to immediately act in a way to counter the effects of binge eating. Binge eating is often associated with immediate, intense negative affect, which can include feelings of guilt, shame, and anxiety (Mitchell, et al., 2012). Viewing the food exit the body and feeling the physical symptoms of fullness decrease may be one way to immediately decrease these intense negative emotions. Vomiting can therefore be conceptualized as resulting from an acute feeling of negative urgency, and a recent study supports the association between negative urgency and bulimic behaviors more broadly, after controlling for sensation seeking (Anestis, et al., 2009). Individuals who have attempted suicide are higher on negative urgency than those with no lifetime suicide attempt (Anestis & Joiner, 2011).

Individuals who are high on negative urgency may become overwhelmed by intense negative affect and feel compelled to decrease the affect immediately, no matter the cost. These individuals may be more likely to make a suicide attempt as a way to decrease intense negative affect than someone who is more capable of tolerating and regulating negative emotions. Additionally, these individuals may be more likely to engage in painful and

provocative activities to decrease their negative affect (such as self-harm) and engage in the opponent processes that lead to acquired capability for suicide. Therefore, the association between vomiting and suicide attempts may result from an underlying high negative urgency. Although vomiting was hypothesized to be associated with suicide attempts/completions, this explanation must be viewed as post hoc. However, this hypothesized explanation can serve as a basis for future investigation.

Although vomiting was not significantly associated with suicide attempts/completions in either of the AN samples or the BN SALT sample, the prevalence of vomiting in those who had attempted/completed suicide was higher than those who had never attempted suicide. Additionally, vomiting was significant in the BN STAGE sample, but the effect size was small (OR = 1.02, 95% CI = 1.00; 1.03). Therefore, the effect of each eating disorder feature may be too small to detect. Results from Aim 5 indicate that, among the sample including both women without an eating disorder and women with BN, vomiting and the presence of BN were each uniquely associated with suicide attempts/completions. These factors acted in an additive manner to increase the odds of a suicide attempt; there was no interaction between vomiting and BN status.

Other eating disorder features, such as laxative use (Selby, et al., 2010), lifetime lowest body weight (Favaro & Santonastaso, 1997), longer duration of illness (Favaro & Santonastaso, 1997), and earlier age of onset have previously been associated with suicide in individuals with eating disorders (Forcano, et al., 2009). In the present study, none of the other eating disorder features were significantly associated with prevalence of suicide attempt/completions in the AN or BN group across the two samples. One reason for the lack of significant findings in these associations is that the samples may have been underpowered

to detect small effects. A second reason might be that acquired capability as currently conceptualized is a threshold that an individual needs to cross before being able to make a serious suicide attempt. Starvation and all of the inappropriate compensatory behaviors can contribute to acquired capability through increased pain tolerance and/or habituation and opponent processes. Therefore, there may not be specific eating disorder features that are uniquely associated with suicide attempts/completions. Rather, reaching a low body weight or engaging in any inappropriate compensatory behavior may be enough for an individual to cross the threshold.

Comorbid Psychiatric Disorders and Personality Traits Associated with Suicide Attempts/Completions

Suicide attempts/completions in women with eating disorders have been associated not only with features of the eating disorder itself but also comorbid psychiatric disorders. Previous research has demonstrated that individuals with an eating disorder who attempt suicide are more likely to have a lifetime history of depression than individuals with an eating disorder who have not attempted suicide (Anderson, et al., 2002; Bulik, et al., 2008; Corcos, et al., 2002; Favaro & Santonastaso, 1997). In the present study, depression was significantly associated with having a lifetime suicide attempt/completion in both AN and BN within the STAGE sample. Depression was not significantly associated with suicide attempts/completions in AN or BN in the SALT sample. However, the prevalence of depression was higher in those with AN who attempted/completed suicide (55.56%) than those with no lifetime suicide attempt (39.34%) and those with BN who attempted/completed suicide (100%) than those with no lifetime suicide attempt (58.73%), again reflecting that SALT may have been underpowered to replicate the finding in STAGE. It is notable that of

those with BN who attempted/completed suicide in the SALT sample, 100% endorsed lifetime depression.

The association between depression and suicide attempts/completions has been widely demonstrated. Epidemiological studies indicate that, of those individuals with a major depressive disorder, 15% will have at least one lifetime suicide attempt (Chen & Dilsaver, 1996). Given the high prevalence of depression in individuals with eating disorders who attempt/commit suicide, some researchers have chosen to control for the presence of depression in order to identify unique factors associated with suicide attempts/completions [i.e. (Bulik, et al., 2008)]. However, no study has tried to disentangle whether the high prevalence of depression may be responsible for the high prevalence of suicide attempts/completions in individuals with eating disorders or whether depression plays a unique role within the context of the eating disorder. Results from the present study indicate that depression does not interact with either AN or BN in predicting suicide attempts. Rather, among the full sample of women, depression and the presence of AN (and, in a separate model, BN) were both independently associated with suicide attempts/completions. These psychiatric disorders acted in an additive manner to increase probability of a suicide attempt/completion rather than interacting in some unique manner.

Alcohol and substance use also have been found previously to be significantly associated with suicide attempts in both AN and BN (Anderson, et al., 2002; Corcos, et al., 2002; Franko, et al., 2004). In the present study, alcohol abuse/dependence was significantly associated with suicide attempts/completions in women with AN in the SALT cohort (OR = 15.87, CI = 3.40; 74.72). Although alcohol abuse/dependence was not significantly associated with suicide attempts/completions in AN within the STAGE cohort, an

examination of the results indicate that this lack of significance might be due to limited power. Of those with AN who attempted/completed suicide, 28.57% had a lifetime diagnosis of alcohol use/dependence compared to 11.11% of those with AN who had never attempted suicide (OR = 3.20, 95% CI = 1.17; 8.73). Although in the adjusted and unadjusted model the confidence interval did not include 1, the model failed to reach significance after controlling for multiple comparisons. Within both the STAGE and SALT BN sample, alcohol abuse/dependence was not significantly associated with suicide attempts/completions. The follow-up analysis to the AN SALT finding indicated that alcohol use and AN status do not interact to increase odds of a suicide attempt but rather act in an additive manner.

Substance use was significantly associated with suicide attempts/completions in women with BN in the STAGE sample; substance use was not assessed in the SALT cohort. Within the AN sample of the STAGE cohort, substance use was not significantly associated with suicide attempts/completion. Further examination of the data indicate that the lack of significance may be due to power, as 36.36% of those with AN who attempted suicide had used substances compared to 6.44% of those who had not attempted suicide. Neither the adjusted or the unadjusted models' confidence intervals included unity; however, after controlling for multiple comparisons the model was no longer significant. The follow-up analysis indicated that alcohol use and BN status do not interact to increase the odds for a suicide attempt/completion, but rather act in an additive manner.

There are several mechanisms by which alcohol and substance use could be associated with suicide attempts/completions. Alcohol and substance use can lead to a decrease in social functioning (Gaffney, 1991), which in turn increases thwarted belongingness and/or perceived burdensomeness. Additionally, alcohol and substance use

may exacerbate or lead to the development of other psychiatric symptoms associated with suicide, such as depressed mood or anxiety (Allan, 1995; Fergusson, Boden, & Horwood, 2009). Further, when an individual is inebriated, she may be disinhibited and less afraid of death. Therefore, this conditionally bound higher capability for suicide can interact with the intensified psychiatric symptoms to increase the risk for a suicide attempt. Substance use, particularly intravenous drug use, has been hypothesized to be associated with suicide attempts/completions by increasing the pain threshold and leading to a more stable acquired capability for suicide (Joiner, 2005). However, this argument loses strength when applied to non-intravenous drug use and alcohol use.

Impulsivity has been associated with alcohol (Aragues, Jurado, Quinto, & Rubio, 2011) and substance use (Dawe & Loxton, 2004; Vitaro, Brendgen, Ladouceur, & Tremblay, 2001), as well as suicide attempts (McGirr, Paris, et al., 2007; McGirr, Renaud, et al., 2007; Zouk, et al., 2006). The current conceptualization of impulsivity as it relates to increases in prevalence of suicide attempts is that impulsive individuals engage in more painful and provocative behaviors (e.g., promiscuous sex, getting piercings, physical fights, jumping from high places) that result in a higher acquired capability for suicide. As described above, the association between impulsivity and suicide attempts may also be related to high negative urgency, or the tendency to act impulsively specifically when experiencing a state of intense negative affect. Individuals with high negative urgency may use alcohol and substances to self-medicate and immediately decrease their negative affect. These individuals may be at higher risk for a suicide attempt both when using substances and when sober if they have not developed skills to tolerate and regulate their intense negative affect.

In addition to mood and substance use disorders, anxiety disorders have also previously been shown to be associated with suicide attempts/completions in women with eating disorders (Bulik, et al., 2008). In the present study, panic disorder was significantly associated with suicide attempts/completions. In STAGE, panic disorder was significantly associated with suicide attempts/completions in both AN (unadjusted OR = 8.09, 95% = 2.57; 25.58) and BN (unadjusted OR = 3.46, 95% CI = 1.60; 7.49); panic disorder was not assessed in SALT. Further analyses indicated that panic disorder acted in an additive manner with AN and separately with BN to increase the odds of a suicide attempt.

One previous study investigated the association between panic disorder and suicide attempts in AN and found results that were consistent with the current study, with panic disorder being associated with suicide in women with AN (OR = 2.74, 95% 1.43; 5.25). No published study has investigated the association between panic disorder in bulimia nervosa. A growing body of literature outside of the eating disorders area indicates that panic disorder is associated with suicide attempts/completions (Goodwin & Roy-Byrne, 2006; Nepon, Belik, Bolton, & Sareen, 2010; Sareen, et al., 2005; Schmidt, Woolaway-Bickel, & Bates, 2001).

Panic disorder is characterized by recurrent panic attacks that consist of periods of intense autonomic arousal. During a panic attack, individuals often worry that the physical symptoms they are experiencing indicate that they are having a heart attack or dying from some other cause. The IPTS posits that through repeated exposure to the potential of death, individuals can habituate to the idea of dying. This decreased fear of death is one element to an acquired capability for suicide (Joiner, 2005). Individuals with recurrent panic attacks are, therefore, repeatedly exposed not only to the idea of their death but also highly aversive

physical symptoms that are often associated with dying. Thus, repeated panic attacks might contribute to an individual's acquired capability for suicide due to the repeated experience of highly aversive physical symptoms often associated with dying.

The association between panic disorder and acquired capability for suicide provides a psychological framework to understand the progression from the experience of recurrent panic attacks to a suicide attempt. However, due to the cross-sectional nature of the data in the present study, temporal precedence cannot be determined. A biological framework can incorporate both the association between panic disorder and eating disorders as well as between panic disorder and suicide without the reliance on temporal precedence. Panic disorder is often comorbid with both AN and BN (9-52%) although there is a wide range of estimates depending on sample characteristics (Swinbourne & Touyz, 2007). Kendler and colleagues (1995) investigated the extent to which genetic and environmental risk factors are shared across six major psychiatric disorders in women. Using multivariate twin analysis, they found that panic disorder and BN loaded onto the same genetic factor. Their hypothesis, based on these results, was that these disorders may have a genetically mediated, shared neurobiologic diathesis (Kendler, et al., 1995). A shared genetic liability could be one potential contributing factor to comorbidity between these two disorders.

Although the molecular genetic literature on panic disorder is limited and lacking replication, some initial evidence has indicated that the serotonin pathway may be implicated in the development of panic disorder (Na, Kang, Lee, & Yu, 2011). As the serotonin pathway has also been associated with both eating disorder and suicidal behaviors, the high prevalence of suicide attempts/completions in individuals with an eating disorder and a comorbid panic disorder may indicate genetic and biological mechanisms. Although these findings are

interesting, it is important to note that serotonin system has been implicated in a wide range of psychiatric conditions. The next generation of genetic and genomic science may shed greater light on the specificity of pathways involved in various disorders and their comorbidities.

Although suicide attempts/completions were associated with depression, alcohol and substance use, and panic disorder in our study, none of the other psychiatric comorbidities investigated in this study was associated with suicide attempts/completions. Generalized anxiety disorder was not significantly associated with suicide attempts in any of the samples. However, the present study may have lacked power to detect significant associations, as evidenced by confidence intervals that did not include unity in both the STAGE and SALT sample of AN and the STAGE sample in BN. Specific phobias and obsessive-compulsive disorder were only assessed in STAGE and were not associated with suicide attempts/completions for either AN or BN. A broad category of "any anxiety disorder" has been associated with suicide attempts in women with AN in at least one previous investigation (Bulik, et al., 2008). However, the combined category in that study included panic disorder and post-traumatic stress disorder, each of which were uniquely associated with suicide attempts; the other anxiety disorders, including generalized anxiety disorder, obsessive-compulsive disorder and specific phobia, were not significantly associated with suicide attempts.

Panic disorder and post-traumatic stress disorder both include intense periods of intense autonomic arousal and an element of fear of death, which are not experienced in other anxiety disorders to the same degree. Therefore, panic disorder and post-traumatic stress disorder (which was not assessed in the present study) may be the anxiety disorders that are

uniquely associated with suicide attempts in women with eating disorders. Future research should continue to assess the specific anxiety disorders associated with suicide attempts in both AN and BN and the mechanisms through which these disorders contribute to liability for a suicide attempt.

For all of the comorbid psychiatric disorders that were associated with suicide attempts/completions, additional analyses indicated that these disorders acted in an additive manner rather than interacting with the presence of an eating disorder. This pattern of findings is important for two reasons. First, these results indicate that the presence of an eating disorder still increases one's risk of a suicide attempt, even when controlling for the presence of a comorbid psychiatric disorder such as depression. Therefore, the increased prevalence of suicide attempts/completions in women with eating disorders is not due exclusively to the increased prevalence of comorbid psychiatric disorders in this population. Second, these findings indicate that having both an eating disorder and comorbid psychiatric disorder does increase one's risk of a suicide attempt/completion beyond the risk associated with each disorder alone. However, the present study may have been underpowered to detect interactions. Although replication of our findings is essential, it is non-trivial to find larger population-based samples in the world to provide adequate power for a replication.

Personality features associated with suicide attempts/completions

None of the personality features assessed were associated with suicide attempts in women with AN or women with BN. Low self-directedness has previously been shown to be associated with a lifetime suicide attempt in individuals with an eating disorder (Bulik, et al., 1999). Additionally, neuroticism has been associated with suicide attempts in psychiatric and community samples (Renaud, et al., 2008). Therefore, it was surprising that these features

were not associated with suicide attempts/completions in the present study. We might have been underpowered to find significant associations, especially given the large amount of missing data.

Strengths

One strength of this study is the use of two large, population-based samples. The use of these samples decreases the biases inherent in using treatment-seeking populations. Treatment seeking populations are likely to be more severely ill and psychologically distressed. Eating disorders, particularly BN, often go undetected in the community (Hoek, 1991; Hudson, et al., 2007). Therefore, a woman is likely to seek treatment if a) her disorder is sufficiently severe to be noticed by others who encourage treatment; b) she is highly distressed by her disorder; c) she has a comorbid disorder for which she is seeking treatment; or d) she is hospitalized for a suicide attempt and then referred for treatment of her eating disorder. Therefore, the previous reliance on treatment seeking samples may have inflated prevalence of suicide attempts.

Further, the use of two datasets allowed for within-study partial replication. Both of the assessments also included detailed eating disorder questions. Therefore, the present study was able to investigate the association between suicide attempts/completions and eating disorders at both the diagnostic level and the symptom level.

Suicide attempts were captured from hospital discharge registers and cause of death registers. This stringent definition of suicide attempt resulted in a conservative estimate not subject to self-report bias. Furthermore, the use of the cause of death register allowed for the identification of completed suicides without conducting additional assessments.

Limitations

Although this study makes a significant contribution to the literature, several limitations should be noted. First, the samples consist of Swedish twins. Although twin registers are often used to conduct research about the general population, twins may differ from the general population in significant ways. The population of Sweden is also fairly homogenous in terms of racial and ethnic demographics. Therefore, results must be interpreted within the context of limited generalizability.

The STR was chosen due to the large sample size and detailed information about eating disordered behaviors. However, due to the low prevalence of eating disorders and suicide attempts, there were few individuals with an eating disorder and even fewer individuals with an eating disorder who have attempted/completed suicide. Therefore, many of the analyses had limited power, particularly within the BN sample and the SALT cohort. Power was further limited by the large amount of missing data.

The STAGE and SALT assessments cover a wide range of physical and psychological variables. Unfortunately, due to the large number of variables being assessed, not all of the constructs were assessed in depth. In STAGE, specific phobia, OCD, and panic disorder were assessed with a single "yes/no" self-report, which limits the validity of these diagnoses. These disorders were not assessed at all in SALT, so the results from STAGE were not able to be replicated.

The SALT cohort has unique limitations. Due to the older age at assessment of this cohort, the data may have been subject to recall bias as participants were asked about

behaviors and symptoms over the course of their life. Furthermore, eating disorders were not widely recognized when this cohort was at the age of eating disorder onset.

Impact and Future Directions

The present study identified several factors associated with suicide attempts/completions in women with eating disorders. However, these associations were identified from a cross-sectional assessment and temporal precedence was not evaluated. Therefore, the present study was not able to address whether having panic disorder, for example, is a predictor of a suicide attempt. Future research should follow women with eating disorders longitudinally in order to establish predictors of suicide attempts.

Two of the findings in the present study were unexpected. First, vomiting was the only eating disorder feature associated with suicide attempts/completion in BN. Although this finding was statistically significant, the odds ratio indicated that the presence of vomiting (a common behavior in individuals with BN) only increased the risk of a suicide attempt a very small amount in this population. Therefore, this finding may not have much clinical significance. Several hypotheses were presented that might explain the unique association between vomiting and suicide attempts. However, this finding needs to be replicated before conclusions are drawn about this association.

The second unexpected finding was the strength of the association between panic disorder and suicide attempts/completions in women with both AN and BN. This association replicates a finding from a study in AN (Bulik 2008), but is a novel finding in women with BN. If replicated, this finding could provide information to help clinicians target those at increased risk for suicide attempts/completions, as women with an eating disorder and comorbid panic disorder may be more than three times as likely to attempt/complete suicide.

The present study investigated whether associations exist between the presence of (a) eating disorder features, psychiatric comorbidity, and personality features, and (b) suicide attempts/completions in women with eating disorders. From these findings, hypotheses were generated based on the IPTS about the mechanisms that might underlie these associations. Specifically, individuals with eating disorders are hypothesized to have a higher acquired capability for suicide. While some previous findings indicate that individuals with eating disorders have higher pain tolerance (Papezova, et al., 2005; Raymond, et al., 1999) than individuals without an eating disorder, and engage in opponent processes when purging or restricting intake (Broussard, 2005), no study has investigated whether individuals with eating disorders habituate to the idea of death. Many current treatments for eating disorders, particularly cognitive-behavioral therapy and motivational interviewing, involve a psycho-education component about the increased mortality of these disorders. If habituation to fear of death is increased in this population and is shown to be associated with an increased risk of suicide attempts/completions, clinicians would need to be mindful of how to present this information.

This study has several direct clinical applications. Clinicians should be aware that women with eating disorders are at increased risk for a suicide attempt compared to women with no history of an eating disorder. Additionally, women with an eating disorder who also have a history of vomiting, depression, alcohol abuse/dependence, substance use, or panic disorder are at even higher risk for a suicide attempt. It is notable that this study assessed lifetime history and not just current comorbidity. Therefore, clinicians should assess for both current presence and lifetime history of these psychiatric disorders and be aware of the increased risk for suicide attempt. Interpersonal interventions targeting social relationships

and cognitive interventions targeting beliefs about burdensomeness and belonging may be particularly helpful for this population. This suggestion must be viewed as tentative since these factors were not assessed directly in the current investigation. Additionally, the possible role of high negative urgency indicates that this population might also benefit from emotion regulation and distress tolerance skills.

Conclusion

Eating disorders are pernicious disorders and have a high mortality rate. While a higher risk of suicide attempts/completions in women with eating disorders has been previously observed, this study is important because of its methodological strengths, including using a population-based sample and hospital discharge records. This study also affirms previous findings in identifying mood, substance abuse, and anxiety comorbidities as being associated with suicide attempts. These findings lead to a host of new questions that are important to address as we continue to work to identify those at highest risk for suicide attempts/completions. In order to improve outcomes and decrease mortality, it is critical to identify individuals who, within this patient population, experience psychological suffering so intense that they feel a need to take their own lives. Understanding who is at risk and the mechanisms underlying this risk will inform the development of effective prevention and treatment interventions.

Table 1: International Classification of Diseases (ICD) codes used to identify suicide attempts and completions and the violence categorization for each code

ICD-8 and ICD-9 Codes for Suicide Attempts and Completions		
E950	Suicide and self-inflicted poisoning by solid or liquid substances	Non-violent
E951	Suicide and self-inflicted poisoning by gases in domestic use	Non-violent
E952	Suicide and self-inflicted poisoning by other gases and vapors	Non-violent
E953	Suicide and self-inflicted injury by hanging strangulation and suffocation	Violent
E954	Suicide and self-inflicted injury by submersion (drowning)	Violent
E955	Suicide and self-inflicted injury by firearms, air guns, and explosives	Violent
E956	Suicide and self-inflicted injury by cutting and piercing instrument	Violent
E957	Suicide and self-inflicted injuries by jumping from high place	Violent
E958	Suicide and self-inflicted injury by other and unspecified means	Non-violent
E959	Late effects of self-inflicted injury	Non-violent
ICD-10 Codes for Suicide Attempts and Completions		
X60	Intentional self-poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics	Non-violent
X61	Intentional self-poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified	Non-violent
X62	Intentional self-poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified	Non-violent
X63	Intentional self-poisoning by and exposure to other drugs acting on the autonomic nervous system	Non-violent
X64	Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances	Non-violent
X65	Intentional self-poisoning by and exposure to alcohol	Non-violent
X66	Intentional self-poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours	Non-violent
X67	Intentional self-poisoning by and exposure to other gases and vapours	Non-violent
X68	Intentional self-poisoning by and exposure to pesticides	Non-violent
X69	Intentional self-poisoning by and exposure to other and unspecified chemicals and noxious substances	Non-violent
X70	Intentional self-harm by hanging, strangulation and suffocation	Violent
X71	Intentional self-harm by drowning and submersion	Violent
X72	Intentional self-harm by handgun discharge	Violent
X73	Intentional self-harm by rifle, shotgun, and larger firearm discharge	Violent
X74	Intentional self-harm by other and unspecified firearm discharge	Violent
X75	Intentional self-harm by explosive material	Violent
X76	Intentional self-harm by smoke, fire, and flames	Violent
X77	Intentional self-harm by steam, hot vapors, and hot objects	Violent
X78	Intentional self-harm by sharp object	Violent
X79	Intentional self-harm by blunt object	Non-violent
X80	Intentional self-harm by jumping from a high place	Violent
X81	Intentional self-harm by jumping or lying before moving object	Violent
X82	Intentional self-harm by crashing of motor vehicle	Violent
X83	Intentional self-harm by other specified means	Non-violent
X84	Intentional self-harm by unspecified means	Non-violent

Table 2. Criteria used for anorexia nervosa (AN) diagnosis

Criteria/Item	Response to Meet Criteria in STAGE	Response to Meet Criteria in SALT
1a. Had a period of time when you weighed much less than other people thought you ought to weight. 1b. BMI calculated from lowest weight and height at lowest weight.	1a. Yes AND 1b. BMI < 18.55	1a. Yes AND 1b. BMI < 18.55
2. STAGE: During the time of low weight, how afraid were you that you might gain weight or become fat? (response on 5 point Likert Scale) SALT: During that time [of low weight], were you afraid of gaining weight or becoming fat?	2. (2) Slightly, (3) Somewhat, (4) Very afraid, OR (5) Extremely afraid	2. Yes
3. STAGE: During the time of low weight, did you feel fat? (response on a 5 point Likert Scale) SALT: How did you think you looked during the period you were thinnest? Did you still feel that you were too fat or that part of your body was too fat?	3. (2) Slightly, (3) Somewhat, (4) Very afraid, OR (5) Extremely afraid	3. Yes

Table 3. Criteria used for bulimia nervosa (BN) diagnosis

Criteria/Item	Response to Meet Criteria in STAGE	Response to Meet Criteria in SALT
1a. Have you even had eating binges when you ate what most people would regard as an unusually large amount of food in a short period of time?	1a. Yes AND	1a. Yes AND
1b. When you were having eating binges, did you feel your eating was out of control?	1b. (2) Slight, (3) Somewhat, (4) Very much, OR (5) Extremely	1b. Yes
2. Which of these did you use during the same time that you were binge eating? Making yourself vomit? Laxatives? Diuretics? Diet Pills? Exercise more than 2 hours per day? Fast or not eat? Other methods?	2. A 'Yes' response to any of these items meets criteria.	2. A 'Yes' response to any of these meets criteria
3a. When you were binging the most, how many binges would you have in a month? 3b. For how long did you have binge eating episodes?	3a. At least 4 times a month AND 3b. At least 1-2 months	3.a. At least 4 times a month
4. Statements regarding weight and shape STAGE: Which of the statements best describes you? SALT: During that period, were you a lot more concerned about your weight and body shape than most people your age?	4. Weight or shape play a moderate part in how I feel about myself OR Weight or shape are important things that affect how I feel about myself. OR Weight or shape are the most important things that affect how I feel about myself.	4. Yes

Table 4: Lifetime prevalence of at least one suicide attempt/completion in women in the STAGE cohort by ED category. Results are presented for both adjusted and unadjusted logistic regression analyses (χ^2, p value) predicting the presence of a lifetime suicide attempts/completions from ED category as well as post-hoc comparisons.

	Lifetime suicide attempt/completion	Results*	Post-Hoc Comparisons*		Post-Hoc Comparisons°	
Eating Disorder Category	N (%)	χ^2 (p-value)	OR (95% CI)□	OR (95% CI) ¥	OR (95% CI) □	OR (95% CI)□¥
No ED (N = 12,248)	202 (1.65%)	39.62 (< .01)	----	----	----	----
AN (N = 379)	22 (5.80%)		3.58 (2.25; 5.70)	----	3.67 (2.34; 5.78)	
BN (N = 354)	42 (11.86%)		7.58 (5.21; 11.03)	2.12 (1.22; 3.69)	8.03 (5.65; 11.40)	2.18 1.28; 3.74)

Abbreviations: ED, eating disorder; AN, anorexia nervosa; BN, bulimia nervosa

P value has been adjusted to control for multiple comparisons using the false discovery rate

* Model controlling for age and using generalized estimating equations

°Unadjusted model

□Compared to the referent (no ED), p < .001

¥Compared to AN, p < .01

Table 5: Suicide characteristics in those women who attempted/completed suicide in STAGE cohort by eating disorder category. Results are presented for general linear models (χ^2, p value) and Poisson regression (χ^2, p value) with ED category as the independent variable.

	No ED (N = 202)	AN (N = 22)	BN (N = 42)	Results*
	N (%)	N (%)	N (%)	χ^2 (p-value)
Violent	23 (16.43)	5 (33.33)	7 (23.33)	2.10 (> .05)
	M (SD)	M (SD)	M (SD)	χ^2 (p-value)
Age at first attempt	26.38 (8.77)	25.18 (7.19)	24.90 (7.33)	1.93 (> .05)
Total number of attempts	2.32 (3.86)	3.05 (4.62)	4.43 (7.50)	3.47 (> .05)

Abbreviations: ED, eating disorder; AN, anorexia nervosa; BN, bulimia nervosa
P values have been adjusted to control for multiple comparisons using the false discovery rate
*Model controlling for age and using generalized estimating equations

Table 6: Lifetime prevalence of eating disorder features and mean (SD) characteristics of women in the STAGE cohort with anorexia nervosa by suicide attempt/completion status. Results are presented for both adjusted and unadjusted logistic regression analyses (χ^2, p value) predicting the presence of lifetime suicide attempts/completions from ED feature.

Eating Disorder Features	Lifetime suicide attempt/completion (N = 22)	No lifetime suicide attempt/completion (N = 357)	Number Missing□	Results*		Results°
	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)	OR (95% CI)
Binge Eating	2 (9.52)	16 (4.78)	23	0.48 (> .05)	2.01 (0.44; 9.20)	2.10 (0.45; 9.80)
Vomit	13 (59.09)	145 (40.62)	0	3.04 (> .05)	2.30 (0.94; 5.68)	2.11 (0.88; 5.07)
Laxative	5 (22.73)	36 (10.08)	0	1.57 (> .05)	2.43 (0.82; 7.17)	2.62 (0.91; 7.53)
Diet Pill	6 (27.27)	51 (14.29)	0	2.03 (> .05)	2.50 (0.94; 6.63)	2.25 (0.84; 6.02)
Diuretic	2 (9.09)	27 (7.56)	0	0.05 (> .05)	1.20 (0.26; 5.53)	1.22 (0.27; 5.51)
Exercise	8 (36.36)	108 (30.25)	0	0.39 (> .05)	1.35 (0.54; 3.35)	1.32 (0.54; 3.23)
Fasting	12 (54.55)	106 (29.69)	0	4.85 (> .05)	3.06 (1.30; 7.23)	2.84 (1.19; 6.78)
Other	7 (31.82)	105 (29.41)	0	0.08 (> .05)	1.14 (0.45; 2.88)	1.12 (0.44; 2.83)
Amenorrhea	9 (45.00)	136 (48.06)	76	0.07 (> .05)	0.88 (0.36; 2.19)	0.88 (0.36-2.20)
	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)	B (SE)
Lowest BMI	15.87 (1.98)	16.43 (1.77)	0	1.62 (> .05)	0.15 (0.11)	0.16 (0.11)
Age of onset	23.18 (6.20)	19.09 (4.92)	5	6.29 (> .05)	-0.12 (0.04)	-0.12 (0.03)
Number of ED behaviors engaged in	2.41 (1.84)	1.62 (1.45)	0	3.87 (> .05)	-0.32 (0.13)	-0.31 (0.13)

Abbreviations: BMI, body mass index; ED, eating disorder

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

*Model controlling for age and using generalized estimating equations

°Unadjusted model

Table 7: Lifetime prevalence of eating disorder features and mean (SD) characteristics of women in the STAGE cohort with bulimia nervosa by suicide attempt/completion status. Results are presented for both adjusted and unadjusted logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from ED feature.

Eating Disorder Features	Lifetime suicide attempt/completion (N = 42)	No lifetime suicide attempt/completion (N = 312)	Number Missing□	Results*		Results°
	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)	OR (95% CI)
Vomit	39 (92.86)	249 (79.81)	0	8.38 (< .03)	1.02 (1.00; 1.03)	3.29 (0.98; 11.00)
Laxative	15 (35.71)	68 (21.79)	0	2.60 (> .05)	1.01 (1.00; 1.02)	1.99 (1.00; 3.96)
¥Diet Pill	11 (26.19)	55 (17.63)	0	1.68 (> .05)	1.69 (0.83; 3.46)	1.66 (0.79; 3.50)
Diuretic	11 (26.19)	39 (12.50)	0	2.62 (> .05)	2.18 (1.00; 4.75)	2.48 (1.16; 5.34)
Exercise	21 (50.00)	136 (43.59)	0	0.90 (> .05)	1.00 (1.00; 1.01)	1.29 (0.68; 2.47)
¥Fasting	22 (53.66)	129 (41.35)	1	2.16 (> .05)	1.65 (0.85; 3.18)	1.64 (0.85; 3.16)
¥Other	7 (16.67)	67 (21.47)	0	0.62 (> .05)	0.73 (0.32; 1.69)	0.73 (0.31; 1.72)
¥Amenorrhea	11 (37.93)	92 (51.69)	147	1.99 (> .05)	0.57 (0.26; 1.25)	0.57 (0.26; 1.28)
	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)	B (SE)
¥Lowest BMI	16.63 (2.89)	17.40 (2.15)	139	1.83 (> .05)	0.14 (0.09)	0.14 (0.08)
Age of Onset	17.86 (5.26)	17.52 (4.10)	3	0.08 (> .05)	-0.01 (0.04)	-0.02 (0.04)
¥Number of Behaviors	3.02 (1.62)	2.38 (1.29)	1	5.40 (> .05)	-0.31 (0.11)	-0.32 (0.11)

Abbreviations: BMI, body mass index; ED, eating disorder

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

*Model controlling for age and using generalized estimating equations

°Unadjusted model

¥Analyses run with independent correlation matrices

Table 8: Lifetime prevalence of comorbid psychiatric disorders and means (SD) of temperament characteristics in women in the STAGE cohort with anorexia nervosa by suicide attempt/completion status. Results are presented for both adjusted and unadjusted logistic regression analyses (χ^2, p value) and general linear models (χ^2, p value) predicting lifetime prevalence of suicide attempts/completions from psychiatric comorbidity and personality features.

	Lifetime suicide attempt/completion (N = 22)	No lifetime suicide attempt/completion (N = 357)	Number Missing□	Results*		Results°
Psychiatric Comorbidity	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)	OR (95% CI)
Depression	19 (86.36)	159 (49.07)	33	12.30 (<.01)	6.85 (2.00; 23.43)	6.57 (1.91; 22.64)
Generalized Anxiety Disorder	7 (53.85)	39 (16.18)	125	4.96 (> .05)	6.49 (2.04; 20.63)	6.04 (1.92; 18.95)
Alcohol Abuse/dependence	6 (28.57)	39 (11.11)	7	2.87 (> .05)	3.60 (1.23; 10.56)	3.20 (1.17; 8.73)
Substance Use	8 (36.36)	23 (6.44)	0	6.16 (> .05)	8.13 (3.06; 21.60)	8.30 (3.16; 21.80)
Phobia	2 (20.00)	42 (16.73)	118	0.14 (> .05)	1.4250 (0.26; 7.71)	1.24 (0.26; 6.07)
Obsessive Compulsive Disorder	3 (17.65)	39 (12.62)	53	0.38 (> .05)	1.60 (0.44; 5.87)	1.48 (0.41; 5.40)
Panic Disorder	13 (76.47)	88 (28.66)	55	10.05 (<.02)	8.48 (2.72; 26.49)	8.09 (2.57; 25.48)
Personality Features	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)	B (SE)
Concerns over Mistakes	13.69 (3.36)	11.33 (4.04)	79	5.81 (> .05)	0.16 (0.06)	0.16 (0.06)
Doubts about Actions	10.38 (2.94)	9.01 (3.60)	75	2.97 (> .05)	0.1046 (0.05)	0.10 (0.07)
Personal Standards	13.33 (2.47)	13.45 (3.53)	82	0.02 (> .05)	-0.0073 (0.05)	-0.01 (0.08)
Extraversion	4.67 (2.09)	5.01 (2.27)	123	0.36 (> .05)	-0.0662 (0.11)	-0.07 (0.12)
Neuroticism	10.53 (5.00)	7.87 (4.60)	112	3.86 (> .05)	0.1263 (0.06)	0.12 (0.06)
Self Directedness	16.43 (3.88)	18.27 (3.17)	91	2.90 (> .05)	-0.1763 (0.09)	-0.17 (0.08)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

*Model controlling for age and using generalized estimating equations

°Unadjusted model

Table 9: Lifetime prevalence of comorbid psychiatric disorders and means (SD) of temperament characteristics in women in the STAGE cohort with bulimia nervosa by suicide attempt/completion status. Results are presented for both adjusted and unadjusted logistic regression analyses (χ^2, p value) and general linear models (χ^2, p value) predicting suicide attempts/completions from psychiatric comorbidity and personality features.

	Lifetime suicide attempt/completion (N = 42)	No lifetime suicide attempt/completion (N = 312)	Number Missing□	Results*		Results°
Psychiatric Comorbidity	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)	OR (95% CI)
Depression	35 (87.50)	160 (56.74)	32	15.87 (< .01)	1.01 (1.00; 1.01)	5.33 (2.03; 14.03)
Generalized Anxiety Disorder	13 (50.00)	42 (21.21)	130	6.84 (> .05)	3.99 (1.73; 9.19)	3.71 (1.60; 8.61)
¥Alcohol Abuse/dependence	11 (26.19)	66 (21.78)	9	0.47 (> .05)	1.34 (0.61; 2.92)	1.27 (0.61; 2.67)
¥Substance Use	14 (33.33)	20 (6.41)	0	10.85 (< .02)	7.26 (3.26; 15.68)	7.30 (3.33; 16.01)
¥Phobia	6 (30.00)	40 (20.10)	135	0.95 (> .05)	1.81 (0.63; 5.19)	1.70 (0.62; 4.71)
¥Obsessive Compulsive Disorder	7 (22.58)	40 (15.94)	72	1.03 (> .05)	1.67 (0.70; 4.00)	1.54 (0.62; 3.81)
¥Panic Disorder	21 (65.63)	90 (35.57)	69	8.24 (< .03)	3.68 (1.64; 8.25)	3.46 (1.60; 7.49)
Personality Features	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)	B (SE)
¥Concerns over Mistakes	13.15 (4.09)	11.87 (4.24)	62	3.07 (> .05)	0.08 (0.04)	0.08 (0.05)
¥Doubts about Actions	11.12 (4.25)	9.77 (4.22)	63	3.20 (> .05)	0.08 (0.04)	0.07 (0.04)
¥Personal Standards	13.43 (3.56)	13.06 (3.44)	68	0.70 (> .05)	0.05 (0.06)	0.03 (0.05)
¥Extraversion	3.75 (2.23)	4.88 (2.26)	90	6.12 (> .05)	-0.23 (0.09)	-0.22 (0.09)
¥Neuroticism	10.50 (4.68)	9.42 (4.90)	89	2.18 (> .05)	0.05 (0.04)	0.05 (0.04)
Self Directedness	15.86 (2.75)	16.73 (3.22)	69	2.89 (> .05)	0.00 (0.00)	-0.09 (0.06)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

*Model controlling for age and using generalized estimating equations

°Unadjusted model

¥Analyses run with independent correlation matrices

Table 10: Results are presented for separate logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from the presence of comorbid psychiatric disorders and the presence of AN within the full STAGE sample. Models were adjusted to control for age and generalized estimating equations were used to account for the twin nature of the data.

	χ^2 (p-value)	OR (95% CI)
Model 1		
Depression	66.40 (< .01)	4.67 (3.47; 6.30)
Anorexia nervosa	8.53 (< .01)	2.74 (1.70; 4.41)
Model 2		
Panic	59.58 (< .01)	6.34 (4.64; 8.67)
Anorexia nervosa	5.75 (< .02)	2.44 (1.44; 4.13)

Table 11: Results are presented for separate logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from the presence of vomiting or a comorbid psychiatric disorder and the presence of BN within the full STAGE sample. Models were adjusted to control for age and generalized estimating equations were used to account for the twin nature of the data.

	χ^2 (p-value)	OR (95% CI)
Model 1		
Vomiting	26.71 (< .01)	3.42 (2.36; 5.00)
Bulimia nervosa	14.37 (< .01)	2.92 (1.82; 4.67)
Model 2		
Depression	68.45 (< .01)	4.59 (3.41; 6.16)
Bulimia nervosa	32.19 (< .01)	5.11 (3.42; 7.62)
Model 3		
Substance Use	41.74 (< .01)	9.57 (6.76; 13.53)
Bulimia nervosa	26.49 (< .01)	6.08 (4.10; 9.04)
Model 4		
Panic disorder	57.07 (< .01)	3.42 (2.36; 5.00)
Bulimia nervosa	14.37 (< .01)	2.92 (1.82; 4.67)

Table 12: Lifetime prevalence of at least one suicide attempt/completion in women in the SALT cohort by ED category. Results are presented for logistic regression analyses (χ^2, p value) modeling suicide attempts/completions from ED category and post-hoc comparisons.

	Lifetime suicide attempt/completion	Result	Post-Hoc Comparisons□
Eating Disorder Category	N (%)	χ^2 (p-value)	OR (95% CI)
No ED (N = 16,075)	317 (1.97)	20.91 (<.01)	____
AN (N = 135)	9 (6.67)		3.55 (1.79; 7.05)
BN (N = 71)	7 (9.86)		5.43 (2.47; 11.96)

Abbreviations: ED, eating disorder; AN, anorexia nervosa; BN, bulimia nervosa

P value has been adjusted to control for multiple comparisons using the false discovery rate

□Compared to the referent (no ED), $p < .001$

Table 13: Suicide characteristics in those women who attempted/completed suicide in SALT cohort by eating disorder category. Results are presented for general linear models (χ^2, p value) and Poisson regression (χ^2, p value) with ED category as the independent variable.

	No Eating Disorder (N = 317)	AN (N = 9)	BN (N = 7)	Result
	N (%)	N (%)	N (%)	χ^2 (p-value)
Violent	30 (9.46)	3 (33.33)	2 (28.57)	5.52 (> .05)
	M (SD)	M (SD)	M (SD)	χ^2 (p-value)
Age at first attempt	42.03 (10.85)	33.67 (11.61)	39.57 (10.72)	5.48 (> .05)
Total number of attempts	2.26 (3.46)	2.00 (0.87)	4.00 (4.00)	1.84 (> .05)

P values have been adjusted to control for multiple comparisons using the false discovery rate

Table 14: Lifetime prevalence of eating disorder features and mean (SD) characteristics of females in the SALT cohort with anorexia nervosa by suicide attempt/completion status. Results are presented for logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from ED feature.

Eating Disorder Features	Lifetime suicide attempt/completion (N = 9)	No lifetime suicide attempt/completion (N = 126)	Number Missing□	Results	
	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)
Binge Eating	2 (25.00)	4 (3.31)	6	4.39 (> .05)	9.75 (1.48; 64.23)
Vomit	2 (22.22)	18 (14.29)	0	0.38 (> .05)	2.09 (0.35; 12.58)
Laxative	1 (11.11)	19 (14.29)	0	0.07 (> .05)	0.82 (0.09; 6.36)
Exercise	1 (11.11)	56 (44.44)	0	4.48 (> .05)	0.16 (0.02; 6.36)
Fasting	3 (33.33)	63 (50.00)	0	0.95 (> .05)	0.50 (0.12; 2.09)
Other	0 (0.00)	3 (2.38)	0	0.42 (> .05)	---
Amenorrhea	4 (50.00)	72 (62.07)	0	0.45 (> .05)	0.61 (0.15; 2.57)
	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)
Lowest BMI	16.83 (1.28)	16.24 (1.77)	0	1.13 (> .05)	-0.25 (0.26)
Age of Onset	30.00 (11.10)	21.38 (7.38)	11	7.58 (> .05)	-0.10 (0.04)
Number of Behaviors	0.78 (1.09)	1.25 (1.07)	0	1.83 (> .05)	0.49 (0.39)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

Table 15: Lifetime prevalence of eating disorder features and mean (SD) characteristics of females in the SALT cohort with bulimia nervosa by suicide attempt/completion status. Results are presented for logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from ED feature.

Eating Disorder Features	Lifetime suicide attempt/completion (N = 7)	No lifetime suicide attempt/completion (N = 64)	Number Missing□	Results	
	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)
Vomit	4 (57.14)	39 (60.94)	0	0.04 (>.05)	0.85 (0.18; 4.15)
Laxative	3 (42.86)	13 (20.31)	0	2.62 (>.05)	2.94 (0.58; 14.81)
Exercise	2 (28.57)	13 (20.31)	0	1.75 (>.05)	0.33 (0.06; 1.84)
Fasting	2 (28.57)	34 (53.13)	0	1.56 (>.05)	0.35 (0.06; 1.95)
Other	0 (0.00)	1 (1.56)	0	0.21 (>.05)	---
Amenorrhea	2 (50.00)	22 (53.66)	26	0.02 (>.05)	0.86 (0.11; 6.73)
	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)
Lowest BMI	16.72 (1.88)	16.96 (2.24)	24	0.06 (>.05)	0.05 (0.21)
Age of Onset	24.17 (9.54)	22.19 (7.57)	8	0.25 (>.05)	-0.04 (0.07)
Number of Behaviors	1.57 (1.13)	1.90 (1.06)	0	0.70 (>.05)	0.35 (0.45)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

Table 16: Lifetime prevalence of comorbid psychiatric disorders and mean (SD) of EPI extraversion score in women in the SALT cohort with anorexia nervosa by suicide attempt/completion status. Results are presented for logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from psychiatric comorbidity and extraversion.

	Lifetime suicide attempt/completion (N = 9)	No lifetime suicide attempt/completion (N = 126)	Number Missing□	Results	
Psychiatric Comorbidity	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)
Depression	5 (55.56)	48 (39.34)	4	0.89 (>.05)	1.92 (0.49; 7.54)
GAD	4 (57.14)	18 (17.48)	25	5.08 (>.05)	6.30 (1.30; 30.60)
Alcohol Abuse/dependence	4 (44.44)	6 (4.80)	1	10.63 (>.04)	15.87 (3.40; 74.72)
EPI Subscale	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)
Extraversion	4.80 (2.39)	4.38 (2.54)	57	0.13 (>.05)	0.07 (0.18)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing not used in % calculations

Table 17: Lifetime prevalence of comorbid psychiatric disorders and mean (SD) of EPI extraversion score in women in the SALT cohort with bulimia nervosa by suicide attempt/completion status. Results are presented from logistic regression analyses (χ^2, p value) predicting suicide attempts/completions from psychiatric comorbidity and extraversion.

	Lifetime suicide attempt/completion (N = 7)	No lifetime suicide attempt/completion (N = 64)	Number Missing□	Results	
Psychiatric Comorbidity	N (%)	N (%)		χ^2 (p-value)	OR (95% CI)
Depression	7 (100.00)	37 (58.73)	1	6.95 (> .05)	---
Generalized Anxiety Disorder	2 (33.33)	15 (32.61)	19	0.00 (> .05)	1.03 (0.17; 6.30)
Alcohol Abuse/dependence	2 (28.57)	6 (9.38)	0	1.79 (> .05)	3.87 (0.61; 24.41)
EPI Subscale	Mean (SD)	Mean (SD)		χ^2 (p-value)	B (SE)
Extraversion	5.50 (2.12)	4.59 (2.18)	37	0.35 (> .05)	0.21 (0.37)

P values have been adjusted to control for multiple comparisons using the false discovery rate

□Number missing

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