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Variation in reproductive outcomes of women with histories of bulimia nervosa, anorexia nervosa, or eating disorder not otherwise specified relative to the general population and closest-aged sisters

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Abstract

Objective: This study seeks to examine the long-term reproductive consequences of eating disorders (ED), to assess variation in reproductive outcomes by ED type, and to examine reproductive differences between women with previous ED diagnosis and their discordant sisters.

Method: Using a sample of women with previous ED diagnosis generated by the Utah Population Database, this study compares the fecundity (parity) and age at first birth of women by ED subtype (bulimia nervosa [BN], anorexia nervosa [AN], and ED not otherwise specified [EDNOS]) ($n = 1,579$). We also employed general population match case-control, and discordant sibling pair analyses, to estimate the magnitude of association between EDs and reproductive outcomes.

Results: Women previously diagnosed with AN or EDNOS experienced delayed first birth (HRR = 0.33, HRR = 0.34, respectively) and lower parity (IRR = 0.19, IRR = 0.22, respectively) relative to BN ($p < .05$), the general population ($p < .05$), and closest-aged sisters ($p < .05$). Women previously diagnosed with BN experienced more moderate reductions and delays to their reproduction, and had similar reproductive outcomes as their discordant sisters.

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CONFLICT OF INTEREST

The authors indicate no conflict of interest.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

Discussion: Clinicians should consider ED type and family fertility histories when addressing the long-term reproductive health needs of women with prior AN, BN, or EDNOS diagnosis. Women previously diagnosed with AN or EDNOS likely experience the greatest reductions and delays in reproduction across their lifespan. Reproductive health screenings may be especially critical for the wellbeing of women with a history of AN or EDNOS.

Keywords

anorexia; bulimia; eating disorders; EDNOS; fertility; reproduction; sibling pairs

1 | INTRODUCTION

There is a well-documented link between eating disorders (ED), reduced fecundability, and infertility (Bulik, Sullivan, Fear, Pickering, & McCullin, 1999; Kimmel, Ferguson, Zerwas, Bulik, & Meltzer-Brody, 2016). Many women seeking fertility treatment have a history of ED psychopathology (Freizinger, Franko, Dacey, Okun, & Domar, 2010), and women with prior or current EDs are more likely to express difficulty becoming pregnant (Easter, Treasure, & Micali, 2011). Research indicates that a history of ED psychopathology is linked to lifetime fertility issues (Kimmel et al., 2016). However, little is known about whether this is the result of delayed pregnancy or lower parity and how it varies across subtypes of ED.

Past longitudinal research, including the literature produced from the MoBa and ALSPAC cohorts, has enriched our understanding of how EDs shape pregnancy, neonatal, and maternal outcomes (Watson et al., 2014), as well as how onset and remission of EDs evolve across pregnancy (Bulik et al., 2007). This work illustrates that EDs influence the reproductive health of women, particularly their ability to achieve and maintain healthy pregnancies. However, it is unclear whether these outcomes translate to differences in reproductive timing or overall parity; limited research indicates that EDs are associated with risk for miscarriage, and greater likelihood of being childless (Linna et al., 2013), but very few studies have considered how a history of ED associates with long-term reproductive outcomes across the life course.

This study examines two primary reproductive outcomes that have been understudied: timing (age at first birth), and parity. This study seeks to build upon prior ED and fertility research by rigorously examining how reproductive outcomes vary by ED subtype (AN, BN, or EDNOS), and relative to nonaffected siblings and population controls, for women diagnosed with an ED before the birth of their first child.

1.1 | Anorexia nervosa, bulimia nervosa, EDNOS, and reproductive outcomes

EDs are complex conditions that are often chronic, developing in early adolescence and often persisting through adulthood (Hudson, Hiripi, Pope, & Kessler, 2007; Keel & Brown, 2010). The lifetime prevalence of ED among women is approximately 5.9% (Hudson et al., 2007). EDs are associated with mental and physical health comorbidities (Hudson et al., 2007; Piran & Robinson, 2011), and increased risk of suicide and mortality among women of childbearing age (Arcelus, Mitchell, Wales, & Nielsen, 2011; Pisetsky, Thornton,

Lichtenstein, Pedersen, & Bulik, 2013; Preti, Rocchi, Sisti, Camboni, & Miotto, 2011). The negative relationship between EDs and reproductive health is attributable to the adverse physical health outcomes of EDs, including extreme low or high bodyweight, and irregular or absent menstruation (Kimmel et al., 2016; Mustelin et al., 2015; Poyastro Pinheiro et al., 2007; Winkler, Frølich, Schulpen, & Støvring, 2017).

Initial ED and reproduction literature focused on anorexia nervosa (AN). AN is associated with infertility (Cousins, Freizinger, Duffy, Gregas, & Wolfe, 2015) and risk of miscarriage (Bulik et al., 1999). Although menstrual disruption is not limited to any one ED subtype (Poyastro Pinheiro et al., 2007), prolonged disruption to menstruation is most common in AN (El Ghoch et al., 2014). Some studies indicate that women with AN diagnosis are more likely to seek fertility treatments than women with BN (Easter et al. 2011); however, these results are mixed (Micali et al., 2014).

A growing literature has examined differences in reproductive outcomes among women with bulimia nervosa (BN) and ED-not otherwise specified (EDNOS). The literature suggests that menstrual disruption is common in women with binge-eating disorder (BED) (Ålgars et al., 2015), and that women seeking infertility treatment are likely to have a history of any ED and/or exhibit BN symptoms (Cousins et al., 2015). Women with a history of BN or EDNOS are more likely to be childless than their peers (Linna et al., 2013). Women with histories of BN have been found to experience higher miscarriage rates relative to women with AN (Micali, Simonoff, & Treasure, 2007).

Despite the association between EDs and fertility difficulties, women with a history of EDs are often still able to conceive (Bulik et al., 2010), and are more likely to identify a pregnancy as unintended (Watson et al., 2014). It is important to note that both biological and social mechanisms shape reproductive choices and outcomes of women with EDs (Barber, 2000; Newson, Postmes, Lea, & Webley, 2005).

This study assesses reproductive timing and parity of women diagnosed with AN, BN, or EDNOS prior to their first birth. This study compares differences in these reproductive outcomes by ED subtype, addressing an important gap in the literature. In addition, this study uses a case-control design to assess the difference in reproductive outcomes between ED subtypes and the general population. This study also employs a discordant sibling pair comparison as a sensitivity analysis to establish robustness of the relationship between EDs and reproductive outcomes by partially accounting for shared familial and/or early life etiological factors, including genetics, which may influence risk for ED and reproductive behaviors.

In a sibling discordance study, outcomes or experiences among siblings who are “discordant” for an exposure of interest are compared (Donovan & Susser, 2011). In these studies, siblings are assumed to share basic aspects of family context as well as half their genome. Discordant sibling pair analyses allow for partial control of potential confounding influences of shared familial and early life etiological factors that shape reproductive outcomes. Sisters tend to have more similar reproductive outcomes relative to those of the

general population (Lyngstad & Prskawetz, 2010), however, few studies have used a sibling design to examine the reproductive outcomes of women with previous ED diagnoses.

Based on the literature indicating that EDs are associated with reduced fertility, we hypothesize that women previously diagnosed with any ED subtype (AN, BN, or EDNOS) will experience lower parity and delayed age at first birth compared to the general population and their sisters. We also hypothesize that there will be variation in the effect by ED subtype, with AN having the most severe reproductive outcomes.

2 | METHOD

2.1 | Data

This study relies on data from the Utah Population Database (UPDB), a unique data source that links high-quality sociodemographic, medical, and vital records. The UPDB has population wide coverage and contains information on over 9 million individuals. The Population and Pedigree Resource link vital records to multigenerational family trees, including medical records provided by the University of Utah Hospitals and Clinics (UUHC), statewide hospitalization records provided by the Utah Department of Health (UDOH), and height, weight, and residence information provided by the Driver's License Division (DLD) using a master subject index. Medical, hospitalization, and DLD records are available from 1995 to 2015. Studies using UPDB data have been approved by the University of Utah's Resource for Genetic and Epidemiologic Research and its Institutional Review Board.

2.2 | Samples

2.2.1 | Eating disorder sample—This study includes females with known ED diagnosis before first birth for parous women, or before age 50 or age last known in Utah for nulliparous women. The ED sample includes women previously hospitalized in the state of Utah (UDOH) or who received outpatient treatment at UUHC. UUHC is Utah's largest clinic system and represents approximately 15% of Utah's total patient population. Primary diagnosis (AN, BN, or EDNOS) was established based on ICD-9 codes from linked medical records. Approximately 1,973 women had previous ED diagnosis, and had valid BMI measurement before first birth or age at censor. Approximately 394 of the original ED sample had missing values on key covariates, with median household income being most common ($n = 341$), yielding an analytic sample of 1,579 women previously diagnosed with an ED.

2.2.2 | General population sample—Women previously diagnosed with an ED were matched to three randomly selected individuals from the Utah population without known ED diagnosis. Inclusion criteria required that general population controls match on five sociodemographic characteristics: birth year, sex, race, ethnicity, and religious affiliation (known Latter-day Saint [LDS] affiliation [4%] or unknown affiliation [96%]). In addition, general population matches do not match on either mother or father identifiers and are therefore not biologically related. Of the 4,726 general population matches, approximately 664 had missing values on key covariates, with median household income ($n = 349$) and

missing BMI ($n = 163$) being most common. Another 946 did not have an available BMI measure before first birth or last known follow-up date. This yields an analytic sample of 4,692 women, 1,579 diagnosed with an ED, and 3,116 general population matches, after list-wise deletion. The average birth year of women was 1985 (standard deviation [SD] = 7.78).

2.2.3 | Matched sibling and general population subsample—Women with previous ED diagnosis were matched using parental identifiers to their closest-aged, biological sister not diagnosed with an ED and who had a valid BMI measure. Of the analytic sample of women with an ED ($n = 1,579$), only 503 had an appropriate sibling match ($n_{\text{sib-analysis}} = 1,006$). We also include the general population matches (of the 503 women with previous ED diagnosis) as a reference group ($n = 1,210$).

Individuals excluded from this study due to missing data were more likely to be racial or ethnic minorities, and have lower median income.

2.3 | Measures

2.3.1 | Dependent variables—Parity is a count of live births between the ages of 15–50 taken from vital and medical records.

Age at first birth is a continuous measure of time from birth to first birth month/year. Fertility window was limited to ages 15–50, with right censoring set at age 50, age of death, or last age known to live in Utah.

2.3.2 | Primary independent variable—Eating disorder is a three-category measure constructed using hospitalization (UDOH) and outpatient (UUHC) medical records. The measure compares those without previous ED diagnosis “0” to individuals with records indicating previous primary diagnosis of AN (ICD-9 code 307.1) “1”, BN (ICD-9 Code 307.51) “2”, or EDNOS (ICD-9 307.50) “3”. This measure is restricted to those with first known diagnosis at age 12 or older, but before first birth/age at right censor (average age at first diagnosis = 23.33 years, $SD = 7.98$ years). Because ICD-9 does not differentiate BED from EDNOS, we are unable to examine women with previous BED diagnosis separately nor re-evaluate diagnoses according to DSM-5 criteria. In addition, specific ED diagnostic procedures employed by statewide hospitals and UUHC are unknown.

2.3.3 | Covariates—Race and ethnicity is a categorical variable comparing non-Hispanic whites, Hispanics, and non-Hispanic other, taken from vital and DLD records. Although there is additional detail on race and ethnicity within the UPDB, the counts of these categories (e.g., non-Hispanic black) are too small for meaningful comparison. Birth year is a continuous variable taken from vital records. Body mass index (BMI) is a continuous measure calculated using height and weight information from medical records at time of first ED event for ED subtype comparisons only. We use earliest available height and weight (before first birth) from driver licenses for ED, general population, and sibling cross-sample comparisons. In addition, average household income is a continuous measure of average household income at the 2000 census block level using addresses listed on drivers' licenses.

Suicide attempt/self-inflicted injury event compares those who were treated for suicide attempt/self-inflicted injury (ICD-9 codes E950–958.9) based on outpatient medical (UUHC) and/or statewide hospitalization records (UDOH) to those who were not treated. The measure of self-injurious behavior and suicide attempt seeks to adjust for the most severe behavioral health issue highly correlated with any lifetime ED diagnosis, which may help explain the relationship between EDs and reduced fertility (Pisetsky et al., 2013; Preti et al., 2011).

Hospitalization for an eating disorder is a categorical measure comparing women who have only received outpatient treatment from UUHC “0”, to women hospitalized once “1,” to those hospitalized more than once “2”. Treatment information beyond inpatient/hospitalization or outpatient event is not available.

Age at first eating disorder diagnosis is a continuous measure of age at first known ED event calculated using month/year of ED event and month/year of birth.

2.4 | Analytic plan

We present descriptive statistics of the full ED and general population samples. We then present unadjusted differences between ED, sibling, and general population subsamples.

To further understand the relationship, we compare age at first birth of women with EDs by ED subtype (AN, BN, and EDNOS) (model 1), adjusting for age at first diagnosis and hospitalization for ED as proxy for disease severity and treatment type, and then ED subtype to general population matches (model 2), using Cox proportional hazard models. Within group comparisons are made by birth year (ED subtype comparisons) or ED person identifier (cases compared to general population comparisons). To investigate the relationship between ED and parity of women (AN, BN, and EDNOS) at time of last follow-up, we compare by ED subtype (model 3), and then ED subtype to general population (model 4), using negative binomial regression. We adjust all models for clustering by birth year or ED person identifier.

In an attempt to adjust for early life factors that may influence ED and fertility, such as genetics or fertility intentions, we compare the age at first birth of women with ED to matched sisters (model 1_{sib-analysis}) using Cox regression. These methods have been criticized for their nongeneralizability and therefore we further assess the relationship with a subsample of the general population (model 2_{sib-analysis}). The same logic is used to repeat the parity analyses using negative binomial regression (models 3–4_{sib-analysis}). We adjust all models for clustering by sibling pair or ED-person identifier.

Because we utilize a matched-pair sampling design, models will exclude sociodemographic variables that do not vary within groups. This includes birth year and race/ethnicity in general population, and race/ethnicity in sibling-pair, comparisons.

3 | RESULTS

Table 1 presents descriptive statistics and unadjusted empirical relationships between ED subtypes and the general population. Women with previous AN diagnosis have the highest

average age at first birth (26.4 years, $SD = 4.78$), when compared with women previously diagnosed with BN (25.66 years, $SD = 4.40$, $p < .05$) or EDNOS (25.62 years, $SD = 5.80$, $p < .05$) or the general population (24.1 years, $SD = 4.53$, $p < .001$). Women with previous ED diagnosis have a significantly lower number of children than those without and this does not vary by subtype. All ED subtypes have similar ages at first diagnosis (between 23 and 24 years); however, women with AN are more likely to have been hospitalized for an ED at least once (68.52%) when compared with women diagnosed with BN (60.54%, $p < .01$) and women diagnosed with EDNOS (50.81%).

Table 2 presents descriptive statistics and unadjusted results comparing women with previous ED diagnosis ($n = 503$), sibling ($n = 503$), and general population (1,210) subsamples. Sisters without previous ED diagnosis have more children (mean = 0.64, $SD = 1.09$) than women diagnosed with ED (mean = 0.34, $SD = 0.69$) ($p < .001$). The general population sample has the highest average number of children of the three groups (mean = 1.30, $SD = 1.75$; $p < .001$). General population has the youngest age at first birth (mean = 23.56 years, $SD = 3.81$), relative to women with ED diagnosis (mean = 25.14 years, $SD = 4.25$; $p < .001$), or matched sisters (mean = 24.76 years, $SD = 4.27$; $p < .001$).

Cox proportional hazard models comparing ED subtype ($n = 1,579$), indicate that the hazard of first birth is higher for women with previous BN diagnosis (hazard rate ratio [HRR] = 1.42, $p < .05$) compared to women with AN, when adjusting for age at ED diagnosis, hospitalization for an ED, suicide attempt/self-inflicted injury event, and all else (Table 3, model 1). However, women with previous EDNOS diagnosis have a similar age at first birth as women with AN (Table 3, model 1). General population comparisons ($n = 4,792$) indicate that the age at first birth is significantly higher for all ED subtypes when adjusting for sociodemographic and other characteristics (Table 3, model 2).

Negative binomial regression results indicate that women with previous BN diagnosis have more children relative to women previously diagnosed with AN (interval rate ratio [IRR] = 1.51, $p < .001$), but that women diagnosed with EDNOS have similar parity profiles as AN, *ceteris paribus* (Table 3, model 3). Model 4 indicates that the rate of birth of women with any ED subtype is significantly lower relative to the general population without an ED ($p < .001$ for all ED subgroups) when adjusting for sociodemographic and other characteristics (Table 3).

Based on cox-proportional hazard models, women previously diagnosed with AN and EDNOS have reduced risk of first birth (i.e., later age) when compared with sisters (HRR = 0.31, $p < .001$ and HRR = 0.48, $p < .05$, respectively) (Table 4, model 1). Women with BN have a similar age at first birth as their matched sisters (Table 4, model 1). Sisters without ED are similar to women in general population subsample with respect to age at first birth (Table 4, model 2).

We also find that women previously diagnosed with AN and EDNOS have lower parity relative sisters (IRR = 0.54, $p < .001$ and IRR = .55, $p < .05$, respectively) (Table 4, model 3) and that women with previous BN diagnosis do not have significantly different parity compared to sisters (Table 4, model 3). In addition, sisters without ED have significantly

lower parity compared to the general population subsample ($IRR = 0.40$, $p < .001$) (model 4).

4 | DISCUSSION

This study took advantage of a unique database to investigate the association between ED and reproductive outcomes in population and sibling controls. This study makes important contributions to the literature by examining long-term reproductive outcomes by ED subtype, including AN, BN, and EDNOS. Compared to the general population, women with any prior ED diagnosis experienced later ages at first birth and lower parity at the end of the follow-up period. This finding varied by ED subtype, with women previously diagnosed with AN or EDNOS having later ages at first birth, and lower parity relative to women previously diagnosed with BN. These results indicate that women with histories of AN or EDNOS may be experiencing greater delay or disruption to their reproduction due to their ED and that these factors cannot be fully explained by shared early life environment or genetics. These findings are important in light of prior research indicating that childbearing is associated with reduced risk of mortality among women with AN (Papadopoulos et al., 2013); reproductive health screenings may be especially critical for the wellbeing of women with histories of AN or EDNOS.

In addition, there may be shared familial or early-life factors shaping the reduced parity of women with a history of EDs. While matched sisters did not have significantly different age at first birth relative to the general population, they did experience lower parity. Clinicians should consider family histories of infertility for women with a history of EDs when addressing their unique reproductive health needs. While a matched sib-pair design is powerful for elucidating mechanisms, there are several key limitations that should be considered (Frisell, Öberg, Kuja-Halkola, & Sjölander, 2012), such as the inability to control for additional genetic variation, and etiological factors unrelated to family experiences such as media and peer influences, or negative affect and low self-esteem (Polivy & Herman, 2002). Some potential nonshared confounding factors of siblings include SES in early adulthood, differences in personality or preference, or health behaviors. Future studies should attempt to better account for known confounding factors associated with EDs and fertility. In addition, underlying genetic and epigenetic etiology is rarely accounted for in ED outcomes research and should be investigated further.

Given that EDs are likely to go undiagnosed or untreated (Hart, Granillo, Jorm, & Paxton, 2011; Weissman & Rosselli, 2017), it is possible that sisters are not truly discordant; sisters identified as not having prior ED diagnosis may have an ED that has gone undiagnosed or was not captured in our sampling design. This may bias our findings toward the null hypothesis.

In this study, we could not include education measures due to sample limitations. However, we include average household income at the 2000 census-block level as a measure of family and neighborhood SES. Although it is unclear whether educational attainment varies by ED subtype, ED psychopathology and related physical and mental health outcomes are potentially disruptive to educational attainment (Maxwell et al., 2011; Tabler et al., 2015).

Given that reduced education is associated with early and high fertility, and we found that any previous ED diagnosis is associated with reduced and delayed fertility, the exclusion of achieved education may be resulting in an underestimation of the association between EDs and reproduction. Future research should examine whether educational attainment varies by ED subtype, and examine how educational attainment attenuates the relationship between EDs and reproduction.

This study does not take into account fertility intentions, another important social factor that may shape reproductive choices. Differences in reproductive outcomes may be an artifact of differential desires for children by ED subtype, or among women with EDs in general. Research indicates that women with EDs may have lower fertility intentions than women without EDs (Easter et al. 2011; Linna et al., 2013), which may be translating to lower completed or delayed fertility. Similarly, this study only examines successfully completed fertility—not pregnancy, miscarriage, or induced abortion. Due to data constraints, we were unable to examine other reproductive experiences that may help explain why we found that fertility timing and parity varies by ED subtype.

It is important to note that these results may not be generalizable to all women in the United States. Utah is a predominantly white, Latter-day Saint population, and has the highest total fertility rate in the United States estimated at 2.3 births per woman (Martin, Hamilton, Osterman, Curtin, & Matthews, 2015). Associations between ED and long-term fertility may be more pronounced in high fertility populations like Utah relative to populations having more reduced fertility trends. In addition, Utah has uniquely low drinking and smoking rates, behaviors that are known to influence female fertility (Merrill, Folsom, & Christopherson, 2005). We were not able to account for variation in religious affiliation or practices, so it is unclear how Utah's unique religious make-up shape these results. In addition, this study was more likely to include women who are white or middle class due to data limitations, limiting the generalizability of our findings to minority or low-income populations.

Finally, this study provides a simplified story of EDs; this study categorizes women by primary ED diagnosis based on ICD-9 codes, and does not examine whether reproductive outcomes are shaped by transitions between (such as AN to BN) or combinations of (such as AN 1 BN) subtypes. We are also unable to identify specific diagnostic procedures, or treatment types. A strength of this study is our ability to establish time order by identifying ED diagnosis before first fertility event, however EDs are often experienced concurrently with first and later pregnancies (Cardwell, 2013; Taborrelli et al., 2016; Ward, 2008). Future research could build on our study by examining how ED onset and relapse, treatment timing, and ED co-occurrence with pregnancy may influence long-term reproductive outcomes.

5 | CONCLUSION

Despite these limitations, this study furthers our knowledge of EDs and reproductive health by examining timing and parity. Understanding how reproduction unfolds across the lifespan for women with histories of ED is important given that childbearing significantly shapes later-life health (Mirowsky, 2005; Spence, 2008). We find that women with histories of AN or EDNOS may be experiencing greater reductions and delays in reproduction across their

lifespan when compared with women with a history of BN. Our study reconfirms the public health message that all ED forms have deleterious consequences for health and wellbeing, but that reproductive health screenings may be especially critical for the wellbeing of women with histories of AN or EDNOS. In addition, women with a history of BN and their sisters may be experiencing similar reproductive outcomes.

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TABLE 1
Descriptive and unadjusted empirical statistics of eating disorder and general population sample

	Women with eating disorders (ED) (<i>n</i> = 1,576)		General population (<i>n</i> = 3,116)	
	AN (<i>n</i> = 395) (reference) or mean (<i>SD</i>)	BN (<i>n</i> = 446) % or mean (<i>SD</i>)	EDNOS (<i>n</i> = 735) % or mean (<i>SD</i>)	No ED (<i>n</i> = 3,116) % or mean (<i>SD</i>)
Dependent variables				
Fertility event (yes)	17.93%	23.32% *	18.61% *	48.33% ***
Age at first birth (range 15–44)	26.4 (4.78)	25.66 (4.38) *	25.62 (5.80) *	24.1 (4.53) ***
Number of children (range 0–8)	0.28 (0.67)	0.35 (0.72)	0.27 (0.64)	1.46 (1.71) ***
Covariates				
Marital status ^a (married)	27.78%	25.34%	18.34% ***	34.18% ***
Suicide attempt/self-inflicted injury event ^b (yes event)	20.51%	26.23% *	18.91%	1.54% ***
Race/ethnicity				
Non-Hispanic white	87.09%	85.87%	86.12%	89.99%
Hispanic	9.37%	10.54%	8.16%	6.19%
Non-Hispanic other	3.54%	3.59%	5.71%	3.82%
Household income ^c (range \$8,465–135,852)	54,157 (20,745)	53,843 (19,272)	52,070 (20,294)	50,397 (18,298) ***
Body mass index (range 13–45) ^d	19.79 (2.93)	22.47 (4.73) ***	22.55 (5.28) ***	22.56 (4.45) ***
Birth year (range 1950–99)	1982.79 (9.54)	1983.3 (8.70)	1985 (9.57) ***	1986.11 (7.49) ***
Eating disorder severity covariates				
Hospitalization for eating disorder ^e				
Never	31.49%	39.46% **	49.18% ***	–
Once	36.78%	37.89% **	41.71% ***	–
More than once	31.74%	22.65% **	9.10% ***	–
Age at eating disorder diagnosis (range 12–50)	23.71 (8.62)	23.54 (7.32)	23.21 (8.35)	–

AN = 5 anorexia nervosa; BN = 5 bulimia nervosa; EDNOS = Eating disorder not otherwise specified.

Notes. Data come from the Utah Population Database (UPDB); includes women in fertility period (age 15–50). All measures taken before first birth for parous women, or age 50/last date known in Utah/death date for nonparous women. Mean differences examined using two-tailed independent sample *t* tests, percent differences examined with Chi-squared tests, comparing general population and eating disorder subtypes to women diagnosed with AN.

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- ^aCompares those married to those who were not married.
 - ^bCompares those who were treated for self-inflicted injury or suicide attempt to those who were not.
 - ^cMeasured as median household income (dollars) at the census (year 2000) block level.
 - ^dMeasured BMI was generated from height and weight information from youngest driver's license issued.
 - ^eCompares those who were not hospitalized for an eating disorder to those who were hospitalized once, to those who were hospitalized more than once.
- * p < .05
- ** p < .01
- *** p < .001.

TABLE 2
Descriptive and unadjusted empirical relationships between ED women, sibling, and general population-match analytic subsamples

	Women previously diagnosed with eating disorder (<i>n</i> = 503) % or mean (<i>SD</i>)	Sibling-match without eating disorder (<i>n</i> = 503) % or mean (<i>SD</i>)	General population (<i>n</i> = 1,210) (reference) % or mean (<i>SD</i>)
Dependent variables			
Number of children (range 0–7)	0.34 (0.69) ***	0.64 (1.09) ***	1.30 (1.75)
Age at first birth (range 15–38)	25.14 (4.25) ***	24.76 (4.27) ***	23.57 (3.83)
Covariates			
Race/ethnicity			
Non-Hispanic white	90.06%	93.04%	92.31%
Hispanic	6.16%	3.98%	4.63%
Non-Hispanic other	3.78%	2.98%	3.06%
Marital status ^a (married)	22.66% **	35.79% **	28.84%
Body mass index ^b (range 11.5–45)	21.59 (4.75) ***	22.06 (4.48)	22.28 (4.38)
Household income (range \$8,465–135,852)	55,572 (19,006) **	55,582 (19,113) **	52,687 (17,345)
Suicide attempt/self-inflicted injury event ^c (yes)	20.68% ***	3.38% **	1.15%

Notes. Data come from the Utah population database (UPDB) includes women in fertility period (age 15–50). All measures taken before first birth for parous women, or age 50/last date known in Utah/death date for nonparous women.

^aCompares those married to those who were not married.

^bMeasured at youngest age using height and weight information from the driver's license division.

^cCompares those who have ever been treated for self-inflicted injury or suicide attempt before the birth of their first child to those who have never been treated.

p <0.01

p <0.001

Cox proportional hazard model (hazard rate ratios) and negative binomial regression (interval rate ratios): influence of eating disorder subtype on risk of first birth and parity

TABLE 3

Cox-proportional hazard models			Age at first birth		Negative binomial regression models		Parity
	ED subtype comparison (model 1)	General population comparison (model 2)	ED subtype comparison (model 3)	General population comparison (model 4)			
Eating disorder ^a (ED)							
Anorexia nervosa	Reference	0.33 *** (0.08)	Reference	0.19 *** (0.02)			
Bulimia nervosa	1.42 * (0.22)	0.37 *** (0.04)	1.51 *** (0.17)	0.26 *** (0.02)			
ED-not otherwise specified	1.25 (0.19)	0.34 *** (0.03)	1.23 (0.19)	0.22 *** (0.02)			
Birth year	—	—	0.95 *** (0.02)	0.99 (0.01)			
Married ^b	3.80 *** (1.18)	2.21 *** (0.13)	4.40 *** (0.55)	2.38 *** (0.17)			
Median income ^c	0.99 *** (0.00)	0.99 *** (0.00)	0.99 ** (0.00)	0.99 *** (0.00)			
Race/ethnicity ^d		—					
Hispanic	1.30 (0.23)	—	1.45 ** (0.17)	1.94 *** (0.17)			
Non-Hispanic other	0.93 (0.19)	—	0.94 (0.17)	1.00 (0.12)			
Body mass index	0.99 (0.01)	0.98 ** (0.01)	0.98 (0.01)	0.99 * (0.00)			
Suicide attempt/self-inflicted injury event ^e	0.75 (0.13)	0.88 (0.13)	0.80 (0.14)	0.75 * (0.11)			
Age at ED diagnosis	0.87 *** (0.01)	—	0.89 *** (0.02)	—			
Hospitalized for ED ^f							
Hospitalized once	1.19 (0.15)	—	1.06 (0.14)	—			
Hospitalized more than once	0.55 ** (0.23)	—	0.56 ** (0.11)	—			

	Cox-proportional hazard models Age at first birth		Negative binomial regression models Parity	
	ED subtype comparison (model 1)	General population comparison (model 2)	ED subtype comparison (model 3)	General population comparison (model 4)
<i>n</i>	1,579	4,692	1,579	4,692

Notes. Data come from the Utah population database; hazard rate ratios (models 1 and 2) and incidence rate ratios (models 3 and 4) reported; robust standard errors in parentheses. All measures taken before first birth for parous women, or age 50/last date known in Utah/death date for nonparous women. Model 1 is stratified, and model 3 is clustered, by birth year to address potential confounding cohort effects. Birth year is absorbed into the baseline hazard in model 1 due to the stratification of models by birth year. Model 2 is stratified, and model 4 is clustered, by ED person identifier to address potential confounding effects of clustering or grouping by ED person. Birth year and race/ethnicity are absorbed into the baseline hazard in model 2 due to stratification by ED person identifier; the general population and ED sample are matched perfectly on these variables. Proportional haz-ards assumption was tested postestimation using Schoenfeld residuals, and log-log plots of survival by eating disorder category. Supporting Information analyses (not shown) include age at BMI measurement to ensure that differences in measurement timing were not significantly biasing results.

^aReference group is anorexia nervosa (models 1 and 3) or general population (models 2 and 4).

^bReference group is unmarried.

^cMedian household income measured in thousands of dollars at the census-block level (year 2000).

^dReference group is non-Hispanic white.

^eReference group is no suicide attempt/self-inflicted injury event.

^fReference group is never been hospitalized for ED.

*
p < .05

**
p < .01

p < .001.

Cox proportional hazard model (hazard rate ratios) and negative binomial regression (interval rate ratios): influence of eating disorder subtype on risk of first birth and parity relative to matched sisters and general population subsamples

TABLE 4

	Cox-proportional hazard models Age at first birth		Negative binomial regression models Parity	
	Matched sister comparisons (model 1)	General population comparison (model 2)	Matched sister comparisons (model 3)	General population comparison (model 4)
Eating disorder ^a (ED)				
Anorexia nervosa	0.31 *** (0.09)	0.39 *** (0.08)	0.54 *** (0.10)	0.21 *** (0.04)
Bulimia nervosa	0.73 (0.16)	0.67 ** (0.04)	0.94 (0.15)	0.37 *** (0.06)
ED-not otherwise specified	0.48 *** (0.10)	0.50 *** (0.08)	0.55 *** (0.08)	0.21 *** (0.03)
Sisters without ED	Reference	0.96 (0.09)	Reference	0.40 *** (0.03)
Birth year	1.10 * (0.04)	1.08 * (0.02)	1.00 (0.01)	0.97 (0.01)
Married ^b	3.23 *** (0.81)	2.21 *** (0.13)	5.27 *** (0.72)	3.22 *** (0.24)
Median income ^c	1.00 (0.01)	0.99 *** (0.00)	1.00 (0.00)	0.99 *** (0.00)
Race/ethnicity ^d				
Hispanic	—	—	1.81 *** (0.40)	2.72 *** (0.32)
Non-Hispanic other	—	—	0.79 (0.31)	1.07 (0.32)
Body mass index	0.96 *** (0.01)	0.98 ** (0.01)	0.97 ** (0.01)	0.98 ** (0.01)
Suicide attempt/self-inflicted injury event ^e	1.02 (0.23)	0.88 (0.13)	1.05 (0.24)	1.02 (0.21)
<i>n</i>	1,006	2,216	1,006	2,216

Notes. Data come from the Utah population database; hazard rate ratios (models 1 and 2) and incidence rate ratios (models 3 and 4) reported; robust standard errors in parentheses. All measures taken before first birth for parous women, or age 50/last date known in Utah/death date for nonparous women. Models 1–2 are stratified by ED person identifier, and models 3–4 are clustered by ED person identifier, to address potential confounding effects of clustering or grouping by ED person. Race/ethnicity is not reported in models 1–2 because sisters, ED women, and general population matches do not vary substantially by race/ethnicity, and therefore race/ethnicity is absorbed into the baseline hazard. Proportional hazards assumption was tested postestimation using Schoenfeld residuals, and log-log plots of survival by eating disorder category.

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- ^aReference group is matched sisters (models 1 and 3) or general population (models 2 and 4).
 - ^bReference group is unmarried.
 - ^cMedian household income measured in thousands of dollars at the census-block level (year 2000).
 - ^dReference group is non-Hispanic white.
 - ^eReference group is no suicide attempt/self-inflicted injury event.
- * p < .05
- ** p < .01
- *** p < .001.