Reproductive Health Outcomes in Eating Disorders

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ABSTRACT

Objective: Eating disorders are common psychiatric disorders in women at childbearing age. Previous research suggests that eating disorders are associated with fertility problems, unplanned pregnancies, and increased risk of induced abortions and miscarriages. The purpose of this study was to assess how eating disorders are related to reproductive health outcomes in a representative patient population.

Method: Female patients ($N = 2,257$) treated at the eating disorder clinic of Helsinki University Central Hospital during 1995–2010 were compared with matched controls identified from the Central Population Register ($N = 9,028$). Patients had been diagnosed (ICD-10) with anorexia nervosa (AN), atypical AN, bulimia nervosa (BN), atypical BN, or binge eating disorder (BED, according to DSM-IV research criteria). Register-based data on number of children, pregnancies, childbirths, induced abortions, miscarriages, and infertility treatments were used to measure reproductive health outcomes.

Results: Patients were more likely to be childless than controls [odds ratio (OR) 1.86; 95% confidence interval (CI) 1.62–2.13, $p < .001$]. Pregnancy and childbirth rates were lower among patients than among controls. BN was associated with increased risk of induced abortion compared to controls (OR 1.85; 95% CI 1.43–2.38, $p < .001$), whereas BED was associated with elevated risk of miscarriage (OR 3.18; 95% CI 1.52–6.66, $p = .002$).

Discussion: Reproductive health outcomes are compromised in women with a history of eating disorders across all eating disorder types. Our findings emphasize the importance of reproductive health counseling and monitoring among women with eating disorders. © 2013 Wiley Periodicals, Inc.

Keywords: eating disorders; reproductive health; pregnancy; induced abortion; miscarriage; fertility

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Introduction

Eating disorders cause significant morbidity and elevated mortality in women at childbearing age.[1,2] At the population level, eating disorders are common health problems affecting at least 5.2–6.5% of young females,[2–6] but they often go undetected in health care.[4,5] Contrary to earlier views, women with eating disorders are often able to conceive despite grave menstrual irregularities, and subsequent to recovery, gonadal functioning normalizes

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in most cases.[7] However, it is suggested that lifetime eating disorders are associated with fertility problems.[8] Because of oligomenorrhea/amenorrhea and uncertainty regarding one's fertility and resultant inadequate use of contraception,[9] women with both anorexia nervosa (AN) and bulimia nervosa (BN) have been more likely to report that their pregnancy was unplanned.[9,10]

Eating disorders are associated with an increased risk for pregnancy complications and adverse effects to both mother and child.[11–13] As eating disorders heavily affect mind, several organ systems, and endocrine function,[14] this is readily comprehensible. Pregnant women with eating disorders thus need enhanced monitoring preferably carrying over the postnatal period, and it has been suggested that women with an active eating disorder should be referred to an obstetrician with an interest in treating high-risk pregnancies and ideally to a specialist eating disorders service.[15]

In prenatal period, increased number of both miscarriages and induced abortions are reported in AN and BN.[10,16–19] Binge eating disorder (BED) is often accompanied by obesity, which in turn has been associated with an elevated risk of miscarriage,[20] and increased risk of stillbirth or early neonatal death.[21]

Our aim was to extend the current knowledge by examining register-based pregnancy outcomes and reproductive health outcomes in a large patient population treated in a specialized eating disorder unit. We hypothesized that compared to controls, individuals treated for eating disorders would have had fewer children across diagnostic categories, higher number of induced abortions and miscarriages, and that they would have received infertility treatments more often. Within diagnostic groups, we hypothesized than women with AN demonstrate most severely impaired reproductive health. Given the severe disturbances in the gonadal axis and the resultant amenorrhea in AN, we hypothesized a high prevalence of childlessness in women treated for AN, and based on literature, elevated risks of miscarriages and induced abortions. We expected to find similar patterns in atypical AN, but with a smaller effect size. We hypothesized that women with BN had had higher number of induced abortions and miscarriages. Lastly, based on literature on obesity, we hypothesized that BED would be associated with an elevated risk of miscarriage.

Method

We identified all patients treated in the eating disorder clinic at the Helsinki University Central Hospital during 1995–2010. A register search on reproductive health measures was carried out on 2,257 female patients and 9,028 controls taken from the Central Population Register, matched for sex, age, and geographical area. Patients who were ≥50 years old at the beginning of the follow-up were excluded. Information was retrieved from four registries: the Central Population Register, the Medical Birth Register, the Register on Induced Abortions, and the Hospital Discharge Register. The obtained measures included numbers and dates of pregnancies, childbirths, induced abortions, and miscarriages; in addition, register-based information on infertility treatments of pregnancies ending into childbirth was acquired.

Participants

The participants in the current study included patients with AN ($N = 502$), atypical AN ($N = 365$), BN ($N = 786$), atypical BN ($N = 445$), and BED ($N = 149$). The diagnoses were set by the attending physician at the eating disorder clinic using ICD-10 criteria,[22] where F50.0, F50.1, F50.2, and F50.3 indicate AN, atypical AN, BN, and atypical BN, respectively (see Table 1). BED was diagnosed using DSM-IV research criteria.

The individual follow-up period of each patient and the controls ($N = 4$ controls per patient) matched by sex, age, and region of residence extended from the day of admission to the clinic until the end of the follow-up period (December 31, 2010), or death ($N = 40$ patients, $N = 37$ controls), moving abroad ($N = 70$ patients, $N = 233$ controls), or reaching the age of 50 years ($N = 107$ patients, $N = 449$ controls). Furthermore, the length of the individual follow-up period was calculated until the first occurrence of the three pregnancy outcomes (childbirth, induced abortion, and miscarriage).

Outcome Measures

Childbirths. The number of biological children was obtained from the Central Population Register, which records number of all live-born children. Data on childbirths were retrieved from the Medical Birth Register. Data quality studies have shown that the majority of the register content corresponded well with hospital record data.[23]

Induced Abortions. Information on induced abortions was acquired from the Register on Induced Abortion. In Finland, induced abortions are allowed for social reasons, medical reasons, or ethical reasons. During the study period, 97% of pregnancy terminations were performed based on social indications, such as young or old age, at least four previous births, or poor economic

TABLE 1. Diagnostic classification of eating disorders applied in the eating disorder clinic at the Helsinki University Central Hospital and number of patients across diagnostic categories

	F50.0 Anorexia Nervosa	F50.1 Atypical Anorexia	F50.2 Bulimia Nervosa	F50.3 Atypical Bulimia	BED[a]
ICD-10 criteria[a]	a. Body weight at least −15% of that expected, or BMI[b] 17.5 or less. b. Weight loss is self-induced and one or more of the following is present: self-induced vomiting/purging; excessive exercise; use of appetite suppressants/diuretics. c. Patient manifests body-image distortion, dread of fatness and has a low weight threshold for her/himself. d. Widespread endocrine disorder involving HPA[c] axis manifests in women as amenorrhoea. e. Diagnostic criteria a and b of Bulimia Nervosa (F50.2) are not met.	One or more key features listed for anorexia nervosa is absent, but otherwise the clinical picture is fairly typical.	a. Patient succumbs to short episodes of overeating of large amounts of food (at least twice a week for 3 months). b. Patient has a persistent preoccupation with eating and craving for food. c. Patient attempts to counteract the effects of food by one or more of the following: self-induced vomiting; purging, periods of starvation; use of drugs. d. Psychopathology consists of morbid dread of fatness and patient sets herself/himself a sharply defined weight threshold.	One or more key features listed for bulimia nervosa is absent, but otherwise the clinical picture is fairly typical.	Patient succumbs to episodes of overeating in which large amounts of food are consumed rapidly combined with experienced loss of control over eating. The episodes occur at least 2 times per week for 6 months with no compensatory behaviors. At least three of the following symptoms are present: -Eating much more rapidly than normal -Eating until uncomfortably full -Eating large amounts of food, even when not physically hungry -Eating alone out of embarrassment at the quantity of food being eaten -Feelings of disgust, depression, or guilt with overeating.
Total number of cases	N = 502	N = 365	N = 786	N = 445	N = 149

[a]Binge eating disorder (BED) was diagnosed according to DSM-IV research criteria.
[b]Body Mass Index.
[c]Hypothalamic-Pituitary-Gonadal axis.

circumstances. Finland has a relatively low induced abortion rate compared to other European countries.[24]

More than 99% of induced abortions mentioned in hospital records are reported to the register, and for most variables, agreement between the register data and the hospital record is shown to be good.[25]

Miscarriages. Data on miscarriages were retrieved from Hospital Discharge Register. Information on the discharge diagnoses (main diagnoses and up to three secondary diagnoses), surgical procedures, dates of admission and discharge, and the hospital code have been recorded since 1968 in all public hospitals. We used ICD-10 diagnoses from O00 to O03 to identify miscarriages and ectopic pregnancies.

Infertility Treatments. Data on infertility treatments were obtained from the Medical Birth Register. Thus, we only had the information on infertility treatments resulting in childbirth. Infertility treatments received at private clinics or in other than maternity hospitals were based on self-report, which was registered in the birth hospital or in the antenatal clinic.

Statistical Analysis

Logistic regression was used to test statistical significances between patients and controls. Number of children was modeled using zero-inflated Poisson model, which models both childlessness and the number of children. This model takes into account over-dispersion and zero-inflation of data. We considered marital status to be a mediator in the mechanism through which eating disorders affect number of children. Thus, marital status was not considered a confounding factor, whereas the study design already accounts for confounding by age. Marital status was obtained from the Central Population Register and classified into three categories: single, married (including registered relationship or widowed), and divorced.

We analyzed pregnancies and pregnancy outcomes in two stages. First, we compared the rates of pregnancies, childbirths, induced abortions, and miscarriages until the first occurrence of these events. Second, the analyses were done for the entire duration of the follow-up period. The analyses were carried out by using a Poisson regression model accounting for the individual follow-up time.

TABLE 2. Demographic characteristics of patients with an eating disorder and of matched controls in the study

			Entire Sample (N = 2,257 Patients, N = 4 Controls per Patient)	Anorexia Nervosa (N = 502)	Atypical Anorexia (N = 365)	Bulimia Nervosa (N = 786)	Atypical Bulimia (N = 445)	BED[b] (N = 149)
Age		Years	25.3 (20.1–28.4)	22.8 (19.1–24.3)	24. 2 (19.5–26.6)	25.2 (20.6–28.0)	26.5 (21.3–30.1)	34.1 (29.3–40.1)
		(IQR[a]) Controls	Matched	Matched	Matched	Matched	Matched	Matched
Marital status	Single	n (%) Patients	1,382 (61.2%)	387 (77.1%)	226 (61.9%)	437 (55.6%)	259 (58.2%)	69 (46.3%)
		Controls	4,734 (52.4%)	1,268 (63.2%)	834 (57.1%)	1,515 (48.2%)	877 (49.3%)	231 (38.8%)
	Married	Patients	651 (28.8%)	91 (18.3%)	104 (28.5%)	267 (34.0%)	135 (30.3%)	50 (33.6%)
		Controls	3,585 (39.7%)	635 (31.6%)	529 (36.2%)	1,377 (43.8%)	744 (41.8%)	275 (46.1%)
	Divorced	Patients	223 (9.9%)	23 (4.6%)	35 (9.6%)	82 (10.4%)	51 (11.5%)	30 (20.1%)
		Controls	709 (7.9%)	105 (5.2%)	97 (6.6%)	252 (8.0%)	159 (8.9%)	90 (15.1%)
Number of children	0	n (%) Patients	1,395 (61.8%)	401 (79.9%)	234 (64.1%)	426 (54.2%)	257 (57.8%)	72 (48.3%)
		Controls	4,422 (49.0%)	1,198 (59.7%)	776 (53.2%)	1,384 (44.0%)	832 (46.7%)	222 (37.3%)
	1	Patients	343 (15.2%)	41 (8.2%)	55 (15.1%)	146 (18.6%)	74 (16.6%)	26 (17.5%)
		Controls	1,594 (17.7%)	325 (16.2%)	276 (18.9%)	559 (17.8%)	317 (17.8%)	113 (19.0%)
	2	Patients	332 (14.7%)	37 (7.4%)	46 (12.6%)	134 (17.1%)	76 (17.1%)	36 (24.2%)
		Controls	1,989 (22.0%)	321 (16.0%)	282 (19.3%)	800 (25.5%)	403 (22.6%)	165 (27.7%)
	≥3	Patients	187 (8.3%)	23 (4.6%)	30 (8.2%)	80 (10.2%)	38 (8.5%)	15 (10.1%)
		Controls	1,023 (11.3%)	164 (8.2%)	126 (8.6%)	401 (12.8%)	228 (12.8%)	96 (16.1%)

Note: Proportions (%) within each patient and control group are provided.
[a]Interquartile range.
[b]Binge eating disorder.

The analyses were done separately for the diagnostic groups. As the rates of various outcomes of pregnancies are directly influenced by the number of pregnancies, we conducted further analyses that accounted for this. A multinomial logistic regression model was used to assess the risk of induced abortion and miscarriage while childbirth was chosen as the reference category. Infertility treatments were analyzed with Pearson's chi-squared test and Fisher's exact when the assumptions for chi-squared test were not met. There were no missing data for number of children, induced abortions, miscarriages, or infertility treatments. Analyses were performed using the Stata statistical software version 11.0 and R program.

Ethical Considerations

Ethical permits were obtained from the Ethics committee of National Institute of Health and Welfare (Dnro THL/184/6.02.00/2011). The study was conducted according to the Helsinki Declaration. Data handling was performed according to the Finnish data protection legislation and the rules of National Institute of Health and Welfare. All register keeping institutions gave their permission to use their data in scientific research. The authors did not have access to the personal identification data, only research codes were used in all analyses.

Results

In the whole sample, the mean age at the beginning of the follow-up period was 25.3 years [interquartile range (IQR) 20.1–28.4]. Being single or divorced was more common among patients than among controls [odds ratio (OR) for being single 1.43; 95% confidence interval (CI) 1.30–1.57, $p <$ .001, OR for being divorced 1.29; 95% CI 1.10–1.51, $p =$ .002], whereas being married was less common among patients (OR .61; 95% CI .55–.67, $p <$ .001). Patients were more likely to be childless than controls (OR 1.86; 95% CI 1.62–2.13, $p <$ .001). Of all patients, 61.8% did not have children, whereas the corresponding percentage was 49.0% in controls. Among those who had had children, the number of offspring did not differ significantly between patients and controls. Demographic characteristics are shown in **Table 2**.

Rates of Pregnancies and Pregnancy Outcomes Until the First Occurrence of a Given Event

Having at least one pregnancy during the follow-up period was less common among women from all patient groups than among controls, yet a statistically significant difference was found only in AN, atypical AN, and atypical BN (**Table 3**). Most prominently this was seen in women with AN, among whom the pregnancy rate was less than half of the rate in the control group. Rate of having at least one childbirth during the follow-up period was significantly lower in all patient groups compared to controls. Rates of at least one induced abortion [rate ratio (RR) .61; 95% CI .39–.96, $p =$ .035] and miscarriage (RR .62; 95% CI .41–.94, $p =$ .026) were lower in patients with AN. Rate of at least one induced abortion was elevated in patients with BN (RR 1.56; 95% CI 1.25–1.96, $p <$ .001). When interpreting these results, it must be taken into account that the number of pregnancies was lower in all patient groups compared to controls.

TABLE 3. Numbers and rates (per 1000 person-years) of pregnancy outcomes in patients with an eating disorder and in matched controls

Diagnostic Group	Outcome	N Patients	N Controls	Person years (in thousands) Patients	Person years (in thousands) Controls	Rate/1,000 person years Patients	Rate/1,000 person years Controls	Rate Ratio (95% Confidence Interval) Patients	Rate Ratio (95% Confidence Interval) Controls	p
Anorexia nervosa	At least one pregnancy	92	708	2.92	9.84	31.51	71.95	.44 (.35–.54)	Reference	<.001
	Pregnancies	137	1,152	3.34	13.59	40.98	84.77	.48 (.40–.58)	Reference	<.001
	At least one childbirth	75	600	3.00	10.43	24.97	57.51	.43 (.34–.55)	Reference	<.001
	Childbirths	81	769	3.34	13.59	24.23	56.59	.43 (.34–.54)	Reference	<.001
	At least one abortion	21	137	3.24	12.88	6.49	10.64	.61 (.39–.96)	Reference	.035
	Abortions	25	179	3.34	13.59	7.48	13.17	.57 (.37–.86)	Reference	.008
	At least one miscarriage	26	164	3.28	12.90	7.93	12.71	.62 (.41–.94)	Reference	.026
	Miscarriages	31	204	3.34	13.59	9.27	15.01	.62 (.42–.90)	Reference	.012
Atypical anorexia	At least one pregnancy	108	547	1.97	7.45	54.72	73.41	.75 (.61–.92)	Reference	.005
	Pregnancies	163	830	2.46	10.04	66.13	82.67	.80 (.68–.95)	Reference	.009
	At least one childbirth	83	454	2.07	7.91	40.03	57.38	.70 (.55–.88)	Reference	.003
	Childbirths	93	554	2.46	10.04	37.73	55.18	.68 (.55–.85)	Reference	.001
	At least one abortion	28	103	2.33	9.53	12.02	10.81	1.11 (.73–1.69)	Reference	.62
	Abortions	35	129	2.46	10.04	14.20	12.85	1.11 (.76–1.61)	Reference	.60
	At least one miscarriage	31	120	2.38	9.62	13.04	12.47	1.05 (.70–1.55)	Reference	.83
	Miscarriages	35	147	2.46	10.04	14.20	14.64	.97 (.67–1.40)	Reference	.87
Bulimia nervosa	At least one pregnancy	358	1,477	5.02	19.86	71.35	74.36	.96 (.85–1.08)	Reference	.48
	Pregnancies	549	2,480	7.21	29.38	76.15	84.41	.90 (.82–.99)	Reference	.029
	At least one childbirth	278	1,300	5.59	21.26	49.76	61.15	.81 (.71–.93)	Reference	.002
	Childbirths	329	1,695	7.21	29.38	45.63	57.69	.79 (.70–.89)	Reference	<.001
	At least one abortion	103	276	6.59	27.60	15.63	10.00	1.56 (1.25–1.96)	Reference	<.001
	Abortions	124	346	7.21	29.38	17.20	11.78	1.46 (1.19–1.79)	Reference	<.001
	At least one miscarriage	86	340	6.75	27.87	12.74	12.20	1.04 (.82–1.32)	Reference	.72
	Miscarriages	96	439	7.21	29.38	13.32	14.94	.89 (.71–1.11)	Reference	.31
Atypical bulimia	At least one pregnancy	148	704	2.57	9.43	57.58	74.69	.77 (.65–.92)	Reference	.004
	Pregnancies	238	1,183	3.31	13.29	71.83	88.99	.81 (.70–.93)	Reference	.003
	At least one childbirth	116	609	2.75	9.98	42.12	61.00	.69 (.57–.84)	Reference	<.001
	Childbirths	140	829	3.31	13.29	42.25	62.36	.68 (.57–.81)	Reference	<.001
	At least one abortion	38	115	3.12	12.64	12.19	9.10	1.34 (.93–1.93)	Reference	.12
	Abortions	47	145	3.31	13.29	14.18	10.91	1.30 (.94–1.81)	Reference	.12
	At least one miscarriage	42	163	3.13	12.69	13.40	12.85	1.04 (.74–1.46)	Reference	.81
	Miscarriages	51	209	3.31	13.30	15.39	15.72	.98 (.72–1.33)	Reference	.89
BED[a]	At least one pregnancy	29	156	0.69	2.57	42.33	60.73	.70 (.47–1.04)	Reference	.074
	Pregnancies	45	269	0.82	3.29	55.14	81.71	.67 (.49–.93)	Reference	.015
	At least one childbirth	14	113	0.72	2.70	19.52	41.90	.47 (.27–.81)	Reference	.007
	Childbirths	20	188	0.82	3.29	24.51	57.11	.43 (.27–.68)	Reference	<.001
	At least one abortion	4	19	0.80	3.18	5.02	5.97	.84 (.29–2.47)	Reference	.75
	Abortions	4	19	0.82	3.29	4.90	5.77	.85 (.29–2.50)	Reference	.77
	At least one miscarriage	18	51	0.78	3.19	23.16	16.01	1.45 (.85–2.48)	Reference	.18
	Miscarriages	21	62	0.82	3.29	25.73	18.83	1.37 (.83–2.24)	Reference	.22

Note: Results of analyses using Poisson regression models accounting for the individual follow-up time are provided.
[a]Binge eating disorder.

TABLE 4. Proportions of pregnancy outcomes in patients with an eating disorder and in matched controls

		Childbirth n (%)	Childbirth OR (95% CI)	Induced Abortion n (%)	Induced Abortion OR (95% CI)	p	Miscarriage n (%)	Miscarriage OR (95% CI)	p
Anorexia nervosa	Patient	81 (59.1%)	Reference	25 (18.2%)	1.33 (.79–2.23)	.29	31 (22.6)	1.44 (.96–2.17)	.08
	Control	769 (66.8%)		179 (15.5%)			204 (17.7)		
Atypical anorexia	Patient	93 (57.1%)	Reference	35 (21.5%)	1.62 (.99–2.65)	.06	35 (21.5)	1.42 (.95–2.11)	.08
	Control	554 (66.7%)		129 (15.5%)			147 (17.7)		
Bulimia nervosa	Patient	329 (59.9%)	Reference	124 (22.6%)	1.85 (1.43–2.38)	<.001	96 (17.5)	1.13 (.88–1.44)	.34
	Control	1,695 (68.3%)		346 (14.0%)			439 (17.7)		
Atypical bulimia	Patient	140 (58.8%)	Reference	47 (19.7%)	1.92 (1.27–2.89)	.002	51 (21.4)	1.44 (1.02–2.04)	.04
	Control	829 (70.1%)		145 (12.3%)			209 (17.7)		
BED	Patient	20 (44.4%)	Reference	4 (8.9%)	1.98 (.60–6.57)	.27	21 (46.7)	3.18 (1.52–6.66)	.002
	Control	188 (69.9%)		19 (7.1%)			62 (23.0)		

Notes: BED, Binge eating disorder; OR, odds ratio; CI, confidence interval.
The results derived from multinomial logistic regression models assessing the risk of induced abortion and miscarriage while childbirth was set as the reference category.

Rates of Pregnancies and Pregnancy Outcomes Until the End of Follow-Up

Overall pregnancy and childbirth rates were significantly lower across all eating disorder groups compared to the rates in the control groups. Patterns in induced abortion and miscarriage rates for the whole duration of the follow-up period were similar to the patterns observed until the first occurrence of the given events.

Proportions of Pregnancy Outcomes

In order to account for the number of pregnancies, we used a multinomial logistic regression model in the second set of analyses that was confined to women with at least one pregnancy to assess the risk of induced abortion and miscarriage while childbirth was set as the reference category (**Table 4**).

Induced Abortions

The highest proportion of induced abortion was observed in women with BN (22.6% of pregnancies in patients, 14.0% in controls, OR 1.85; 95% CI 1.43–2.38, $p < .001$) and atypical BN (19.7% vs. 12.3% of pregnancies, OR 1.92; 95% CI 1.27–2.89, $p = .002$). There was a trend toward increased risk of induced abortion in atypical AN (21.5% in patients vs. 15.5% in controls, OR 1.62; 95% CI .99–2.65, $p = .06$), but women with AN and BED did not have an increased risk of induced abortion.

Miscarriages

Miscarriage as the outcome of a pregnancy was most common in women with BED, among whom miscarriages occurred in 46.7% of pregnancies (23.0% in controls, OR 3.18; 95% CI 1.52–6.66, $p = .002$). Likewise, we observed a similar tendency in women with atypical BN, as 21.4% of their pregnancies ended in miscarriage, whereas the percentage was 17.7% in their controls (OR 1.44; 95% CI 1.02–2.04, $p = .04$). Women with BN did not have miscarriages more often than control women (17.5% vs. 17.7% of pregnancies, OR 1.13; 95% CI .88–1.44, $p = .34$). There was a trend toward increased risk of miscarriage in women with AN (OR 1.44; 95% CI .96–2.17, $p = .08$) and atypical AN (OR 1.42; 95% CI .95–2.11, $p = .08$).

Infertility Treatments

Of all women who gave birth, 4.5% of the control group had conceived with the help of infertility treatment while the corresponding percentage was 7.2% in the whole patient group. There were no statistically significant differences across the diagnostic groups.

Discussion

In this study, individuals who had received treatment for an eating disorder demonstrated generally impaired reproductive health. Being childless was common among women with a lifetime eating disorder. In line with this, pregnancy and childbirth rates were lower among patients than among controls. Most prominently this was seen in women with lifetime AN, whose pregnancy rates were less than half of the rates of the reference group. Induced abortions were most common in women with lifetime BN, whereas miscarriages were most common in women with lifetime BED. Miscarriages were indeed surprisingly frequent in BED, as BED patients had miscarriage in almost half of their pregnancies.

Our findings provide further support for the previous findings of increased induced abortions in AN and BN,[10,16] yet our findings in AN were confined to atypical forms of AN. This might be at least partly attributable to the absence or irregularity of menstruation that could lead to inadequate use of contraceptives.[9,10] Another possible explanation could be impulsive personality traits characteristic especially of those with BN,[26] leading to risky sexual behavior and subsequent unplanned pregnancies.

Contrary to what we hypothesized based on previous literature, women with a history of BN in our study did not have miscarriages more often than control women. However, an increased risk of miscarriage was observed in women with atypical BN. Previously Abraham et al.,[16] Micali et al.,[18] and Morgan et al.[19] have reported an association between BN and miscarriage. The miscarriage rate in BN was similar to the average population level in the study of Crow et al.,[27] while a comparison group was not available in this study. In our study, one explanation for the lack of association between BN and miscarriage could be remission of eating disorder symptoms.

Our study provides borderline evidence for the association between AN and miscarriage, previously described by Bulik et al.[17] We do not know whether this is related to a permanent effect of AN on reproductive health, continuation of restrictive eating patterns or yet unknown factors. Furthermore, it is not clear what constitutes a healthy weight in the management of AN and BN.[28–30] Although attainment of a BMI of 19 kg/m^2 is often

accepted as being sufficient,[28] individual variation in lowest limit of sufficient weight is substantial; results from pelvic ultrasound studies of adolescents with AN show that this BMI might not be adequately high for the pelvic organs to mature.[29,30] Low BMI has been found to be associated with an elevated risk of miscarriage.[31]

Our study is to our knowledge the first one to study miscarriages in BED patients. Present in most individuals with either previous or current BED, obesity is known to have an adverse effect on reproductive health, including an elevated risk of miscarriage.[20] Lashen et al.[32] have suggested polycystic ovary syndrome, diabetes, impaired endometrial receptivity and oocyte abnormality as potential mediators of the detrimental effects of obesity/overweight to pregnancy. Further explanations include leptin and adiponectin abnormalities,[33,34] elevated stress hormones, hormonal responses to binge eating, dietary factors,[35] and somatic illnesses, such as hypertension and cardiovascular disease. The risk of miscarriage in BED was notably high in our study, which might be related to the fact that patients with more severe forms of BED are referred to specialist treatment.

Proportion of childbirths subsequent to infertility treatments was over 7% in patients and 4.5% in control women in our study, yet no significant differences were found across the diagnostic groups. This is in line with the findings of Freizinger et al.,[36] who reported that women with eating disorders are overpresented among women who seek treatment for infertility. We had information only on infertility treatments resulting in childbirth. Thus, our study provides a lower bound estimate for the usage of infertility treatments among female patients with eating disorders.

From the psychological point of view, reproductive functions have a close relationship to body satisfaction and overall femininity in women, which in turn tend to present as troubled issues among individuals with an eating disorder. Clinicians should therefore be aware of and prepared to handle the potential negative cycle where problems in reproductive health further exacerbate via psychological stress the patient's eating disorder symptoms, which in turn may worsen reproductive health problems.

Strengths and Limitations

The strengths of our study include large size of the sample and excellent coverage and validity of the register data on reproductive health. Some limitations need to be addressed. We were limited to variables recorded in the national health registries. Our findings might overestimate the rate of adverse reproductive health outcomes in the community due to the clinical setting, and thus, they are presumably not generalizable to nonclinical populations. The diagnoses in our study were intake diagnoses and did not account for comorbidity, diagnostic crossover, and remission/continuation of eating disorder symptoms during the follow-up. We were unable to assess binge/purge AN separately, as ICD-10 does not define this entity.

Conclusions

Reproductive health outcomes are compromised in patients across all eating disorder types. Our findings emphasize the importance of reproductive health counseling and continuous monitoring among women with current or past eating disorders in order to avoid exacerbation of both eating disorder symptoms and unfavorable reproductive health outcomes. We suggest that reproductive health among of individuals with BED and fertility problems in individuals across eating disorder categories are highlighted in future studies.

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