THESIS

EXPLORING THE RELATIONSHIP BETWEEN HORMONAL CONTRACEPTIVE METHODS AND SYMPTOMS OF DEPRESSION AND BULIMIA NERVOSA

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ABSTRACT

EXPLORING THE RELATIONSHIP BETWEEN HORMONAL CONTRACEPTIVE METHODS AND SYMPTOMS OF DEPRESSION AND BULIMIA NERVOSA

Research has been unable to determine if there is a link between hormonal contraceptive (HC) use, Major Depressive Disorder (MDD), and Bulimia Nervosa (BN). There is a well-documented sex discrepancy in the lifetime prevalence of both of these diagnoses such that women are disproportionately affected. Prevalence rates of MDD are similar between males and females during childhood. However, following the onset of puberty, women are inordinately affected by both MDD. This difference has been observed throughout the duration of the female reproductive years. Prevalence rates of MDD between males and females return to equivalence following menopause. Females are also at a much greater risk of developing an eating disorder (ED) during their lifetime, and the age of onset typically aligns with puberty. The effect of HC on mental health remains largely unknown. The current body of research on HC use and MDD is characterized by inconsistent, and even contradictory, findings about both the presence and direction of the such a relationship. There is a paucity of research examining HC use and BN, though changes in appetite and weight gain are two of the most commonly reported side effects of HC use. The present study aimed to explore such relationships among a sample of undergraduate women at Colorado State University. Using self-report measures, this project attempted to examine potential correlations between HC use and symptoms of MDD and BN. Data from 378 respondents was collected via survey and analyzed using Multiple Linear Regression. Participants were categorized into HC users and Nonhormonal Contraceptive (NC)

users. No significant relationship was observed between HC use and MDD. Negative correlations were identified between HC use and two measures of maladaptive eating implicated in the etiology and maintenance of BN: Cognitive Restraint and Emotional Eating. These findings suggest that HC use might actually serve as a protective factor for the development of BN. Further research is needed to better understand these relationships and to better inform individuals considering HC as part of their reproductive health practices.

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Exploring the Relationship between Hormonal Contraceptive Methods and Symptoms of Depression and Bulimia Nervosa

Overview

Millions of women worldwide use hormonal contraception (HC) as part of their reproductive health practices. Though the implementation of such reproductive technology has resulted in a myriad of benefits, most notably a marked decrease in unplanned pregnancies, there is a growing body of evidence of a negative influence of HC on mental health (Freeman et al., 2001; Hall, White, Rickert, Reame & Westhoff, 2012, 2013; Skovlund, Mørch, Kessing & Lidegaard, 2016; Svendal, Berk, Pasco, Jacka, Lund & Williams, 2012; Toffol, Heikinheimo, Koponen, Luoto & Partonen, 2011). Despite these concerns, associations between the use of HC and psychopathology in women of reproductive age remain inadequately addressed. Research has produced mixed evidence for the positive association between HC use and Major Depressive Disorder (MDD; Hall, Moreau, Trussell & Barber, 2013; Joffe & Cohen, 1998; Pagano, Zapata, Berry-Bibee, Nanda & Curtis, 2016; Svendal et al., 2012; Toffol et al., 2011), and there is a paucity of research examining the relationship between HC use and eating disorders (ED; Hall et al., 2013). Further, many women who discontinue HC cite adverse side effects as their reason for cessation (Abma, Dawson, Martinez & Mosher, 2004; Mosher & Jones, 2010). Two commonly implicated side effects are depressed mood and weight gain, which may indicate that the mechanisms involved in HC treatment may also regulate mood, self-image and weight management (Jimerson, 1990; Joffe & Cohen, 1998; McEwen, 2001; Schmidt, Nieman, Danaceau, Adams & Rubinow, 1998). A greater understanding of the relationship between HC use and MDD and ED is necessary to inform accurate contraceptive education, as well as to

determine which contraceptive method is optimal for each patient after consideration of psychological symptoms.

Depression. Major Depressive Disorder (MDD) is a diagnosis assigned to patients who suffer from episodes of depressed mood and/or anhedonia that last for at least two weeks, which cause significant distress or impairment, and cannot be explained by bereavement (American Psychiatric Association, 2013). Depressed mood is most often characterized by feelings of sadness, guilt, fatigue and hopelessness. Anhedonia describes a loss of interest or pleasure in almost all activities, including those from which the individual previously derived great satisfaction. Depressive episodes may include many other symptoms, such as change in appetite or sleep, and may manifest very differently across individuals.

Depression has been associated with considerable burden in both developed and developing countries. In a study of the global burden of disease attributable to mental and substance use disorders, depressive disorders (MDD and Bipolar Disorder) resulted in 40.5% of disability-adjusted life years (Murray et al., 2013; Whiteford, 2013). The lifetime prevalence of depression in women (21.3%) across different countries and ethnic groups is nearly double the rate seen in men (12.7%; Noble, 2005; Whiteford, 2013). Depression is the primary cause of disease-related disability in women. However, sex differences in depression only appear following the onset of puberty, with both male and female children exhibiting similar incidence rates until around age 12 (Wesselhoeft, Pedersen, Mortensen, Mors & Bilenberg, 2015). These differences persist until midlife and then return to equivalent prevalence among men and women. Therefore, women are at greatest risk of developing MDD for the duration of their reproductive years (Noble, 2005). Although this difference is one of the most widely documented findings in psychiatric epidemiology, there is a lack of consensus regarding explanatory factors for these sex

differences (Albert, 2015; Baxter, Scott, Ferrari, Norman, Vos & Whiteford, 2014; Cyranowski, Frank, Young & Shear, 2000; Ferrari et al., 2013; Ford & Erlinger, 2004; Hammarström, Lehti, Danielsson, Bengs & Johansson, 2009; Kessler, McGonagle, Swartz, Blazer & Nelson, 1993). The two female sex hormones, estrogen and progesterone, have been thought to play a role in the development of depressive symptoms (Skovlund et al., 2016).

A 2014 review found cursory evidence that gonadal steroid hormones influence the cortical and subcortical brain regions implicated in emotional and cognitive processing (Toffoletto, Lanzenberger, Gingnell, Sundström-Poromaa, & Comasco, 2014). The use of combined oral contraceptives (estrogen and progesterone) in women with a history of experiencing adverse side effects of the birth control pill has been associated with depressed mood and changes in emotional brain reactivity (Gingnell et al., 2013). Progesterone hormone therapy has been shown to cause mood disturbance in women (Holst, Bäckström, Hammarbäck & von Schoultz, 1989; Sherwin, 1991). This is believed to occur because external progestins, in comparison to naturally occurring progesterone, increase levels of monoamine oxidase. This in turn degrades serotonin concentrations, which may cause depression and irritability (Klaiber, Broverman, Vogel, Peterson & Snyder, 1996). Additional findings have suggested that changes in estrogen levels may induce depressive episodes among women who are predisposed to developing MDD (Payne, 2003).

Hormonal Contraception. According to a 2008 survey, 62% of adult women in the United States reported using some type of contraception (Mosher & Jones, 2010). The leading method was the oral contraceptive pill, followed by female sterilization. In contrast, a 2011 study reported that adolescent females most commonly used the condom (96%), followed by withdrawal (57%) and the oral contraceptive pill (56%; Martinez, Copen & Abma, 2011).

Additionally, the study reported an increase in adolescent use of "other hormonal methods" from 2% to 6% from 2002-2008, indicating that HC injectables, emergency contraception, the contraceptive patch, and the contraceptive ring are becoming increasingly popular choices among teenaged women.

Very few studies have explored the association between modern low-dose hormonal contraception and MDD, and those that do exist have produced mixed results. Four studies found that users of progestin-only contraception were more likely to develop a mood disorder and use antidepressants than non-users of HC (Lindberg, Foldemo, Josefsson & Wiréhn, 2012; Skovlund et al., 2016; Toffol et al., 2011; Wiréhn, Foldemo, Josefsson & Lindberg, 2010). Conversely, three studies indicated that use of HC was positively associated with improved mood (Keyes et al., 2013; Toffol et al., 2011, 2012). Other studies found no relationship between HC use and any mood symptoms (Duke, Sibbritt & Young, 2007; Pagano et al., 2016). Further, endocrinologists have produced similarly inconsistent findings about HC-related mood dysregulation.

The neurosteroid hypothesis of premenstrual dysphoric disorder (PMDD), a mood disorder with onset in the leutal phase of menstruation, posits that symptom onset can be attributed to hormonal sensitivity and abnormal responsivity to ovarian steroids in afflicted individuals. Nguyen et al. found that women with PMDD had similar responses to estrogen and progresteron-based steroids found in many HC methods, only observing diagnois-related differences in response to sulfated steroid metabolites (2017). Such mixed evidence across healthcare fields explains why some physicians prescribe HC as a treatment for mood dysregulation in PMDD (Brant, Ye, Teng & Lotke, 2017; Freeman et al., 2004), even though many findings suggest that PMDD symptoms are exacerbated by endogenous hormones

(Graham & Sherwin, 1992; Schiller, Schmidt & Rubinow, 2014; Schmidt, Nieman, Danaceau, Adams & Rubinow, 1998).

These incongruities also complicate our understanding of termination of HC use. Mood symptoms are one of the most commonly cited reasons for HC cessation (Poromaa & Segebladh, 2012; Rosenberg & Waugh, 1998; Sanders, Graham, Bass & Bancroft, 2001), a decision which can put women at risk for unplanned pregnancies or other complications. Discontinuation of oral contraceptives is responsible for half of the 1 million annual unplanned teenage pregnancies in the United States (Hall et al., 2012). HC use both modulates internal hormone production and introduces synthetic hormones to the body, and thus an exploration of their effect on women's mood is necessary.

Bulimia Nervosa. There is a paucity of research examining the relationship between HC use and disordered eating. This fact is surprising and concerning, due to the high rates of both HC use and maladaptive eating patterns among women of reproductive age. In fact, eating disorders are the third most common chronic illness affecting women in America (Rich, 2006). The largest adult study of eating disorders to date, the National Comorbidity Study Replication (NCS-R), reported a lifetime prevalence of 0.9% Anorexia Nervosa (AN), 1.5% for Bulimia Nervosa (BN), and 3.5% for binge-eating disorder (BED) among American women (Hudson, Hiripi, Pope & Kessler, 2007). A supplement of the NCS-R examining adolescent girls age 13-18 reported slightly lower lifetime prevalence rates in the three aforementioned types of ED (Swanson, Crow, Le Grange, Swendsen & Merikangas, 2011).

BN is a diagnosis characterized by recurrent episodes of binge-eating followed by purging behaviors to prevent weight gain (Bernacchi, 2017). The most common purging behavior is vomiting, but laxative misuse, restricting food intake, and excessive compensatory

exercise are also common practices in BN (American Psychiatric Association, 2013; National Institute of Mental Health (n.d.)). Health problems resulting from overexposure to stomach acid can occur with BN, such as tooth decay and fatal esophageal and/or gastric ruptures. BN is also associated with an increased risk of suicidality. Unlike in AN, most BN sufferers are of average or slightly above average weight. This fact, combined with the secretive nature of binging and purging, can lead to BN going unrecognized by health providers (Bernacchi, 2017).

Much like MDD, the age of onset for BN typically develops in adolescence or early adulthood, and the vast majority of affected individuals are female. It is known that HC use acts upon the same system that moderates appetite (Hall et al., 2012), and that weight gain is a common side effect of HC use (Gallo, Lopez, Grimes, Schulz, & Helmerhorst, 2011). Existing research has established a link between female sex hormones, appetite, and eating behaviors (Hirschberg, 2012). Hormonal changes, such as those experienced by HC users, could increase risk for the development of BN (Naessén, Carlström, Byström, Pierre & Hirschberg, 2007; Resch, Szendei & Haasz, 2004). Moreover, Bulimia Nervosa is highly comorbid with Major Depressive Disorder. Research on adult samples has found that the comorbidity between depression and eating disorders exceeds the comorbidity of any other mood disorder and eating disorders (Perez, Joiner & Lewinsohn, 2004). It is therefore imperative that social scientists investigate the potentially destructive relationship between BN, MDD, and HC use.

The present study aimed to examine these relationships in a population of American undergraduate women. Though directionality and causality cannot be definitively determined, the present study attempted to identify potential correlations between HC use and symptoms of MDD and BN. Participant HC use and presence/severity of both MDD and BN symptomatology were assessed using self-report measures. The goal was to add to the larger body of research

concerning whether or not HC use may contribute to the development and maintenance of these disorders.

Method

Participants

Individuals eligible to participate were female undergraduate students at Colorado State University (CSU) and at least 18 years of age. CSU is a public university in Fort Collins, Colorado. A power analysis was conducted using G*Power to determine sample size. A sample of 81 participants was necessary to detect a small effect size ($\alpha = 0.05$; $1-\beta = 0.80$; $f^2 = 0.10$; Faul, Erdfelder, Buchner & Lang, 2009). The present study aimed to recruit a sample of 400 to allow for loss of participants due to attrition and exclusionary criteria. To ensure that incident events of depression and disordered eating were identified, data collected from women with a depression and/or eating disorder diagnosis which preceded their placement on a hormonal contraception were excluded.

Data were collected from 458 participants in total. Data from participants who did not complete the entire testing battery were not included in analysis ($N = 44$). Data recorded from participants who met exclusionary criteria were not included in analysis ($N = 36$). Statistical analyses were conducted for 378 participants that both met inclusion criteria and completed the entire testing battery. Demographic data for the sample is presented in two tables below. Table 1 provides reported racial and ethnic identities.

Table 1
Participant Race/Ethnicity Demographics (N=378)

Measure	*n*	%
Hispanic/Latino/Spanish origin		
Nonhispanic	321	84.9
Mexican, Mexican American, Chicano/a	32	8.5
Puerto Rican	2	0.5
Cuban	0	0.0
Other Hispanic, Latino, or Spanish origin	19	5.0
Prefer not to answer	4	1.1
Racial Identity		
White	319	84.4
Black or African American	5	1.3
American Indian or Alaska Native	2	0.5
Asian	6	1.6
Native Hawaiian or Pacific Islander	2	0.5
Asian Indian	1	0.3
Biracial/Mixed Race	29	7.7
Prefer not to answer	14	3.7

Table 2 contains the mean and standard deviation of continuous demographic variables. The Biracial/Mixed Race category included any combination of 2 or more of the provided options. The survey included several racial/ethnic identities that were not endorsed as stand-alone identities (not reported in combination with any other identity) by any participants in this sample, including Chinese, Japanese, Korean, Vietnamese, Guamanian or Chamorro, Samoan, Other Pacific Islander, and Other Asian.

Table 2
Means and Standard Deviations of Participant Demographics

Measure	*n*	*M*	*SD*	α	*Range*
Age	378	18.77	1.86	.50	18-28
Age of Menarche	377	12.47	1.33	.50	8-17.50
Age of first HC prescription	268	16.27	1.57	.50	11-22
Body Mass Index	377	23.47	4.86	.50	15.92-48.25

Procedure

Recruitment. Participants for the present study were recruited from the CSU research pool. The CSU research pool is a student sample comprised of undergraduate students enrolled in basic psychology courses (PSY100 and PSY250). Students in these courses are required to

serve as a participant in 6 hours of research conducted by the Department of Psychology in the College of Natural Sciences during the academic semester. Recruitment began in the Fall 2019 academic semester and was completed at the assigned due date for research credits. Each participant was assigned to a group based upon her indicated current contraceptive methods so as to enable subsequent within and between-group comparisons. Current contraception method was defined in the present study as any means by which a participant is preventing pregnancy, including prescription birth control methods that have been in place for a minimum of 28 days at the time of consent.

Design. The present study is best conceptualized as correlational because it sought to explore potential relationships between HC and symptoms of MDD and BN. Following recruitment and consenting, participants were categorized based on their current contraceptive method. HC was categorized according to hormone type and route of administration. Participants then completed a brief survey and four self-report assessments online via Qualtrics. This questionnaire collected demographic information as well as relevant reproductive and mental health history. Following completion of the survey, participants were immediately asked to complete four self-report measures on Qualtrics: the Beck Depression Inventory II (BDI-II; Beck, Steer & Brown, 1996), the SCOFF Questionnaire (Morgan, Reid & Lacey, 1999), the Three Factor Eating Questionnaire-R18 (Karlsson et al., 2000), and three relevant subscales of Eating Disorder Inventory-3 (EDI-3; Garner, 2004). Participants completed the entire battery once during the course of the Fall 2019 academic semester, and received course credit only after all parts of the battery were completed.

Research Questions

The present study aimed to address the following research questions:

1. Is HC use associated with MDD symptomatology?
2. Is HC use associated with BN symptomatology?

Hypothesis 1: Individuals using HC will report higher rates of MDD symptomatology than nonusers.

Hypothesis 2: Individuals using HC will report higher rates of BN symptomatology than nonusers.

Measures

Demographics. Age, height, weight, race and ethnicity were collected.

Reproductive Health History. Participants were asked to report whether they were sexually active and what (if any) method(s) of contraception they were currently using. They were also asked to report relevant history concerning reproductive health, including age of menarche, age of first HC prescription, duration of HC use, and reason for HC prescription.

Beck's Depression Inventory - II. The Beck's Depression Inventory - II (BDI-II; Beck, Steer & Brown,1996) is a 21-item self-report measure adapted to measure DSM-IV criteria for Major Depression Disorder. The current item content includes: sadness, pessimism, past failure, anhedonia, guilty feelings, punishment feelings, self-dislike, self-criticalness, suicidal ideation, crying, agitation, loss of interest, indecisiveness, feelings of worthlessness, loss of energy, disturbance in sleeping pattern, irritability, changes in appetite, concentration difficulty, tiredness or fatigue, and loss of interest in sex.

The SCOFF Questionnaire. The SCOFF is a very brief 5-item measure designed to detect eating disorders in adult women in primary care settings (Morgan, Reid & Lacey, 1999). The SCOFF has shown excellent reliability and validity, with demonstrated sensitivity of 84.6% and specificity of 89.6% for AN and BN in a sample of 341 women (Luck et al., 2002). The

SCOFF was developed in England, and therefore has some wording that may be confusing to American participants (i.e. The word "sick" to mean "vomit"). To ensure clarity in responding, the 5 items were adapted for use with an American sample. The SCOFF is typically administered by a primary care provider, and all items on the SCOFF result in a binary yes/no response. For use in the present study, the SCOFF was presented in a self-report format using the online Qualtrics platform.

The Three-Factor Eating Questionnaire – R18. The Three Factor Eating Questionnaire was originally developed by Stunkard and Messick in 1985 as a 51-item self-report scale that measures three dimensions of human eating behavior: cognitive restraint of eating, disinhibition, and caloric intake related to emotional distress. It was later modified into a more parsimonious 18-item self-report (Karlsson et al., 2000). Analyses of this revised version indicate strong psychometric properties comparable to the original scale, and items loaded onto the same three factors (Anglé et al., 2009; Brytek-Matera, Rogoza & Czepczor-Bernat, 2017; FLVS, 2004). The factors were renamed as Uncontrolled Eating (UE), Cognitive Restraint (CR), and Emotional Eating (EE). These three factors are implicated in the etiology and maintenance of Bulimia Nervosa. The questionnaire provides a measure of maladaptive eating patterns that do not meet clinical diagnostic threshold for ED. Previous research suggests that the prevalence of full threshold ED is less represented in community samples than clinical samples. Research with community samples indicate a greater incidence of subthreshold and atypical ED presentations observed in the general population (Favaro, Ferrara & Santonastaso, 2003). The TFEQ-R18 is included in the present battery to assess BN symptom endorsement across the entire spectrum of symptom severity, rather than only including those individuals who meet full diagnostic criteria. This may also serve as a means to detect subclinical individuals who may be at risk for ED

development. The wording of item 1 was slightly modified from "When I smell a sizzling steak or a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.", into "When I smell a delicious food, I find it very difficult to keep from eating, even if I have just finished a meal." This change was first made by Anglé et al. in order to accommodate the growing prevalence of vegetarian and vegan diets, and to allow respondents to respond more accurately regardless whether meat was part of their diet (2009; Kosonen et al., 2005).

The Eating Disorder Inventory - 3. The Eating Disorder Inventory-3 (EDI-3; Garner, 2004) is a 91-item self-report measure frequently used by researchers and clinicians to assess symptoms relevant to the development and maintenance of AN, BN, and EDNOS. This comprehensive scale measures the psychological traits and symptoms implicated in the development and maintenance of ED. The current study utilized the three clinical subscales from this measure that evaluate risk for ED development: Drive for Thinness (DT), Bulimia (B), Body Dissatisfaction (BD). The EDI-3 is considered the gold standard in ED assessment among the international healthcare community. This measure has demonstated strong validity and reliability in both clinical and community samples (Cumella, 2006).

Data Analysis. To examine the present research question, simple linear regression was conducted to assess if there was a correlation between HC use and MDD/BN symptomatology. A simple linear regression assesses the relationship among a dichotomous, ordinal, or interval/ratio predictor variable on an interval/ratio criterion variable. In this instance, the independent variable of interest is current use of HC. The dependent variables are reported symptomatology of MDD and BN. The following regression equation represents the main effects model that will be used: y = b1*x1 + b2*x2 +b3*x3+…+ c; where Y = estimated dependent variable, c = constant (which includes the error term), b = regression coefficients and x = each independent variables.

Standard multiple linear regression was used to further evaluate significant relationships identified by SLR analyses, and included covariates within the model. Other variables that have been identified as potential covariates include age at time of assessment, Body Mass Index (BMI), and family history of MDD and/or ED. The standard method enters all predictors simultaneously into the model and is appropriate unless theory sufficiently supports a different method. *R*-squared, the multiple correlation coefficient of determination, will be reported and used to determine how much variance in the dependent variable can be accounted for by the set of predictors. The assumptions of multiple regression (linearity, homoscedasticity and multicollinearity) will be assessed. Linearity assumes that a straight line relationship between the predictor variables and the criterion variable, and homoscedasticity assumes that scores are normally distributed about the regression line. Linearity and homoscedasticity will be assessed via examination of a scatter plot. The absence of multicollinearity assumes that predictor variables are not too related and will be assessed using Variance Inflation Factors (VIF). VIF values over 10 will suggest the presence of multicollinearity (Statistics Solutions, 2013). All analyses were conducted using R Studio data analysis software (Team, 2015).

Results

Complications/Qualifications/Limitations. Statistical analyses were conducted for 378 participants that both met inclusion criteria and completed the entire testing battery. Missing responses to individual survey items were rare ($N = 4$). In these 4 cases, the missing data point was replaced with the mean value of all responses to that item (Van der Heijden, Donders, Stijnen & Moons, 2006).

Due to the large variety of measured contraceptive methods ($N = 20$), as well as the tendency of many respondents to use multiple methods concurrently, it was necessary to collapse these subcategories into two main categories of interest: Hormonal Contraceptive (HC) Users and Nonhormonal Contraceptive (NC) Users. The key predictor variable (HC use) was coded as a dichotomous factor in R, where dummy coded values of 0 indicated NC users and 1 indicated HC users. This variable was treated as a binary categorical factor in analyses. This grouping allowed for comparisons between HC and NC groups in a parsimonious manner. However, it eliminated the ability to compare differential effects of each method and/or combination of methods.

The SCOFF measure was removed during the preliminary data analysis phase. It was determined that the items on this measure were redundant, as the content was already collected by battery measures with stronger psychometric properties. Additionally, the SCOFF score represents a symptom-count rather than a normally distributed outcome score. Due to these considerations it was removed from further data analyses and scores from this measure were not reported.

Preliminary Analyses. Histograms along with skewness and kurtosis values were examined prior to statistical analysis in order to determine whether assumptions were met. If the normality assumption was violated a series of transformations were compared to determine which transformation of the outcome variable best approximated normality, e.g., identity, square root, natural logarithm. Alternative analyses were selected in cases where normality could not be approximated with transformations, e.g., negative binomial regression. Assumptions of linearity, homoscedasticity, independence, and normality were satisfied for TFEQ-R18 subscale scores as well as the DT and BD scores derived from the EDI-3. The BDI-II score was not normally

distributed. This outcome variable was transformed using the square of the score, which met all assumptions. The B subscale score of the EDI-3 also failed to meet the assumption of normal distribution. It was determined that a negative binomial regression should be used when conducting statistical analyses for this variable.

Primary Analyses. The statistical analyses for the current project consisted of two steps: Simple Linear Regression (SLR) and Multiple Linear Regression (MLR). SLR was used to assess bivariate relationships between the binary predictor variable (HC use) and each outcome variable. For relationships that were identified as statistically significant, MLR was then implemented in order to examine the effect of adding covariates in the model. Covariates identified as potential confounding variables included age at time of survey, BMI, and family history of mental illness (either MDD or ED).

The relationship between HC use and symptoms of depression was assessed using BDI-II scores. Maladaptive eating patterns were assessed using the three independent subscale scores of the TFEQ-R18: Uninhibited Eating (UE), Cognitive Restraint (CR), and Emotional Eating (EE). Symptoms of eating disorders were assessed using three independent subscale scores from the EDI-3: Bulimia (B), Body Dissatisfaction (BD), and Drive for Thinness (DT). The mean, standard deviation, and range for each outcome measure are displayed below (see Table 3).

Table 3
Means and Standard Deviations of Key Measures (N=378)

				Range	
Measure	*M*	*SD*	α	*Possible*	*Actual*
Beck Depression Inventory - II	13.66	10.29	.50	0-63	0-49
Three Factor Eating Questionnaire - R18					
Uncontrolled Eating	18.79	5.42	.50	0-35	0-35
Cognitive Restraint	13.61	4.02	.50	0-24	0-24
Emotional Eating	6.14	2.35	.50	0-12	0-12
Eating Disorder Inventory - 3					
Body Dissatisfaction	14.71	10.04	.50	0-39	0-39
Drive for Thinness	12.01	10.31	.50	0-43	0-43
Bulimia	4.95	5.71	.50	0-30	0-30

SLR was conducted for each outcome variable to test the hypotheses that HC use would be predictive of greater scores on symptom measures for MDD and BN, respectively. Six distinct SLR analyses were completed in total (see Table 4).

Table 4

Simple linear regressions of bivariate relationships between hormonal contraceptive use and outcome measure scores.

Variable	*B*	*SE B*	*β*	*t*	*p*
Depression	0.12	0.16	0.04	0.74	.46
Uncontrolled Eating	0.10	0.58	0.01	0.17	.87
Cognitive Restraint	-1.02	0.43	-0.12^{+}	-2.39	.02*
Emotional Eating	-0.58	0.25	-0.11^{+}	-2.06	.04*
Body Dissatisfaction	-0.88	1.08	-0.04	-0.82	.42
Drive for Thinness	-1.3	1.1	-0.06	-1.18	.24

*$p < .05$. **$p < .01$. ***$p < .001$.
+ $\beta > \pm .01$.

Major Depressive Disorder Symptomology. The first hypothesis predicted that HC use would be positively associated with MDD symptoms. This relationship was measured using the BDI-II, which accounts for both the presence of symptoms of MDD as well as their severity. A simple linear regression was calculated to predict BDI-II score based on HC use. The relationship was positive but not statistically significant (F (1, 376) = 0.55, p = .46, β = .04). Therefore, the hypothesis was not supported.

Bulimia Nervosa Symptomology. The second hypothesis predicted that HC use would be positively associated with BN symptoms. This relationship was assessed using two measures, the TFEQ-R18 and the EDI-3. Maladaptive eating patterns were accounted for using the TFEQ-R18, which provides scores on three dimensions of eating habits. These dimensions are Uncontrolled Eating (UE), Cognitive Restraint (CR), and Emotional Eating (EE). UE refers to the tendency to eat more than usual due to a loss of control over intake combined with subjective feelings of hunger. CR refers to the effortful restriction of food intake in order to control or decrease body weight. EE refers to the tendency to overeat in the presence of emotional dysregulation. Higher scores in the respective scales suggest greater levels of cognitive restraint,

uncontrolled or emotional eating. SLR identified two statistically significant relationships between HC use and TFEQ subscale scores: CR and EE.

A simple linear regression was calculated to predict CR based on HC use. HC use significantly predicted CR scores (b = -1.02, $t(376)$ = -2.39, p = .02, β = - .12). HC use also explained a significant proportion of variance in CR scores (R^2 = .02, $F(1, 376)$ = 5.69, $p < .05$).

A multiple linear regression was then calculated to predict CR score based on HC use, current age, BMI, and family history of eating disorders (see Table 5). In this model, two variables significantly predicted CR scores (F (5, 371) = 2.69, $p < .05$), with an R^2 of 0.04. HC use significantly predicted CR scores (b = -0.88, $t(371)$ = -2.08, p = .04, β = - .11). Lack of family history of ED significantly CR scores as well (b = -1.5, $t(371)$ = -2.25, p = .03, β = - .18). BMI and age were not predictive of CR score.

Table 5
Simple linear regression of bivariate relationship between hormonal contraceptive use and Cognitive Restraint score followed by simultaneous multiple regression model including potential covariates.

	Model 1					Model 2				
Variable	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*
HC Use	-1.02	0.43	-0.12$^+$	-2.39	0.02*	-0.88	0.42	-0.11$^+$	-2.08	.04*
BMI						0.06	0.04	0.07	1.34	.18
Age						0.12	0.11	0.06	1.08	.28
No Family History of ED						-1.50	0.67	-0.18$^+$	-2.25	.03*
R^2										0.04
F										2.69
Df										(5, 371)

*$p < .05$. **$p < .01$. ***$p < .001$.
+ $\beta > \pm .01$.

HC use significantly predicted EE scores (b = -0.58, $t(376)$ = -2.06, p = .04, β = - .11). HC use also explained a significant proportion of variance in EE scores (R^2 = .01, $F(1, 376)$ = 4.25, $p < .01$).

A multiple linear regression was then calculated to predict EE score based on HC use, current age, BMI, and family history of eating disorders (see Table 6). In this model, two predictors significantly predicted EE scores (F (5, 371) = 5.09, $p < .05$), with an R^2 of 0.06. HC use predicted EE score (b = -0.45, t(371) = -1.84, $p < .1$, β = -.09). BMI also significantly predicted EE score (b = 0.11, t(371) = 4.51, $p < .001$, β = .23). Family history of ED and age were not predictive of EE score.

Table 6
Simple linear regression of bivariate relationship between hormonal contraceptive use and Emotional Eating score followed by simultaneous multiple regression model including potential covariates.

	Model 1					Model 2				
Variable	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*
HC Use	-0.58	0.25	-0.11^{+}	-2.06	0.04*	-0.45	0.25	-0.09	-1.84	.07$^{\cdot}$
BMI						0.11	0.02	0.23^{+}	4.51	8.79e$^{-0.6}$***
Age						-0.06	0.06	-0.05	-0.91	.36
No Family History of ED						-0.18	0.39	-0.04	-0.46	.65
R^2										0.06
F										5.09
Df										(5, 371)

• $p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$.
+$B > \pm .01$.

A simple linear regression was calculated to predict UE score based on HC use. No significant relationship was found between the two variables (F (1, 376) = 0.03, p = .87, β = .01).

Three subscales of the EDI-3 were utilized to identify clinical-threshold symptoms of eating disorder risk: Drive for Thinness (DT), Body Dissatisfaction (BD), and Bulimic symptomology (B). Again, the second hypothesis predicted that HC use would be positively associated with scores on these three subscales. The DT and BD scales measure two constructs implicated in the development and maintenance of all eating disorders, while the third assesses

risk specific to BN.

Table 7

Negative binomial regression model for bivariate relationship between hormonal contraceptive use and Bulimia subscale scores.

Variable	*B*	*SE B*	*β*	*z*	*p*	*RR*
Bulimia	-0.11	0.12	0.12+	-0.91	.37	0.9

+ β > ± .01.

A negative binomial regression was calculated to predict bulimic symptoms (B) based on HC use (see Table 7). No statistically significant relationship was found between the two variables (Z (377) = -0.91, p = .365). However, this relationship may be of clinical significance because HC use was associated with a 9% decrease in bulimic symptoms (b = -.109, rate ratio for e^b = 0.9).

A simple linear regression was calculated to predict Body Dissatisfaction (BD) based on HC use. No significant relationship was found between the two variables (F (1, 376) = 0.66, p = .42, β = -.04).

A simple linear regression was calculated to predict Drive for Thinness (DT) based on HC use. No significant relationship was found between the two variables (F (1, 376) = 1.38, p = .24, β = -.06).

Discussion

HC and MDD. Our analyses did not identify an association between HC use and MDD symptomology. No differences in BDI-II score were noted between the HC user group and NC participants. Therefore, the hypothesis that HC use would be positively associated with increased MDD symptomology was not supported. This finding diverged from one side of the existing literature, which argues that HC use and MDD are positively related (Gingnell et al., 2013; Holst, Bäckström, Hammarbäck, & von Schoultz, 1989; Lindberg, Foldemo, Josefsson & Wiréhn, 2012; Klaiber, Broverman, Vogel, Peterson & Snyder, 1996; Payne, 2003; Sherwin,

1991; Skovlund et al., 2016; Toffol et al., 2011). These findings also diverged from the opposing side of the argument, which theorizes that HC use is a protective factor for MDD (Keyes et al., 2013; Toffol et al., 2011, 2012). Our findings suggested that HC use and MDD were unrelated, and were consistent with results from other studies that failed to identify a relationship between the two constructs in either direction (Duke, Sibbritt & Young, 2007; Pagano et al., 2016).

There are a number of potential explanations for these findings. The first and most obvious explanation would be that there is not a relationship between HC use and MDD. Alternatively, the lack of relationship between these two variables could have been attributed to limitations in the current study. One possible explanation could have been that differential effects of various HC methods were lost in the process of collapsing all different types of HC into a single group. This procedure did not allow for examination of BDI-II scores according to HC type (e.g. progesterone-only, estrogen only, combined, implant, etc.). Past findings have indicated that different dosages and routes of ingestion are related to different levels of risk for developing MDD (Skovlund et al., 2016; Wiréhn, Foldemo, Josefsson & Lindberg, 2010). It was also possible that the BDI-II, a diagnostic measure for MDD, failed to capture subclinical symptoms of MDD that may have been present in the sample.

HC and BN. The hypothesis that HC would be positively related BN symptoms was not supported. Analyses of TFEQ-R18 scores suggesed that HC use was negatively associated with both EE and CR scores, while no association was observed between HC use and UE. Analyses of the EDI-3 scores did not identify any association between HC use and B, DT, or BD subscale scores.

One possible explanation was that HC use could have served as a protective factor in regard to the development of ED, specifically in reduction of EE and CR. Many studies have

identified positive associations between BMI and EE scores (Fleurbaix Laventie Ville Sante (FLVS) Study Group et al., 2004; Rabbaa Khabbaz, 2019). This was replicated by the current study, which identified a strong positive relationship between BMI and EE. While the connection between EE and disordered eating is relatively straightforward, the relationship between CR and disordered eating is more nuanced. When an individual is high in CR, food intake is regulated by mental control rather than physiological sensation (Sweerts, Apfeldorfer, Romo & Kureta-Vanoli, 2016). That is to say that this individual does not stop eating because they are full, but because they have decided to stop. High levels of CR have been associated with restrictive eating disorders like Anorexia Nervosa, and have been theorized to lead to the neglect of hunger cues in order to lose weight or maintain a low body weight (Linardon et al., 2018). Therefore, decreases in EE and CR identified among HC users suggested lower risk of BN. This was in contrast to the outcome predicted by the second hypothesis.

No relationships were identified between HC use and BN symptomology as assessed by the EDI-3 subscales. Therefore, the second hypothesis was not supported by these findings. The relationship between HC use and B scores suggested a small negative effect, which could be of clinical interest. However, this finding was not statistically significant, so all inferences drawn from this finding are strictly speculative. At the time of this report, there was a paucity of research examining the relationship between HC use and ED. The few studies that are in existence at this time suggest a positive relationship between HC use and ED prevalence and severity (Hall et al., 2013; Gallo, Lopez, Grimes, Schulz & Helmerhorst, 2011).

It is unclear why this was not supported by our analyses. One possible explanation could be due to demographic features of the sample. The state of Colorado has the lowest rate of adult obesity in the United States of America. The average rate of adult obesity in Colorado is 23.0%,

a flattering figure compared to the national average of 30.9% (Levi, Segal, St. Laurent & Rayburn, 2019). Colorado also boasts a health-conscious culture, access to seasonal outdoor recreation of all kinds, and consistently high rankings in overall wellbeing (Gallup-Healthways, 2017). The Gallup-Sharecare Wellbeing Index (GSWI) is a measure used to evaluate community and state wellness. It is a composite score comprised of ratings in 5 areas: sense of purpose, social life, financial security, community environment, and physical health. The most recent report ranked Colorado 6th in overall state wellbeing and 2nd in physical health. Further, the city of Fort Collins was ranked 14th in overall community wellbeing and 8th in physical health. Both Colorado and Fort Collins have been consistently included in the top-scoring quartile of the GSWI since 2008 (Gallup-Healthways, 2017).

Surprisingly, Colorado also has a high rate of suicide, ranking 7th out of all states. In 2018, there were 1,282 reported deaths due to suicide (Hedegaard, Curtin & Warner, 2020). Why this seeming polarity in mental health exists in Colorado is not fully understood. Numerous studies have documented geographic patterns of suicidality across the United States, and the western states have consistently higher rates even after controlling for demographic variables (Brenner, Cheng, Clark & Camargo, 2011; Karch et al., 2009). Further, suicide completion is positively correlated with altitude (Blair, Fowler, Jack & Crosby, 2016). Existing research has pointed to many possible explanations for this phenomenon, including access to mental health services, firearm access, exposure to sunlight, and rural isolation (Betz, Valley, Lowenstein, Hedegaard, Thomas, Stallones & Honigman, 2011; Hemenway & Miller, 2002). Participants of the current study may not be representative of this trend due to increased availability of mental health services (e.g. University Counseling Center), the relatively low altitude of the front range (compared to the Rocky Mountain counties), and the high student population of Fort Collins.

It is possible that the sample, taken from the student body of Colorado State University in Fort Collins, experienced BN and MDD symptoms at a lower-than-average rate due to these protective environmental factors. Additionally, studies have found that UE is less pronounced in women than in men, and is less directly linked to ED development (Rabbaa Khabbaz, 2019). This may have accounted for the lack of strong associations between HC use and UE in our all-female sample. As with MDD, these results could also have reflected the true nature of the relationship (or lack thereof) between HC use and ED.

Limitations. Several limitations to this study must be considered in light of these findings. The data were obtained through self-reported questionnaires. Though frequently used in community surveys (Ciarma & Matthew, 2017; Cuthbert & Kozak, 2013), self-report measures reflect the participants' subjective experiences. Bias could have been introduced due to participants forgetting or being unwilling to disclose certain information. This consideration was especially relevant to the present study due to the sensitive nature of the data collected. Participants were asked to report intimate details about their health, such as weight, their reproductive history and practices, and their mental health. Due to the highly personal and often stigmatized nature of the survey content, social desirability may have influenced participant response patterns. Further, this study was correlational in nature, and therefore unable to establish a causal relationship between HC use and the outcome variables of interest. Other, prospective longitudinal studies are required to establish causality between HC use, MDD and ED.

The sample used in the present study was not representative of the true population of women using HC. Due to the sampling methods used, the sample was limited in age range (18-28 years) and was largely Caucasian (84.4%). The collapsing of all HC methods into a single

binary predictor variable could have underrepresented in-group variance between different HC methods, dosages, and delivery routes. Many participants reported using multiple different strategies in order to prevent pregnancy, often mixing HC and NC methods, so it was impossible to establish duration of HC use alone.

In regard to measurement, using more than a single measure of MDD may have better captured the true incidence of depressive symptoms within the sample, especially those at a subclinical level. Several inadvertent factors that may have biased the outcomes of this study were identified. These include the translation of physical self-report measures into an online format for administration. It is unknown how this novel route of administration affected measure psychometrics and/or outcome data.

Implications. This study added to the growing body of science seeking to better understand the complex relationship between HC use and mental health. In this sample, HC use was not associated with increased risk of MDD. Associations that were found between HC use, EE and CR suggest an impact of HC use on appetite and eating habits. Future research examining the relationship between HC use, MDD and ED is encouraged. Replication with a larger and more diverse sample is warranted to enable a more inclusive perspective on the potential impacts of race, ethnicity, and age on this relationship. Larger samples would provide sufficient statistical power to examine in-group variability for HC users across HC type, dosage, and duration. Further investigation is needed to explore the relationship between endogenous hormones and dietary restraint. Future research should seek to measure differences in MDD and ED symptomology between various HC methods, in addition to comparing to a control group of NC users. This information would be very valuable in providing accurate and comprehensive reproductive health counseling to women.

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