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**Beyond Puberty: How Artificial Hormones Impact Depression in Young Adults**

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## **Abstract**

Depression is a mood disorder that can be caused by any combination of environmental, biological, genetic, and psychological factors and affects women more than men. Over the past few decades the use of birth control has been continually increasing. To analyze whether or not the high rates of depression correlates to the use of hormonal birth control, an anonymous survey was sent out to college women which contained the Beck's Depression Inventory as well as background information questions. The results were obtained and analyzed. After doing a T test, the P-value was calculated to be  $6.261 \times 10^{-6}$  and the test statistic T was found to be 5.0505. The low P value rejects the null hypothesis that there is no effect on women's mental health from hormonal birth control. Additionally, the test statistic T fell in the region of rejection which also allows us to reject the null hypothesis and accept the alternative hypothesis that hormonal birth control does have an effect on the mental health of college aged women.

## **Introduction**

According to a CDC article published in 2022, 1 in 10 women living in America experienced a major depressive episode within the last year. This equates to nearly 12 million women in the United States who experience depression yearly. Women between the ages of 14-25 experience depression at a rate nearly two times more than men (Albert, P. 2015).

Additionally, around 25% of women between the ages 15-49 take oral contraceptives, have a contraceptive implant, or have an intrauterine implant (Daniels, K. & Amba, J. 2022 ). Of these contraceptives, oral contraceptives also known as the pill, are most commonly used (IQWIG, 2017). The pill comes in three forms: progesterone only, estrogen-progesterone mixed, and extended use pill. Birth control works by preventing ovulation, preventing implantation of

the fertilized egg into the womb, or by creating a thick, sticky layer of mucous in the cervix which makes it difficult for the sperm to move and reach the egg (IQWiG, 2017).

As depression in young women is increasing as well as the use of birth control, it is important to better understand how these two things may be related. The goal of this study is to analyze and evaluate if there is a correlation between the increase of depression in females and the use of hormonal birth control.

## **Background**

### **Depression in Women**

Depression is a medical condition that affects women more than men (U.S. Department of Health and Human Services, 2020). The different levels of depression between men and women may be due to hormonal, biological, and environmental factors that differ between the genders. Depression is a mood disorder that can be caused by any combination of environmental, biological, genetic, and psychological factors (U.S. Department of Health and Human Services, 2020). An individual with depression may struggle with everyday activities like sleeping, eating, working, studying, and personal hygiene. Depression has been found to correlate with the fluctuation of hormonal changes in women. Spikes in depression are especially common during puberty, prior to menstruation, after pregnancy, and at perimenopause (U.S. Department of Health and Human Services, 2020).

### **Hormonal Birth Control**

The pill, as it is often referred to, is the most common form of birth control used. It is an oral contraceptive, and 25% of women between the ages of 15-44 who currently use a form of

contraceptive use the pill (Cooper et al., 2022). The pill was invented by Margaret Sanger when she started her search for a “magic pill” in 1912 (PBS, n.d.). She wanted a pill that was as easy to take as aspirin and functioned in a way to prevent conception.

Today, there are three types of oral contraceptives which include a progesterone only pill, an estrogen-progesterone combined pill, and an extended use pill. The most widely used pill is the estrogen-progesterone combined pill. Estrogen is a hormone which is produced primarily in the ovaries, corpus luteum, and placenta (Cue et al., 2013). One role of estrogen is its control of menstrual bleeding (Cooper et al., 2022). However, it also has critical functions in the liver, muscles, heart, bones, and brain (Cue et al., 2013). Progesterone is a steroid hormone produced in the adrenal cortex and the ovaries of women (Cable, J & Grider, M., 2022). It is the primary hormone that prevents pregnancy. Unbalanced levels of progesterone can lead to menstrual irregularities, miscarriages, early labor, decreased fertility, granulosa tumor cells, or breast cancer (Cable, J & Grider, M., 2022).

Different forms of hormonal contraceptives include an intrauterine device (IUD), an arm implant, skin patches, a vaginal ring, and injections (CDC, 2023). The hormones found in these contraceptives (progesterone and sometimes estrogen) prevent ovulation in women. Another method of preventing pregnancy that some of these contraceptives use is the prevention of implantation of fertilized eggs into the womb. The contraceptive may also act to create a thick, sticky layer of mucus in the cervix which makes it difficult for the sperm to move and to ultimately reach the egg (IQWiG, 2017).

## **Brain Development of Females**

Most biomedical research of the brain is done on males rather than on females. This unevenness in research has led to a lack of understanding of women's health as a female brain functions much differently than a male's. Women are more likely than men to develop cognitive impairments such as Dementia or Alzheimer's (Barrientos, M et al., 2019). Females are also more vulnerable to psychological disorders, infections, and certain types of cancers due to the fact that the brain of females fundamentally remodels throughout the normal ovarian cycle, perinatal development, pregnancy, and old age. It is said that the female brain is not fully developed until the age of 25. However, it is close to full structural maturity by the time a woman passes adolescence. It is after adolescence that sex hormones begin playing a large role in neuroimmune function and brain dynamics. There is a high sensitivity to the fluctuation of hormones in the female brain. E2, a type of estrogen, has a direct influence on the female brain function (Barrientos, M et al., 2019). The hormonal changes that occur during the estrous cycle can fundamentally remodel the brain. Estrogen interacts with the neuroimmune system which causes this cyclic remodeling of the brain. The interaction between estrogen and the neuroimmune system causes women to be more at risk for neuroimmune disorders during some stages of the ovarian cycle (Barrientos, M et al., 2019).

## **Beck's Depression Inventory**

The Beck's Depression Inventory (BDI) is a self-reporting questionnaire that asks the user to rate 21 different symptoms and attitudes from zero to three. It was created in 1961 by Aaron T. Beck and revised in 1978 and 1996 (Jackson-Koku, 2016). Beck developed the questionnaire by observing common attitudes and symptoms in patients that had depression. He

compared the results to patients who did not have depression and who did not experience the same attitudes and symptoms. After his observations, he created the 21 questions which cover cognitive, affective, somatic, and vegetative symptoms of depression as described in the DSM-IV for major depressive disorders.

On the 4-point scale (0-3), 0 indicates the symptom is absent and 3 indicates severe symptoms. At the end of the questionnaire, all of the numbers are totalled with a low of zero and a high of 63. Scores from 0-10 represent normal ups and downs of life. Scores from 11-16 show a mild mood disturbance. 17-20 indicates borderline clinical depression, 21-30 moderate depression, 31-40 severe depression, and 40+ extreme depression. The BDI has been translated into many different languages for use in other countries. The mean correlation coefficients between clinical ratings of depression and the BDI for psychiatric and non-psychiatric patients are 0.72 and 0.60. The construct validity is 0.92 for psychiatric patients and 0.93 for college students (Jackson-Koku, 2016).

## **Methods**

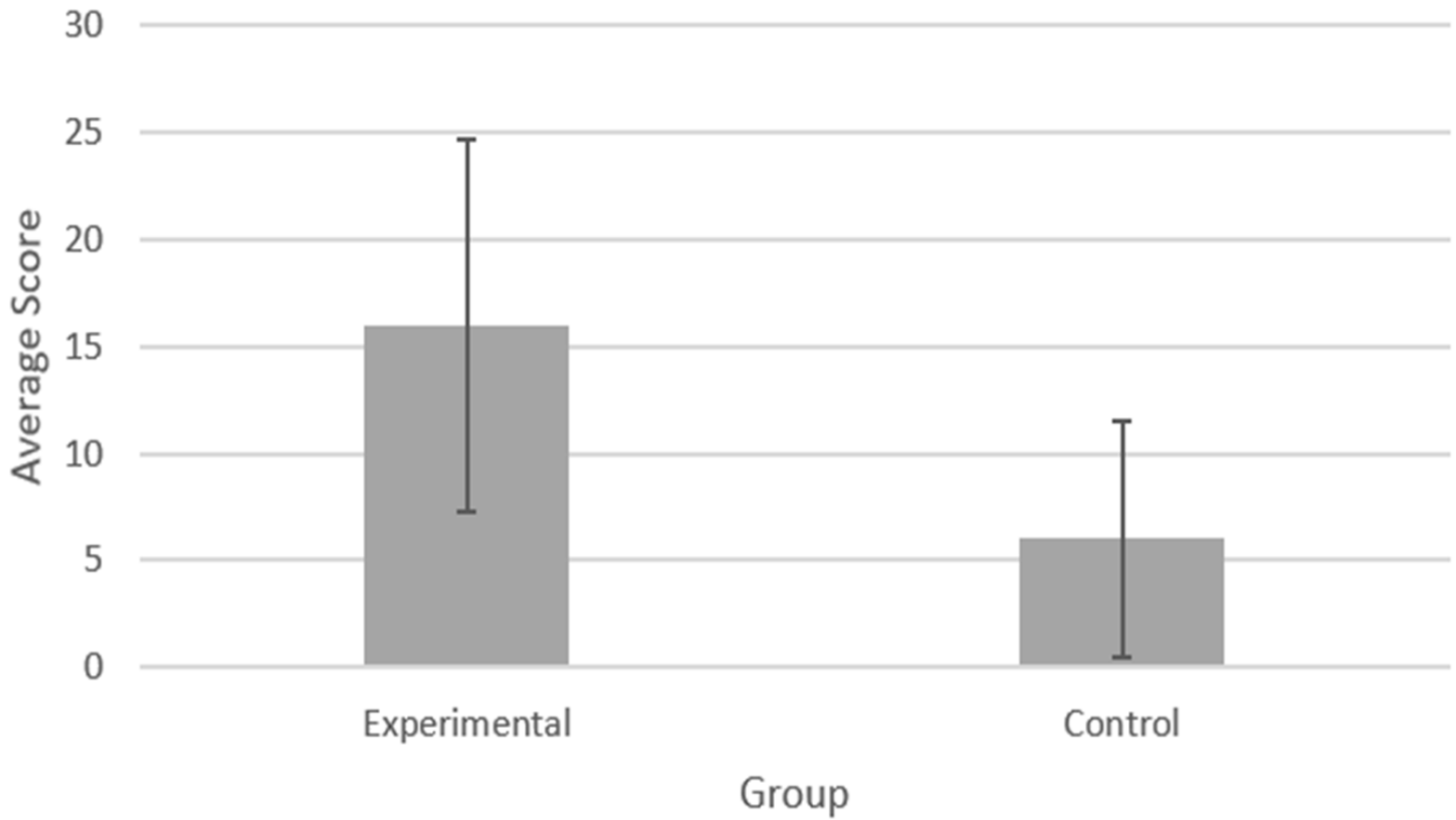
An anonymous Google survey was sent out to prospective participants via email, text message, and GroupMe. The survey consisted of a section for the participants age, a section to indicate if the participant was on hormonal birth control, the Beck's Depression Inventory, and lastly, a section for comments. The Beck's Depression Inventory is a survey composed of 21 questions that cover cognitive, affective, somatic, and vegetative symptoms of depression. The participants were asked to answer each question using a 4 point scale where 0 indicates the symptom is absent and 3 indicates the symptom is severe. After the data was obtained, the numbers were totaled for each participant to see what their depression ranked on the Beck's

Depression Inventory scale. Scores between 0 and 10 represent normal ups and downs of life, scores between 11 and 16 represent a mild mood disturbance, 17 to 20 shows borderline clinical depression, 21 to 30 moderate depression, 31 to 40 severe depression, and 40+ extreme depression. After all scores were totalled the average was found for both the control group and the experimental group. An unequal variance T-test was used to determine if the difference in results were significant. The average age, age range, score for each group, and score ranges were also determined.

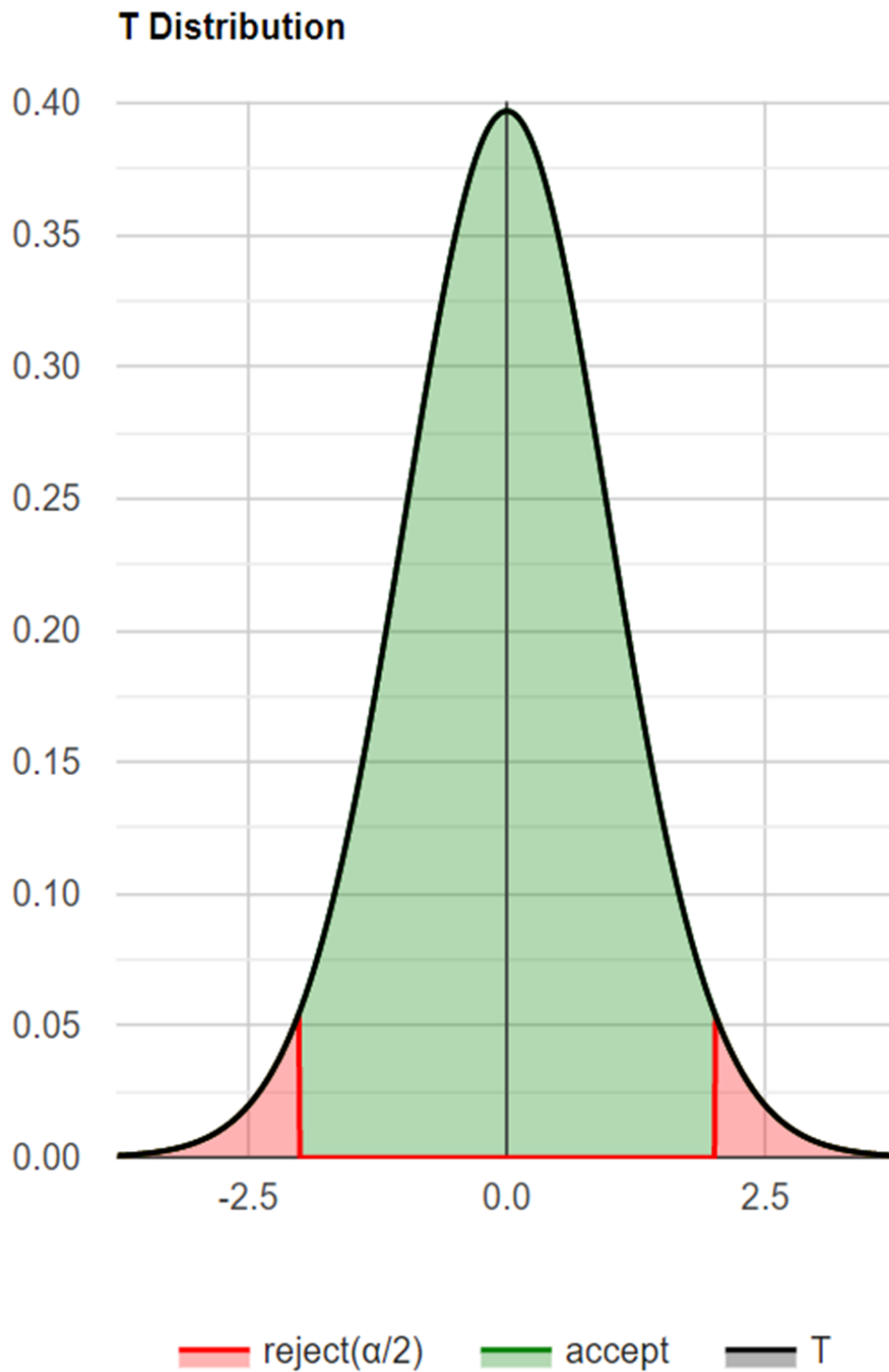
## **Results**

This study included 32 women on hormonal birth control with an average age of 20.16 and an age range from 18 to 23. Twenty women not on hormonal birth control participated in this study serving as the control group; they had an average age of 20.73 with an age range from 19 to 27. The average Beck's Depression Inventory score for the experimental group was 15.96 and the control group's average score was 6.00 (figure 1). The calculated P-value was  $6.261 \times 10^{-6}$ , which strongly supports the hypothesis that hormonal birth control affects women's depression and allows the null hypothesis to be rejected. Additionally, the test statistic T was 5.0504, which falls outside of the region of acceptance and also allows the null hypothesis to be rejected (figure 2).





**Figure 1: Average Scores for Each Test Group on the Beck's Depression Inventory.** The average score of the women on birth control was 15.96 and the standard deviation for this groups data was 8.66. The average score for the women not on birth control was 6.00 with a standard deviation of 5.56.



**Figure 2: T Test Distribution to Determine Level of Significance.** The T distribution is shown with the region of rejection in red and the region of acceptance in green. The T value was 5.0505, which falls in the region of reject indicating a significant result and rejecting the null hypothesis.

## **Discussion**

This study found that hormonal birth control does impact the depressive symptoms of college aged women. There has not been extensive studies done on the topic, but with the increase of depression in women as well as the increased use of birth control, it is a topic that would benefit from further research. This study was limited to a semester time frame and a small sample size. It would be beneficial if a study was conducted across multiple college campuses in the United States, as well as a more narrow age group. Looking at how long each individual was on birth control may also affect the outcome of future studies. Environmental, genetic, and circumstantial factors may contribute to varying test results.

## **Conclusion**

After analyzing the data, the null hypothesis is rejected and the alternative hypothesis that hormonal birth control has an effect on the mental health of college aged women is accepted. The P-value was  $6.261 \times 10^{-6}$  which rejects the null hypothesis. The statistical test T value was 5.0504 which fell outside of the acceptance range and into the rejection range. This also indicates that the null hypothesis is rejected and the alternative hypothesis is kept.

There has not been a lot of research done on the relationship between hormonal birth control and depression. As the use of hormonal contraceptives continues to increase and so does depression in young women, this is an area of research that needs to be looked at on a greater scale.

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## Appendix

### Comments from Participants

This appendix contains comments left by some of the women who participated in the study. The quotes are directly from the anonymous individuals.

- I use to be on Birth control but stopped taking it because it made me nauseous and ruined my appetite. I also had skin issues and felt like the last effects both physical and emotional were worse than before.
- thinning, breaking hair has been a really bad one as well.
- I know that my birth control had huge side effects when I first started it but then it became more normal and now I've been on it for so long I don't know what I would like off it.
- didn't lose weight but gained 10 pounds!
- I used to be on birth control and felt much more irritable and depressed. I took the pill for four years and finally got off of it and I'm so glad I did.

