THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF PSYCHOLOGY

The Effects of Prenatal Antidepressant Exposure on Depression and Anxiety in Children

DEIRDRE HALL
Fall 2021

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Science
with honors in Psychology

Reviewed and approved* by the following:

Jenae M. Neiderhiser
Distinguished Professor of Psychology and Human Development and Family Studies
Thesis Supervisor

Jeffrey Love
Professor of Psychology
Honors Adviser

* Electronic approvals are on file.

ABSTRACT

During pregnancy, many women deal with anxiety or depression and must decide whether they will continue to take antidepressants while pregnant. When making this decision, mothers must consider what effect antidepressants have on a developing fetus. Little is known about the mental health outcomes in children who were prenatally exposed to antidepressants. To this point, studies have not shown clearly that maternal antidepressant use during pregnancy is predictive of the development of ADHD or autism in exposed children. The same is true of depression and anxiety. The current study used a longitudinal adoption design to examine child mental health outcomes at age 11 years for children whose mothers used antidepressants during pregnancy. Because the children in this study were adopted by genetically unrelated parents at birth, this study is uniquely able to separate environmental factors that influence child mental health development from genetic and other factors, including maternal depression and antidepressant exposure. When the children were eleven years old, their adoptive mothers and fathers rated the child's anxious and depressive symptoms. These ratings were used to examine if there was a significant difference in anxiety/depression scores between children of mothers who were taking antidepressants during pregnancy, mothers who were diagnosed with anxiety or depression but were not medicated during pregnancy, and mothers who were not on antidepressants and were not diagnosed with anxiety or depression. The results found no significant differences between these groups, suggesting that antidepressants did not create an increased risk of anxiety or depression in children who were prenatally exposed to them.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Dr. Neiderhiser for her patience, guidance, and feedback throughout this process. Thank you for allowing me to feel comfortable asking you all my questions, even when I worried that they were silly or bothersome. You have made my first real experience with doing research a positive one that I will never forget as I continue in grad school and beyond. Thank you also to Dr. Mari Greecher, Tong Chen, and Stephane Paquin, all of whom assisted me with getting and analyzing the data for this project. Dr. Greecher has been an excellent mentor and teacher during my time as a research assistant in Dr. Neiderhiser's lab, and I have greatly appreciated her feedback and time spent working with me.

I wouldn't be where I am today without the endless support of my family and friends. Thank you to everyone who has helped me to grow into a better student and a hard worker, and who has encouraged me to ask questions. I owe my accomplishments to you!

Introduction

Antidepressants are taken by a significant number of pregnant women. In a study of over one hundred thousand pregnancies from 1999-2003, 8.7% of women who gave birth used antidepressants at some point during pregnancy (Cooper, 2007). Given the sizable number of women using antidepressants during pregnancy, it is important to understand the possible short- and long-term effects of antidepressants on a growing baby. Currently, the possible effects of antidepressants on the developing fetus remains largely unknown, especially in regard to the later mental health outcomes in children who were prenatally exposed to antidepressants. It is important for women to understand the risks of taking antidepressants while pregnant so that they can make an informed decision about whether or not to continue taking them throughout their pregnancy. This study will analyze mental health outcomes in eleven-year-old children who were prenatally exposed to antidepressants to examine the possible associations between prenatal antidepressant exposure and negative or positive outcomes.

Biology of Antidepressants

Selective serotonin reuptake inhibitors (SSRIs) and serotonin norepinephrine reuptake inhibitors (SNRIs) are two kinds of antidepressants included in this study, both of which fall into the category of SRIs. SRIs inhibit the reuptake of serotonin, causing the concentration of serotonin in the brain to increase (Hanley, 2015). During gestation, serotonin is a key part of brain development. SRIs can cross the placenta, raising questions about how increased levels of serotonin might impact the baby's brain development and later mental health outcomes (Hanley,

2015). In mice, prenatal exposure to SRIs increased depression and anxious behaviors later in life (Hanley, 2015). There is a need to continue this research in humans in order to examine if prenatal exposure to antidepressants has a similar effect on the development of affective disorders in humans as it does in mice.

Antidepressant Use During Pregnancy

In a large study conducted in the US, it was found that the prevalence of mood disorders and anxiety disorders in pregnant women was 13% for each (Vesga-López et al., 2008). 9 out of the 13% of women who experienced any mood disorder during their pregnancy were diagnosed with depression (Ramos et al., 2007). In other words, many pregnant women need to manage mood disorders like anxiety or depression. Antidepressants are used to treat anxiety, depression, and bipolar disorder, and to a lesser extent to treat headaches and migraines (Cascade, Kalali & Thase, 2007). Though mood disorders are commonly treated with antidepressants, there are just a few studies specifically examining their effects on the developing fetus (Bonari et al., 2004; Field, 2006; Dieter et al., 2008; Glover, 2014). This is especially problematic as prenatal exposure to mood disorders has been shown to have detrimental effects on the child, including an increased risk of developing a depressive disorder during adolescence, preterm delivery, low birth weight, and delays in cognitive and emotional development throughout childhood (Monk, 2001; Hammen, 2003; Bonari et al., 2004).

Mood disorders during pregnancy can be further complicated by the fact that many women stop taking certain medications while they are pregnant. In the study in which 9% of women experienced depression during pregnancy, only some (6.6%) of the women were being

treated for their depression. Of the women who were being treated with antidepressants, the percentage who continued to take their medication dropped from 6.6% in the year before pregnancy to 3.7% during the first trimester, then to 1.6% during the second trimester and 1.1% during the third trimester (Ramos et al., 2007). So, about 90% of the women in the sample who were taking antidepressants before becoming pregnant stopped taking them during pregnancy. The study does not indicate why the women stopped taking antidepressants, but other studies have found that mothers discontinue medication use during pregnancy due to fear of teratogenicity, or because they are following the advice of a healthcare provider who is unsure of the risks of continuing medication use (Einarson et al., 2001). These fears may be unfounded. Currently, there is insufficient evidence to show that prenatal antidepressant exposure is the cause of adverse outcomes in mental health of children. However, there are studies that indicate that untreated maternal depression during pregnancy may have adverse outcomes for the child and the mother. Untreated maternal depression has been linked with maternal morbidity and suicide attempts as well as problems with the baby including miscarriage, low APGAR scores at birth, and preterm delivery (Bonari, 2004).

Mental Health Outcomes

Most research examining the effects of prenatal exposure to antidepressants has focused on the development of ADHD and autism in exposed children. A paper analyzing the available studies on risk of ADHD concluded that there was not enough evidence to support that prenatal exposure to antidepressants increases risk of ADHD (Uguz, 2018). Multiple studies have found that prenatal use of antidepressants was not linked with development of autism spectrum disorder

(Sørensen, 2003; Clements et al, 2015). In fact, a recent meta-analysis of 14 studies concluded that there is not an association between prenatal antidepressant exposure and autism (Vega et al., 2020). To summarize the available literature, prenatal exposure to antidepressants has not been consistently shown to cause an increased risk of ADHD or autism spectrum disorder in children. With that being said, studies agree that further research is needed in order to identify the influence of maternal mental illness (genetics) and separate it from prenatal environmental (i.e. prenatal exposure to antidepressants) influences on child mental health outcomes.

Findings from studies on anxiety and depression outcomes in children who were prenatally exposed to antidepressants have been mixed. For example, a study of 110 mother-child pairs reported that the children of mothers who took SRIs displayed higher levels of internalizing and anxious behaviors (indicators of depression and anxiety) at age three, and higher levels of internalizing (depressed) behaviors at age six (Hanley et al., 2015). This implicates prenatal exposure to SRIs in the development of anxiety and depression in children at a young age, although it is also possible that there are other confounding factors such as genetic risk for such problems. A different study concluded that prenatal exposure to psychotropic medications did not increase the levels of internalizing behaviors in four-year-old children, and that further research was needed to understand the impact of confounding factors such as maternal psychiatric disorders (Misri et al., 2006). In contrast to these findings, a systematic review of studies, completed in 2020, concluded that prenatal antidepressant exposure is associated with the development of affective disorders but not with other psychiatric disorders, such as ADHD and autism (Rommel et al., 2020). The overall results of the studies available are inconclusive as to whether antidepressants are a cause of negative mental health outcomes in children, making it a topic worth exploring further. All of the studies described here also mention confounding

factors including maternal mood and maternal illness severity. Therefore, it is important that future work in this area take such potential confounds into account.

Environmental Influences of Maternal Mood

Maternal mood has been shown to affect the mental health outcomes of children. Impaired maternal mood, defined as a mother's depressed, anxious, or unpredictable mood, has been shown to negatively impact children. A study published in the *American Journal of Psychiatry* found that impaired maternal mood when the child was four years old was associated with children displaying more internalizing behaviors at age four years. Specifically, maternal anxiety and depressed maternal mood both had an effect on the child's internalizing behaviors, although this effect was smaller for depressed mood (Misri et al., 2006). This means that the children of mothers who displayed anxious or depressed behaviors were more likely to also show behaviors related to depression during early childhood.

Other studies have examined why maternal depression may have such effects on children. Murray et al. found that depressed mothers more frequently negated their infants' behavior as opposed to encouraging or affirming behavior, and ultimately there was an increase in cycles of negative communication between depressed mothers and their infants. These mothers were also less sensitive to their infants, which was related to an increase in the infants' negative expressions. Additionally, at 18 months, infants of depressed mothers were more likely to score lower on the Bayley Scales, which measure cognitive development (Murray et al., 1996). These findings indicate that there is an association between impaired maternal mood and infant wellbeing. It is possible that the negative relationship between a mother and her child could lead

the child to have an impaired mood or develop a mental illness. This association could also be related to the child's inherited risk for developing symptoms of depression and anxiety, but few studies have attempted to distinguish these effects (see Pemberton et al., 2010 and Laurent et al., 2013, for exceptions to this).

A longitudinal study on variance of maternal mood- including the large variation caused by bipolar disorder, anxiety, and/or depression- found that increased variance (maternal mood entropy) was associated with increased child negative affectivity at the ages of six months, 12 months, 24 months, and seven years. It was also associated with increased anxiety symptoms at age 10, and depressive symptoms at age 13 (Glynn et al., 2018). The study evaluated prenatal maternal mood as well as postnatal maternal mood at the time of child outcome evaluation. The results show that a mother's mood can have a significant effect on the mood of the child from a young age and could be a factor in development of anxiety and depression in the child.

There is not enough research to conclusively determine whether a mother's depressed or anxious mood causes a child to develop a mental illness, but it is possible and therefore a confounding factor in available research. An adoption study allows us to separate the environmental factor of impaired maternal mood from genetic factors that contribute to a child's mental health outcomes. Because the children in the current study were adopted, the rearing environment is not confounded with the birth mother's depressed/anxious mood during pregnancy, allowing us to disentangle the prenatal effects of impaired maternal mood from rearing environmental effects. If the child developed a mental illness, it was not because of postpartum impaired maternal mood of the biological mother in the child's environment. This also assumes that the child's adoptive parents did not display symptoms of depression or anxiety.

Maternal Mental Illness Severity

Another confounding factor in the research available is the severity of a mother's mental illness. If a mother chooses to continue use of antidepressants during pregnancy, it is likely that she is more severely depressed than a mother who was depressed but unmedicated while pregnant (Oberlander et al., 2006). This is important to note because all of the women in the current study are mothers who continued to take antidepressants for at least part of their pregnancy, which may indicate that their depression was more severe. As a result, we will not necessarily be able to separate the effects of severe maternal depression from the effects of mild maternal depression on child mental health outcomes.

Severity of depression was determined in other studies using depression inventory scores. For example, a study on the effects of maternal depression severity on offspring conducted in 2003 used mothers' scores on the Delusions-Symptoms States Inventory (DSSI) to determine if the depression qualified as severe or mild. The study found that severity of maternal depression contributed to a child's risk for depression and did so more than a long duration of mild depression (Hammen & Brennan, 2003). In the current study, we do not have information about how severe a mother's mental illness was. The only indicators of depression severity that we have from the medical records are suicidal ideation or suicide attempts that were reported as occurring in the past or during the pregnancy for the mother. Even these are not clear indicators that a mother's depression was more severe than the depression of another mother in our sample. Based on available research, it is also unclear if more severe mental illness would have a lasting effect on the child. Therefore, this is a limitation of the current study.

Current Study

The current report uses a parent-offspring adoption design to examine the effects of maternal antidepressant use during pregnancy on child internalizing behaviors during early adolescence. Because the sample used includes adopted children who were placed at birth with genetically unrelated adoptive parents the effects of prenatal exposure to antidepressants can be distinguished from the effects of the rearing environment on the child. Most of the research previously conducted has focused on the development of ADHD and autism in children as a result of prenatal antidepressant exposure (Mezzacappa et al., 2017; Man et al., 2018; Morales et al., 2018), while this study will focus on the development of depression and anxiety during early adolescence. The antidepressants examined in this study include MAOIs, SNRIs, SSRIs, Tetracyclic antidepressants, and Tricylic antidepressants, although they are not considered individually but rather as any use. Most research available has focused exclusively on SSRIs, making this study unique in its ability to expand beyond one type of antidepressant.

This study will compare children's internalizing behaviors (depression and anxiety symptoms) at 11 years of age across groups constituted from their mothers use of antidepressants and severity of mental disorders symptoms. Specifically, three groups are compared: 1) the children of mothers who were taking antidepressants during pregnancy and were diagnosed with depression, bipolar disorder, or anxiety in the past or during the current pregnancy (even if the mother's diagnosis is unknown), 2) children of mothers who were not taking antidepressants and who were diagnosed with depression or anxiety in the past or during the current pregnancy, and 3) the control group comprised of children whose mothers were not on antidepressants during pregnancy and were not (to our knowledge) diagnosed with depression, anxiety, or bipolar

disorder. The control group will give a baseline for how often children in the study were diagnosed with depression or anxiety without maternal mental illness or antidepressants being possible causes.

My hypotheses for this study are: (1) Maternal antidepressant use during pregnancy will be related to higher levels of depressive and/or anxiety symptoms in the child at age 11 years. (2) Children of mothers with a history of depression or anxiety who were not taking antidepressants during pregnancy will not have an increased likelihood of developing depression or anxiety due to antidepressants exposure.

Method

Participants & Procedure

The current study used data collected for the Early Growth and Development Study (EGDS). The goal of this longitudinal study is to examine how environmental factors interact with genetic influences to effect child development (Leve et al., 2013; Leve et al., 2019). Participants were recruited from 45 adoption agencies across the country in two cohorts, both of which were used in the current study. A child's eligibility for the EGDS study depended on several factors. First, the adoption placement had to be domestic. Second, placement of the child occurred within three months postpartum. Third, the infant was placed with an adoptive family that was not biologically related to the child. Fourth, the child did not have any major medical conditions. Finally, the birth and adoptive parents were able to understand English at an eighth-grade level.

In total, 561 children in two cohorts were included in the EGDS study. Of these 561 children, 320 had data for the variables used in the current study. Between both cohorts, the combined percentage of children in the sample who were male was 57.2%. More demographic information can be found in Table 1.

Measures

Birth mother antidepressant and mental health diagnoses. A categorical variable was created based on two binary indicators of mother antidepressant use and mental health diagnoses.

Birth mother antidepressant use. A binary indicator of birth mother antidepressant use was created using medical records of birth mothers in the EGDS sample. These medical records contain information about birth mothers' doctor visits for prenatal care, labs (for example blood tests and urinalyses), and other pregnancy information. The information in these records includes background information about the mother (living situation during pregnancy, information about the father of the baby, previous pregnancies, psychiatric history), her medical history, medications she took during pregnancy, substance abuse information, and delivery information. If the medical record indicates that the mother was taking antidepressants during pregnancy, the mother was included in the current study. These medical records are not always complete or medical care did not span for a mother's whole pregnancy, so it is possible that antidepressant information is missing. However, even if there is no information about antidepressants during pregnancy, any psychiatric diagnoses for the mother are often mentioned in delivery information, which is rarely entirely missing.

Birth mother mental health diagnoses. A binary indicator of birth mothers' diagnosis of anxiety or depression was identified based on her prenatal medical records.

A three-level categorical variable was created based on these two binary indicators of mother antidepressant use and mental health diagnoses. A first group (N=51) comprise the children of mothers who were taking antidepressants during pregnancy, regardless of their mental health diagnoses. A second group (N=49) was composed of children of mothers who were not taking antidepressants but had anxiety or depression at any time in her life, before and/or during her pregnancy. Finally, a third group (N=202) included all children from mothers who were not taking antidepressants and were not diagnosed with depression or anxiety at any time in her life.

Child anxiety and depression. Adoptive parents in this study evaluated their adopted children when they were 11 years of age using the school-age Child Behavior Checklist (CBCL) (Achenbach T.M. & L.A. Rescorla, 2001). For the current study, we used the anxious/depressed subscale, which uses 13 items to rate depressive and anxious symptoms in children. Items are 1) cries a lot, 2) fears certain animals, situations, or places other than school, 3) fears going to school, 4) fears he/she might think or do something bad, 5) feels he/she has to be perfect, 6) feels unloved, 7) feels worthless, 8) nervous, high-strung, or tense, 9) too fearful or nervous, 10) feels too guilty, 11) self-conscious or easily embarrassed, 12) talks about killing self and 13) worries. Higher scores on this scale correspond to increased depressive or anxious symptoms. This scale ranged from 0 to 15with a mean of 3.25 and was log-transformed prior to analyses because it showed a skewed distribution.

Statistical Plan

First, descriptive statistics were calculated for the child anxiety/depression scores. The mean anxiety/depression score was then computed for each comparison group as well as the standard deviation for scores of each group (see Figure 1). Finally, analysis of variance was executed.

Results

Descriptive Statistics

Descriptive statistics analyses were performed using SPSS. These statistics can be found in Table 2. The data was skewed, so child anxiety and depression scores were log-transformed. The kurtosis value also suggests that there were some outliers in the data, but not enough for them to be problematic. Even so, because the data was skewed and not a normal distribution, values were log-transformed. Descriptive statistics for each comparison group's log-transformed scores are shown in Table 3.

ANOVA

Levene test of homogeneity of variance indicated that variances were comparable across groups (Levene statistics=.507, p=.603). ANOVA analysis showed that there was no significant mean difference in outcomes between the comparison groups ($F = 0.392$, $p = 0.676$). This analysis is shown in Table 4.

Discussion

Understanding the effect that prenatal exposure to antidepressants has on the development of depression and anxiety in the exposed child is an important part of determining whether antidepressants are safe to be taken during pregnancy. The main goal of this study was to examine the impact that prenatal exposure to antidepressants had on development of depression and anxiety symptoms in a child by age eleven when a birth mother's impaired mood postpartum was not an environmental factor influencing the child's mental health. This study compared mental health outcomes for depression and anxiety in children who were prenatally exposed to antidepressants to children who were not prenatally exposed to antidepressants. Another objective of this study was to compare these group outcomes to outcomes for children whose birth mothers had depression or anxiety but were not on antidepressants, which would allow for consideration of the heritability of depression and anxiety. My first hypothesis was that prenatal exposure to antidepressants would be related to increased depressive and anxious symptoms at the age of eleven. My second hypothesis was that children of mothers with a history of depression or anxiety who were not taking antidepressants during pregnancy would not have an increased likelihood of developing depressive or anxious symptoms at age eleven.

This study found that birth mother prenatal antidepressant use was not significantly associated with a difference in depression or anxiety outcomes for children. There was no significant difference in depression and anxiety scores for each group of children. These results do not support my hypothesis that children who were prenatally exposed to antidepressants would be more likely to display depressive or anxious symptoms as a result of that exposure. The results are surprising considering the research on mice showing increased depressive and anxious

symptoms as a result of prenatal antidepressant exposure (Hanley, 2015). The results of the current study also do not agree with findings of a review of studies which concluded that prenatal antidepressant exposure was associated with affective disorders in children (Rommel et al., 2020). However, other studies found similar results, including a sibling study that found no difference in depression or anxiety outcomes for siblings who were prenatally exposed to antidepressants in comparison to siblings who were not (Nulman et al., 2015). The sibling study used the same Child Behavior Checklist that was used in the current study to measure child depressive and anxious symptoms, making their mental health outcome results directly comparable to ours (Nulman et al., 2015). Since the results of previous studies have been mixed, the results of this study are valuable and contribute to the growing body of research available on the impact on prenatal exposure to antidepressants. The results of this study contribute support the lack of association between prenatal antidepressant exposure and negative mental health outcomes for children regarding depression and anxiety. The implications of this result are that mothers might feel less inclined to stop taking antidepressants during pregnancy, knowing that they are not putting their child's mental health at risk by taking them. According to this study's results, antidepressants do not increase the likelihood of depression or anxiety in children who are prenatally exposed to them. However, further research is needed to find out if this result is repeated under different conditions, with different environmental factors being controlled for.

It is interesting that children in the sample whose birth mothers had depression or anxiety and were not taking antidepressants had mental health outcomes similar to children whose mothers did not have these diagnoses. Given past research suggesting the heritability of depression, this surprising result highlights the need for further research that separates genetic factors influencing mental health outcomes from environmental factors (Gershon et al., 1976). In

this study, the environmental factor of a birth mother's maternal mood was not a factor that affected the child's mental health outcomes. This removal might not have entirely eliminated impaired (depressed, anxious, unpredictable) mood from the child's environment, but it is more likely that the child's environment did not include impaired maternal mood.

Limitations in this study included a small sample size, and inability to disentangle genetic factors and some environmental factors. Another limitation was that information provided in the birth mothers' medical records is not always complete. It is possible that medication information or psychiatric diagnosis information was missing from some records. Therefore, some children in the control group (whose mothers were not taking antidepressants and were not diagnosed with anxiety or depression) could have been in the wrong category due to missing information. It is also possible that a mother who had a diagnosis was taking antidepressants, but the records did not have that medication information, so children in that category were in the wrong one as well. For future research, a study involving a survey asking the mother about her medication use and psychiatric diagnoses at the time of pregnancy would provide more accurate information on these factors. Even with the limitations of missing information in the medical records and a small sample size, the unique adoption design of the study provides insight on mental health outcomes that most studies have not had to this point.

The current study was limited in its ability to control for some confounding factors, such as maternal mental illness severity, which could have a genetic impact on the child's mental health outcomes. Future research on the effects of prenatal exposure to antidepressants could take this factor into account by measuring maternal depression and evaluating differences in outcomes for children whose mothers had more severe as opposed to less severe mental illness. Future research on antidepressant exposure should control for maternal mental illness severity

and, if not using an adoption study, should also control for maternal impaired mood. Another direction that could be taken by future research would be to employ a sibling study in order to compare mental health outcomes when one sibling was prenatally exposed to antidepressants and the other was not. It would also be interesting to compare outcomes for siblings who were both prenatally exposed to antidepressants to see if the results significantly vary. Greatly differing results for biological siblings who were raised in the same environment and were both prenatally exposed to antidepressants could be indicative that the antidepressant exposure did not affect mental health outcomes, assuming other environmental factors are being controlled for.

Conclusion

This study contributes to the current research available on the effects of using antidepressants during pregnancy by showing that in this sample, there were no significant effects of prenatal exposure to antidepressants on child depression and anxiety. Based on this result, mothers can take antidepressants during pregnancy without worrying about the effect that their medication might have on the child's mental health. However, this study's limitations, and the conflicting conclusions in other studies show the need for further research that can disentangle genetic factors from environmental factors that contribute to child depression and anxiety. Future studies should control for maternal mental illness severity. Additionally, future studies should consider an adoption study design like the one the current study utilized. This will allow studies to separate the possible effects of a mother's behaviors related to mental illness (impaired maternal mood) on the child from other factors.

References

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA school-age forms & profiles: An integrated system of multi-informant assessment*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Bonari, L., Pinto, N., Ahn, E., Einarson, A., Steiner, M., & Koren, G. (2004). Perinatal Risks of Untreated Depression during Pregnancy. The Canadian Journal of Psychiatry, 49(11), 726–735. https://doi.org/10.1177/070674370404901103

Cascade, E. F., Kalali, A. H., & Thase, M. E. (2007). Use of antidepressants: expansion beyond depression and anxiety. Psychiatry (Edgmont (Pa. : Township)), 4(12), 25–28.

Clements, C., Castro, V., Blumenthal, S. et al. Prenatal antidepressant exposure is associated with risk for attention-deficit hyperactivity disorder but not autism spectrum disorder in a large health system. Mol Psychiatry 20, 727–734 (2015). https://doi.org/10.1038/mp.2014.90

Cooper, W. O., Willy, M. E., Pont, S. J., & Ray, W. A. (2007). Increasing use of antidepressants in pregnancy. American Journal of Obstetrics and Gynecology, 196(6). doi:10.1016/j.ajog.2007.01.033

Dieter, J. N., Emory, E. K., Johnson, K. C., & Raynor, B. D. (2008). Maternal depression and anxiety effects on the human fetus: Preliminary findings and clinical implications. *Infant Mental Health Journal, 29*(5), 420-441. doi:10.1002/imhj.20192

Einarson, A., Selby, P., & Koren, G. (2001). Abrupt discontinuation of psychotropic drugs during pregnancy: fear of teratogenic risk and impact of counselling. Journal of psychiatry & neuroscience : JPN, 26(1), 44–48.

Field, T., Diego, M., & Hernandez-Reif, M. (2006). Prenatal depression effects on the fetus and newborn: A review. *Infant Behavior and Development, 29*(3), 445-455. doi:10.1016/j.infbeh.2006.03.003

Glover, V. (2014). Maternal depression, anxiety and stress during pregnancy and child outcome; what needs to be done. *Best Practice & Research Clinical Obstetrics & Gynaecology, 28*(1), 25-35. doi:10.1016/j.bpobgyn.2013.08.017

Glynn, L. M., Howland, M. A., Sandman, C. A., Davis, E. P., Phelan, M., Baram, T. Z., & Stern, H. S. (2018). Prenatal maternal mood patterns predict child temperament and adolescent mental health. Journal of Affective Disorders, 228, 83-90. doi:10.1016/j.jad.2017.11.065

Hammen, C., & Brennan, P. A. (2003). Severity, Chronicity, and Timing of Maternal Depression and Risk for Adolescent Offspring Diagnoses in a Community Sample. Archives of General Psychiatry, 60(3), 253. doi:10.1001/archpsyc.60.3.253

Hanley, G., Brain, U. & Oberlander, T. Prenatal exposure to serotonin reuptake inhibitor antidepressants and childhood behavior. Pediatr Res 78, 174–180 (2015). https://doi.org/10.1038/pr.2015.77

Man, K. K., Chan, E. W., Ip, P., Coghill, D., Simonoff, E., Chan, P. K., . . . Wong, I. C. (2018). Prenatal antidepressant exposure and the risk of attention-deficit hyperactivity disorder in children: A systematic review and meta-analysis. *Neuroscience & Biobehavioral Reviews, 86*, 1-11. doi:10.1016/j.neubiorev.2017.12.007

Mezzacappa, A., Lasica, P., Gianfagna, F., Cazas, O., Hardy, P., Falissard, B., . . . Gressier, F. (2017). Risk for Autism Spectrum Disorders According to Period of Prenatal Antidepressant Exposure: A Systematic Review and Meta-analysis. *JAMA Pediatrics, 171*(6), 555. doi:10.1001/jamapediatrics.2017.0124

Misri, S., Reebye, P., Kendrick, K., Carter, D., Ryan, D., Grunau, R. E., & Oberlander, T. F. (2006). Internalizing Behaviors in 4-Year-Old Children Exposed in Utero to Psychotropic Medications. American Journal of Psychiatry, 163(6), 1026-1032. doi:10.1176/ajp.2006.163.6.1026

Monk, C. Stress and Mood Disorders During Pregnancy: Implications for Child Development. *Psychiatr Q* **72,** 347–357 (2001). https://doi.org/10.1023/A:1010393316106

Morales, D. R., Slattery, J., Evans, S., & Kurz, X. (2018). Antidepressant use during pregnancy and risk of autism spectrum disorder and attention deficit hyperactivity disorder: Systematic review of observational studies and methodological considerations. *BMC Medicine, 16*(1). doi:10.1186/s12916-017-0993-3

Murray, L., Fiori-Cowley, A., Hooper, R. and Cooper, P. (1996), The Impact of Postnatal Depression and Associated Adversity on Early Mother-Infant Interactions and Later

Infant Outcome. Child Development, 67: 2512-2526. https://doi.org/10.1111/j.1467-8624.1996.tb01871.x

Oberlander TF, Warburton W, Misri S, Aghajanian J, Hertzman C. (2006). Neonatal Outcomes After Prenatal Exposure to Selective Serotonin Reuptake Inhibitor Antidepressants and Maternal Depression Using Population-Based Linked Health Data. Arch Gen Psychiatry. 63(8):898–906. doi:10.1001/archpsyc.63.8.898

Ramos, É., Oraichi, D., Rey, É., Blais, L. and Bérard, A. (2007), Prevalence and predictors of antidepressant use in a cohort of pregnant women. BJOG: An International Journal of Obstetrics & Gynaecology, 114: 1055-1064. https://doi.org/10.1111/j.1471-0528.2007.01387.x

Rommel, A., Bergink, V., Liu, X., Munk-Olsen, T., & Molenaar, N. M. (2020). Long-Term Effects of Intrauterine Exposure to Antidepressants on Physical, Neurodevelopmental, and Psychiatric Outcomes:. The Journal of Clinical Psychiatry, 81(3). doi:10.4088/jcp.19r12965

Sørensen, M. J., Grønborg, T. K., Christensen, J., Parner, E. T., Vestergaard, M., Schendel, D., & Pedersen, L. H. (2013). Antidepressant exposure in pregnancy and risk of autism spectrum disorders. Clinical epidemiology, 5, 449–459. https://doi.org/10.2147/CLEP.S53009

Uguz, Faruk MD Maternal Antidepressant Use During Pregnancy and the Risk of Attention-Deficit/Hyperactivity Disorder in Children, Journal of Clinical Psychopharmacology: June 2018 - Volume 38 - Issue 3 - p 254-259 doi: 10.1097/JCP.0000000000000868

Vega, M. L., Newport, G. C., Bozhdaraj, D., Saltz, S. B., Nemeroff, C. B., & Newport, D. J. (2020). Implementation of Advanced Methods for Reproductive Pharmacovigilance in Autism: A Meta-Analysis of the Effects of Prenatal Antidepressant Exposure. American Journal of Psychiatry, 177(6), 506-517. doi:10.1176/appi.ajp.2020.18070766

Vesga-López O, Blanco C, Keyes K, Olfson M, Grant BF, Hasin DS. Psychiatric Disorders in Pregnant and Postpartum Women in the United States. Arch Gen Psychiatry. 2008; 65(7):805–815. doi:10.1001/archpsyc.65.7.805

Tables

Table 1. *Demographic Information for Birth Parents and Adoptive Parents (N = 320).*

Variable	BM	BF	AM	AF
Age at TC birth (avg)				
Mean	24.4 ± 6	26.1 ± 7.8	37.6 ± 5.7	38.1 ± 5.7
Range	13-43	15-58	23-55	24-59
Race/ethnicity				
Caucasian	70.9% Cauc.	71.8% Cauc.	92.1% Cauc.	91.1% Cauc.
African-American	13.5% Afr. Am.	13.3% Afr. Am.	3.4% Afr. Am.	4.5% Afr. Am.
Hispanic/Latino	6.2% Hisp./Lat.	8% Hisp./Lat.	2% Hisp. Lat.	2.5% Hisp. Lat.
Multi-racial	4.8% Multi-eth	5.3% Multi-eth	1% Multi-eth	0.6% Multi-eth
Other	4.6% other	1.6% other	1.5% other	1.3% other
Median income at child birth ($)	14,550	23,000	110,000	
Median education attainment to date	High School degree	High School degree	4-year college or university	4-year college or university

Note. BM = Birth Mother, BF = Birth Father, AP1 = Adoptive Parent 1, AP2 = Adoptive Parent 2

Table 2. *Descriptive Statistics for Child Behavior Checklist Raw Scores and Log-Transformed Scores*

		Child Anxious/Depressed Score	Log of Child Anxious/Depressed Score
N	Valid	293	293
	Missing	9	9
Mean		3.2491	1.1848
Std. Deviation		3.19852	0.73389
Skewness		1.433	0.039
Kurtosis		1.836	-0.793
Minimum		0.00	0.00
Maximum		15.00	2.77

Table 3. *Descriptive Statistics for Group Mean AP1-AP2 Log-transformed Scores*

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Anti - ; Depress - ; Anxiety -	196	1.2105	0.72762	0.05197	1.1080	1.3130	0.00	2.77
Anti - ; Depress + OR Anxiety +	47	1.1521	0.70930	0.10346	0.9438	1.3603	0.00	2.48
Anti + ; Depress -/+ ; Anxiety -/+	50	1.1149	0.78850	0.11151	0.8908	1.3390	0.00	2.71
Total	293	1.1848	0.73389	0.04287	1.1004	1.2692	0.00	2.77

Table 4. *ANOVA*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.424	2	0.212	0.392	0.676
Within Groups	156.848	290	0.541		
Total	157.272	292			

Figures

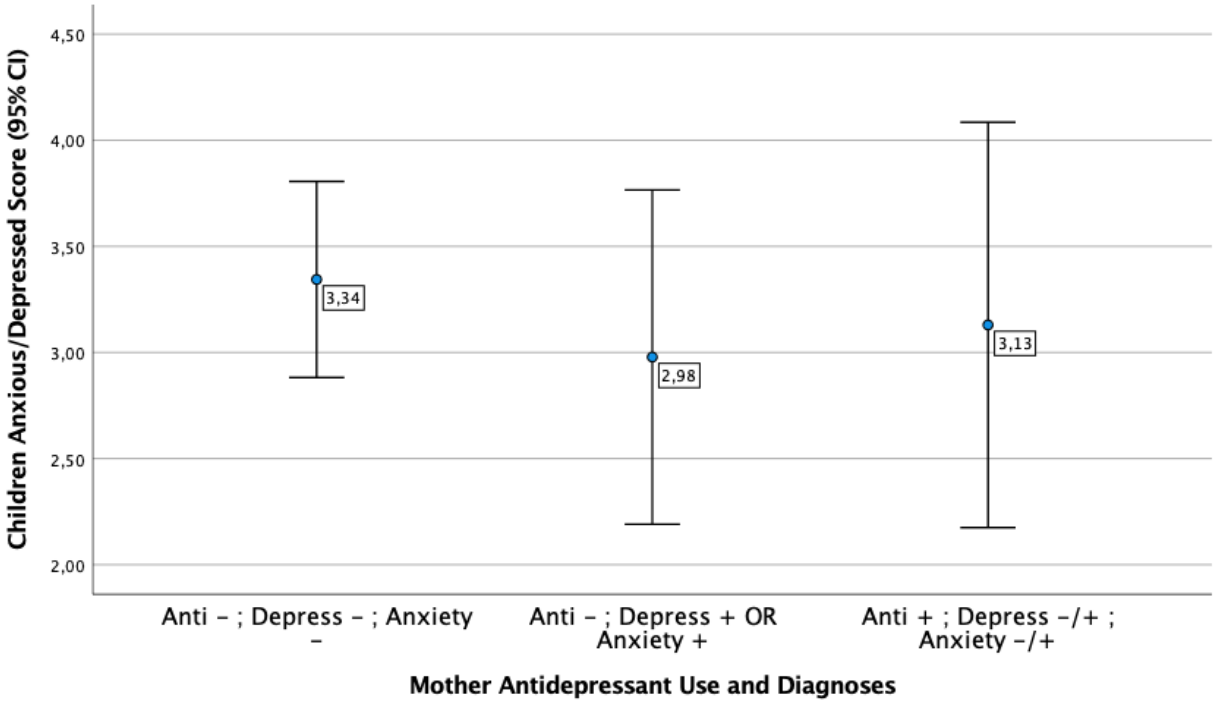

Figure 1. Means of CBCL anxious/depressed subscale for children 11 years of age according to their birth mother's use of antidepressants and mental health diagnoses.

ACADEMIC VITA

Deirdre Hall

deirdre.k.hall@gmail.com/dxh5484@psu.edu

Education

Schreyer Honors College at The Pennsylvania State University
Bachelor's in Biological Sciences and Health Professions
Minor: Psychology
Graduation: December 2021

Research Experience

Research Assistant- Medical record coder

- August 2020- November 2021
- Worked as a medical record coder for 3 semesters and a summer under the supervision of Dr. Greecher in the "Gene Environment Interplay Across the Lifespan" Lab (Dr. Neiderhiser) at Penn State
- Coded prenatal medical records for the Early Growth and Development Study

Honors

- Dean's List (Fall 2018, Spring 2019, Spring 2020, Fall 2020, Spring 2021)

Volunteering, Leadership and Activities

- Big Sister in the Big Brothers Big Sisters program of Centre County (October 2021-Present)
- Member of The Singing Lions (Fall 2019-Present)
    - Secretary of The Singing Lions (Fall 2020-Spring 2021)
    - Music Director of The Singing Lions (Spring 2021-Present)
- Tour Guide and Volunteer at the Eberly College of Science Welcome Day (Fall 2021)
- No Refund Theatre Company (Fall 2019)
- Schreyer Student Council Member (Fall 2018-Spring 2019)