Western Kentucky University

TopSCHOLAR®

Masters Theses & Specialist Projects | Graduate School

Spring 2021

The Influence of Prenatal Yoga on Mental Health in Pregnancy During the COVID-19 Pandemic

Cathryn Duchette
Western Kentucky University, catieduchette@gmail.com

Follow this and additional works at: https://digitalcommons.wku.edu/theses

 Part of the Alternative and Complementary Medicine Commons, Kinesiology Commons, Obstetrics and Gynecology Commons, and the Psychiatric and Mental Health Commons

Recommended Citation

Duchette, Cathryn, "The Influence of Prenatal Yoga on Mental Health in Pregnancy During the COVID-19 Pandemic" (2021). *Masters Theses & Specialist Projects.* Paper 3491.
https://digitalcommons.wku.edu/theses/3491

This Thesis is brought to you for free and open access by TopSCHOLAR®. It has been accepted for inclusion in Masters Theses & Specialist Projects by an authorized administrator of TopSCHOLAR®. For more information, please contact topscholar@wku.edu.

THE INFLUENCE OF PRENATAL YOGA ON MENTAL HEALTH IN PREGNANCY DURING THE COVID-19 PANDEMIC

A Thesis
Presented to
The Faculty in the School of Kinesiology, Recreation, and Sport
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

By
Cathryn Duchette

May 2021

THE INFLUENCE OF PRENATAL YOGA ON MENTAL HEALTH IN PREGNANCY DURING THE COVID-19 PANDEMIC

Date Recommended March 26, 2021

Rachel Tinius Digitally signed by Rachel Tinius Date: 2021.04.09 16:12:48 -05'00'

Rachel Tinius, Director of Thesis

Whitley Stone Digitally signed by Whitley Stone Date: 2021.04.09 10:04:32 -05'00'

Whitley Stone

Maire Blankenship, DNP, APRN Digitally signed by Maire Blankenship, DNP, APRN Date: 2021.04.09 11:53:49 -05'00'

Maire Blankenship

Danilo Tolusso Digitally signed by Danilo Tolusso Date: 2021.04.09 09:57:07 -05'00'

Danilo Tolusso

Associate Provost for Research and Graduate Education

ACKNOWLEDGEMENTS

This thesis would not have been possible without the support of many amazing people. Dr. Rachel Tinius offered continued advice and mentorship over the last three years, even while on maternity leave. I could never have imagined how much I would accomplish as a graduate student, and every one of my successes has been because she allowed me to be so involved in her research and so independent in my own. I feel incredibly lucky to have had the opportunity to work with Dr. Tinius, and I am very thankful for the impact she has had on my life and academic experiences.

I would also like to thank my committee, Dr. Whitley Stone, Dr. Maire Blankenship, and Dr. Danilo Tolusso, whose help has been essential for creating a final product that I am proud of. I am so grateful for the time and energy that they have all invested in this thesis. I have learned so much from each of these mentors, and I feel more confident going into my future education and career with the knowledge they have shared.

I also want to thank my classmates for their support and friendship during every moment of this graduate program. Logan Wiseman has been a constant source of kindness and positivity, and he made every class and project more fun. Ariel Tomes, along with her never-ending encouragement, helped with qualitative data analysis and made these results more reliable. I am very lucky to have been surrounded by such wonderful and driven peers.

Finally, I want to thank my amazing family, my mom and sister. I'm where I am today because of everything they have done to support me, and I hope they know just how much that support means to me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

THE INFLUENCE OF PRENATAL YOGA ON MENTAL HEALTH IN PREGNANCY DURING THE COVID-19 PANDEMIC

Cathryn Duchette May 2021 90 pages

Directed by: Rachel Tinius, Whitley Stone, Maire Blankenship, and Danilo Tolusso

School of Kinesiology, Recreation, and Sport Western Kentucky University

The COVID-19 pandemic poses risks to the mental health of expecting mothers as studies have demonstrated increased levels of stress and anxiety for new and expectant mothers during the pandemic. Prenatal yoga has been shown to be effective for improving mental health during pregnancy, but no research has been done to determine its effect on mental health during a pandemic. The purpose of this study was to determine the influence of a 10-week prenatal yoga intervention on the mental health of pregnant women during the COVID-19 pandemic. Baseline levels of anxiety and depression were high, with an average depression score of 8.10 ± 4.85 (score > 8 represents possible depression) and an average anxiety score of 39.26 ± 12.99 (score ≥ 39 represents clinical significance). There were no differences in demographic factors or depression/anxiety scores between groups at baseline. Women (n = 19) were randomized to a yoga or a non-yoga control group. Same day surveys suggest that immediately post-yoga session, women felt significantly less depressed (p = 0.028), tense (p < 0.001), and fatigued (p = 0.004). Post-intervention, there were significant group differences in anxiety (p = 0.002), depression (p = 0.032), and total mood disturbance (p = 0.002). The findings of this study may provide clinicians with valuable information regarding alternative exercise options for mental health during pregnancy during the COVID-19 pandemic.

Introduction

In March 2020, just four months after a novel coronavirus had been identified in China, the World Health Organization (WHO) recognized the disease caused by this coronavirus (COVID-19) as a pandemic[1]. Chinese doctors recommended preventative measures of wearing face masks, self-quarantining, and city-wide lockdowns, but these recommendations were not enough to prevent the spread of the virus, and the number of positive cases around the world continued to rise[2,3]. Symptoms of COVID-19 vary considerably, ranging from cold or flu like symptoms to pneumonia, respiratory distress, and even death[3,4]. This pandemic has caused significant stress and anxiety for both healthy and at-risk populations.

Pregnant women have been especially vulnerable to the mental health consequences surrounding the virus. Along with worrying about how infection might affect their own health, expectant mothers have to consider how the virus might impact their pregnancy, their unborn baby, and their labor/delivery experience. Social distancing recommendations necessitated a removal of social support, which is especially important for mental health during pregnancy[5,6]. The evidence of increased risk of COVID-19 infection and death for pregnant women further contributes to the stress that pregnant women experience[7,8]. In addition, many women may be unable or hesitant to access mental health services due to an increased risk of exposure to the virus. It is believed that this further contributes to the increased occurrences of moderate-to-high anxiety levels and/or self-reported depression in pregnant women during this pandemic[9].

The number of pregnant women with depression and anxiety has increased significantly since the onset of the pandemic[9]. Anxiety and depression have detrimental effects on nearly every aspect of maternal and fetal health[10,11]. Women with high levels of anxiety and depression have a poorer quality of life, and they are also at increased risk of adverse birth outcomes (e.g., cesarean delivery, preterm birth)[10,11]. Maternal mental health throughout pregnancy also affects postpartum recovery; mothers with elevated stress throughout pregnancy are more likely to experience problems bonding with the infant and an increased risk of anxiety and depression later in life[11,12]. Biomarkers associated with stress, anxiety, and depression can negatively affect fetal brain development, leading to learning and behavior issues in childhood[9,12]. Clinicians should recognize that managing mental health during pregnancy is essential for the health of both mother and fetus.

It is well-known that physical activity can improve mental health in both pregnant and non-pregnant populations. Unfortunately, many pregnant women report decreased physical activity levels since the onset of social distancing and stay-at-home guidelines[9], which likely impacts mental health. Women who met the minimum guidelines of 150 minutes of moderate physical activity per week had lower depression and anxiety scores than women who did not meet these guidelines[9,13,14,15]. It is increasingly important to find safe and enjoyable ways to improve mental health during pregnancy, despite the restrictions associated with the pandemic. Various modes of physical activity, including yoga, may be a promising mental and physical health and fitness mediator for pregnant women and their offspring.

Yoga combines physical activity and mindfulness, making it appealing to many people. Yoga is particularly useful for pregnant women, who often seek gentler forms of exercise to compensate for the aches and pains associated with pregnancy[16]. Though it has not yet been documented during the COVID-19 pandemic, the mediation and mindfulness of prenatal yoga can be used to relieve stress and anxiety during pregnancy, benefiting both maternal and fetal health[17,18]. Additionally, the physical aspect of yoga can help women maintain and/or improve physical fitness, which can help expecting mothers accommodate the increase in weight and shift in center of gravity as pregnancy progresses[19,20,21]. Prenatal yoga is also beneficial for the fetus, as it improves both developmental and birth outcomes[16,22].

The risk of a sedentary, stressful, and anxiety filled pregnancy has increased significantly during the COVID-19 pandemic[9,17]. Each of these factors can negatively affect the mother and fetus, making activities for mental and physical health even more important than pre-pandemic. Fortunately, prenatal yoga has the potential to benefit both aspects of health during pregnancies in this pandemic[17]. One session of yoga improves stress and anxiety, but regular yoga practice can be even more beneficial; Newham et al.[23] found anxiety scores decreased following an eight-week yoga program. While a large number of studies document the benefits of yoga for stress relief for expectant mothers and the general population, none to date have evaluated the influence of a prenatal yoga program on mental health factors during a prolonged stressful period such as the COVID-19 pandemic. The results of the study are clinically relevant and timely as the pandemic is ongoing.

Purpose & Hypotheses

The purpose of this thesis was to determine the influence of a 10-week prenatal yoga program on maternal mental health (as measured through anxiety and depression scores) during pregnancy in a pandemic. This study is the first to address the potential influence of 10 weeks of prenatal yoga on maternal mental health during a pandemic, a critical factor in overall maternal health. In addition, this study also examined the acute changes in maternal stress and anxiety after a single session of yoga.

- Aim 1: Determine how a 10-week prenatal yoga program influences maternal anxiety and depression during a public health crisis.
    - Hypothesis A: Anxiety and depression will be lower after a 10-week program of prenatal yoga compared to baseline values among intervention participants.
    - Hypothesis B: Anxiety and depression will be lower in the yoga group compared to the control group following the intervention.
- Aim 2: Determine how a single yoga class influences maternal stress and anxiety during a public health crisis.
    - Hypothesis: Psychological stress and anxiety will be lower after a single yoga class compared to baseline values.

Literature Review

COVID-19

In December 2019, the outbreak of a novel coronavirus in a seafood market in China led to a rapidly spreading disease that proved to be both fatal and capable of significant evolution[3]. The new virus was known as 2019 novel coronavirus (2019-nCoV), then severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), followed by the now widely known disease caused by the virus: coronavirus disease, or COVID-19[3,24]. Many of the symptoms of COVID-19 are similar to a flu or cold, including fever, cough, sore throat, and fatigue, but severe cases can progress to pneumonia, acute respiratory syndrome distress, multi-organ failure, and death[3,4]. Although the disease was thought to be most dangerous to elderly populations and patients with comorbidities, young and healthy people have also suffered from severe disease progression and death[2,3].

Soon after the first cases presented, Chinese doctors found that community spread was occurring and implemented prevention measures such as face masks, quarantines, and city-wide lockdowns[2,3]. However, these measures were unsuccessful in containing the spread, and by January 2020 the Centers for Disease Control and Prevention (CDC) had reported cases in the United States, as well as many other countries[3,25]. On January 30, 2020, the World Health Organization (WHO) designated the novel coronavirus as a public health emergency of international concern[1,26]. In March 2020, the WHO recognized COVID-19 as a pandemic[1].By February 2021, just over one year after the outbreak, the United States had seen upwards of 26.4 million cases of COVID-19 and 443,000 deaths as a result of COVID-19[27]. These numbers continue to grow, even with

the development and distribution of a vaccine; on January 8, 2021 alone, more than 300,000 new cases were reported[28].

Although this is not the first pandemic to occur in the 21st century, or even in the most recent decade, it has arguably been the one with the most disastrous results. Along with the exponential increase in positive cases and deaths, the COVID-19 pandemic resulted in a transition to virtual education and work, state- and city-wide lockdowns, and an increase in food insecurity and homelessness[29-32]. Across the world, citizens had to adjust to major shifts in every aspect of their lives, as well as cope with the stress and fear of exposure to an unknown disease. Pregnant women in particular had an unprecedented strain placed on an already stressful time, as initially little was known on how this novel coronavirus might affect a pregnant woman or her fetus[3].

COVID-19 and Expecting Mothers

Understanding the impact of COVID-19 on a pregnant woman and her fetus became a major concern during the pandemic, because pregnant women are more susceptible to infection and respiratory disease[6,33,34]. Pregnant women were disproportionately affected by previous outbreaks of respiratory illnesses, such as the H1N1 influenza in 2009, the severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002, and the Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012[34,35]. During the SARS-CoV epidemic, pregnant women had poorer clinical outcomes than non-pregnant women, including significantly greater rates of ventilation and intensive care unit admission, as well as a higher fatality rate[36,37]. Although data on pregnancy and the MERS-CoV epidemic is limited, research suggests that this infection was also associated with poor clinical outcomes for pregnant women, including the risk

of fetal death[38]. Along with research on disease progression and severity, understanding the effect of COVID-19 infection on pregnant women became a major research question during the pandemic.

The prognosis for a pregnant woman who contracts COVID-19 remains unclear. In several early reports, pregnant patients with COVID-19 seemed to respond similarly to non-pregnant patients[39,40]. In preliminary studies, none of the involved pregnant participants developed pneumonia or died[34,41], and most patients displayed the expected symptoms of fever and dry cough[39,42]. These early reports showed no difference between women who were and were not pregnant in regard to the incidence of severe disease progression[40], providing promising results about the relative risk of pregnant women during this pandemic.

As the pandemic worsened, later studies found that pregnant women were at an increased risk of severe disease progression, including admission to intensive care units, need for ventilation, and mortality[43-45]. This risk may be further heightened for women with comorbidities such as obesity and gestational diabetes[46]. One report found that nearly all women with a history of severe COVID-19 infection were overweight, obese, or had other comorbidities[7]. These investigators also found that pregnant women without comorbidities experienced higher rates of complications and death from COVID-19 than non-pregnant women[7]. These studies were published after the pandemic had been progressing for some time, suggesting that initial reports might inadequately represent the risk to pregnant women; it is possible that these later studies provide a better understanding of the true risk to pregnant women during pregnancy, labor, and delivery.

One concern related to labor and delivery for a COVID-19 positive patient is the increased likelihood of a cesarean birth.

In pregnancies uncomplicated by infection or comorbidities, many obstetricians generally try to avoid cesarean deliveries. Along with the inherent risks of any surgical procedure, a cesarean delivery has long-term implications for both maternal and fetal health[47,48]. According to the CDC, cesarean deliveries made up 31.7% of births in the United States in 2019[49]. In several recent reports, the rate of cesarean delivery was much higher for COVID-19 positive laboring mothers, ranging from 77.7%-100%[34,41,42,50]. The high rate of cesarean births in COVID-19 positive mothers compared to the 2019 average indicates that cesarean delivery might have been viewed as the safest or only option, despite a lack of evidence supporting this view[51-53]. The American College of Obstetricians and Gynecologists (ACOG), as well as other professional organizations, have made evidence-based statements regarding the safety and efficacy of a vaginal delivery for COVID-19 positive women[33,39,53]. The decision for an operative delivery should be made based on obstetric factors such as maternal or fetal distress, rather than on COVID-19 status, but this is not reflected in the reports included in this review. It should be noted that in most cases, these cesarean deliveries had positive outcomes for both mother and infant. However, Della Gatta et al.[39] noted that the indication for surgical delivery was often not provided in these reports.

The CDC recommends wearing a facial mask, staying six or more feet away from anyone outside of your household, avoiding crowds, and frequent handwashing and disinfection to prevent the spread of COVID-19[54]. Along with this, ACOG recommends that pregnant women keep their prenatal appointments to optimize their health[53].

Pregnant women appear to be at an increased risk of severe disease presentation and potentially adverse outcomes of labor and delivery, making it imperative to follow the recommended precautions. Data indicates that multi-layer cloth masks alone can block anywhere from 50-70% of the small particles that are responsible for disease transmission[55], with several studies finding that wearing a face mask is associated with a 70% reduced risk of transmission[56,57]. Disease transmission was further reduced among those who followed other precautions, such as social distancing and frequent handwashing[56,57]. Pregnant women should protect themselves and their fetus by following these CDC guidelines as much as possible[46].

COVID-19 and Fetal Health

Anxiety is already heightened during pregnancy because an expecting woman becomes concerned about the health of her growing fetus, as well as her own health to support and protect her child[58]. Initially, it was not known if the novel coronavirus could be transmitted from an infected mother to her fetus during pregnancy or delivery, which caused a great deal of concern for pregnant women[6]. Fortunately, vertical transmission during pregnancy appears to be uncommon.

Vertical transmission refers to the transmission of a pathogen from a pregnant woman to her fetus during or immediately after birth[50,59]. This includes transmission through the placenta, breastmilk, or direct contact[50,59]. Based on initial research, it appears that vertical transmission in utero is uncommon, and therefore is not the primary risk to the fetus of a COVID-19 positive mother[33,34,39,42,60]. Although there is less evidence on the presence of the virus in breastmilk, amniotic fluid, and cord blood, several studies have found no viral load in these biological agents, even in mothers who

tested positive for COVID-19[33,34,61,62]. While one study found that a sample of breastmilk was positive for COVID-19[63], research generally suggests that breastfeeding is not a route of vertical transmission, although it is recommended that COVID-19 positive mothers wear a mask while breastfeeding because of the close proximity to the infant[33,60].

Although vertical transmission in utero does not appear to be a major factor for neonatal infection, several cases have exhibited the need for continued safety precautions after birth. In February 2020, a newborn became the youngest person to be infected with COVID-19 after testing positive just 30 hours after birth to a COVID-19 positive woman[64]. In the same hospital, another infant began showing symptoms approximately two weeks after birth, after the mother and nanny both tested positive and began showing symptoms[64]. While vertical transmission is still possible in these cases, it is important to note that infants can still become infected if their caretakers are sick or exposed to others who are sick[35]. The safety precautions previously mentioned (e.g., masks, social distancing, and hand washing) are important during pregnancy and become even more important after delivery to protect the newborn[45,60].

The primary effect of COVID-19 infection on a fetus can be seen during labor and delivery. Research overwhelmingly suggests the increased risk for preterm birth in COVID-19 positive mothers. Studies have observed 12.6-25%[45,46,65,66] of COVID-19 positive mothers deliver preterm, while the national average of preterm deliveries was just 10.0-10.2% across 2018[67] and 2019[68]. Based on this trend, pregnant women with a confirmed COVID-19 infection in their third trimester may be at an increased risk of a preterm delivery[50]. COVID-19 infection during pregnancy may also increase the risk of miscarriage or stillbirth, although it is not always possible to identify the cause of fetal

death. In one study, the 3.2% rate of stillbirth was four times higher in women with COVID-19 than among baseline data collected prior to the outbreak[46]. Some studies have observed much lower rates of fetal death, at 0.7%[65] and 0.9%[66], while others have observed a similarly increased trend at 2%[33] and 2.2%[45] of all births. Fetal outcomes certainly appear to deteriorate as maternal condition become more severe. In several instances, fetal or neonatal death occurred to women who required mechanical ventilation, entered septic shock, or died[39,45].

The increased prevalence of cesarean delivery in COVID-19 positive mothers has implications for both mother and infant. The vaginal secretions and skin-to-skin contact during vaginal birth are important for development of the infant's immune responses[60], yet some research suggests skin-to-skin contact be avoided in COVID-19 positive mothers to reduce the risk of neonatal infection[33]. Delayed umbilical cord clamping has also been discouraged by some authors[33], while others argue that a few more moments of placental perfusion after a vaginal delivery will not significantly alter the risk of vertical transmission[40]. This lack of consensus regarding neonatal safety may have contributed to the trend of cesarean delivery for COVID-19 positive mothers.

Although the COVID-19 pandemic does not seem to affect pregnant women and their fetuses as severely as other coronavirus pandemics such as MERS-CoV and SARS-CoV, there is still inherent risk to such a virulent infection during pregnancy. The uncertainty of personal and public safety, the risk of exposure to and spread of the novel coronavirus, and the prevention measures recommended by the CDC, national, and local governments have all contributed to a decline in mental health in pregnant women.

Mental Health During Pregnancy

COVID-19 and Mental Health

The sudden and dramatic outbreak of the novel coronavirus had a significant impact on the mental health of the general population. Heitzman et al.[69] coined the term "pandemic acute distress disorder" to describe a variation of post-traumatic stress disorder secondary to the outbreak, with the dominant feature being "prolonged anxiety reaction and inability to break away from permanent trauma." Up to 96% of patients who contract and recover from COVID-19 have post-traumatic stress symptoms and a higher prevalence of depression[70]. Although this figure refers to the general population, some studies have found that women were more stressed about the coronavirus than men, suggesting that these aspects of mental health might be worse for women[71]. Feeling trapped as a result of isolation, fear of exposure to the virus, and cancellation of family gatherings and public holidays have all contributed to negative mental health during the pandemic[5].

In addition to these stressors, pregnant women also have to worry about potential exposure to the virus while seeking prenatal care and the consequences of infection for fetal health[5,6,72]. Salehi et al.[6] found that the fear of COVID-19 during pregnancy was positively correlated with anxiety and poor mental health and negatively correlated with happiness. Several studies found that a higher percentage of pregnant women had clinically relevant depression and anxiety during the pandemic than before[9,73]. Farrell et al.[73] found that both anxiety and depression scores were higher postnatal than antenatal, indicating that these mental health problems do not desist after delivery. Mental health during pregnancy can have significant consequences for both mother and fetus[10,11,12],

making mental health during the COVID-19 pandemic an important consideration for pregnant women.

Mental Health and Maternal Well-Being

Women with poor mental health during pregnancy are less likely to engage in positive health behaviors that might improve health[74], so it is important for both mother and fetus that mental health is appropriately managed. Many pregnant women experience anxiety related to fetal health, labor and delivery, and parenting[12,58]. Stress, anxiety, and depression can increase the risk of gestational hypertension, preeclampsia, and upper respiratory tract infection, all of which pose significant risks to maternal health[10,11]. Poor mental health during pregnancy also contributes to sleeping problems and difficulty controlling weight gain[11]. The effects of mental health during pregnancy can extend into the postpartum period, potentially impairing infant bonding and effectiveness of care[12]. Stress, depression, and anxiety affect every aspect of life, and the negative effects for maternal health can extend well past delivery.

Stress during pregnancy is associated with a reduced antibody response to vaccines, along with an increased susceptibility to infection[10,11,75]. Developing COVID-19 vaccines have been shown to be safe for pregnant women[76], but the excess stress associated with pregnancy during a pandemic might reduce the effectiveness of the vaccine[10]. Along with this, increasing levels of stress regarding the pandemic may decrease immune resistance and response to the virus[10,11,75]. Stress about COVID-19 may reduce the body's ability to fight infection and respond appropriately to vaccines, making mental health an even more important consideration during pregnancy in a pandemic.

Mental Health and Fetal Development

Maternal stress, depression, and anxiety have lasting effects on childhood and adulthood health through a process known as fetal programming[12,77]. Although the exact mechanisms are still under investigation, current research suggests that anxiety and stress stimulate the maternal hypothalamic-pituitary-adrenal axis, which then causes an increase in maternal levels of cortisol[17,23]. The increase in maternal cortisol levels results in an increase in fetal cortisol levels, which is hypothesized to impair fetal growth by inhibiting the growth of the placenta[23]. The placenta itself also releases corticotropic releasing factor, which further increases the secretion of cortisol[22]. This exposure to stress in-utero is a risk factor for developmental issues that could last well past birth to affect the life of the exposed fetus, as low birth weight and premature birth both have long-term consequences[22,85]. Many maternal factors, including mental health, can have detrimental effects on fetal development with lasting consequences[77,78]. Maternal stress can result in elevated neonatal cortisol levels, low Apgar scores, low birth weight, and premature labor and delivery[9,10,23,73,79]. Low birth weight is related to the frequency and severity of depressive symptoms, IQ, and an increased risk for ADHD[80]. Additionally, it is also the leading cause of neonatal mortality as low birth weight is associated with increased risk of disabilities, infections, and diseases[81,82]. Premature birth is similarly associated with increased infant morbidity, mortality, and neurodevelopmental and behavioral problems[79,83]. Excess stress, anxiety, or depression during pregnancy may lead to lifelong conditions for the infant, further contributing to the importance of mental health during pregnancy for fetal well-being.

Along with growth and birth outcomes, maternal stress during pregnancy is also associated with inflammation and/or abnormal fetal brain development[22]. Depression and stress during pregnancy increase maternal levels of interlekin-6 (IL-6), an inflammatory cytokine, and decrease levels of interleukin-10, an important anti-inflammatory cytokine[10]. IL-6 and other inflammatory cytokines negatively affect the fetal brain at every stage of development, extending well into childhood[84]. This inflammatory marker impacts fetal programming to influence learning, behavior, and motor development after birth, and is also linked to attention deficit disorders, irritability, and depression in childhood[9,11,12,75,80,85]. Managing maternal mental health during pregnancy is essential for the quality of life and well-being of the mother, but it is also vital for improving the health of her child long after labor and delivery.

There is no question that maternal mental health during pregnancy has significant impacts for both a mother and her fetus. As of July 2020, the WHO had yet to address mental health during the pandemic[86], even though mental health should be a primary concern for everyone affected by the virus[32]. Considering the other immediate concerns associated with the pandemic, mental health may be overlooked. Fortunately, it is well known that exercise can have significant benefits for mental health, particularly for pregnant women.

Exercise and Pregnancy

Evidence supports exercise during pregnancy for both mother and fetus similarly to those who are not pregnant. Exercise may mitigate the changes in mood and fatigue often experienced by pregnant women[87,88]. Other common symptoms of pregnancy include nausea and joint and muscular pain; exercise can diminish these uncomfortable

symptoms as well[89,90]. Exercise is associated with improved energy, memory, and discomfort[88,91]. During pregnancy, relief of these types of symptoms becomes even more important for the comfort of an expecting mother. Exercise and physical activity can also decrease the maternal inflammation associated with stress, anxiety, and depression, which has significant benefits for both the mother and her fetus [88,92].

Exercise for Maternal Health

Pregnancy is a vulnerable period for mental health, and the incidence of stress, depression, and anxiety is higher in pregnant women than in non-pregnant women[93]. Although many women decrease physical activity levels during pregnancy[87,89], antenatal exercise is a powerful tool for preventing these declines in mental health[88,93]. Health-related quality of life improves with regular exercise, and the risk of depression increases without exercise[89].

Physical activity during pregnancy reduces the risk of developing hypertension, preeclampsia, and gestational diabetes mellitus, each of which can pose serious risks to both physical and mental health[87,94]. Regular exercise during pregnancy can also improve labor and delivery outcomes, potentially reducing the risk of cesarean delivery and perineum tears[19,87,89,95]. These delivery outcomes complicate and prolong recovery, and avoiding these adverse outcomes can promote mental health during healing. During the COVID-19 pandemic, antenatal exercise was associated with decreases in anxiety and depression scores[9,73]. Many women reduced their physical activity at the onset of social distancing and isolation measures[9,73], but those who continued to meet the 150 minutes per week guideline[14,15] had significantly lower depression and anxiety scores[9]. Although up to 60% of pregnant women do not meet minimum exercise guidelines[14,15,96], regular

physical activity has significant effects on stress, anxiety, and depression. These improvements in mental health are important for maternal health, but they can also have significant impacts on fetal health.

Exercise for Fetal Development

Though many women fear that exercising during pregnancy will harm their fetus, evidence suggests that fetal injuries during exercise are highly unlikely and that exercise is well tolerated by both the fetus and mother[14,97]. Although there are hypothetical potential risks to the fetus, current evidence suggests that the exercise induced interference of transplacental oxygen, carbon dioxide, and nutrient transport has no lasting effects on the fetus[97]. Similarly, the changes in fetal heart rate and oxygen transfer as a result of maternal exercise do not have adverse effects on the fetus, and maternal exercise does not increase the risk of fetal growth restriction[14,97,98].

One major concern regarding exercise during pregnancy is that the redirection of blood flow while exercising will harm the fetus by resulting in hypoxia, which would consequently impair the growth of the fetus. Though physiologically reasonable, de Oliveria et al.[98] found that moderate intensity exercise causes no change in blood flow to the uterus, placenta, or fetus. They also found that there were no cases of fetal growth restriction in the exercise intervention group, and throughout pregnancy all fetuses demonstrated appropriate growth[98]. Rather than impairing growth, physical activity protects against a low birth weight and intrauterine growth restriction during gestation[99].

Low birth weight can lead to lasting health consequences, but a high birth weight also poses risks for a child as they grow. The increase in birth weight is due to an

increase in fat mass, which predisposes the child to obesity, metabolic dysfunction, hypertension, and insulin resistance later in life[100]. Physical activity has a protective effect against these negative birth outcomes for all women, particularly for obese women, because infants born to obese women are more likely to have a higher birth weight and a higher body mass index as they grow[99,100]. Exercising during pregnancy has also been associated with a greater ponderal index at birth, which is in turn associated with a decreased risk of hypertension in adulthood[101]. Although women might worry about the safety of their child during pregnancy, exercise has numerous benefits for the fetus, and these benefits can extend well past birth. Physical activity during pregnancy can mediate the effects of mental health on fetal development by reducing maternal inflammation, cortisol levels, and maternal stress, all of which have positive effects for mother, fetus, and labor outcomes[22,85]. Yoga is a popular form of exercise for many pregnant women, because the combination of movement and mindfulness is particularly beneficial for both maternal and fetal health.

Yoga During Pregnancy

Yoga is a mind-body practice that can improve health, decrease stress and anxiety, and increase self-awareness[17,23]. Yoga has particular benefits for pregnant women, which is why it has grown in popularity as a mode of exercise during pregnancy in recent years[23]. Yoga is non-invasive, low impact, and has relatively few side effects compared to other forms of exercise, making it an appealing option for women experiencing the aches and pains associated with pregnancy[16]. In addition to relieving the physical symptoms of pregnancy, the relaxation and meditation facilitated by yoga

practice can also improve some of the stress, anxiety, and depression that many women experience during pregnancy[12].

Maternal Health and Stress Relief

One of the most commonly noted benefits of yoga is the stress relief that results from the relaxation and meditation practices. This is especially important for expecting mothers, who experience increasing stress and anxiety as their pregnancy progresses, but there are also many other benefits to practicing yoga during pregnancy. Yoga has been shown to decrease the risk of developing preeclampsia and gestational diabetes mellitus, and it can also prevent preterm birth[17,101]. Prenatal yoga can also reduce the incidence of edema, mood swings, muscle soreness, and excessive weight gain, as well as promote good overall health by improving sleep quality and decreasing stress, anxiety, and depression[17,18]. Women who practice yoga throughout their pregnancy experience less labor pain, less stress, anxiety, and depression, and fewer incidences of fetal disorders[18,22,102]. The focus on relaxation and rest that is central to many yoga practices also plays a role in managing gestational hypertension and diabetes, as well as reducing the incidence of preeclampsia[17,18].

Because of the risks associated with certain medications, pregnancy is an especially vital time to consider non-pharmacological managements of stress and anxiety[17,22]. Fortunately, yoga is an especially effective method; one session of yoga is enough to significantly decrease salivary cortisol and reduce perception of anxiety[22]. Maternal stress is associated with both oxidative stress and psychological stress, and yoga has proved effective for reducing both types[16,102]. This reduction in maternal stress factors has positive effects for fetal outcomes and development, particularly on metabolic

function, neurodevelopment, and inflammatory pathways of the fetus[16]. Yoga during pregnancy also decreases the risk of some of the adverse anxiety-driven postnatal outcomes, such as postpartum depression and impaired infant bonding[23]. Because yoga practice encompasses both the mind and the body, it is an excellent mode of exercise for pregnant women to improve their health, decrease stress, and improve both maternal and fetal outcomes of pregnancy and labor[85,102].

Yoga and Fetal Outcomes

While maternal stress, anxiety, and inflammation can all negatively impact the fetus, physical activity during exercise can mediate the effects of these risk factors. Yoga in particular has beneficial effects for both a mother and her growing fetus. When women practice yoga throughout their pregnancy, they tend to experience a lower incidence of fetal disorders[22]. Along with this, yoga improves immune function and decreases cortisol levels, both of which lead to more positive outcomes for both mother and fetus[22]. A single session of yoga is sufficient to reduce reported anxiety and salivary cortisol, both subjective and physiological measures of stress and anxiety[23]. The reduction in both experienced and physiological stress has significant implications because of the relationship between anxiety and adverse pregnancy outcomes[12]. At birth, significantly fewer women who practiced prenatal yoga gave birth to babies with low APGAR scores at 1 and 5 minutes after birth[16,18]. Although Badon et al.[101] found no relationship between yoga practice and birthweight or ponderal index, both of which have implications for long-term health, the reduction in maternal stress and inflammatory markers has immediate benefits for the development of the fetus. Yoga as a form of exercise during

pregnancy can reduce physiological markers of maternal stress, which is vital for proper fetal development of the.

Safety of Prenatal Yoga

Although prenatal yoga is safe for both mother and fetus, ACOG recommends that certain yoga positions be avoided due to potential adverse outcomes (e.g., decreased venous return and/or hypotension)[97]. Some of the poses to be avoided included Child's Pose, Corpse Pose, Downward Facing Dog, and Happy Baby Pose[97]. However, a preliminary study found that even in yoga poses commonly listed as contraindicated during pregnancy, maternal and fetal vital signs remained normal throughout the duration of the specific movements[103]. They found that pulse oximetry and uterine tocometry remained normal during all postures (both recommended and contraindicated)[103]. While fetal heart rates were accelerated, there was no sustained tachycardia, even in poses commonly identified as contraindicated for pregnancy[103]. There was no sustained elevation in blood pressure for any mother, no unsafe elevation in temperature, and no oxygen desaturation for any mother or infant[103]. Additionally, no participant reported feeling unsafe during the session or having any negative side effects after the session, aside from a few reporting some muscle soreness[103]. While certain motionless postures, such as laying supine for extended periods of time[97], should still be avoided, this new evidence increases the feasibility and accessibility of yoga for expecting mothers. These results further support the current knowledge that yoga benefits a mother and her fetus with minimal risk of harm or distress.

During the COVID-19 pandemic, the risk of a sedentary, stressful pregnancy has increased significantly. Pregnant women are experiencing increased stress and anxiety, as

well as decreases in physical activity[9,17]. Each of these factors can negatively affect both maternal and fetal health, making activities for mental and physical health even more important than pre-pandemic. Fortunately, prenatal yoga can be used to benefit both of these aspects of health during pregnancies in this pandemic[17]. One session of yoga has been shown to improve stress and anxiety, but regular yoga practice can be even more beneficial: pre-class anxiety scores were lower at the end of an eight-week program than at the start of the program[23].

While a large number of studies have been published regarding the benefits of yoga for stress relief, including a number of prenatal studies, none to date have researched the influence of a prenatal yoga program on mental health during a prolonged period of stress such as the COVID-19 pandemic. Therefore, the purpose of this study was to examine the effects of a 10-week prenatal yoga intervention on mental health during pregnancy in a pandemic.

Methods

Recruitment

This study was approved by Western Kentucky University's Institutional Review Board (IRB 20-267). Participants were recruited through social media, chain referral sampling, and word-of-mouth. Based on the funding available and the pilot nature of the study, 24 women were enrolled in the study.

Inclusion/ Exclusion Criteria

Inclusion criteria for the study:

1. 18-44 years old
2. Physician release to participate in exercise
3. > 12 weeks pregnant (Be Happy Yoga & Salt Cave requires participants to be at least 13 weeks to participate in prenatal yoga)

Exclusion criteria for the study:

1. Multiple gestation pregnancy
2. Unable to provide voluntary informed consent
3. Any medical condition (pregnancy-related or not) that would preclude exercise[14,15]
4. > 26th week of pregnancy at the start of study participation (allowing women to finish the 10 weeks of yoga before reaching full-term (≥ 37 weeks)

In addition, if any participant presented to any session with absolute contraindications to exercise during pregnancy[14,15], she was told to call her doctor and not participate in any exercise that day. If any participant began to develop any of the warning signs to discontinue exercise while pregnant, she was told to stop the session and

call her doctor. A registered prenatal yoga teacher discussed these indications in classes. Appendix A contains a list of ACOG contradictions and warning signs for exercise during pregnancy.

Baseline Surveys

After enrollment in the study, participants were sent a set of electronic baseline surveys via email. Before moving forward with the survey, participants had to read and electronically sign the informed consent document. Researchers' contact information was provided in case any participant had additional questions or concerns. After signing the document, participants were directed to the remaining surveys. These surveys included a demographic survey, Health-Related Quality of Life Survey (HRQoL), Edinburgh Perinatal Depression Scale (EPDS), State Trait Anxiety Inventory (STAI), and Self-Rated Abilities for Health Practices Scale (SRAHP) (surveys can be found in Appendices C-G). The primary outcome assessments, EPDS and STAI, have been used reliably in a number of prenatal studies, including several yoga studies, as well as being validated in pregnant populations[9,23,104-106]. After completing these surveys, participants were randomized to the yoga group or the control group using an online randomizer program. Participants in the yoga group were sent the Physician's Release form (Appenidx B). Once they had completed the Physician's Release (i.e. had written permission to participate from their obstetric provider), they were given instructions on how to sign up for classes. Participants in the control group were sent the Profile of Mood States Questionnaire (POMS) after their baseline surveys (Appendix H). Once this survey was completed, they were sent a $50 gift card.

Yoga Classes

Participants in the intervention group were asked to complete the Profile of Mood States Questionnaire before and after the first class to determine the acute effects of one yoga class on mood. The pre-class assessment also served as their pre-intervention response. Women were then asked to attend at least one prenatal yoga class each week for the next 9 weeks (10 weeks total). At the end of 10 weeks, all participants were asked to fill out the same set of baseline surveys and the Profile of Mood States Questionnaire for a second time. Yoga participants were also asked to complete the final yoga survey, asking about any additional yoga they practiced, their experience with the classes, and open-ended questions about how yoga helped their mental health (Appendix I). This survey also included questions about any possible increase in stress due to the rising number of COVID-19 cases in an effort to control for environmental bias (i.e. women were more stressed at the end of the 10-weeks but due to factors unrelated to yoga).

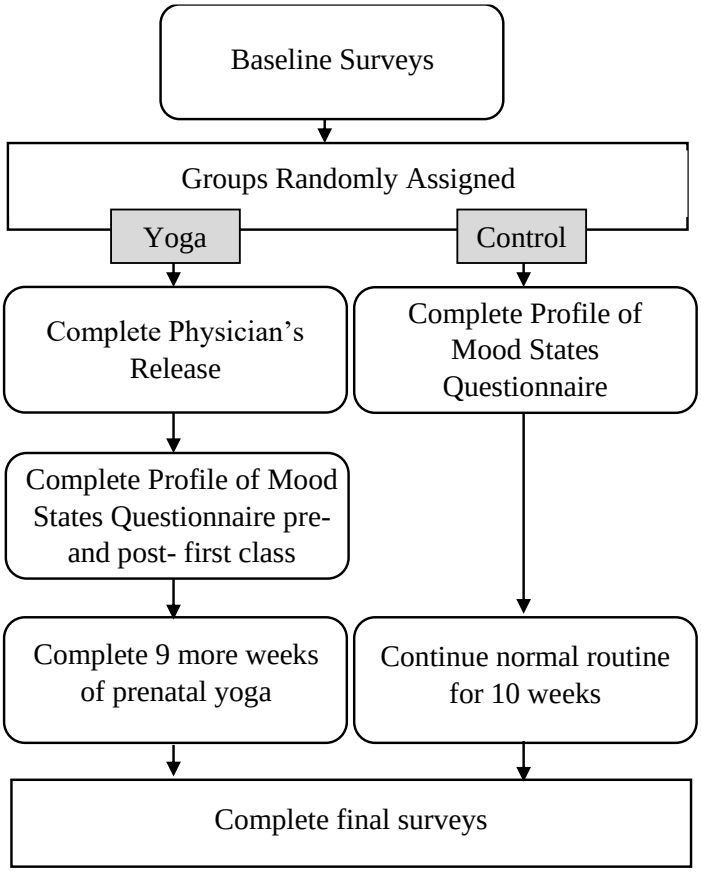
All prenatal yoga classes took place at a local yoga studio with a registered prenatal yoga teacher and all classes occurred at the same location and were supervised by a teacher (Be Happy Yoga and Salt Cave). The study's grant covered the cost of one class (~1.25 hours) per week, but participants were able to attend more classes at their discretion. According to the studio's standards and practices, women were required to be at least 13 weeks pregnant to participate in prenatal yoga classes. During prenatal yoga classes, participants did not complete poses on the stomach or flat on the back, and a yoga blanket was used to prevent women from lying flat on their backs in supine poses. Any side laying poses were done on the left side, and no deep twists were performed. Women participated in 10 weeks of yoga according to these guidelines and the instruction of the registered prenatal yoga teacher. Participants could choose to

participate in in-person classes, virtual classes, or a combination of the two. All in-person classes were limited to a maximum of six women, were led with social distancing procedures in place, and participants were asked to keep their masks on until they were seated on their mat at an appropriate distance from other students.

Control Group

Participants in the control group were asked by the investigators to not participate in any yoga practice during these 10 weeks. No restrictions were given for any other form of physical activity during study participation. At the end of 10 weeks, these participants were asked to fill out the same final surveys as the yoga group. Along with these final surveys, control group participants also completed a survey regarding exercise frequency, duration, and type during the previous 10 weeks (Appendix J). This survey also included questions about any possible increase in stress due to the rising number of COVID-19 cases. When they completed these surveys, they received their second and final $50 gift card. The study flow for each group is summarized in Figure 1.

Figure 1: Study flow for each group



Statistical Plan

A 2x2 (group x time) mixed model ANOVA was used to analyze the effects of the intervention on depression, anxiety, and total mood disturbance between the two groups. Independent samples *t*-tests were used to compare demographic characteristics as well as baselines score for anxiety and depression. Chi-square tests were used to compare categorical data between groups at baseline to ensure there were no differences between groups at the start of the intervention. Paired *t*-tests were used to assess the Profile of Mood States Questionnaire responses pre- and post-class. All data were analyzed using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., USA).

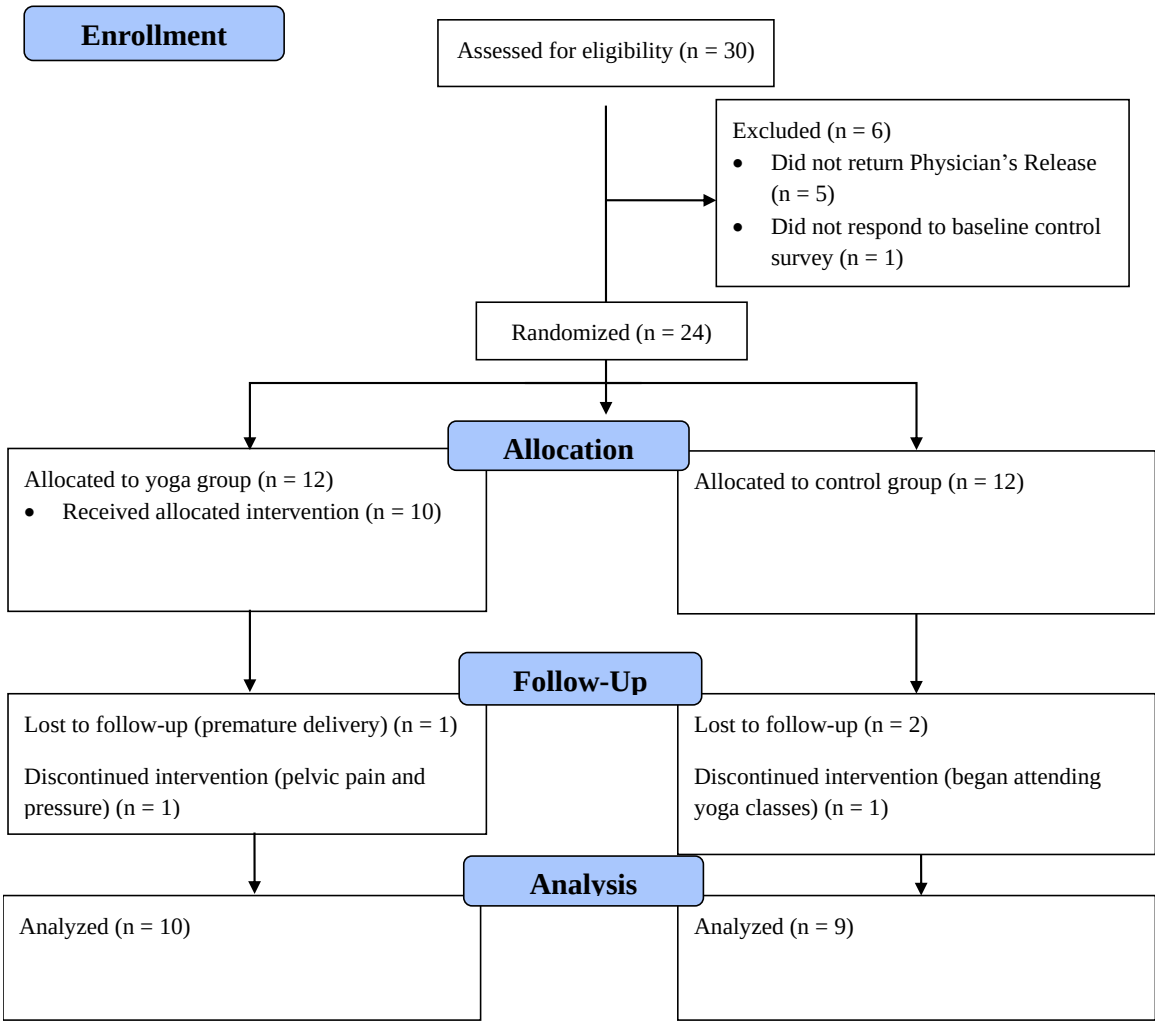
Statistical significance was set *a priori* at $p < 0.05$. All data are reported as mean ± standard deviation unless otherwise stated.

Qualitative analysis of the open-ended responses was conducted using Erlingsson & Brysiewicz's guide to content analysis[107]. Two researchers independently analyzed and coded the responses by identifying meaning units, codes related to those meaning units, and overarching themes encompassing the codes. For example, a meaning unit such as "I could leave the worries around the door or I could bring them in and move through them with the different positions" could have a code of "help with worry" and a theme of "improved mental health." Recurring thoughts or statements could then be grouped together using the same theme and similar codes, allowing researchers to identify the most common themes[107]. Each reviewer independently reviewed all responses, then met to discuss the most frequently used themes and codes and reach a consensus regarding the most prevalent themes.

Results

Thirty women were assessed for eligibility, and 24 women were included in the study and randomly assigned to a group, with 12 women in each group. A total of 19 participants completed the study. Three women were lost to follow up and excluded from the control group, and two women were lost to follow up in the yoga group. Complete reasons for exclusion can be found in Figure 2. Final analyses include a total of 10 women in the yoga group and 9 in the control group.

Figure 2: CONSORT diagram depicting participant recruitment, loss, and number of participants included in final analyses



There were no significant differences between the groups at baseline (Table 1). Baseline surveys indicated high levels of anxiety and depression, as shown by an average depression score of 8.10 ± 4.85 (score > 8 represents possible depression) and an average anxiety score of 39.26 ± 12.99 (score $\geq$ 39 represents clinical significance).

Table 1: Characteristics of participants at baseline.

	Total (N = 19)	Yoga (n = 10)	Control (n = 9)	p value
Age	28.52 ± 3.74	27.1 ± 2.88	30.11 ± 4.10	0.790
Weight (kg)	80.64 ± 24.76	72. 95 ± 19.79	89.18 ± 27.98	0.159
Height (in)	65.26 ± 2.53	64.50 ± 2.71	66.11 ± 2.14	0.173
BMI	29.33 ± 9.08	27.15 ± 7.17	31.74 ± 10.74	0.284
STAI Score[†]	39.26 ± 12.99	42.80 ± 16.00	35.33 ± 7.68	0.221
EPDS Score [‡]	8.10 ± 4.85	8.30 ± 6.14	7.88 ± 3.21	0.860
Parity	Primagravida n = 7 Multigravida n = 12	Primagravida n = 4 Multigravida n = 6	Primagravida n = 3 Multigravida n = 6	0.764
Education Level				0.484
Some high school	0 (0)	0 (0)	0 (0)	
Highschool/GED	2 (10.52)	0 (0)	2 (22.22)	
Associates	4 (21.05)	2 (20)	2 (22.22)	
Bachelors	8 (42.10)	5 (50)	3 (33.33)	
Masters	4 (21.05)	2 (20)	2 (22.22)	
PhD or Higher	1 (5.26)	1 (10)	0 (0)	
Technical/Trade	0 (0)	0 (0)	0 (0)	
Marital Status				0.906
Single	4 (21.05)	2 (20)	2 (22.22)	
Married	15 (78.94)	8 (80)	7 (77.77)	
Income				0.466
<$10,000	0 (0)	0 (0)	0 (0)	
$10,000-$20,000	4 (21.05)	2 (20)	2 (22.22)	
$20,001-$40,000	4 (21.05)	3 (30)	1 (11.11)	
$40,001-$60,000	1 (5.26)	1 (10)	0 (0)	
$60,001-$80,000	7 (36.84)	2 (20)	5 (55.55)	
>$80,000	3 (15.78)	2 (20)	1 (11.11)	
Race				
White	17 (89.47)	8 (80)	9 (100)	0.156
Black	2 (10.52)	2 (20)	0 (0)	
Other	0 (0)	0 (0)	0 (0)	
Current Health Status				
Excellent	1 (5.26)	1 (10)	0 (0)	0.553
Very good	10 (52.63)	5 (50)	5 (55.55)	
Good	7 (36.84)	3 (30)	4 (44.44)	
Fair	1 (5.26)	1 (10)	0 (0)	
Poor	0 (0)	0 (0)	0 (0)	
≤ 30 min Moderate Physical Activity				0.312
0 days/week	2 (10.52)	1 (10)	1 (11.11)	
1-2 days/week	6 (31.57)	2 (20)	4 (44.44)	

3 days/week	7 (36.84)	3 (30)	4 (44.44)
4-5 days/week	2 (10.52)	2 (20)	0 (0)
6-7 days/week	2 (10.52)	2 (20)	0 (0)

Note: Data presented as mean ± standard deviation or *n* (%). † State-Trait Anxiety (STAI) score ≥ 39 represents clinically significant anxiety. ‡ Edinburgh Perinatal Depression Scale (EDPS) score > 8 represents possible depression.

Several women chose to participate in a combination of in-person and virtual classes, with a majority only taking virtual classes (Table 2). Changes in anxiety and depression were similar among both virtual classes only and a combination of virtual and in-person classes (Figures 3 & 4).

Table 2: Summary of class participation by modality

Class option	Number of participants (N = 10)
In-person only	0 (0)
Virtual only	6 (60)
Combination of in-person and virtual	4 (40)

Note: Data presented as *n* (%).

Figure 3: Anxiety scores among participants who attended virtual classes only or a combination of virtual and in-person classes

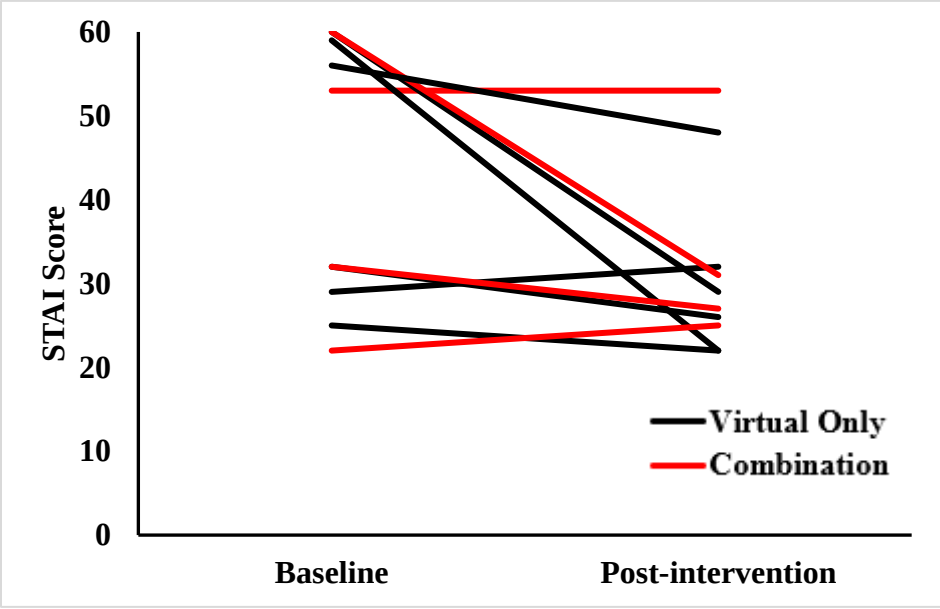
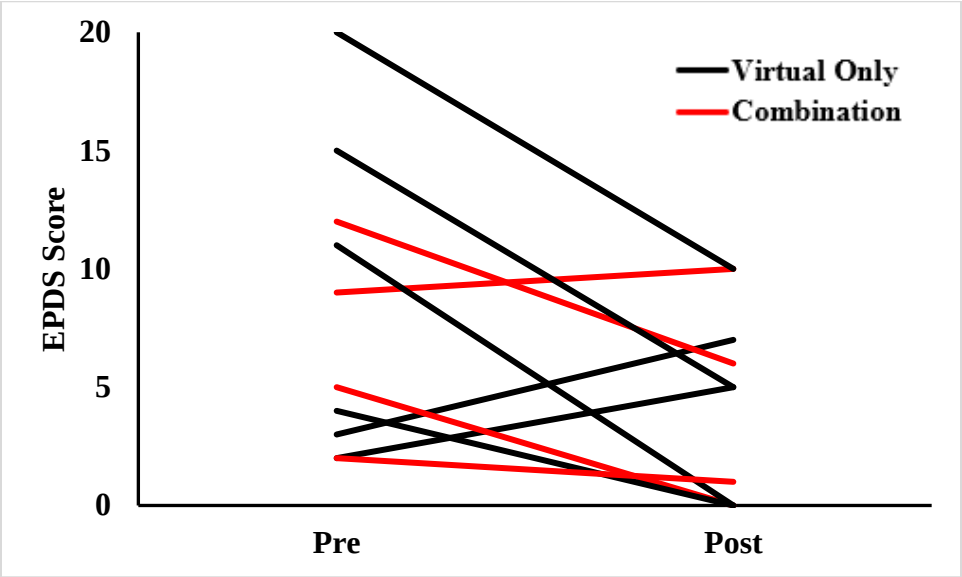


Figure 4: Depression scores among participants who attended virtual classes only or a combination of virtual and in-person classes



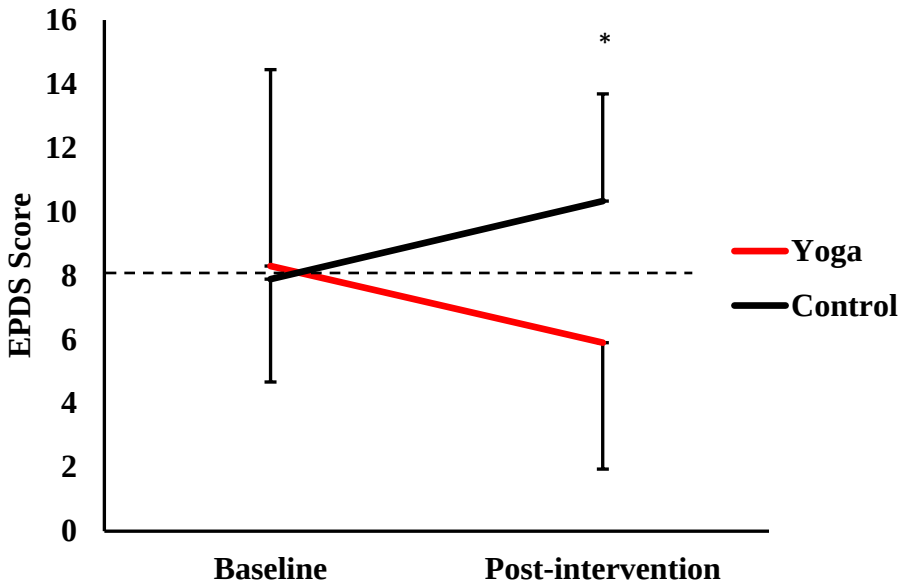
Chronic Effects of Yoga

- Aim 1: Determine how a 10-week prenatal yoga program influences maternal anxiety and depression during a public health crisis.
    - Hypothesis A: Anxiety and depression will be lower after a 10-week program of prenatal yoga compared to baseline values among intervention participants.
    - Hypothesis B: Anxiety and depression will be lower in the yoga group compared to the control group following the intervention.

A two-way ANOVA revealed a significant interaction effect for group and time on depression ($F_{1,17} = 5.421$; $p = 0.032$; $\eta_p^2 = 0.242$; $1\text{-}\beta = 0.593$) and anxiety ($F_{1,17} = 13.055$; $p = 0.002$; $\eta_p^2 = 0.434$; $1\text{-}\beta = 0.925$). Depression and anxiety exceeded the scores

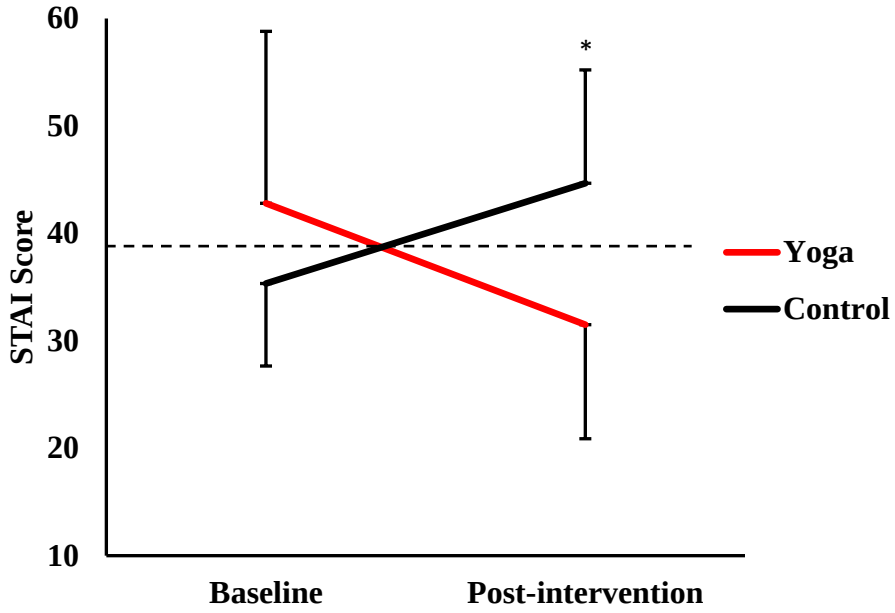
indicating possible depression and clinically significant anxiety in the control group and decreased well below these thresholds in the yoga group (Figures 5 and 6).

Figure 5: Baseline and post-intervention depression scores in yoga and control group



*indicates statistical significance, $p = 0.032$; dashed line reflects threshold for possible depression

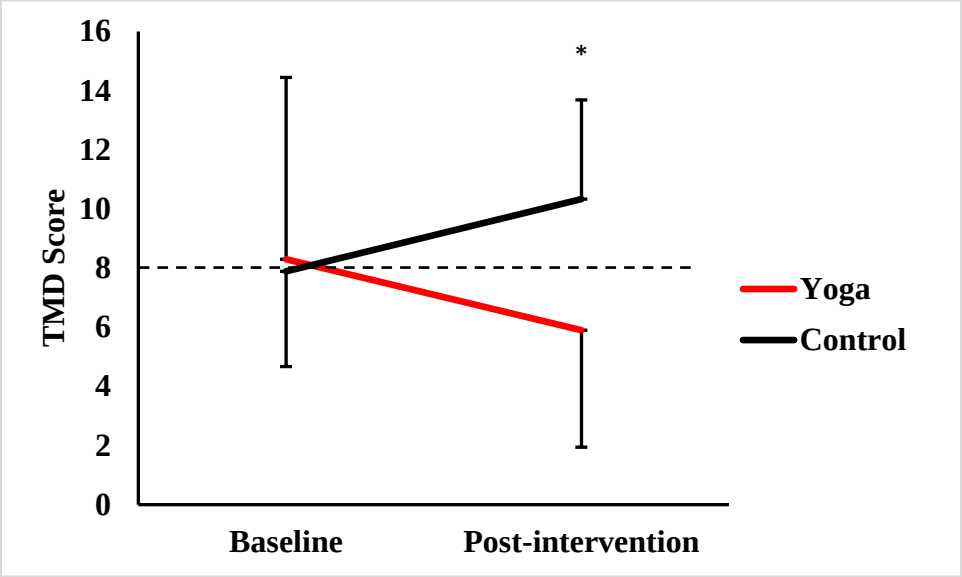
Figure 6: Baseline and post-intervention anxiety scores in yoga and control groups



*indicates statistical significance, $p = 0.002$; dashed line reflects clinically significant anxiety threshold

At the end of the intervention, there was a significant group and time interaction for total mood disturbance ($F_{1,16} = 13.479$; $p = 0.002$; $\eta_p^2 = 0.457$; $1\text{-}\beta = 0.931$). A general trend was observed where total mood disturbance increased in the control group and decreased in the yoga group (Figure 7).

Figure 7: Difference in total mood disturbance between yoga and control groups



Note: High TMD scores reflect high scores in anger, depression, tension, confusion, and fatigue and low scores in self-esteem and vigor. Low TMD scores reflect lower scores in anger, depression, tension, confusion, and fatigue and higher scores in self-esteem and vigor. *indicates significant difference between groups, $p = 0.002$

Acute Effects of Yoga

- Aim 2: Determine how a single yoga class influences maternal stress and anxiety during a public health crisis.
    - Hypothesis: Psychological stress and anxiety will be lower after a single yoga class compared to baseline values.

One yoga participant failed to complete the pre-session survey, and another failed to complete the post-session survey. Therefore, mood data on the effects of one class includes 10 of the initial 12 participants. Immediately post-yoga class, women felt significantly less depressed ($t_9 = 2.617$; $p = 0.028$; $d = 0.828$), tense ($t_9 = 5.419$; $p < 0.001$; $d = 1.714$), and fatigued ($t_9 = 3.833$; $p = 0.004$; $d = 1.212$). Participants also had significant improvements in vigor ($t_9 = -3.503$; $p = 0.007$; $d = -1.108$) and self-esteem (t_9

= -2.941; p = 0.016; d = -0.930) after one class. Post-class and post-intervention values of each POMS subscale are located in Table 3.

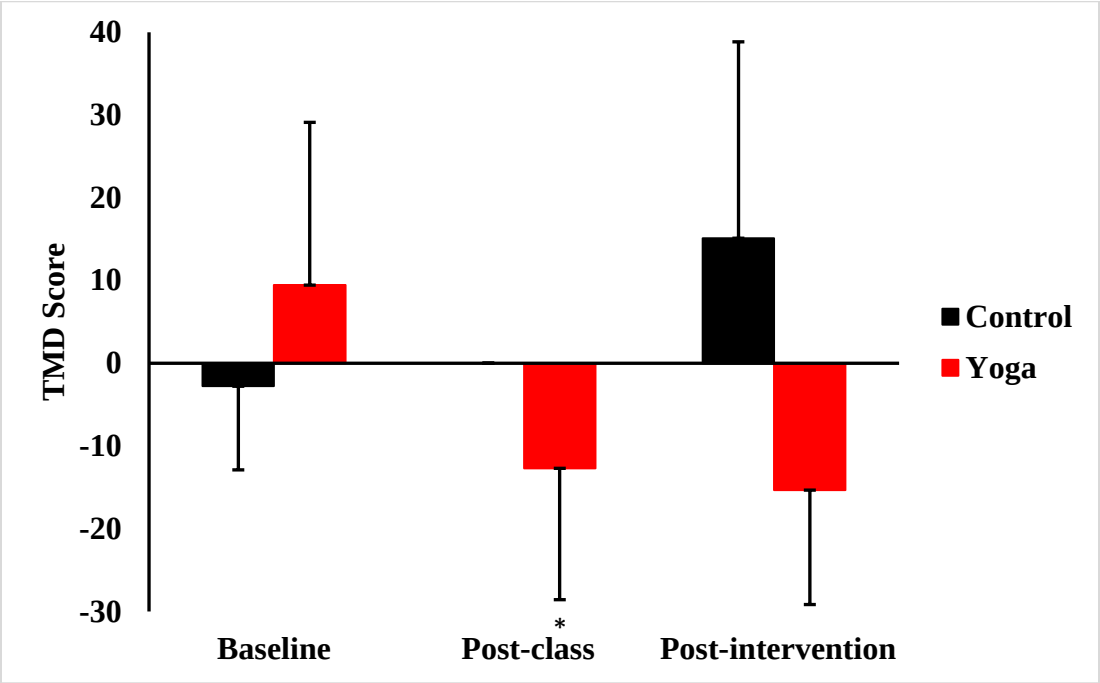
Table 3: Changes in POMS subscales post-class and post-intervention.

Subscale	Baseline	Post-class	Post-intervention
Anger			
Yoga	5.60 ± 5.64	1.30 ± 2.86*	0.66 ± 1.65
Control	2.22 ± 2.68	-	5.44 ± 4.74
Confusion			
Yoga	4.80 ± 2.25	2.30 ± 1.94*	3.66 ± 2.59
Control	3.44 ± 1.87	-	5.44 ± 4.15
Depression			
Yoga	3.10 ± 3.47	0.90 ± 2.02*	0.88 ± 1.36
Control	0.77 ± 2.33	-	3.11 ± 3.68
Esteem			
Yoga	11.40 ± 3.62	14.20 ± 3.19*	16.33 ± 2.64#
Control	14.22 ± 1.56	-	13.55 ± 2.96
Fatigue			
Yoga	8.50 ± 4.30	3.20 ± 2.09*	3.33 ± 2.12#
Control	6.00 ± 3.42	-	10.55 ± 4.90#
Tension			
Yoga	7.20 ± 3.19	1.90 ± 1.96*	4.77 ± 4.73
Control	4.55 ± 1.74	-	8.55 ± 5.45
Vigor			
Yoga	5.10 ± 4.30	8.10 ± 4.28*	12.33 ± 5.83#
Control	5.55 ± 3.28	-	4.44 ± 2.78

*indicates significant improvement from pre-class to post-class; # indicates significant change from pre-intervention to post-intervention

There were several significant differences in POMS subscale scores at the end of the intervention. Vigor (t = -4.394; p = 0.002; d = 5.309) and self-esteem (t = -4.373; p = 0.002; d = 3.201) significantly increased, and fatigue decreased (t = 4.406; p = 0.002; d = 3.480) in the yoga group. In the control group, fatigue increased from baseline to the end of 10 weeks (t = -2.515; p = 0.036; d = 5.433). One class was sufficient to improve total mood disturbance (t = 4.390; p = 0.002; d = 1.388), and regular prenatal yoga practice over the course of 10 weeks maintained this improvement (Figure 8).

Figure 8: Total mood disturbance scores in the yoga and control groups at baseline, post-class, and post-intervention



*indicates significant difference post-class, $p = 0.002$

Themes from Open Response Questions

Tables 4 and 5 contain the themes that emerged in response to open-ended questions on the final surveys, as well as representative quotes that summarize each theme and code. Women in both groups expressed similar concerns, and the two most common themes were identified as 1) COVID-19 has made mental health worse, and 2) prenatal yoga and exercise helped with mental health.

Theme 1: COVID-19 has made mental health worse

All participants agreed that COVID-19 presented challenges that made their mental health worse, with difficulties associated with social distancing and self-isolation being a common theme. One prenatal yoga participant said:

I don't feel comfortable taking my children anywhere in public, so we stay at home most of the time. As a social person, that drains my energy and exacerbates any depressive thoughts.

This thought was echoed by many prenatal yoga participations and was also reflected in the control group, with one control group participant mentioning:

Being pregnant during covid has caused a lot of anxiety and not having as many activities to go out and do has been hard.

Although all participants mentioned the difficulty of COVID-19 in relation to mental health, there were many factors that were unique to each woman. Among these concerns were fetal health, financial problems, relationship difficulties, and spouse's health:

I was diagnosed with mild preeclampsia at 33 weeks and have been on bedrest. This caused me to have to stop working and my 3 children to be looked after by family in another state.

I've been laid off multiple times, and I am denied unemployment, so I have been stressed about money mostly.

My husband was diagnosed with testicular cancer and underwent a major surgery to remove tumors. He is unable to help or assist around the house and we have had to travel for lots of doctor appts out of state.

My anxiety in general regarding covid and delivery went up during the study period (i.e. covid has gotten worse, I am closer to deliver, baby has IUGR).

Participants listed these concerns, as well as many others, as reasons their mental health deteriorated during the pandemic and the study period. One participant exemplified the complex and multi-faceted feelings associated with the pandemic by detailing her own experience with mental health and COVID-19:

> *Personally impacted by COVID death in my family, and many family members contracting COVID; stressed by not knowing how to handle COVID; stressed for wanting to be social and have interactions, but not able to do so; stressed for not feeling understood by others in my caution of COVID; of not knowing the truth and facts about the virus - the uncertainties of it and how it affects different people.*

Naturally, identifying ways to deal with these challenges to mental health was important for many women. Prenatal yoga helped many participants prioritize self-care and shift their focus away from pandemic-related worries, which helped improve mental health.

Theme 2: Prenatal yoga helped with mental health

Among the prenatal yoga participants, all women agreed that prenatal yoga was useful for mental health. One commonly mentioned reason for this was the idea that prenatal yoga helped participants focus on themselves and their baby, rather than on the pandemic and associated stressors:

> *It got my mind off some of the craziness happening and reminded me of the baby growing inside me and the bond we have. And also how I can do things to help me stay calm and in turn, help the baby.*

[Yoga] helped me be present, during the class; relaxing my body and mind and working to intentionally set aside worries, anxieties, and things out of my control. It was a time in which I was able to completely forget what was going on in the outside world.

Participants cited this deliberate shift in focus as especially beneficial for mental health. Along with the benefits in mental health, many participants enjoyed the physical benefits of yoga:

My favorite part was the physical exercises, I also felt physically better after.

Felt good to stretch my body and have the deep relaxation at the end.

I loved being able to do gentle poses to help ease stress or pain.

It was a space where I could leave the worries around the door or I could bring them in and move through them with the different positions. It was soothing to have a physical outlet.

Prenatal yoga participants also enjoyed the flexibility that was associated with the virtual class option. This flexibility relived stress related to both busy schedules and potential COVID-19 exposure:

I enjoyed being able to take the virtual classes to fix in a flexible schedule and be a part of the class without having to worry about being around others while pregnant.

The virtual classes helped ease my worry about being around others and different people while being pregnant during this time.

By the end of the 10-week intervention, prenatal yoga had helped women prioritize themselves and recognize the need to take care of their mental health. Several women cited the importance of taking time for themselves, as well as the necessity of self-care for the well-being of their entire household:

Virtual Yoga has been great for helping me get back to that regular "me time" and help me decompress. I am a SAHM [stay at home mom] so my exercise time is very important to help me de-stress.

I have learned over the past 10 weeks that I must find and dedicate the time to my own well-being and with that, I have to sacrifice other care tasks around the house like making dinner, cleaning, and laundry. At the end of the day (and the 10 weeks), my home is happier and healthier because I've learned to care for myself in a new way.

Prenatal yoga may have also helped women prepare for delivery and motherhood more than other forms of exercise. While the difference in preparedness may have been due to individual circumstances, it's possible that the mindful integration of mother's connection to baby in prenatal yoga helped women feel ready for motherhood. At the end of the study, one control group participant stated:

I don't feel prepared enough for a baby and stressing about not having everything together like I should.

In contrast to this, a prenatal yoga participant said:

> *I have felt less stressed about birth and being a mother over the past 10 weeks.*

Along with these comments about prenatal yoga, participants in both groups discussed ways that exercise in general helped their mental health.

Exercise helped with mental health. Participants in both groups also mentioned the ways that exercise in general helped with their mental health. Prenatal yoga participants said:

> *Without exercise I can feel general stress and anxiety build up and changes my outward mood towards others. I am a much more joyful, confident, and energetic person when I add exercise to my normal routine.*

> *Our gym was shut down for several months because of Covid, and it was taking a toll on my physical and mental health.*

Similarly, some control group participants felt that exercising helped their overall mental health:

> *Helps clear my mind.*

> *Being able to focus on something to better myself and not what was causing stress.*

> *Kept a normal routine.*

While some control group participants felt that they benefitted from exercise, one participant stated that exercise still did not significantly improve their mental health:

[COVID] is still at the forefront of my daily worry.

Other control group participants felt that exercise did not help their mental health and COVID-19-related anxiety at all. When asked how exercise helped with COVID-19-related stress and anxiety, one participant simply replied:

It didn't.

Although the benefits of exercise other than prenatal yoga for mental health were unclear for this group of women, it is undeniable that COVID-19 has introduced new challenges for mental health. These challenges have been exacerbated by pregnancy and the various stressors, both expected and unexpected, that accompany pregnancy. Tables 4 and 5 summarize the main themes and representative quotes from each group.

Table 4: Yoga group responses to open-ended questions organized by theme

Question	Theme	Quote
How did yoga help you deal with general stress and/or anxiety?	Improved mood and mental health	"Without exercise I can feel general stress and anxiety build up and changes my outward mood towards others. I am a much more joyful, confident, and energetic person when I add exercise to my normal routine."
		"I always did the recorded sessions, not the live ones, so I would choose to do them at a time when I was feeling stressed or needed a break. By the end of the session I always felt much more calm and clear-headed."
		"Yoga definitely boosted my mood in the hours that followed."
		"It was a space where I could leave the worries around the door or I could bring them in and move through them with the different positions. It was soothing to have a physical outlet."
		"Relaxing my body and mind and working to intentionally set aside worries, anxieties, and things out of my control."
	Focus on myself and baby	"It helped me carve out time each week to focus on me and also have time to focus on baby and me."
		"It forced me to stop what I was doing and stop thinking about everything else happening around me and focus on myself."
How did yoga help you deal with COVID-19 related stress and/or anxiety?	Took mind off of COVID-19	"It got my mind off some of the craziness happening and reminded me of the baby growing inside me and the bond we have. And also how I can do things to help me stay calm and in turn, help the baby."
		"It was a time in which I was able to completely forget what was going on in the outside world."
		"Virtual Yoga has been great for helping me get back to that regular "me time" and help me decompress. I am a SAHM [stay at home mom] so my exercise time is very important to help me de-stress."

		"I enjoyed being able to take the virtual classes to fix in a flexible schedule and be apart of the class without having to worry about being around others while pregnant."
	Knowledge that classes were safe	"I think it helped to have a way to get my body moving that I could do without leaving home. I spend a lot of time at home studying/working at my kitchen table, so being able to take a break and move was a big help."
		"Reminded me that I can still find ways to unwind and relax that are safe for me, my baby, and my family"
Has your mental health changed over the last 10 weeks? If yes, please explain.	COVID-19 made mental health worse/ fear of being in public	"It fluctuates. I can feel confident in public and have the "lets go on with our lives" attitude, and the next I am not wanting to leave the house. I do believe that in the past 10-weeks I have become less comfortable with going out in public or having people to my house. Mostly due to the increasing Covid cases close to our family and friends, and our town."
		"I don't feel comfortable taking my children anywhere in public, so we stay at home most of the time. As a social person, that drains my energy and exacerbates any depressive thoughts."
		"We can't go anywhere or do anything and I feel stuck behind the four walls of my house."
		"Personally impacted by COVID death in my family, and many family members contracting COVID; stressed by not knowing how to handle COVID; stressed for wanting to be social and have interactions, but not able to do so; stressed for not feeling understood by others in my caution of COVID; of not knowing the truth and facts about the virus - the uncertainties of it and how it affects different people."
		"I feel less worried and tense."
	Yoga helped mental health	"Ability to recognize tension and stress in my body, and my own inability to control many of the things around me (and my baby); being mindful of my present circumstance and where I am mentally/emotionally"

		"The virtual classes helped ease my worry about being around others and different people while being pregnant during this time."
What did you like about the prenatal yoga classes?	Poses helped with aches and pains of pregnancy	"I loved having classes tailored to me (because I was the only one). I could then take those positions and self-soothe different aches and pains as my baby boy moved and grew." "Felt good to stretch my body and have the deep relaxation at the end" "It was nice to be able to continue doing yoga while being pregnant and not having to be too restrictive in poses because others were offered." "I loved the instructor and the way that she took into consideration all the aches and pains that take place during pregnancy." "I loved being able to do gentle poses to help ease stress or pain."
Is there anything else you would like to share about your experience with prenatal yoga or your feelings of stress, anxiety, or depression during the last 10 weeks?	Individual stressors make mental health worse	"It has definitely helped keep me active and also incorporate other exercises and healthy choices during my pregnancy." "I love that it's a class specifically designed for pre-natal so I know that I don't have to remember modifications or feel "less-than" if I was attending a regular class." "It helped me in a major way. At the beginning of the study I was suffering from severe anxiety and depression." "The past 10 weeks I have been in couples' counseling with my husband as well as trying to still figure out SAHM life with toddler twins and still find time for myself. There were days where I didn't prioritize myself because of this and those were the days reflected in my poor mental/physical/emotional health days earlier in the survey. I have learned over the past 10 weeks that I must find and dedicate the time to my own well-being and with that, I have to sacrifice other care tasks around the house like making dinner, cleaning, and laundry. At the end of the day (and the

	10 weeks), my home is happier and healthier because I've learned to care for myself in a new way."
	"I have felt less stressed about birth and being a mother over the past 10 weeks"
	"I should mention that I do have clinical depression/bipolar, and I started on a new medication about a month ago (buproprion) that has helped my symptoms A LOT. I also started doing my third round of TMS therapy (about 2-3 weeks ago) and have been doing physical therapy for my low back consistently throughout. With that said, I do feel that some of the improvement in both my mood and my physical symptoms has been caused by/helped along by the yoga. I also feel like yoga has been helpful in reducing my headaches - I had been getting tension headaches a fair bit, but I've noticed that they have reduced a lot, and I'm feeling a lot less tension in my neck and shoulders in general. The only thing I've changed with regards to that is doing yoga."
	"My anxiety in general regarding covid and delivery went up during the study period (i.e. covid has gotten worse, I am closer to deliver, baby has IUGR). Yoga definitely help me to feel calmer each week. Sometimes I felt pressure or even stress to make sure I could find a time to do it as I am working full time with minimal childcare. That said, every time I did it, I always felt calmer mentally and felt better physically. I was always glad I did it after!"

Table 5: Control group responses to open-ended questions organized by theme

Question	Theme	Quote
How did exercise help you deal with general stress and/or anxiety?	Something else to focus on	"Being able to focus on something to better myself and not what was causing stress."
		"Gave me something else to focus on and made my body feel better."
	Mental health benefits	"Moderately helped."
		"Helps clear my mind."
		"Builds confidence."
How did exercise help you deal with COVID-19 related stress and/or anxiety?	Somewhat beneficial for COVID-19 related stress	"Somewhat. It still at the forefront of my daily worry."
		"It didn't."
		"Kept a normal routine."
		"It gave me something to focus on while I was out of work due to Covid shutdown."
Has your mental health changed since the start of these 10 weeks? If yes, please explain.	Mental health has gotten worse	"I don't feel prepared enough for a baby and stressing about not having everything together like I should."
		"More nervous and anxious regarding COVID. Scared me or my family will get sick. Worried about the holidays and trying to navigate COVID during the end of pregnancy."
Has your COVID-19-related stress and anxiety changed over the course of the 10 weeks? If yes, how so (i.e. stressed by the rise in case numbers, been personally impacted by	Individual stressors make mental health worse	"Yes my husband was diagnosed with testicular cancer and underwent a major surgery to remove tumors. He is unable to help or assist around the house and we have had to travel for lots of dr appts out of state."
		"Being pregnant during covid has caused a lot of anxiety and not having as many activities to go out and do has been hard."

COVID-19, etc…)		"I've been laid off multiple times, and I am denied unemployment, so I have been stressed about money mostly."
Have any other stressors changed during your 10-week participation? (Ex. financial concerns, work-related concerns, concerns about your baby, etc.) If yes, please explain.	Individual stressors make mental health worse	"Financial concerns have definitely been a worry of mine over the last few weeks as I won't be receiving maternity leave once I have the baby." "I was diagnosed with mild preeclampsia at 33 weeks and have been on bedrest. This caused me to have to stop working and my 3 children to be looked after by family in another state." "Maternity leave, finances, moving, might deliver baby late and I'm tired of being pregnant, relationship issues"

Discussion

Consistent with the hypotheses of the study, prenatal yoga improved mental health (as part of 10-week prenatal yoga program and acutely before and after a single session). After the intervention, the yoga group had lower anxiety and depression than the control group, and acute mood improvements were noted after just one class. Yoga participants agreed that prenatal yoga helped them cope with both day-to-day stress and COVID-19-related stress.

The COVID-19 pandemic has created mental health challenges for many people, but these challenges are uniquely exacerbated in pregnant women[5,6,69,71,72]. Stress over fetal health and labor and delivery, along with the removal of social support as a result of social distancing, have contributed to an increase in the number of pregnant women with anxiety and depression[9,73]. This decline in mental health has implications for both maternal and fetal health. Along with increasing the risk of hypertension, preeclampsia, and infection[10,11,75], poor mental health during pregnancy also affects fetal neurodevelopment[22,84]. The consequences of this can last well into adulthood, further contributing to the importance of controlling mental health during pregnancy[12].

The results of this study are in line with most of the existing research on prenatal yoga, which agrees that prenatal yoga is beneficial for both short- and long-term mental health improvements. However, this study is the first to observe the effects of a prenatal yoga intervention in a prolonged period of stress, such as a pandemic. Regarding short-term improvements, Newham et al.[23] observed significant differences in anxiety after one class of yoga among pregnant women. Additionally, anxiety scores were lower before the last yoga class of the study than before the first class[23]. Similar to the findings of this

thesis study, Satyapriya et al. found that stress decreased in a yoga group and increased in the control group after a 16-week intervention[108]; these findings were replicated in a later study on well-being during pregnancy[109]. Field et al. also observed greater decreases in anxiety and depression after 12 weeks of a prenatal yoga and massage intervention than in a control group[110]. Several studies have examined salivary cortisol and found that this physiological measure of stress is significantly lower after just one class, and also lower than control group salivary cortisol at the end of the study[22,23]. One of these studies also found that salivary immunoglobulin A, a prominent immune antibody in the mucus membranes, increased in the yoga group compared to the control group[22]. Along with the decrease in physiological stress, this increase indicates enhanced immune function after 20 weeks of prenatal yoga[22]. In a study examining physical health, participants in the yoga intervention had significantly lower incidences of hypertension, preeclampsia, and intrauterine growth restriction[16]. Interestingly, Davis et al. found no differences in anxiety and depression between a yoga and control group after eight weeks of prenatal yoga[104]. One possible explanation for the lack of consistent findings is that longer interventions (> 8 weeks) may be more conducive to significant improvements in mental health. The present study contributes significantly to the field by demonstrating the effectiveness of prenatal yoga for mental health during stressful time periods, such as the COVID-19 pandemic.

Although there were significant differences in both anxiety and depression at the end of the study, neither measure was reduced completely by the intervention. This may be related to the nature of mental health. While there are many factors that contribute to depression, it is generally agreed that eating a poor diet, leading a sedentary life, and

disrupted sleeping patterns can all worsen depression[111-113]. A healthy diet, physically active lifestyle, and regular sleep are not always enough to treat depression, but these lifestyle factors can improve depression when used with other lifestyle modifications or with clinical treatments, such as medication and therapy[114,115]. Giuntella et al.[114] found that lifestyle factors such as sleep, social interaction, and physical activity were more closely associated with depression during the pandemic than prior to the pandemic. However, resuming physical activity during the pandemic was not enough to improve mental health[114]. This relationship is reflected in one prenatal yoga participant in this study, who had clinically diagnosed depression and bipolar disorder. She was being treated with medication and transcranial magnetic stimulation, which helped her symptoms, but she also reported that yoga helped with her physical and mental symptoms (Table 4). Once weekly prenatal yoga classes may not be enough to treat depression, but when used in conjunction with other therapeutic modalities and lifestyle modifications, prenatal yoga can help improve depression and overall mental health.

It is important to note that the pandemic continued to escalate over the course of this study. The number of positive COVID-19 cases continues to rise, as did the number of deaths as a result of COVID-19 from October 2020 to February 2021[27,28]. Additionally, a new variant was identified and began to spread, creating additional uncertainty and stress[116]. Vaccines began to be more widely available, which may have helped relive COVID-19-related anxiety, but initially these vaccines were only available to limited populations, which may have excluded most of the study participants[117]. It would have been reasonable to expect a plateau in mental health in the intervention group, as even maintaining mental health would be an important achievement during

such a stressful time. However, despite the circumstances of the pandemic worsening during data collection (which was substantiated by self-reported participant experiences), the yoga group saw significant improvements in anxiety, depression, and overall mood. One class was enough to significantly improve every subscale of the POMS questionnaire, as well as total mood disturbance. These effects were maintained across 10 weeks, and at the end of 10 weeks yoga participants also reported significantly lower anxiety and depression scores.

This study has several notable strengths. The study was a randomized controlled clinical trial, which is the strongest level of evidence and allows the ability to determine cause and effect. All yoga classes throughout the study were led by the same registered prenatal yoga teacher with many years of experience. Participants were able to form connections with this teacher, and her experience allowed them to trust her and feel comfortable in classes. Another strength is the autonomy granted to participants with respect to class format. Each week, participants were able to choose to attend classes virtually or in-person. This choice allowed participants to decide where they felt safest each week, improved adherence, and also removed the stress of travel to and from the studio for those who chose virtual classes. Lastly, this study was able to observe a unique period of the pandemic where cases were increasing and a new variant of the virus was spreading. Although mental health has been turbulent during the entirety of the pandemic, this period represented a particularly interesting time to observe mental health and evaluate the effects of prenatal yoga.

One limitation in this study was the potential for bias based on the individual impact of the pandemic throughout data collection. As data collection occurred over a

period of several months, the mental status of participants at the end of the study may have varied widely based on the number of positive cases, the availability of vaccines, and the impact on themselves and their families. Additionally, the benefits of prenatal yoga may not have been as pronounced with virtual classes as with in-person classes. The lighting, background noise, and social interaction of in-person yoga classes can play an important role in enjoyment and mental health improvement, and these elements were missing from virtual practice. Finally, it was not possible to control for other methods that participants may have used to manage their depression or anxiety, such as medication or therapy. While one participant did mention that yoga in addition to these treatments was beneficial for her mental health, it is not possible to isolate the effects of prenatal yoga in these instances.

Future research should continue to study mental health interventions in pregnancy. A similarly structured randomized controlled trial could be designed to assess the effect of prenatal or unmodified yoga for mental health in a postpartum population during the COVID-19 pandemic. Other studies may also investigate the effects of other forms of exercise on mental health in pregnancy during the COVID-19 pandemic. Finally, future research may examine the effects of prenatal yoga on mental health for pregnant women who were already diagnosed with clinical depression, anxiety, bipolar disorder, or other mental health disorders at the start of the COVID-19 pandemic. Although the COVID-19 pandemic may end in the near future, other pandemics may arise in the near or distant future, and stressful situations will continue to be inevitable in personal and professional life. Understanding how to support the mental health of pregnant women during this pandemic and other stressful time periods has important

implications for the health of mothers, as well as for the health of their children. Prenatal yoga may continue to be a viable exercise option for women who are still weary of going to gyms or being around large groups of people as life in America slowly transitions back to normalcy.

Conclusion

The results of this study support the use of prenatal yoga for mental health during pregnancy in the COVID-19 pandemic. These results have immediate clinical significance for women who are pregnant or trying to become pregnant during the COVID-19 pandemic. It is difficult to anticipate when the pandemic will improve, and until the number of positive cases improves and vaccines are widely available, mental health will continue to be an important concern. Mental health during pregnancy has important implications for both maternal and fetal health, making it essential to promote the mental health of pregnant women in every way possible during the COVID-19 pandemic. After this 10-week prenatal yoga intervention, anxiety and depression scores were well below clinical thresholds for yoga participants and well above these thresholds for control participants, and just one class was enough to elicit favorable changes in mental health. Along with other lifestyle modifications, providers can recommend prenatal yoga to their pregnant patients as a way to improve both physical and mental health during the COVID-19 pandemic.

References

1. Listings of WHO's response to COVID-19 [Internet]. [cited 2021 Feb 2]. Available from: https://www.who.int/news/item/29-06-2020-covidtimeline
2. Cowling BJ, Aiello AE. Public Health Measures to Slow Community Spread of Coronavirus Disease 2019. The Journal of Infectious Diseases. 2020 May 11;221(11):1749–51.
3. Singhal T. A Review of Coronavirus Disease-2019 (COVID-19). Indian J Pediatr. 2020 Apr 1;87(4):281–6.
4. CDC. Coronavirus Disease 2019 (COVID-19) – Symptoms [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Feb 2]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html
5. Kajdy A, Feduniw S, Ajdacka U, Modzelewski J, Baranowska B, Sys D, et al. Risk factors for anxiety and depression among pregnant women during the COVID-19 pandemic: A web-based cross-sectional survey. Medicine (Baltimore). 2020 Jul 24;99(30):e21279.
6. Salehi L, Rahimzadeh M, Molaei E, Zaheri H, Esmaelzadeh-Saeieh S. The relationship among fear and anxiety of COVID-19, pregnancy experience, and mental health disorder in pregnant women: A structural equation model. Brain Behav. 2020 Nov;10(11):e01835.
7. Lokken EM, Walker CL, Delaney S, Kachikis A, Kretzer NM, Erickson A, et al. Clinical characteristics of 46 pregnant women with a severe acute respiratory syndrome coronavirus 2 infection in Washington State. Am J Obstet Gynecol. 2020 Dec;223(6):911.e1-911.e14.

8. CDC. Pregnant People: At increased risk for severe illness from COVID-19 [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Mar 29]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/pregnant-people.html
9. Davenport MH, Meyer S, Meah VL, Strynadka MC, Khurana R. Moms Are Not OK: COVID-19 and Maternal Mental Health. Front Glob Womens Health [Internet]. 2020 [cited 2021 Feb 2];1. Available from: https://www.frontiersin.org/articles/10.3389/fgwh.2020.00001/full?utm_source=fweb&utm_medium=nblog&utm_campaign=ba-sci-fgwh-covid-moms-depression
10. Christian LM. Stress and Immune Function during Pregnancy: An Emerging Focus in Mind-Body Medicine. Curr Dir Psychol Sci. 2015 Feb 27;24(1):3–9.
11. Crosson JB. Psychoneuroimmunology, Stress, and Pregnancy. International Journal of Childbirth Education. 2012 Apr;27(2):76–9.
12. Dunkel Schetter C, Tanner L. Anxiety, depression and stress in pregnancy: implications for mothers, children, research, and practice. Curr Opin Psychiatry. 2012 Mar;25(2):141–8.
13. Hermann A, Fitelson EM, Bergink V. Meeting Maternal Mental Health Needs During the COVID-19 Pandemic. JAMA Psychiatry [Internet]. 2020 Jul 15 [cited 2020 Nov 9]; Available from: https://jamanetwork.com/journals/jamapsychiatry/fullarticle/2768028
14. ACOG Committee Opinion No. 650: Physical Activity and Exercise During Pregnancy and the Postpartum Period. Obstet Gynecol. 2015 Dec;126(6):e135–42.

15. ACSM's guidelines for exercise testing and prescription. Vol. 10. Philadelphia, PA: Wolters Kluwer; 2018.
16. Rakhshani A, Nagarathna R, Mhaskar R, Mhaskar A, Thomas A, Gunasheela S. The effects of yoga in prevention of pregnancy complications in high-risk pregnancies: a randomized controlled trial. Prev Med. 2012 Oct;55(4):333–40.
17. Nadholta P, Bali P, Singh A, Anand A. Potential benefits of Yoga in pregnancy-related complications during the COVID-19 pandemic and implications for working women. Work. 2020;67(2):269–79.
18. Jiang Q, Wu Z, Zhou L, Dunlop J, Chen P. Effects of yoga intervention during pregnancy: a review for current status. Am J Perinatol. 2015 May;32(6):503–14.
19. Piper TJ, Jacobs E, Haiduke M, Waller M, McMillan C. Core Training Exercise Selection During Pregnancy. Strength & Conditioning Journal. 2012 Feb;34(1):55–62.
20. Martens DL, Hernandez B, Strickland G, Boatwright D. Pregnancy and Exercise: Physiological Changes and Effects on the Mother and Fetus. Strength & Conditioning Journal. 2006 Feb;28(1):78–82.
21. Schoenfeld B. Resistance Training During Pregnancy: Safe and Effective Program Design. Strength & Conditioning Journal. 2011 Oct;33(5):67–75.
22. Chen P-J, Yang L, Chou C-C, Li C-C, Chang Y-C, Liaw J-J. Effects of prenatal yoga on women's stress and immune function across pregnancy: A randomized controlled trial. Complement Ther Med. 2017 Apr;31:109–17.

23. Newham JJ, Wittkowski A, Hurley J, Aplin JD, Westwood M. Effects of antenatal yoga on maternal anxiety and depression: a randomized controlled trial. Depress Anxiety. 2014 Aug;31(8):631–40.
24. CDC. Coronavirus Disease 2019 (COVID-19) [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Feb 2]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/cdcresponse/about-COVID-19.html
25. Coronavirus Disease 2019 [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Feb 2]. Available from: https://www.cdc.gov/media/releases/2020/p0121-novel-coronavirus-travel-case.html
26. IHR Emergency Committee on Novel Coronavirus (2019-nCoV) [Internet]. [cited 2021 Feb 2]. Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-statement-on-ihr-emergency-committee-on-novel-coronavirus-(2019-ncov)
27. CDC. COVID Data Tracker [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Feb 2]. Available from: https://covid.cdc.gov/covid-data-tracker
28. Coronavirus in the U.S.: Latest Map and Case Count - The New York Times [Internet]. [cited 2021 Feb 3]. Available from: https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html
29. Adedoyin OB, Soykan E. Covid-19 pandemic and online learning: the challenges and opportunities. Interactive Learning Environments. 2020 Sep 2;0(0):1–13.

30. Tracking the COVID-19 Recession's Effects on Food, Housing, and Employment Hardships [Internet]. Center on Budget and Policy Priorities. 2020 [cited 2021 Feb 2]. Available from: https://www.cbpp.org/research/poverty-and-inequality/tracking-the-covid-19-recessions-effects-on-food-housing-and
31. Gershman J. A guide to state coronavirus lockdowns. Wall Street Journal. Retrieved April. 2020;3.
32. Pfefferbaum B, North CS. Mental Health and the Covid-19 Pandemic. New England Journal of Medicine. 2020 Aug 6;383(6):510–2.
33. Dashraath P, Wong JLJ, Lim MXK, Lim LM, Li S, Biswas A, et al. Coronavirus disease 2019 (COVID-19) pandemic and pregnancy. Am J Obstet Gynecol. 2020 Jun;222(6):521–31.
34. Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. The Lancet. 2020 Mar 7;395(10226):809–15.
35. Schwartz DA, Graham AL. Potential Maternal and Infant Outcomes from Coronavirus 2019-nCoV (SARS-CoV-2) Infecting Pregnant Women: Lessons from SARS, MERS, and Other Human Coronavirus Infections. Viruses. 2020 Feb;12(2):194.
36. Wong SF, Chow KM, Leung TN, Ng WF, Ng TK, Shek CC, et al. Pregnancy and perinatal outcomes of women with severe acute respiratory syndrome. American Journal of Obstetrics and Gynecology. 2004 Jul 1;191(1):292–7.

37. Lam CM, Wong SF, Leung TN, Chow KM, Yu WC, Wong TY, et al. A case-controlled study comparing clinical course and outcomes of pregnant and non-pregnant women with severe acute respiratory syndrome. BJOG: An International Journal of Obstetrics & Gynaecology. 2004;111(8):771–4.
38. Assiri A, Abedi GR, Al Masri M, Bin Saeed A, Gerber SI, Watson JT. Middle East Respiratory Syndrome Coronavirus Infection During Pregnancy: A Report of 5 Cases From Saudi Arabia. Clinical Infectious Diseases. 2016 Oct 1;63(7):951–3.
39. Della Gatta AN, Rizzo R, Pilu G, Simonazzi G. Coronavirus disease 2019 during pregnancy: a systematic review of reported cases. American Journal of Obstetrics & Gynecology. 2020 Jul;223(1):36–41.
40. Mullins E, Evans D, Viner RM, O'Brien P, Morris E. Coronavirus in pregnancy and delivery: rapid review. Ultrasound Obstet Gynecol. 2020 May;55(5):586–92.
41. Chen S, Huang B, Luo DJ, Li X, Yang F, Zhao Y, et al. [Pregnancy with new coronavirus infection: clinical characteristics and placental pathological analysis of three cases]. Zhonghua Bing Li Xue Za Zhi. 2020 May 8;49(5):418–23.
42. Liu D, Li L, Wu X, Zheng D, Wang J, Yang L, et al. Pregnancy and Perinatal Outcomes of Women With Coronavirus Disease (COVID-19) Pneumonia: A Preliminary Analysis. American Journal of Roentgenology. 2020 Mar 18;215(1):127–32.
43. Zambrano LD. Update: Characteristics of Symptomatic Women of Reproductive Age with Laboratory-Confirmed SARS-CoV-2 Infection by Pregnancy Status — United States, January 22–October 3, 2020. MMWR Morb Mortal Wkly Rep

[Internet]. 2020 [cited 2021 Feb 4];69. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6944e3.htm

44. Ellington S. Characteristics of Women of Reproductive Age with Laboratory-Confirmed SARS-CoV-2 Infection by Pregnancy Status — United States, January 22–June 7, 2020. MMWR Morb Mortal Wkly Rep [Internet]. 2020 [cited 2021 Feb 4];69. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6925a1.htm
45. Delahoy MJ. Characteristics and Maternal and Birth Outcomes of Hospitalized Pregnant Women with Laboratory-Confirmed COVID-19 — COVID-NET, 13 States, March 1–August 22, 2020. MMWR Morb Mortal Wkly Rep [Internet]. 2020 [cited 2021 Feb 4];69. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6938e1.htm
46. Panagiotakopoulos L. SARS-CoV-2 Infection Among Hospitalized Pregnant Women: Reasons for Admission and Pregnancy Characteristics — Eight U.S. Health Care Centers, March 1–May 30, 2020. MMWR Morb Mortal Wkly Rep [Internet]. 2020 [cited 2021 Feb 4];69. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6938e2.htm
47. Vääräsmäki M, Raudaskoski T. Pregnancy and delivery after a cesarean section. Duodecim. 2017;133(4):345–52.
48. Sandall J, Tribe RM, Avery L, Mola G, Visser GH, Homer CS, et al. Short-term and long-term effects of caesarean section on the health of women and children. Lancet. 2018 Oct 13;392(10155):1349–57.
49. Hamilton BE. Births: Provisional Data for 2019. :10.

50. Zhu H, Wang L, Fang C, Peng S, Zhang L, Chang G, et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia. Translational Pediatrics. 2020 Feb;9(1):510–60.
51. Lopian M, Kashani-Ligumsky L, Czeiger S, Cohen R, Schindler Y, Lubin D, et al. Safety of vaginal delivery in women infected with COVID-19. Pediatr Neonatol. 2021 Jan;62(1):90–6.
52. Cai J, Tang M, Gao Y, Zhang H, Yang Y, Zhang D, et al. Cesarean Section or Vaginal Delivery to Prevent Possible Vertical Transmission From a Pregnant Mother Confirmed With COVID-19 to a Neonate: A Systematic Review. Front Med [Internet]. 2021 [cited 2021 Apr 6];8. Available from: https://www.frontiersin.org/articles/10.3389/fmed.2021.634949/full
53. American College of Obstetricians and Gynecologists. COVID-19 FAQs for obstetricians-gynecologists, obstetrics. Washington, DC: ACOG; 2020. Available at: https://www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics. Retrieved 3 Feb 2020.
54. CDC. COVID-19 and Your Health [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Feb 4]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html
55. CDC. Coronavirus Disease 2019 (COVID-19) [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Feb 4]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/more/masking-science-sars-cov2.html

56. Doung-Ngern P, Suphanchaimat R, Panjangampatthana A, Janekrongtham C, Ruampoom D, Daochaeng N, et al. Case-Control Study of Use of Personal Protective Measures and Risk for SARS-CoV 2 Infection, Thailand. Emerg Infect Dis. 2020 Nov;26(11):2607–16.
57. Payne DC, Smith-Jeffcoat SE, Nowak G, Chukwuma U, Geibe JR, Hawkins RJ, et al. SARS-CoV-2 Infections and Serologic Responses from a Sample of U.S. Navy Service Members - USS Theodore Roosevelt, April 2020. MMWR Morb Mortal Wkly Rep. 2020 Jun 12;69(23):714–21.
58. Guardino CM, Schetter CD. Understanding Pregnancy Anxiety: Concepts, Correlates, and Consequences. ZERO TO THREE. 2014 Mar;34(4):12–21.
59. Arora N, Sadovsky Y, Dermody TS, Coyne CB. Microbial vertical transmission during human pregnancy. Cell Host Microbe. 2017 May 10;21(5):561–7.
60. Dumitriu D, Emeruwa UN, Hanft E, Liao GV, Ludwig E, Walzer L, et al. Outcomes of Neonates Born to Mothers With Severe Acute Respiratory Syndrome Coronavirus 2 Infection at a Large Medical Center in New York City. JAMA Pediatr. 2021 Feb 1;175(2):157.
61. Wang S, Guo L, Chen L, Liu W, Cao Y, Zhang J, Feng L. A case report of neonatal COVID-19 infection in China. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America. 2020 Mar 12.
62. Hu X, Gao J, Luo X, Feng L, Liu W, Chen J, et al. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Vertical Transmission in Neonates Born to Mothers With Coronavirus Disease 2019 (COVID-19) Pneumonia. Obstet

Gynecol [Internet]. 2020 Apr 24 [cited 2021 Feb 8]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7219851/

63. Wu Y, Liu C, Dong L, Zhang C, Chen Y, Liu J, et al. Coronavirus disease 2019 among pregnant Chinese women: case series data on the safety of vaginal birth and breastfeeding. BJOG: An International Journal of Obstetrics & Gynaecology. 2020;127(9):1109–15.
64. Steinbuch Y. Chinese baby tests positive for coronavirus 30 hours after birth [Internet]. New York Post. 2020 [cited 2021 Feb 4]. Available from: https://nypost.com/2020/02/05/chinese-baby-tests-positive-for-coronavirus-30-hours-after-birth/
65. Woodworth KR. Birth and Infant Outcomes Following Laboratory-Confirmed SARS-CoV-2 Infection in Pregnancy — SET-NET, 16 Jurisdictions, March 29–October 14, 2020. MMWR Morb Mortal Wkly Rep [Internet]. 2020 [cited 2021 Feb 4];69. Available from: https://www.cdc.gov/mmwr/volumes/69/wr/mm6944e2.htm
66. Knight M, Bunch K, Vousden N, Morris E, Simpson N, Gale C, et al. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study. BMJ. 2020 Jun 8;369:m2107.
67. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK. Births: Final Data for 2018. Natl Vital Stat Rep. 2019 Nov;68(13):1–47.
68. Martin JA, Hamilton BE, Osterman MJK. Births in the United States, 2019. NCHS Data Brief. 2020 Oct;(387):1–8.

69. Heitzman J. Impact of COVID-19 pandemic on mental health. Psychiatr Pol. 2020 Apr 30;54(2):187–98.

70. Vindegaard N, Benros ME. COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. Brain Behav Immun. 2020 Oct;89:531–42.

71. Limcaoco RSG, Mateos EM, Fernández JM, Roncero C. Anxiety, worry and perceived stress in the world due to the COVID-19 pandemic, March 2020. Preliminary results. medRxiv. 2020 Apr 6;2020.04.03.20043992.

72. Hussein J. COVID-19: What implications for sexual and reproductive health and rights globally? Sexual and Reproductive Health Matters. 2020 Jan 1;28(1):1746065.

73. Farrell T, Reagu S, Mohan S, Elmidany R, Qaddoura F, Ahmed EE, et al. The impact of the COVID-19 pandemic on the perinatal mental health of women. J Perinat Med. 2020 Nov 26;48(9):971–6.

74. Alhusen JL, Ayres L, DePriest K. Effects of Maternal Mental Health on Engagement in Favorable Health Practices During Pregnancy. Journal of Midwifery & Women's Health. 2016;61(2):210–6.

75. Christian LM. Psychoneuroimmunology in Pregnancy: Immune Pathways Linking Stress with Maternal Health, Adverse Birth Outcomes, and Fetal Development. Neurosci Biobehav Rev. 2012 Jan;36(1):350–61.

76. CDC. Vaccination Considerations for People Pregnant or Breastfeeding [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Mar 9].

Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html

77. Kwon EJ, Kim YJ. What is fetal programming?: a lifetime health is under the control of in utero health. Obstetrics & gynecology science. 2017 Nov;60(6):506.

78. Marciniak A, Patro-Małysza J, Kimber-Trojnar Ż, Marciniak B, Oleszczuk J, Leszczyńska-Gorzelak B. Fetal programming of the metabolic syndrome. Taiwanese Journal of Obstetrics and Gynecology. 2017 Apr 1;56(2):133-8.

79. Lilliecreutz C, Larén J, Sydsjö G, Josefsson A. Effect of maternal stress during pregnancy on the risk for preterm birth. BMC Pregnancy and Childbirth. 2016 Jan 15;16(1):5.

80. O'Donnell KJ, Meaney MJ. Fetal Origins of Mental Health: The Developmental Origins of Health and Disease Hypothesis. AJP. 2016 Nov 14;174(4):319–28.

81. Baghianimoghadam MH, Baghianimoghadam B, Ardian N, Alizadeh E. Risk factors of low birth weight and effect of them on growth pattern of children up to sixth months of life: A cross-sectional study. J Educ Health Promot [Internet]. 2015 May 19 [cited 2020 May 4];4. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4456878/

82. Barakat R, Lucia A, Ruiz JR. Resistance exercise training during pregnancy and newborn's birth size: a randomised controlled trial. International Journal of Obesity. 2009 Sep;33(9):1048–57.

83. Halimi asl A asghar, Safari S, Parvareshi Hamrah M. Epidemiology and Related Risk Factors of Preterm Labor as an obstetrics emergency. Emerg (Tehran)

[Internet]. 2017 [cited 2021 Feb 22];5(1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5325899/

84. Rudolph MD, Graham AM, Feczko E, Miranda-Dominguez O, Rasmussen JM, Nardos R, et al. Maternal IL-6 during pregnancy can be estimated from newborn brain connectivity and predicts future working memory in offspring. Nature Neuroscience. 2018 May;21(5):765–72.
85. Curtis K, Weinrib A, Katz J. Systematic review of yoga for pregnant women: current status and future directions. Evid Based Complement Alternat Med. 2012;2012:715942.
86. Dong L, Bouey J. Public Mental Health Crisis during COVID-19 Pandemic, China. Emerg Infect Dis. 2020 Jul;26(7):1616–8.
87. Hinman SK, Smith KB, Quillen DM, Smith MS. Exercise in Pregnancy: A Clinical Review. Sports Health. 2015 Nov 1;7(6):527–31.
88. O'Connor PJ, Poudevigne MS, Johnson KE, de Araujo JB, Ward-Ritacco CL. Effects of resistance training on fatigue-related domains of quality of life and mood during pregnancy: A randomized trial in pregnant women with back pain. Psychosom Med. 2018 Apr;80(3):327–32.
89. Rodríguez-Blanque R, Aguilar-Cordero MJ, Marín-Jiménez AE, Menor-Rodríguez MJ, Montiel-Troya M, Sánchez-García JC. Water Exercise and Quality of Life in Pregnancy: A Randomised Clinical Trial. Int J Environ Res Public Health. 2020 Feb 17;17(4).

90. Petrov Fieril K, Glantz A, Fagevik Olsen M. The efficacy of moderate-to-vigorous resistance exercise during pregnancy: a randomized controlled trial. Acta Obstet Gynecol Scand. 2015 Jan;94(1):35–42.
91. Ward-Ritacco C, Poudevigne MS, O'Connor PJ. Muscle strengthening exercises during pregnancy are associated with increased energy and reduced fatigue. Journal of Psychosomatic Obstetrics & Gynecology. 2016 Jun;37(2):68–72.
92. Chiavaroli V, Hopkins SA, Derraik JGB, Biggs JB, Rodrigues RO, Brennan CH, et al. Exercise in pregnancy: 1-year and 7-year follow-ups of mothers and offspring after a randomized controlled trial. Sci Rep. 2018 Aug 27;8(1):12915.
93. Takahasi EHM, Alves MTSS de B e, Alves GS, Silva AAM da, Batista RFL, Simões VMF, et al. Mental health and physical inactivity during pregnancy: a cross-sectional study nested in the BRISA cohort study. Cad Saude Publica. 2013 Aug;29(8):1583–94.
94. Barakat R, Pelaez M, Lopez C, Lucia A, Ruiz JR. Exercise during pregnancy and gestational diabetes-related adverse effects: a randomised controlled trial. Br J Sports Med. 2013 Jul;47(10):630–6.
95. Fournier D, Feeney G, Mathieu M-E. Outcomes of Exercise Training Following the Use of a Birthing Ball During Pregnancy and Delivery. The Journal of Strength & Conditioning Research. 2017 Jul;31(7):1941–7.
96. Hesketh KR, Evenson KR. Prevalence of U.S. Pregnant Women Meeting 2015 ACOG Physical Activity Guidelines. Am J Prev Med. 2016 Sep;51(3):e87–9.

97. Artal R, O'Toole M, White S. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. Br J Sports Med. 2003 Feb;37(1):6–12.
98. de Oliveria Melo AS, Silva JLP, Tavares JS, Barros VO, Leite DFB, Amorim MMR. Effect of a physical exercise program during pregnancy on uteroplacental and fetal blood flow and fetal growth: a randomized controlled trial. Obstet Gynecol. 2012 Aug;120(2 Pt 1):302–10.
99. Takito MY, Benício MHD. Physical activity during pregnancy and fetal outcomes: a case-control study. Rev Saude Publica. 2010 Feb;44(1):90–101.
100. Catalano PM, Farrell K, Thomas A, Huston-Presley L, Mencin P, de Mouzon SH, et al. Perinatal risk factors for childhood obesity and metabolic dysregulation. Am J Clin Nutr. 2009 Nov;90(5):1303–13.
101. Badon SE, Littman AJ, Chan KCG, Williams MA, Enquobahrie DA. Associations of Maternal Light/Moderate Leisure-Time Walking and Yoga With Offspring Birth Size. J Phys Act Health. 2018 Jun 1;15(6):430–9.
102. Kwon R, Kasper K, London S, Haas DM. A systematic review: The effects of yoga on pregnancy. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2020 Jul 1;250:171–7
103. Polis RL, Gussman D, Kuo Y-H. Yoga in Pregnancy: An Examination of Maternal and Fetal Responses to 26 Yoga Postures. Obstet Gynecol. 2015 Dec;126(6):1237–41.

104. Davis K, Goodman SH, Leiferman J, Taylor M, Dimidjian S. A randomized controlled trial of yoga for pregnant women with symptoms of depression and anxiety. Complement Ther Clin Pract. 2015 Aug;21(3):166–72.

105. Bergink V, Kooistra L, Lambregtse-van den Berg MP, Wijnen H, Bunevicius R, van Baar A, et al. Validation of the Edinburgh Depression Scale during pregnancy. Journal of Psychosomatic Research. 2011 Apr 1;70(4):385–9.

106. Gunning MD, Denison FC, Stockley CJ, Ho SP, Sandhu HK, Reynolds RM. Assessing maternal anxiety in pregnancy with the State-Trait Anxiety Inventory (STAI): issues of validity, location and participation. Journal of Reproductive and Infant Psychology. 2010 Aug 1;28(3):266–73.

107. Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. Afr J Emerg Med. 2017;7(3):93-99.

108. Satyapriya M, Nagendra HR, Nagarathna R, Padmalatha V. Effect of integrated yoga on stress and heart rate variability in pregnant women. Int J Gynaecol Obstet. 2009 Mar;104(3):218–22.

109. Satyapriya M, Nagarathna R, Padmalatha V, Nagendra HR. Effect of integrated yoga on anxiety, depression & well being in normal pregnancy. Complement Ther Clin Pract. 2013 Nov;19(4):230–6.

110. Field T, Diego M, Medina L, Delgado J, Hernandez A. Yoga and massage therapy reduce prenatal depression and prematurity. J Bodyw Mov Ther. 2012 Apr;16(2):204–9.

111. Sarris J, O'Neil A, Coulson CE, Schweitzer I, Berk M. Lifestyle medicine for depression. BMC Psychiatry. 2014 Apr 10;14(1):107.

112. Walsh R. Lifestyle and mental health. Am Psychol. 2011 Oct;66(7):579–92.

113. Hidaka BH. Depression as a disease of modernity: explanations for increasing prevalence. J Affect Disord. 2012 Nov;140(3):205–14.

114. Giuntella O, Hyde K, Saccardo S, Sadoff S. Lifestyle and mental health disruptions during COVID-19. PNAS [Internet]. 2021 Mar 2 [cited 2021 Mar 24];118(9). Available from: https://www.pnas.org/content/118/9/e2016632118

115. García-Toro M, Ibarra O, Gili M, Serrano MJ, Oliván B, Vicens E, et al. Four hygienic-dietary recommendations as add-on treatment in depression: a randomized-controlled trial. J Affect Disord. 2012 Oct;140(2):200–3.

116. CDC. About Variants of the Virus that Causes COVID-19 [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Mar 24]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/transmission/variant.html

117. CDC. When Vaccine is Limited, Who Gets Vaccinated First? [Internet]. Centers for Disease Control and Prevention. 2021 [cited 2021 Mar 24]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations.html

Appendices

Appendix A: Contraindications to Exercise During Pregnancy and Indicators to Stop Exercise (ACOG)

Box 1. Absolute Contraindications to Aerobic Exercise During Pregnancy ⇦

- Hemodynamically significant heart disease
- Restrictive lung disease
- Incompetent cervix or cerclage
- Multiple gestation at risk of premature labor
- Persistent second- or third-trimester bleeding
- Placenta previa after 26 weeks of gestation
- Premature labor during the current pregnancy
- Ruptured membranes
- Preeclampsia or pregnancy-induced hypertension
- Severe anemia

Box 2. Relative Contraindications to Aerobic Exercise During Pregnancy ⇦

- Anemia
- Unevaluated maternal cardiac arrhythmia
- Chronic bronchitis
- Poorly controlled type 1 diabetes
- Extreme morbid obesity
- Extreme underweight (BMI less than 12)
- History of extremely sedentary lifestyle
- Intrauterine growth restriction in current pregnancy
- Poorly controlled hypertension
- Orthopedic limitations
- Poorly controlled seizure disorder
- Poorly controlled hyperthyroidism
- Heavy smoker

Box 4. Warning Signs to Discontinue Exercise While Pregnant ⇦

- Vaginal bleeding
- Regular painful contractions
- Amniotic fluid leakage
- Dyspnea before exertion
- Dizziness
- Headache
- Chest pain
- Muscle weakness affecting balance
- Calf pain or swelling

Appendix B: Physician's Release Form

A LEADING AMERICAN UNIVERSITY WITH INTERNATIONAL REACH

SCHOOL OF KINESIOLOGY, RECREATION & SPORT

PHYSICIAN'S RELEASE

Patient's Name _____

This page will give you the information you will need to understand why this study is being done and why your patient is being invited to participate. It will also describe any known risks, inconveniences or discomforts that your patient may have while participating in this study. We encourage you to ask questions at any time, including via email or phone.

1. PURPOSE
   The purpose of the study is to determine the impact of a 10-week yoga program on stress, depression, and anxiety in pregnant women during the coronavirus pandemic.

2. PROCEDURES
   This study will involve 10 weeks of a supervised prenatal yoga class. At the first and last classes, participants will respond to a series of surveys. Half of the participants will not perform any yoga, and the other half will participate in 10 weeks of yoga classes. All yoga classes will take place virtually or in-studio through Be Happy Yoga & Salt Cave in Bowling Green, KY and will be led by a Registered Prenatal Yoga teacher.

3. RISKS
   Potential risks from participation in the study are fatigue, soreness, or injury from participating in the yoga classes. NOTE: Please do not sign this form if you believe your patient has any condition that would preclude light exercise.

4. BENEFITS
   The patient will be compensated for her time and effort by receiving 10 free weeks of prenatal yoga or $20 for responding to surveys. Women who participate in the yoga intervention will have access to trained professionals to support their activity.

5. QUESTIONS

If you have any questions or concerns about your patient's participation in this program, please call Rachel Tinius (Rachel.tinius@wku.edu, 270-745-5026).

Physician's Signature _____

Date _____

Printed name _____

Appendix C: Demographic Survey

1. Age: _____ years
2. Pre- pregnancy weight: _____ pounds

3. Height: _____

4. How many weeks pregnant are you? _____
    a. Is this your first baby? Yes No
    b. If no, how many other children do you have? _____ children
    c. How old are they? _____

5. Race (circle one) African American Asian/Pacific Islander

    Caucasian Latino Other:_____

6. Race/ ethnicity:
    - ○ African American
    - ○ Asian/Pacific Islander
    - ○ Caucasian
    - ○ Latino
    - ○ Other: _____
7. What is the highest level of education you have completed?
    - ○ Some high school
    - ○ Highschool/GED
    - ○ Associates
    - ○ Bachelors
    - ○ Masters
    - ○ PhD or Higher
    - ○ Technical/Trade
8. What is your marital status?
    - ○ Single
    - ○ Married
    - ○ Separated
    - ○ Divorced
    - ○ Widowed
9. What is your annual income (or combined annual income if you have a spouse/partner)?

    ○ Less than $10,000

    ○ $10,001 to $20,000

    ○ $20,001 to $40,000

    ○ $40,001 to $60,000

    ○ $60,001 to $80,000

○ Greater than $80,000

11. How would you describe your current health status?

○ Excellent

○ Very good

○ Good

○ Fair

○ Poor

12. How many days per week do you accumulate at least 30 minutes of *moderate* physical activity? (*moderate*= activity that causes a noticeable increase in your breathing)?

○ 0 days per week

○ 1-2 days per week

○ 3 days per week

○ 4-5 days per week

○ 6-7 days per week

Appendix D: Health-Related Quality of Life Survey

1. Would you say that in general your health is
    a. Excellent
    b. Very good
    c. Good
    d. Fair
    e. Poor

2. Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health **not** good?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
3. Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health **not** good?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
4. During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
5. During the past 30 days, for about how many days did PAIN make it hard for you to do your usual activities, such as self-care, work, or recreation?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
6. During the past 30 days, for about how many days have you felt sad, blue, or depressed?
    a. 1-3 days

b. 4-6 days
c. 7-10 days
d. 10-14 days
e. More than 14 days
f. none

7. During the past 30 days, for about how many days have you felt worried, tense, or anxious?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
8. During the past 30 days, for about how many days have you felt you did **not** get enough rest or sleep?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. none
9. During the past 30 days, for about how many days have you felt very healthy and full of energy?
    a. 1-3 days
    b. 4-6 days
    c. 7-10 days
    d. 10-14 days
    e. More than 14 days
    f. None

Appendix E: Edinburgh Postnatal Depression Scale

Perinatal Services BC
An agency of the Provincial Health Services Authority

Edinburgh Perinatal/Postnatal Depression Scale (EPDS)

For use between **28–32 weeks** in **all** pregnancies and **6–8 weeks** postpartum

Name: _____ Date: _____ Gestation in Weeks: _____

As you are having a baby, we would like to know how you are feeling. Please mark "X" in the box next to the answer which comes closest to how you have felt in the **past 7 days**—not just how you feel today.

In the past 7 days:

1. I have been able to laugh and see the funny side of things
   - 0 ☐ As much as I always could
   - 1 ☐ Not quite so much now
   - 2 ☐ Definitely not so much now
   - 3 ☐ Not at all

2. I have looked forward with enjoyment to things
   - 0 ☐ As much as I ever did
   - 1 ☐ Rather less than I used to
   - 2 ☐ Definitely less than I used to
   - 3 ☐ Hardly at all

3. I have blamed myself unnecessarily when things went wrong
   - 3 ☐ Yes, most of the time
   - 2 ☐ Yes, some of the time
   - 1 ☐ Not very often
   - 0 ☐ No, never

4. I have been anxious or worried for no good reason
   - 0 ☐ No, not at all
   - 1 ☐ Hardly ever
   - 2 ☐ Yes, sometimes
   - 3 ☐ Yes, very often

5. I have felt scared or panicky for no very good reason
   - 3 ☐ Yes, quite a lot
   - 2 ☐ Yes, sometimes
   - 1 ☐ No, not much
   - 0 ☐ No, not at all

6. Things have been getting on top of me
   - 3 ☐ Yes, most of the time I haven't been able to cope
   - 2 ☐ Yes, sometimes I haven't been coping as well as usual
   - 1 ☐ No, most of the time I have coped quite well
   - 0 ☐ No, I have been coping as well as ever

7. I have been so unhappy that I have had difficulty sleeping
   - 3 ☐ Yes, most of the time
   - 2 ☐ Yes, sometimes
   - 1 ☐ Not very often
   - 0 ☐ No, not at all

8. I have felt sad or miserable
   - 3 ☐ Yes, most of the time
   - 2 ☐ Yes, quite often
   - 1 ☐ Not very often
   - 0 ☐ No, not at all

9. I have been so unhappy that I have been crying
   - 3 ☐ Yes, most of the time
   - 2 ☐ Yes, quite often
   - 1 ☐ Only occasionally
   - 0 ☐ No, never

10. The thought of harming myself has occurred to me
    - 3 ☐ Yes, quite often
    - 2 ☐ Sometimes
    - 1 ☐ Hardly ever
    - 0 ☐ Never

Total Score ☐

Appendix F: State-Trait Anxiety Inventory Questionnaire

State Trait Anxiety Inventory

Read each statement and select the appropriate response to indicate how you feel right now, that is, at this very moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	1	2	3	4
	Not at all	**A little**	**Somewhat**	**Very Much So**
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I feel tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel uncomfortable	1	2	3	4
11. I feel self confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I feel jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Appendix G: Self Rated Abilities for Health Practices Scale

The following scale asks whether you are able to perform various health practices within the context of your lifestyle and any disabilities you may have. This includes any assistance you have available to you, such as an attendant to help with stretching exercises, for example. Read each statement and use the following scale to indicate how well you are able to do each of the health practices, **not** how often you actually do it.

- 0 = Not at all
- 1 = A little
- 2 = Somewhat
- 3 = Mostly
- 4 = Completely

I AM ABLE TO:

Self Rated Abilities for Health Practices Scale

1	Find healthy foods that are within my budget	1 2 3 4
2	Eat a balanced diet	1 2 3 4
3	Figure out how much I should weight to be healthy	1 2 3 4
4	Brush my teeth regularly	1 2 3 4
5	Tell which foods are high in fiber content	1 2 3 4
6	Figure out from labels what foods are good for me	1 2 3 4
7	Drink as much water as I need to drink every day	1 2 3 4
8	Figure out things I can do to help me relax	1 2 3 4
9	Keep myself from feeling lonely	1 2 3 4
10	Do things that make me feel good about myself	1 2 3 4
11	Avoid being bored	1 2 3 4
12	Talk to friend and family about the thingsthat are bothering me	1 2 3 4

13	Figure out how I respond to stress	1 2 3 4
14	Change things in my life to reduce my stress	1 2 3 4
15	Do exercises that are good for me	1 2 3 4
16	Fit exercise into my regular routine	1 2 3 4
17	Find ways to exercise that I enjoy	1 2 3 4
18	Find accessible places for me to exercise in the community	1 2 3 4
19	Know when to quit exercising	1 2 3 4
20	Do stretching exercises	1 2 3 4
21	Keep from getting hurt when I exercise	1 2 3 4
22	Figure out where to get information on how to take care of my health	1 2 3 4
23	Watch for negative changes in my body's condition (pressure sores, breathing problems)	1 2 3 4
24	Recognize what symptoms should be reported to a doctor or nurse	1 2 3 4
25	Use medication correctly.	1 2 3 4
26	Find a doctor or nurse who gives me good advice about how to stay healthy	1 2 3 4
27	Know my rights and stand up for myself effectively	1 2 3 4
28	Get help from others when I need it	1 2 3 4

Range of Total Score = 0 – 112.
Higher scores indicate greater abilities for health practices
Subscales:
Nutrition: Items 1-7
Psychological Well Being: Items 8-14
Exercise: Items 15-21
Responsible Health Practices: Items 22-28
There are no reversed scored items.

Appendix H: Profile of Mood States Questionnaire- POMS-A

Below is a list of words that describe feelings people have. Please **CIRCLE THE NUMBER THAT BEST DESCRIBES HOW YOU FEEL <u>RIGHT NOW</u>**.

	Not at all	**A little**	**Moderately**	**Quite a lot**	**Extremely**
Tense	0	1	2	3	4
Angry	0	1	2	3	4
Worn out	0	1	2	3	4
Unhappy	0	1	2	3	4
Proud	0	1	2	3	4
Lively	0	1	2	3	4
Confused	0	1	2	3	4
Sad	0	1	2	3	4
Active	0	1	2	3	4
On-edge	0	1	2	3	4
Grouchy	0	1	2	3	4
Ashamed	0	1	2	3	4
Energetic	0	1	2	3	4
Hopeless	0	1	2	3	4
Uneasy	0	1	2	3	4
Restless	0	1	2	3	4
Unable to concentrate	0	1	2	3	4
Fatigued	0	1	2	3	4
Competent	0	1	2	3	4
Annoyed	0	1	2	3	4
Discouraged	0	1	2	3	4

Resentful	0	1	2	3	4
Nervous	0	1	2	3	4
Miserable	0	1	2	3	4
Confident	0	1	2	3	4
Bitter	0	1	2	3	4
Exhausted	0	1	2	3	4
Anxious	0	1	2	3	4
Helpless	0	1	2	3	4
Weary	0	1	2	3	4
Satisfied	0	1	2	3	4
Bewildered	0	1	2	3	4
Furious	0	1	2	3	4
Full of pep	0	1	2	3	4
Worthless	0	1	2	3	4
Forgetful	0	1	2	3	4
Vigorous	0	1	2	3	4
Uncertain about things	0	1	2	3	4
Bushed	0	1	2	3	4
Embarrassed	0	1	2	3	4

Appendix I: Final Survey- Yoga Participants

1. Current weight: _____ pounds
2. Did you practice yoga outside of the 10 classes paid for by the study?

   Yes No

   a. If yes, how many days per week?
      i. 1-2 days
      ii. 2-3days
      iii. 3-4 days
      iv. 4-5 days
      v. 5-6 days
      vi. 7 days
3. Did you participate in any exercise other than prenatal yoga during the last 10 weeks?

   Yes No

   a. If yes, how many days per week?
      i. 1-2 days
      ii. 2-3days
      iii. 3-4 days
      iv. 4-5 days
      v. 5-6 days
      vi. 7 days
   b. If yes, about how long was each session?
      i. 5-10 minutes
      ii. 10-20 minutes
      iii. 20-30 minutes
      iv. 30-40 minutes
      v. 40-50 minutes
      vi. 50-60 minutes
      vii. More than 1 hour
   c. If yes, what modes of exercise did you participate in? (select all that apply)
      i. Walking
      ii. Running
      iii. Biking (either stationary or outdoors)
      iv. CrossFit
      v. Swimming
      vi. Dancing/ Zumba
      vii. Strength training
      viii. HIIT
      ix. Other (please specify): _____
4. How much did practicing yoga help you relax from the start to end of each class?

Very much Some Neutral Not much Not at all

5. How much did practicing yoga help you relax from the start to end of 10 weeks?

   Very much Some Neutral Not much Not at all

6. Was the social interaction of your yoga classes (either virtually or in studio) helpful during this time of social distancing?

   Very much Some Neutral Not much Not at all

7. How did yoga help you deal with general stress and/or anxiety?

8. How did yoga help you deal with COVID related stress and/ or anxiety?

9. Has your mental health changed since the start of the 10 weeks?

   Yes- I feel my mental health has gotten worse

   Yes- I feel my mental health is better

   My mental health has not changed

   If yes, please explain: _____

10. Has your COVID-related stress and anxiety changed over the course of the 10 weeks?

    Yes

    No

    If yes, how so (i.e. stressed by the rise in case numbers, been personally impacted by COVID-19, etc…) ?

11. Have any other stressors changed during your 10-week participation? (Ex. financial concerns, work-related concerns, concerns about your baby, etc.)

    Yes

    No

If yes, please explain:

12. What did you like about the prenatal yoga classes?

13. Was there anything you did not like about the prenatal yoga classes?

14. Is there anything else you would like to share about your experience with prenatal yoga or your feelings of stress, anxiety, or depression during the last 10 weeks?

Appendix J: Final Survey- Control Group Participants

1. Current weight: _____ pounds
2. Did you participate in any exercise during the last 10 weeks?

   Yes No

   a. If yes, how many days per week?
      i. 1-2 days
      ii. 2-3days
      iii. 3-4 days
      iv. 4-5 days
      v. 5-6 days
      vi. 7 days
   b. If yes, about how long was each session?
      i. 5-10 minutes
      ii. 10-20 minutes
      iii. 20-30 minutes
      iv. 30-40 minutes
      v. 40-50 minutes
      vi. 50-60 minutes
      vii. More than 1 hour
   c. If yes, what modes of exercise did you participate in? (select all that apply)
      i. Walking
      ii. Running
      iii. Biking (either stationary or outdoors)
      iv. CrossFit
      v. Swimming
      vi. Dancing/ Zumba
      vii. Strength training
      viii. HIIT
      ix. Other (please specify): _____
   d. If yes, how did exercise help you deal with general stress and/or anxiety?

   e. If yes, how did exercise help you deal with COVID related stress and/ or anxiety?

3. Has your mental health changed since the start of the 10 weeks?

   Yes- I feel my mental health has gotten worse

Yes- I feel my mental health is better

My mental health has not changed

If yes, please explain: _____

4. Has your COVID-related stress and anxiety changed over the course of the 10 weeks?

   Yes

   No

   If yes, how so (i.e. stressed by the rise in case numbers, been personally impacted by COVID-19, etc…) ?

5. Have any other stressors changed during your 10-week participation? (Ex. financial concerns, work-related concerns, concerns about your baby, etc.)

   Yes

   No

   If yes, please explain: