

Original Research

## Prenatal Yoga and Mental Health During the COVID-19 Pandemic: A Randomized-Control Trial

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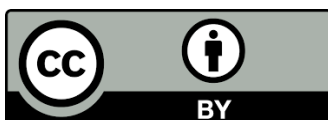
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### Abstract

Studies have demonstrated that new and expectant mothers experience increased levels of stress and anxiety during the COVID-19 pandemic. Though prenatal yoga is an effective mode of improving mental health during pregnancy, no research has evaluated its effect on mental health during times of extreme stress, such as a global pandemic. The purpose of this study was to determine the influence of a single session and a 10-week prenatal yoga intervention on the mental health of pregnant women during the COVID-19 pandemic. Women ( $n = 19$ ;  $28.52 \pm 3.74$  years;  $20.94 \pm 4.69$  weeks gestation; BMI  $29.33 \pm 9.08$ ) were randomized into a yoga or a non-yoga control group. There were no differences in demographic factors or depression/anxiety scores between groups at baseline. Baseline levels of anxiety and depression were high, with an average depression score of  $8.10 \pm 4.85$  (scores  $> 8$  represent possible depression) and an average anxiety score of  $39.26 \pm 12.99$  (scores  $\geq 39$  represent a clinically significant anxiety). After just one session of yoga, women reported feeling less



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depressed ( $p = 0.028$ ), tense ( $p < 0.001$ ), and fatigued ( $p = 0.004$ ). After 10 weeks, the yoga group had lower anxiety ( $p = 0.002$ ), depression ( $p = 0.032$ ), and total mood disturbance ( $p = 0.002$ ) scores when compared to the control group. Yoga appears to benefit the mental health of expectant mothers, even in times of extreme stress. The findings of this study provide clinicians with valuable information regarding alternative exercise options for mental health during pregnancy during the COVID-19 pandemic.

### **Keywords**

Pregnancy; expectant mothers; stress; anxiety; mental well-being; coronavirus; motherhood

## **1. Introduction**

The mental health of pregnant women has been especially vulnerable to the consequences surrounding the novel coronavirus, specifically COVID-19 [1, 2]. Along with worrying about how infection might affect their own health, expectant mothers must consider how the virus might impact their pregnancy, their unborn fetus, and their labor/delivery experience [3]. Social distancing recommendations necessitated a removal of social support, which is especially important for mental health during pregnancy [3, 4]. The evidence of increased risk of COVID-19 infection and death for pregnant women further contributes to the stress they experience [5-9]. In addition, many women may be unable or hesitant to access mental health services due to an increased risk of exposure to the virus in these communal spaces. These are believed to be contributing factors to the increased incidence of moderate-to-high anxiety levels and/or self-reported depression in pregnant women during this pandemic [2]. Beyond health-related concerns, COVID-19 exacerbated many stressors including logistical considerations, such as lack of childcare, occupational challenges, and financial uncertainty.

The prevalence of pregnant women with depression and anxiety has increased significantly since the onset of the pandemic [2, 10, 11]. Anxiety and depression have detrimental effects on nearly every aspect of maternal and fetal health [12, 13]. Women with high levels of anxiety and depression have a poorer quality of life and are at increased risk of adverse birth outcomes (e.g., cesarean delivery, preterm birth) [12, 13]. Maternal mental health during pregnancy can also affect 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 [13, 14]. Biomarkers associated with stress, anxiety, and depression can negatively affect fetal brain development, which may contribute to learning and behavior issues in childhood [2, 14]. Clinicians should recognize that managing maternal mental health is essential for the well-being 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 expectant mothers report decreased physical activity levels since the onset of social distancing and stay-at-home guidelines, which likely increases their risk for diminished mental health [2]. Pregnant women who met the American College of Sports Medicine's minimum recommendations of 150 minutes of moderate physical activity per week during the COVID-19 pandemic had lower depression and anxiety scores than women who did not

meet these guidelines [2, 15-17]. It is increasingly important to find safe and enjoyable ways to improve mental health during pregnancy despite the restrictions associated with the pandemic, such as fear of exposure at public gyms, gyms closing, and lack of time or childcare.

Various modes of physical activity, including yoga, may be a promising mental and physical health and fitness mediator for pregnant women and their fetuses [18, 19]. Yoga is appealing to many as it combines physical activity and mindfulness. Prenatal yoga is particularly useful for pregnant women, who often seek gentler forms of exercise to compensate for the discomfort and physical changes associated with pregnancy [20]. Though it has not yet been documented during the COVID-19 pandemic, the meditation and mindfulness of prenatal yoga can be used to relieve stress and anxiety during pregnancy, benefiting both maternal and fetal health [21, 22]. One session of yoga can improve stress and anxiety, but regular yoga practice may be even more beneficial; Newham et al. found anxiety scores decreased following an eight-week yoga program [23]. Beyond this, the physical aspect of yoga can help pregnant women maintain and/or improve physical fitness, which can help them accommodate the increase in weight and shift in center of gravity as pregnancy progresses [24-27]. Prenatal yoga also benefits developmental and birth outcomes for the fetus [20, 28].

The risk of a sedentary, stressful, and anxiety-filled pregnancy has increased significantly during the COVID-19 pandemic [2, 21]. Each of these factors can negatively affect the mother and fetus, making activities for mental and physical health even more important than in pre-pandemic pregnancies. Fortunately, prenatal yoga has the potential to benefit both of these aspects of health during this trying time [21].

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 determine the influence of a 10-week prenatal yoga intervention on maternal mental health (as measured through anxiety and depression scores) during pregnancy in a pandemic. A secondary purpose was to examine the impact of a single prenatal yoga session on maternal stress and anxiety. The results of the study are clinically relevant and timely as the pandemic is ongoing.

## **2. Materials and Methods**

This study was conducted from October 2020 to February 2021. 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 criteria were 18-44 years of age, physician's release to participate in exercise, and > 12 weeks gestation (as required by the yoga studio). Exclusion criteria were multiple gestation pregnancy, any condition that would prevent exercise during pregnancy, inability to provide voluntary informed consent, or > 26 weeks gestation.

After enrollment in the study, participants were sent a set of electronic baseline surveys via email. The first portion of these surveys was an IRB approved informed consent document, which had to be acknowledged and signed before participants could move on to the remaining surveys. Demographic characteristics, including height and weight, were self-reported. BMI was calculated by researchers using participant responses. The primary outcome measures were depression and

anxiety as measured by the Edinburgh Perinatal Depression Scale (EPDS) and the State Trait Anxiety Inventory (STAI). These assessments have been used reliably in a number of prenatal studies, including several yoga interventions, as well as being validated in pregnant populations [2, 23, 29-31]. After completing these surveys, participants were randomized to the yoga or control group using an online randomization tool.

## **2.1 Yoga Group**

After group assignment, participants in the yoga group were sent the Physician's Release form. 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 (delivered face-to-face or virtual). Participants in the intervention group were asked to complete a shortened version of the Profile of Mood States Questionnaire (POMS) before and after the first class to determine the acute effects of one yoga class on mood [32, 33]. The POMS Questionnaire is a valid and reliable survey used to assess acute changes in mood states and is commonly used in pregnant and postpartum populations [34-37]. The pre-class assessment also served as their baseline 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 POMS Questionnaire. Yoga participants were also asked to complete the final yoga survey, asking about any yoga they practiced beyond the study requirements. In an effort to control for environmental bias, this survey also included questions about any possible factors that may have impacted their stress, such as the rising number of COVID-19 cases (i.e. women were more stressed at the end of the 10-weeks, but due to factors unrelated to yoga).

All prenatal yoga classes (~1.25 hours each) took place at a local yoga studio with a registered prenatal yoga instructor. The same registered prenatal yoga instructor taught the class each week. 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. According to the studio's standards and practices, women were required to be at least 13 weeks pregnant to participate in prenatal yoga classes. Participants did not complete poses on the stomach or flat on the back, and a yoga blanket was placed halfway down the spine to prevent women from lying flat on their backs in supine poses. Any deep relaxation poses were done on the left side or seated, and no deep twists were performed. Flexion and extension of the back were minimized to maintain a neutral spine, and breath retention was not performed in any of the poses. Participants were always encouraged to keep their legs comfortably wide apart and use chairs or the wall if they needed additional support in any pose.

Along with these safety precautions, each class followed a similar pattern. Prenatal yoga classes consisted of affirmations for a healthy delivery and guided relaxation to visualize the baby growing, which were performed at the start and end of class. Along with these meditation and relaxation techniques, participants performed various poses. Rather than flowing through the poses, participants held poses to increase strength, balance, and comfort. Poses performed included standing poses, balancing poses, modified squats, seated wide leg forward folds, and chest and arm stretches. Pelvic floor strengthening was also done by having participants rest their legs in a seated

wide leg position or against a wall and engaging abdominal muscles. While each of the 10 classes followed this pattern, the poses performed and order of the class varied from week to week. All classes followed the same safety restrictions, and all participants were made aware of what was safe and unsafe in their first class with the study.

## **2.2 Control Group**

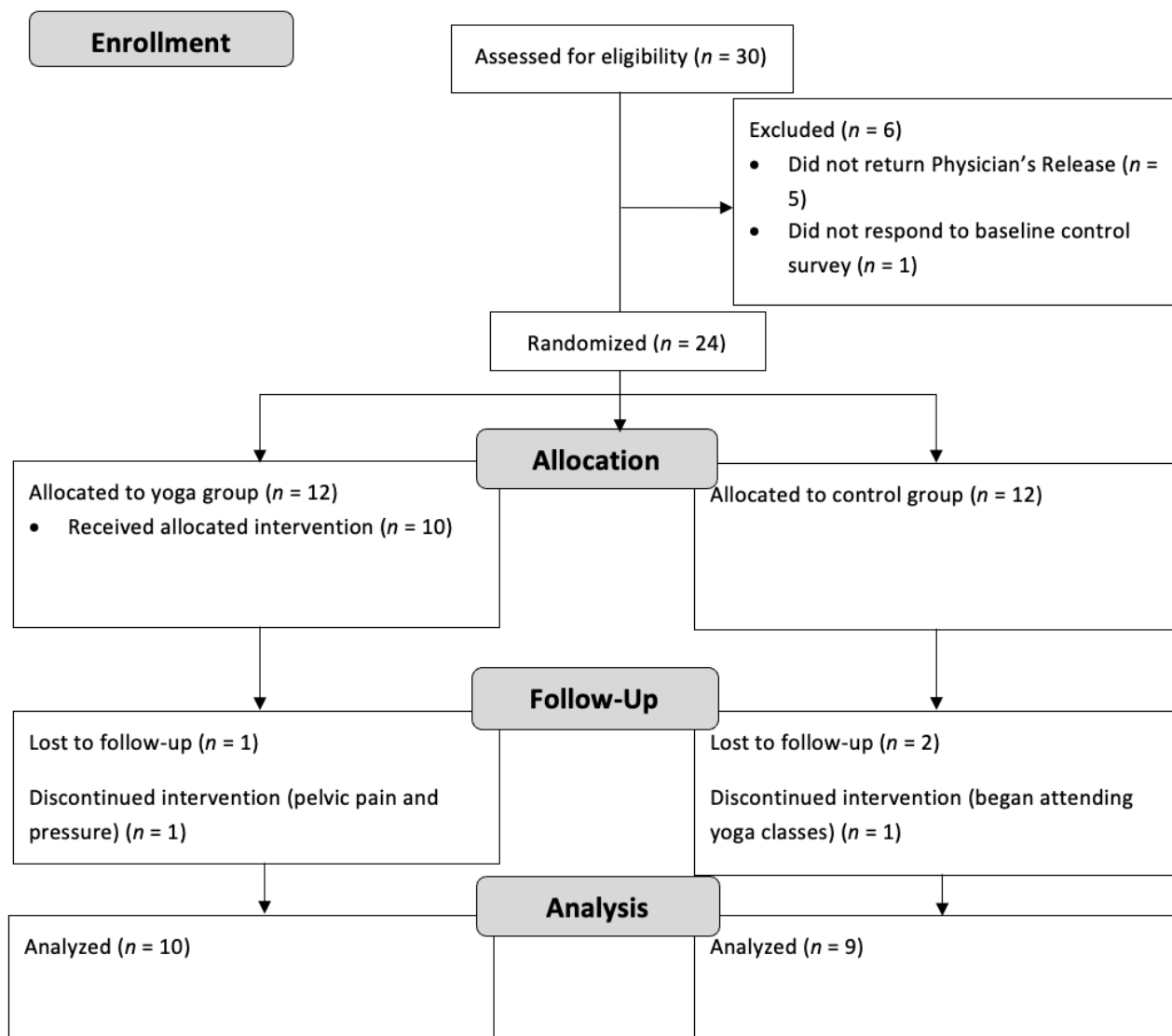
After group assignment, participants in the control group were sent the POMS Questionnaire following their baseline surveys. Participants in the control group were asked by the investigators to not participate in yoga during these 10 weeks. No restrictions were given for other forms of physical activity during study participation. At the end of 10 weeks, these participants were asked to fill out the same final surveys as the yoga group (with the exception of the final yoga survey). Along with these final surveys, control group participants also completed a survey regarding exercise frequency, duration, and type during the previous 10 weeks. This survey also included questions about any possible increase in stress due to the rising number of COVID-19 cases.

## **2.3 Statistical Plan**

A series of 2x2 (group x time) mixed model ANOVA were 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 POMS Questionnaire responses pre- and post-class and pre- and post-intervention. Cohen's *d* was calculated as a measure of effect size by dividing the mean difference between groups or timepoints by the pooled standard deviation. Effect size was defined as small ( $d = 0.2$ ), medium ( $d = 0.5$ ), and large ( $d = 0.8$ ) [38]. 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  $\pm$  standard deviation unless otherwise stated. This study was approved in April 2020 by Western Kentucky University's Institutional Review Board (IRB 20-267).

## **3. Results**

Thirty women were assessed for eligibility, and 24 women were randomized (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 1. Final analyses include a total of ten women in the yoga group and nine in the control group.



**Figure 1** 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  $8.10 \pm 4.85$  (score > 8 represents possible depression) and an average anxiety score of  $39.26 \pm 12.99$  (score  $\geq 39$  represents clinically significant anxiety).

**Table 1** Baseline demographic variables between yoga and control groups.

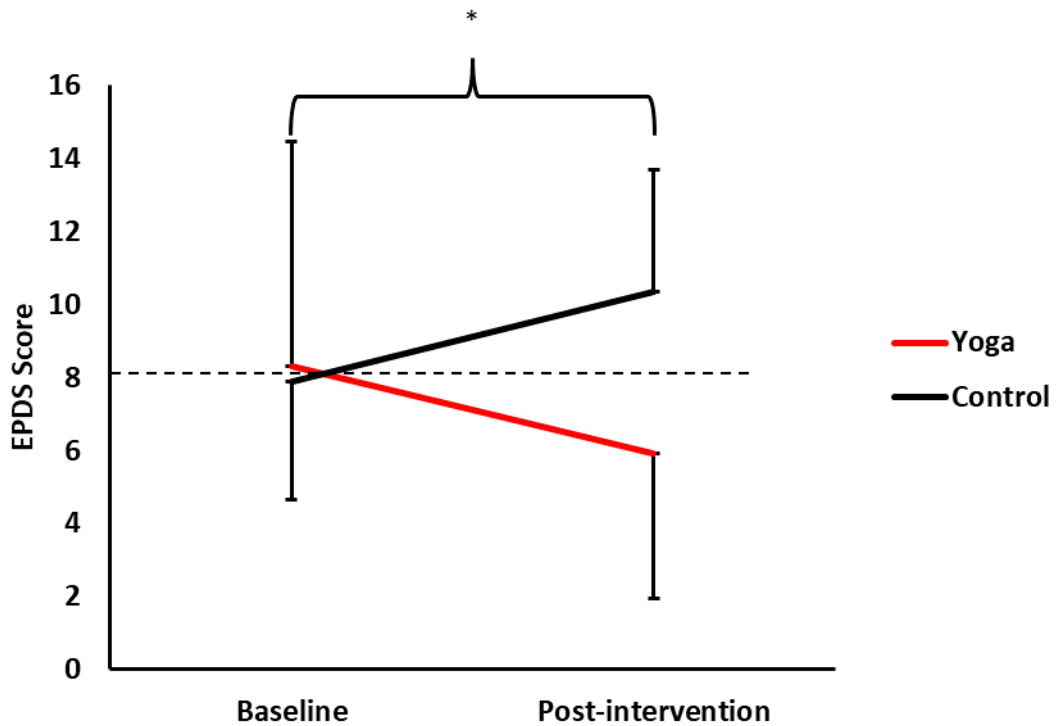
	Total (n = 19)	Yoga (n = 10)	Control (n = 9)	p value
Age	28.52 ± 3.74	27.1 ± 2.88	30.11 ± 4.10	0.790
Weight (kg)	80.64 ± 24.76	72.95 ± 19.79	89.18 ± 27.98	0.159
Height (in)	65.26 ± 2.53	64.50 ± 2.71	66.11 ± 2.14	0.173
BMI	29.33 ± 9.08	27.15 ± 7.17	31.74 ± 10.74	0.284
STAI Score <sup>†</sup>	39.26 ± 12.99	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 <i>n</i> = 7 Multigravida <i>n</i> = 12	Primagravida <i>n</i> = 4 Multigravida <i>n</i> = 6	Primagravida <i>n</i> = 3 Multigravida <i>n</i> = 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				0.156
White	17 (89.47)	8 (80)	9 (100)	
Black	2 (10.52)	2 (20)	0 (0)	
Other	0 (0)	0 (0)	0 (0)	
Current Health Status				0.553
Excellent	1 (5.26)	1 (10)	0 (0)	
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.

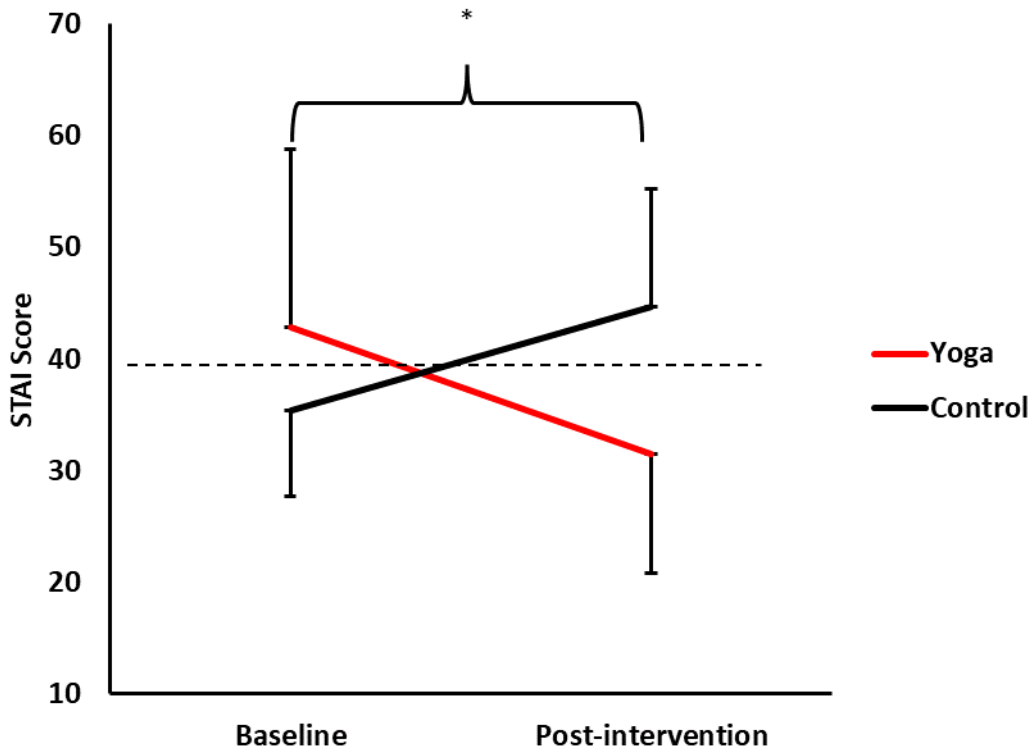
### 3.1 Effects of Yoga Intervention

Two-way ANOVAs revealed significant interaction effects for group x time on both depression ( $F_{1,17} = 5.421$ ;  $p = 0.032$ ;  $\eta_p^2 = 0.242$ ) and anxiety ( $F_{1,17} = 13.055$ ;  $p = 0.002$ ;  $\eta_p^2 = 0.434$ ). There were no significant effects for group ( $p = 0.260$ ) or time ( $p = 0.983$ ) on depression. There were no significant effects for group ( $p = 0.541$ ) or time ( $p = 0.735$ ) on anxiety. Depression and anxiety exceeded the thresholds that indicates possible depression and clinically significant anxiety in the control group and decreased well below these thresholds in the yoga group (Figures 2 and 3).



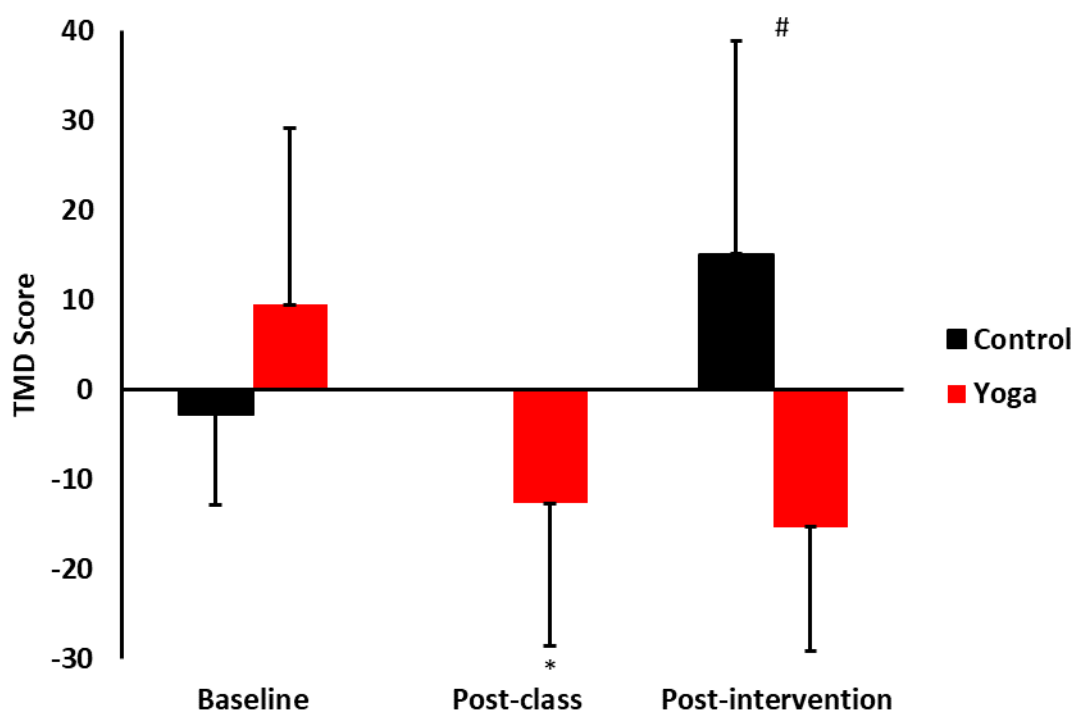
**Figure 2** Baseline and post-intervention depression scores in yoga and control group. \*indicates a significant group x time interaction,  $p = 0.032$ ; dashed line reflects threshold for possible depression.





**Figure 3** Baseline and post-intervention anxiety scores in yoga and control groups. \*indicates a significant group x time interaction,  $p = 0.002$ ; dashed line reflects clinically significant anxiety threshold

At the end of the intervention, there were no significant effects for group ( $p = 0.145$ ) or time ( $p = 0.562$ ) on total mood disturbance, but there was a significant group x time interaction ( $F_{1, 16} = 13.479$ ;  $p = 0.002$ ;  $\eta_p^2 = 0.457$ ). A general trend was observed where total mood disturbance increased in the control group and decreased in the yoga group from pre to post intervention (Figure 4).



**Figure 4** Total mood disturbance scores in the yoga and control groups at baseline, post-class, and post-intervention. \*indicates significant difference pre-class to post-class,  $p = 0.002$ ; # indicates significant group x time interaction at post-intervention,  $p = 0.002$ .

### 3.2 Effects of One Session of Prenatal Yoga

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. 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 ( $t_9 = 3.833$ ;  $p = 0.004$ ;  $d = 1.212$ ) immediately post-yoga class. 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 Questionnaire subscales are located in Table 2.

**Table 2** Changes in POMS subscales post-class and post-intervention.

Subscale	Baseline	Post-class	Post-intervention
<b>Anger</b>			
Yoga	5.60 ± 5.64	1.30 ± 2.86	0.66 ± 1.65
Control	2.22 ± 2.68	-	5.44 ± 4.74
<b>Confusion</b>			
Yoga	4.80 ± 2.25	2.30 ± 1.94	3.66 ± 2.59
Control	3.44 ± 1.87	-	5.44 ± 4.15
<b>Depression</b>			
Yoga	3.10 ± 3.47	0.90 ± 2.02	0.88 ± 1.36
Control	0.77 ± 2.33	-	3.11 ± 3.68
<b>Esteem</b>			

Yoga	11.40 ± 3.62	14.20 ± 3.19	16.33 ± 2.64
Control	14.22 ± 1.56	-	13.55 ± 2.96
<b>Fatigue</b>			
Yoga	8.50 ± 4.30	3.20 ± 2.09	3.33 ± 2.12
Control	6.00 ± 3.42	-	10.55 ± 4.90
<b>Tension</b>			
Yoga	7.20 ± 3.19	1.90 ± 1.96	4.77 ± 4.73
Control	4.55 ± 1.74	-	8.55 ± 5.45
<b>Vigor</b>			
Yoga	5.10 ± 4.30	8.10 ± 4.28	12.33 ± 5.83
Control	5.55 ± 3.28	-	4.44 ± 2.78

Note: Data presented as mean ± standard deviation.

### 3.3 Control Group Exercise Survey Responses

Table 3 contains the results of the final exercise survey for the control group. All control group participants ( $n = 9$ ) reported participating in exercise other than prenatal yoga during their study participation.

**Table 3** Control group final exercise survey responses.

	Responses ( $n = 9$ )
Did you participate in any exercise during the last 10 weeks?	
Yes	5
No	4
<b>If yes, how many days per week?</b>	
1-2	1
2-3	4
3-4	0
4-5	0
5-6	0
7	0
<b>If yes, how long was each session?</b>	
5-10 minutes	0
10-20 minutes	1
20-30 minutes	1
30-40 minutes	1
40-50 minutes	1
50-60 minutes	1
More than 1 hour	0
<b>If yes, what modes of exercise did you participate in? (Select all that apply)</b>	

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Walking	3
Running	0
Cycling	0
Strength training	2
Crossfit	1
Swimming	0
Dancing/ Zumba	0
HIIT	0

**If yes, what modes of exercise did you participate in? (open response)**

Balance exercises	1
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**4. Discussion**

Prenatal yoga improved mental health as part of 10-week prenatal yoga program and over the course of 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. Post-intervention, anxiety and depression scores were well below clinical thresholds for yoga participants, but well above these thresholds in the control group.

The results of this study are consistent 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 [20, 23, 39-41]. 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. This is clinically important because stress is especially high among pregnant and postpartum women during the pandemic [1, 2], and stress and anxiety during pregnancy can have serious implications for maternal and fetal health [12-14]. Along with poorer clinical outcomes of labor, delivery, and postpartum recovery, poor mental health during pregnancy negatively impacts fetal brain development and childhood health [1, 12-14]. In a study examining physical health during pregnancy, participants in a yoga intervention had significantly lower incidences of hypertension, preeclampsia, and intrauterine growth restriction (IUGR) [20]. Because physical health during pregnancy, including elevated blood pressure and IUGR, is related to poor mental health [42, 43], it is possible prenatal yoga could serve as a mechanism for improving downstream outcomes through improved mental health.

The present study also found acute improvements in mood after just one session of yoga. This is similar to previous work, as Newham et al. observed significant differences in anxiety after one class of yoga among pregnant women [23]. 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 [39]; these findings were replicated in a later study on well-being during pregnancy [40]. 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 [41]. Davis et al. found no differences in anxiety and depression between a yoga and control group after eight weeks of prenatal yoga [29]. 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.

Several prenatal yoga studies have examined objective markers of stress such as 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 [23, 28]. Another study found that salivary immunoglobulin A, a prominent immune antibody in the mucus membranes, increased in the yoga group compared to the control group [28]. Along with the decrease in physiological stress, this increase indicates enhanced immune function after 20 weeks of prenatal yoga [28]. The present study was unable to assess these parameters due to COVID-19 restrictions on human subjects research.

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 recognized that eating a poor diet, a sedentary lifestyle, and disrupted sleeping patterns can all worsen depression [44-46]. 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 [47, 48]. Giuntella et al. 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 [48]. However, resuming physical activity during the pandemic was not enough to improve mental health [48]. 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 continued to rise, as did the number of deaths as a result of COVID-19 from October 2020 to February 2021 when this study was conducted [9]. The local COVID-19 situation resembled the national COVID-19 situation, and the number of confirmed cases and deaths continued to rise exponentially both locally and nationally [49, 50]. Additionally, a new variant was identified and began to spread, creating additional uncertainty and stress [51]. Vaccines began to be more widely available, which may have helped relieve COVID-19-related anxiety, but initially these vaccines were only available to limited populations, which may have excluded most of the study participants [52]. 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 improve each 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 their study participation 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 music, 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. Along with the variation in class experiences, 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. The main outcomes of this study were measured via subjective assessments (EPDS and STAI). Although honesty was encouraged and responses were anonymous, some participants may not have wanted to admit having any mental health issues on these questionnaires. Finally, the current study only utilized a sample size of 19 participants, and all classes took place in the same location with the same instructor; as a result, the results may not be widely generalizable.

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 for pregnant women. 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.

## **5. Conclusions**

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 end, and mental health will continue to be an important concern for months

and even years to come. 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.

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### **Author Contributions**

All authors were involved in study design. CD led data collection, analysis, and manuscript writing. RAT assisted with data collection and participant communication. DVT assisted with statistical analyses. WJS and MMB assisted with literature review. All authors edited and approved the final manuscript.

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### **Competing Interests**

The authors have declared that no competing interests exist.

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