

DOI: <https://dx.doi.org/10.18203/2320-1770.ijrcog20232287>

## Original Research Article

# A prospective randomized controlled trial to study the effect of prenatal yoga on maternal weight gain and psychological stress in pregnancy and its association with pregnancy outcomes

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**Received:** 05 June 2023

**Accepted:** 03 July 2023

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## ABSTRACT

**Background:** Objective of study was to evaluate the effect of prenatal yoga on maternal gestational weight gain (GWG) and psychological stress in pregnancy (PSS) and to evaluate the effect of prenatal yoga on labour outcomes.

**Methods:** Prospective randomized controlled trial conducted at AIIMS, New Delhi between May 2020-December 2021. Sixty women each were recruited in the yoga and control group. Women in the yoga group attended 60 minutes supervised yoga sessions followed by self-sessions. Women in the control group received routine antenatal care along with 30 minutes per day of walking and dietary counselling. The assessment was done for the weight (WT), dietary intake (D) and perceived stress score (PSS) at the time of recruitment (WT1, D1, PSS1), 28 weeks (WT2, D2, PSS2) and 36 weeks (WT3, D3, PSS3) and the results were then compared.

**Results:** At recruitment all the parameters in both groups were comparable. The difference in mean and difference in percentage in terms of gestational weight gain (GWG) at recruitment and at 36 weeks was statistically significant (p-value=0.027). The per cent weight gain in the Yoga group was significantly low (p value=0.048). The control group experienced more amount of stress both at 28 weeks (p-value = 0.021) and 36 weeks (p-value <0.0001). The difference in mean and difference in percentage in terms of PSS1 and PSS2 (p-value=0.011), PSS2 and PSS3 (p-value=0.0001) PSS1 and PSS 3 (p-value=0.0001). Labour outcomes were comparable between both groups.

**Conclusions:** Yoga helps in controlling excessive GWG and helps prevent many adverse feto-maternal outcomes associated with obesity.

**Keywords:** Labour outcomes, Maternal gestational weight gain, Prenatal yoga, Psychological stress in pregnancy

## INTRODUCTION

Pregnancy is a condition in which women undergo different physiological changes and is accompanied by unique physical and psychological demands. There is a need to manage the various physical, emotional, mental, and pain states that arise throughout the stages of pregnancy and labour. The well-being and quality of life of the mother are critical for optimal pregnancy outcomes.

Women gain around 10 to 12 kgs during their pregnancy. Almost a fifth of women gain inadequate amounts and about a third of women gain excessive weight.<sup>1</sup> The incidence of excessive gestational weight gain has a detrimental effect on maternal and fetal outcomes.<sup>2</sup>

Anxiety, depression, and stress in pregnancy are other important risk factors for adverse outcomes for mothers and children.<sup>3</sup> Pregnancy anxiety is associated with shorter

gestation and has adverse implications for preterm birth, lower birth weight, fetal neurodevelopment, and child outcomes.<sup>4</sup>

Additionally, high-stress levels in pregnancy are carried forward to the postpartum period which impairs parenting quality and effectiveness leading to long-term potential negative consequences for children later in life, such as the development of attention deficit hyperactivity disorder or lowered performance on aspects of executive functions.<sup>5,6</sup> Mind-body practices that cultivate general health, diminish stress, and increase self-awareness, such as yoga, may be particularly effective in addressing both the physical and psycho-emotional aspects of pregnancy and labour.<sup>7</sup>

Yoga is a term derived from the Sanskrit term “yuj” which was used in its early contexts as the term for joining a chariot or a cart to an animal such as a horse or an ox. Yoga, in this sense, is a discipline that advances the physical and psychological self towards overall well-being. At the basic level, Yoga is a system of stretching exercises and postures (asana) combined with deep breathing (pranayama) and meditation. Yoga asanas constitute a low-impact, intentional, and readily modifiable form of exercise that makes it suitable for pregnant women. Physical poses can help to strengthen muscles and control gestational weight gain while breathing techniques and relaxation methods can help relieve stress and improve general well-being including quality of sleep.<sup>8</sup>

The present study was conducted to evaluate the impact of Yoga on gestational weight gain and maternal stress levels in pregnancy.

## METHODS

This was a single-centre, open-label, RCT with 120 eligible women randomized into the intervention or control groups in a 1:1 ratio. The women were recruited prospectively from the antenatal clinic at the All India Institute of Medical Sciences (AIIMS), New Delhi (CTRI registration number: CTRI/202/05/025402).

### Inclusion criteria

Primigravida at 16-20 weeks period of gestation (POG) with no known fetomaternal high-risk factors, aged 20-35 years of age, and a BMI between 19.8-25 Kg/m<sup>2</sup> who were willing to participate in the study were recruited.

### Interventions

Patients assigned to the yoga group went through yoga training according to the specialized yoga module designed for this trial by yoga physicians and yoga therapists at the Centre for Integrative Medicine and Research (CIMR), AIIMS, New Delhi. The yoga module was specifically developed and tailored according to gestation (i.e., 2<sup>nd</sup> and 3<sup>rd</sup> trimester of pregnancy). The module was further validated by 17 yoga experts of national repute.

**Table 1: Yoga module in practice in pregnancy.**

Second trimester practice			
	Techniques	Rounds	Duration
<b>A</b>	Prayer		1 min
<b>B</b>	Sukshmayayama		
	<b>Neck movements</b>	5 rounds each	5 min
	Forward and backward bending		
	Right and left bending		
	<b>Shoulder movements</b>		
	Shoulder stretch		
	Shoulder rotation		
	<b>Knee movements</b>		
	Knee stretch		
	Knee rotation		
	<b>Ankle movements</b>		
	Ankle stretch		
	Ankle rotation		
	<b>Toe movements</b>		
<b>C</b>	<b>Breathing practices</b>		
	Hands in and out breathing	10 rounds	8 min
	Tiger breathing		
<b>D</b>	<b>Asana</b>		
	Tadasana	1 round each	15 min
	Veerbhadrasana ii		
	Katichakrasana		

Second trimester practice			
	Utkatasana		
	Purnatitaliasana		
	Parivratasukhasana		
	Vipareetkarni		
	Shavasana		
<b>E</b>	<b>Pranayama</b>		
	Nadishodhana	10 rounds each	5 min
	Sitali		
<b>F</b>	<b>Meditation</b>		
	Nadanusandhana		5 min
<b>G</b>	Ending prayer		1 min
Third trimester practice			
<b>A</b>	Prayer		1 min
<b>B</b>	<b>Sukshnavyayama</b>		
	<b>Shoulder movements</b>	5 rounds each	5 min
	Shoulder stretch		
	Shoulder rotation (both sides)		
	<b>Wrist movements</b>		
	<b>Finger movements</b>		
	<b>Knee movements</b>		
	Knee stretch		
	<b>Ankle movements</b>		
	Ankle stretch		
	Ankle rotation		
	<b>Toe movements</b>		
<b>C</b>	<b>Breathing practices</b>		
	Hands in and out breathing	10 rounds	10 min
	Hand stretch breathing		
	Sectional breathing		
<b>D</b>	<b>Asana</b>		
	Utthitaparsvakonasana	1 round each	15 min
	Malasana		
	Baddhakonasana		
	Parivrttajanusukhasana		
	Parivrttasukhasana		
<b>E</b>	<b>Pranayama</b>		
	Nadishodhana	10 rounds each	5 min
	Bhramari		
<b>F</b>	<b>Meditation</b>		
	Nadanusandhana		5 min
<b>G</b>	Ending prayer		1 min

The module (Table 1) comprised preliminary stretching and loosening exercises followed by breathing exercises, isotonic physical postures (Asanas), controlled breathing (Pranayama), and meditation (Dhyana). There were 8 compulsory supervised sessions of which 4 were taught during the second trimester and another 4 in the third trimester.

Each supervised yoga session was conducted by institutionally trained yoga experts at the Centre for Integrative Medicine and Research (CIMR). A booklet containing the details of the practices and a pictorial presentation of the yoga module was shared with the participants. To ensure compliance all the participants were required to do regular yoga practice for a minimum of 4 days per week, at home. Participants were contacted

on a weekly basis to ensure they were practising yoga and to address any issues they may have encountered. Regular online yoga sessions were conducted thrice a week by the trained yoga experts at CIMR. All the sessions were meticulously documented. The antenatal visit schedule was as per the hospital protocol.

The control group underwent routine antenatal care and counselling with the advice of 30min walk/day and dietary counselling.

### Outcomes

The primary outcomes were the assessment of maternal weight gain and psychological stress (by perceived stress

scale) at baseline, 28 weeks, and 36 weeks. The secondary outcomes were the assessment of labour outcomes such as the need for labour induction, labour duration, pain, the requirement of labour analgesia, the need for augmentation, and the mode of delivery.

**Sample size calculation**

The sample size for the proposed study was calculated based on research conducted by Pelaez et al in which it was observed that the weight gain due to exercise intervention and standard care was 11.5±3.5 kg and 13.72±4.1 kg respectively.<sup>9</sup> Assuming similar observations will be made for the present study, the required sample for 80% power at a 5% level of significance was 50 per group.

A total of 120 patients were recruited between January 2020 and November 2021. The study protocol was approved by the institutional ethical committee (Ref. No: IECPG-683/19.12.2019, RT-32/30.01.2020)

The required number of patients in each group was randomized using Random Allocation Software.<sup>10</sup> Written consent was obtained from all participants. Since it was a two-arm RCT trial with a ratio of 1:1, patients were given serial numbers sequentially starting from 1 to 120 after inclusion criteria had been applied. The sequence generation was done by the fourth author and allocation was done by the second author after consulting telephonically for every consecutive patients. The allocation of group was random however blinding for the intervention and outcome assessment was not possible. The first author along with a team carried out the yoga intervention. The outcome assessment was done by the second, and third author

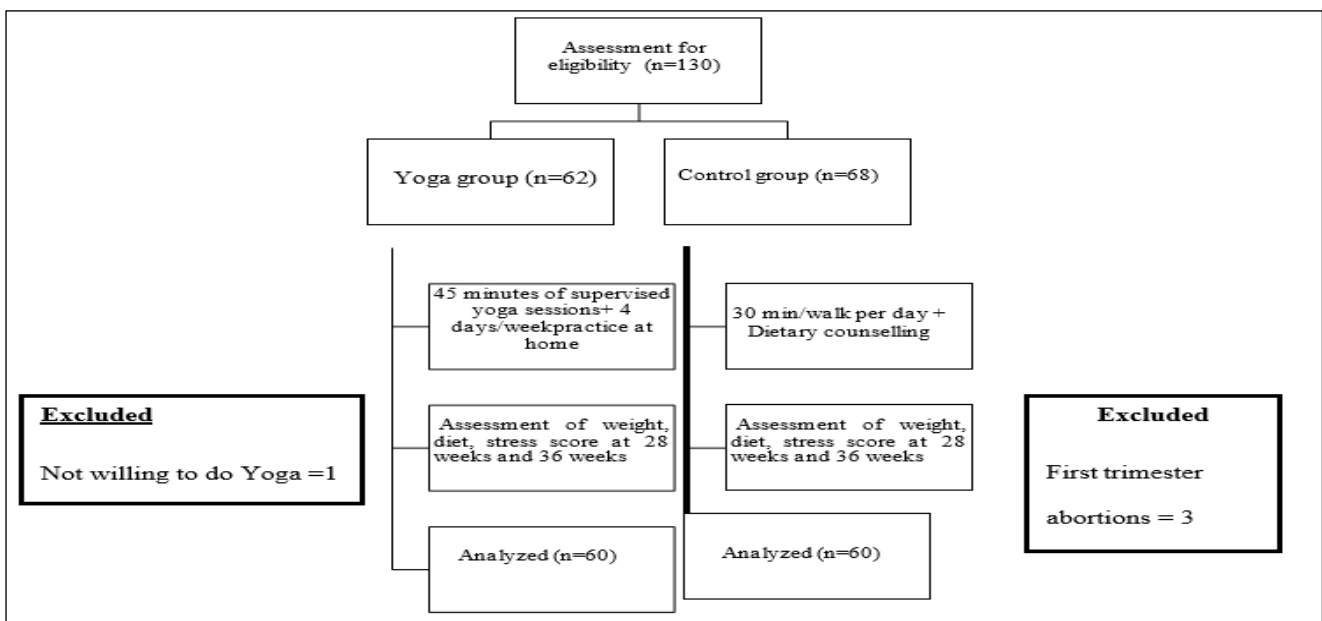
**Statistical analysis**

Data analysis was carried out using the statistical software STATA version 12.0. Continuous data were tested for normality assumption using the Kolmogorov-Smirnov test. Descriptive statistics such as mean, standard deviation and range values were calculated. A comparison of mean values was performed using Student’s t-independent test. For skewed data median and inter-quartile range (IQR) values were calculated and compared using a non-parametric Mann-Whitney U-test.

Categorical data were presented as frequency and per cent values, and comparison of categorical data will be done using Chi-square and Fischer’s exact test Considering weight gain of 11 kg as the cut-off value, significant factors that were likely to correlate with optimum weight gain was assessed using univariate and multivariable using logistic regression analysis. For all the statistical tests, a two-sided probability of p<0.05 was considered as statistical significance.

**RESULTS**

Figure 1 shows the consort diagram for the study. Between January 2020 and November 2021, 120 patients were recruited. There were 60 patients in each group and the analysis was by original assigned groups. The mean age of the yoga group was 27.8±3.4 years, and the control group was 27.0±3.5 years. Both groups were comparable (p=0.184). Women in both groups were recruited in the second trimester. The mean period of gestation among the yoga group was 18.3±1.4 weeks and the control group was 17.8±1.5 (p= 0.156).



**Figure 1: Consort diagram.**

Among the 60 women in the study group, 29 participants attended more than 8 supervised sessions throughout their 2<sup>nd</sup> and 3<sup>rd</sup> trimesters, while 31 participants attended a minimum of 6 supervised sessions. All participants performed at least 3 sessions per week at home from recruitment till delivery (Table 2).

**Table 2: Distribution of supervised yoga sessions.**

No. of supervised yoga sessions	Number of women (n=60) (%)
6-8	31 (51.7)
9-16	14 (23.3)
17-24	14 (23.3)
> 25	1 (1.7)

There were no complications reported during or after practising yoga module. Women in both groups were asked about their pre-pregnancy weight and it was noted at recruitment. The mean weight of the women in the yoga group at recruitment was 57.7±9.5 kgs and that in the control group was 57.8±10.7 kgs (p-value=0.947). The mean BMI (Quetelet's index) in both groups was also statistically comparable (p=0.776). The maternal weight at 3 set points of times at recruitment, at 28 weeks and at 36 weeks is depicted in Table 3.

**Table 3: Comparison of weight at recruitment, 28 weeks and 36 weeks.**

Weight ± SD (in Kgs)	Yoga group (n=60)	Control group (n=60)	P value
Pre-pregnancy weight	57.7±9.5	57.8±10.7	0.961
Weight at recruitment (WT 1)	57.8±9.6	57.6±10.7	0.947
Weight at 28 weeks (WT 2)	62.6±10.1	62.4±11.8	0.934
Weight at 36 weeks (WT3)	67.6±9.3	68.9±10.9	0.466

**Primary outcomes**

*Percent weight gain*

Percent weight gain was calculated using total weight gain in pregnancy divided by weight at recruitment. The percent weight gain in yoga group was significantly lower when compared to weight gain in the control group (p value=0.048). Table 4 demonstrates the same.

*Psychological stress*

All the women in both study groups were assessed according to the perceived stress score (PSS) containing the questionnaire.

The mean psychological stress score (PSS1) at recruitment in the yoga group was 14.7±5.5 and while that in the controls group was 14.8±5.0 (p value=0.931). The mean PSS at 28 weeks (PSS2) and 36 weeks (PSS3) is represented in Table 5. The stress score in the controls group was higher when compared to the yoga group and the value was statistically significant both at 28 weeks and 36 weeks.

**Table 4: Percent weight gain.**

Percent weight gain	Yoga group (n=60)	Control group (n=60)	P value
Mean±SD	17.6±7.2%	20.3±7.4%	0.048

**Table 5: Comparison of stress score at recruitment, 28 weeks, and 36 weeks.**

Psychological stress score ± SD (in points)	Yoga group (n=60)	Control group (n=60)	P value
PSS 1 (at recruitment)	14.7±5.5	14.8±5.0	0.931
PSS 2 (at 28 weeks)	13.0±3.7	14.9±5.0	0.021
PSS 3 (at 36 weeks)	10.6±2.9	15.7±4.9	<0.0001

**Table 6: Difference between stress score at 28 weeks (PSS2) and 36 weeks (PSS3).**

PSS 2-PSS 3	Yoga group (n=60)	Control group (n=60)	P value
Difference in mean±SD	2.4±2.6	-0.7±3.6	<0.0001
Percentage difference±SD	16.5±17.1	-7.2±22.4	<0.0001

**Table 7: Difference in mean and a differential percentage between recruitment and 36 weeks (PSS 1- PSS 3).**

PSS 1-PSS 3	Yoga group (n=60)	Control group (n=60)	P value
Difference in mean±SD	4.1±5.1	-0.9±4.9	<0.0001
Percentage difference±SD	20.5±33.5	-11.6±35.6	<0.0001

Tables 5, 6 and 7 demonstrate the difference in mean and differential percentages of psychological stress perceived at recruitment, 28 weeks and 36 weeks.

**Secondary outcomes**

Gestational age at delivery was similar in both groups (p value=0.769). Preterm deliveries in both groups were statistically similar (p value=0.769). Induction of labour was done among 40% of the yoga group and 46.6% of the control group (p value=0.386). Labour analgesia was offered to all the women in both the yoga and control study groups. Only 1 (1.7%) woman in the yoga group opted for labour analgesia and received it. The vaginal delivery rate was 53.3% in the yoga group vs 60.0% in the control group. Cesarean delivery rate was 46.7% in the yoga group vs 40.0% in the control group. However, the difference was not statistically significant (p value=0.461). The most common indications of caesarean delivery in the yoga group were fetal distress (32.1%), and failed induction (32.1%) while that in the most common control group was failed induction (54.5%) followed by fetal distress (25%). The mean birth weight of babies in the yoga group and the control group was 2855.6±513.9 kg and 2750.6±441.3 respectively which was statistically comparable (p=0.232).

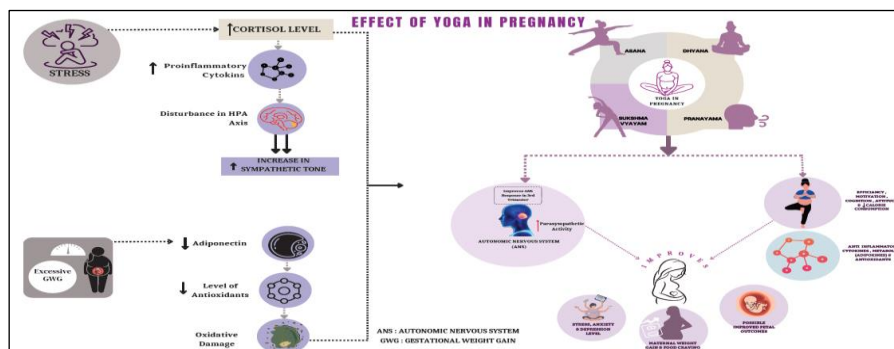
**DISCUSSION**

Yoga, an ancient Indian practice based on the principles of mind–body medicine is one of the commonest forms of complementary and alternative medicine therapies and is increasingly being practised worldwide. There is an increasing body of evidence of its beneficial effect in pregnancy. This study reiterates that the pregnancy-specific yoga module designed for the second and third trimesters has a positive impact on gestational weight gain and maternal stress levels in pregnancy which may eventually translate into better fetal and maternal outcomes. The present study looked into a limited number of outcomes of yoga in pregnancy and was not powered to look into specific obstetric and neonatal outcomes of pregnancy.

**Principal findings**

The present study demonstrated a clinically significant impact of yoga during the second and third trimesters of pregnancy on gestational weight gain and also on maternal psychological stress. There have been several studies evaluating the impact of yoga on various aspects of

pregnancy and childbirth. However, only a few studies have specifically looked at gestational weight gain. In a retrospective study by Wadhwa et al, 200 primiparous women aged between 20-40 years were enrolled.<sup>12</sup> Results showed that the women, who followed regular antenatal exercises that included yoga asanas had a gestational weight gain of 11.5±2.1kgs which was significantly lower than the 15.1±1.6 kgs in the control group (p< 0.05). The present study also reiterates the outcome that the per cent weight gain in the yoga group was significantly lower when compared to weight gain in the control group (p value=0.048). A randomized controlled trial, evaluating the effect of yoga on fetal and maternal outcomes, conducted 17 years back, showed a significant improvement in fetal birth weight while there was a significant decrease in preterm labour and fetal growth restriction.<sup>11</sup> However, the gestational weight gain was comparable in both groups. The reason for insignificant differences in weight gain was not reported. But we need a reason-either a lack of uniform yoga, compliance etc. The American College of Obstetrics and Gynaecology recommends moderate-intensity physical activity for 150 min per week to help prevent EGWG. The results of our study can be interpreted to conclude that yoga, being a moderate physical activity, is suitable for pregnant women. Moreover, the safety and cost-effectiveness of yoga makes it an attractive option. The current study also looked at the impact of yoga on the levels of stress in pregnancy. In the study, the stress scores in the control group, as assessed by the PSS questionnaire were significantly more than the yoga group at 28 weeks (p-value = 0.021) and 36 weeks (p-value <0.0001). The difference in mean and difference in percentage in terms of stress scores at recruitment and at 28 weeks (p-value = 0.011) and at 28 and 36 weeks (p-value=<0.0001) among both groups was also statistically significant. Previous studies have similarly demonstrated a positive effect of yoga on maternal stress levels.<sup>13,14</sup> Satyapriya et al, in a randomized controlled trial, studied the effect of integrated yoga practice on perceived stress in healthy pregnant women. They recruited 122 healthy women between the 18<sup>th</sup> and 20<sup>th</sup> week of pregnancy and results were evaluated for 45 participants per group who completed the study. They reported that the perceived stress decreased by 31.57% in the yoga group and increased by 6.60% in the control group (P=0.001).



**Figure 3: Postulated mechanisms for the beneficial effect of yoga in pregnancy.**

The postulated mechanisms (Figure 3) for the beneficial effect of yoga in pregnancy may be multifactorial. During pregnancy, the excessive accumulation of adipose tissue in pregnancy especially visceral adipose tissue leads to dysregulation of adipokine release, including leptin, adiponectin, and resistin.<sup>15-20</sup> This also generates an imbalance between the prooxidative and antioxidative systems that result in an increase in reactive oxygen species (ROS).<sup>16,19</sup> Excessive ROS production alters different cellular components such as proteins, lipids, and DNA, generating oxidized biomolecules that have a deleterious effect on pregnancy.<sup>17</sup> Yoga as an exercise by controlling excessive gestational weight gain controls the cascading effect of oxidative damage which has been implicated in the pathophysiology of pre-eclampsia, gestational diabetes mellitus, insulin resistance and placental dysfunction.<sup>21</sup> Numerous studies have shown the effectiveness of yoga in stress management.<sup>22</sup> Yoga-based relaxation training normalizes the function of the autonomic nervous system by deviating both sympathetic and parasympathetic indices toward more “normal” middle region of the reference values.<sup>23</sup> Other studies have shown yoga to have an immediate down-regulating effect on the HPA axis responses to stress.<sup>24</sup>

## CONCLUSION

Yoga helps in controlling excessive gestational weight gain and helps prevent many adverse fetomaternal outcomes associated with obesity. Yoga also helps in maintaining balanced physical, social and mental well-being by decreasing stress levels among pregnant women.

## ACKNOWLEDGMENTS

Authors would like to thank the Ministry of AYUSH, Government of India, for support through the Centre of Excellence scheme to the Centre for Integrated Medicine and Research (CIMR), All India Institute of Medical Sciences (AIIMS), New Delhi, India; the staff at CIMR for support; and colleagues who referred patients for enrollment into this trial.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Shukla A, Prasad D, Sharma KA, Shainy P, Singh D, Sharma V, et al. A prospective randomized controlled trial to study the effect of prenatal yoga on maternal weight gain and psychological stress in pregnancy and its association with pregnancy outcomes. *Int J Reprod Contracept Obstet Gynecol* 2023;12:2437-44.