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Effects of Antenatal *Yoga* on Maternal Stress and Clinical Outcomes in North Indian Women: A Randomised Controlled Trial

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Introduction

Yoga is a Sanskrit word introduced in 3,000 BC by Patanjali, a Sanskrit scholar and an Indian physician. It means to yoke or to join together. *Yoga* is widely recognised as a form of mind-body medicine that creates a balance among emotional, mental, physical, and spiritual dimensions. It is a comprehensive system that uses physical postures (*asana*), breathing exercises (*pranayama*), concentration and meditation (*dharana* and *dhyana*), and contemplative practice[1]. Research shows that *Yoga* regulates the nervous system and physiological system functioning (i.e., immune, endocrine, neurotransmitter, and cardiovascular), improves psychological well-being (frequency of positive mood states and optimism), and physical fitness (strength, flexibility, and endurance)[2].

Yoga therapy improves many aspects of health, particularly stress-related illnesses[3]. Evidence shows that stress contributes to the aetiology of heart disease, cancer, stroke, as well as other chronic diseases[4]. Research has shown that prenatal maternal stress increases the risk of spontaneous abortion, preterm labour, foetal malformations, and growth restriction.

Different components of *Yoga* work in different ways. Yoga asanas work at physical body level and for pregnant women it improves physical strength, enhances flexibility and endurance. It is also thought to increase hormones from the endocrine glands, as a result of pressure applied to the glands during set postures. Second component *Om chanting* has an effect on the parasympathetic system and reduces stress. Third component Pranayama, increases oxygen supply to the foetus and facilitates easier delivery. The fourth component of yoga practice Yoga Nidra, is a specialised practice that generates deep relaxation. The fifth component Dhyana or Meditation in conjunction with *asanas* and breathing awareness reduces excessive thinking. Thus the rationale of this study is to observe the effect of yoga therapy on maternal stress levels, autonomic nervous system and obstetric outcomes, and the hypothesis being that *Yoga* therapy reduces stress.

Material and methods

This randomised controlled trial was conducted by the Department of Obstetrics and Gynaecology in collaboration with the Department of Physiology at a tertiary hospital in Delhi from November 2015 to April 2017. Prior approval from the institutional ethics committee for human research was obtained. The aim of the study was to assess the effect of *Yoga* therapy on maternal stress level, heart rate variability, and obstetric outcomes in low risk antenatal women. The objectives of the study were: a) To assess the effect of *Yoga* therapy for 12 weeks on maternal stress level using 'Perceived Stress Scale' (PSS); b) To compare the heart rate variability (HRV) in *Yoga* and control group; c) To compare proportion of women developing gestational hypertension, preterm delivery and foetal growth restriction in the *Yoga* and control group.

Low-risk antenatal women at 18 - 20 weeks of gestation were recruited from the outpatient department. After screening and informed consent, simple randomisation was done (Fig. 1). All women were divided into 2 groups:

Group I: Intervention group

Antenatal women who practiced *Yoga* therapy for 50 minutes, thrice a week for 12 weeks along with routine physical activity. Thirty eight women completed the study.

Group II: Control group

Antenatal women who did their routine physical activity. Forty women completed the study.

The intervention group followed *Yoga* regime designed for second and third trimester under the guidance of a trained *Yoga* instructor (Fig. 2). Every week, one session was carried-out in the hospital under the supervision of the trained *Yoga* expert; the other two sessions of the week were done by the patient at home. Compliance was ensured by maintaining a *Yoga* diary and telephonically. The intervention group did their routine physical activity in addition to *Yoga*. Control group did their routine physical activity.

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Assessment of stress using Perceived Stress Scale (PSS) was done at initial recruitment, i.e., at 18 - 20 weeks of gestation, midpoint and at the end of the study duration. PSS scores are obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 and 4 = 0) to the four positively stated items (items 4, 5, 7, and 8) and then summing across all scale items.

Baseline heart rate variability was measured using Finometer at recruitment and end of study. The energy in the HRV series in 2 specific frequency band was studied, i.e., low frequency band (0.04 - 0.15 Hz) and high frequency band (0.15 - 0.40 Hz). The LF/HF ratio was calculated. The low frequency and high frequency band values were expressed as normalised units. Only frequency domain analysis was done.

Analysis was done using standard statistical methods by SPSS VERSION21. Categorical data was summarised as frequencies and proportions while continuous data as mean, median and mode. Subgroup analysis was done between *Yoga* and control group for PSS, heart rate variability and outcome of pregnancy. Independent and paired t test was used to analyse stress score measured at different times of study. One way ANOVA and repeated measure ANOVA was used for analysing quantitative variables in the study. A p value < 0.05 was considered statistically significant.

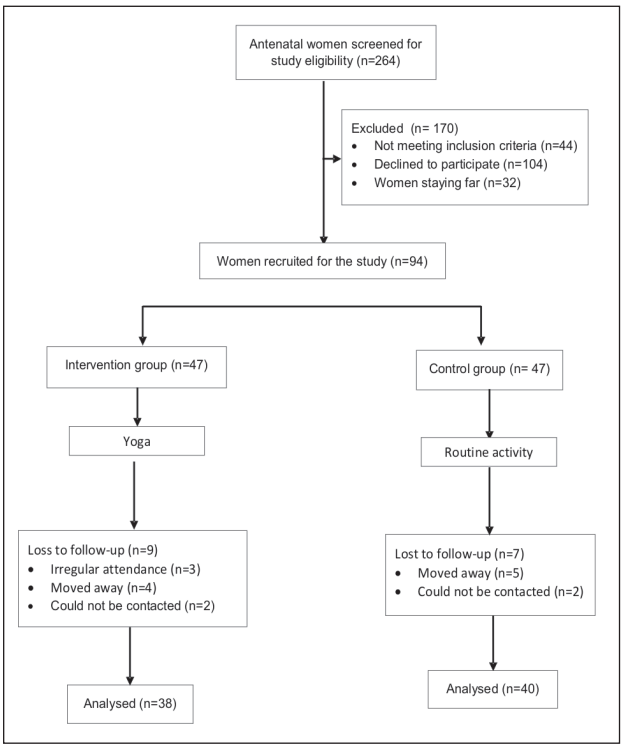

Fig. 1: *Consort flow diagram.*

	From 20-week gestation to 32-week gestation	
	From 20 to 26 weeks of gestation	**From 26 to 32 weeks of gestation**
Loosening exercises (5 min)		
Sideward bending	Yes	Yes
Twisting	Yes	Yes
Breathing exercises (10 min)		
Hand stretch breathing	Yes	Yes
Hand in and out breathing	Yes	Yes
Tadasana breathing	Yes	Yes
Tiger breathing	Yes	Yes
Asanas		
A) Standing (8 min)		
1. *Ardhakatichakrasana*	Yes	Yes
2. *Padahastana*	Yes	No
3. *Ardhachakrasana*	Yes	Yes
4. *Prasarita*	Yes	Yes
B) Sitting (6 min)		
1. *Ustrasana*	Yes	No
2. *Baddhakonasana*	No	Yes
3. *Upavista*	Yes	Yes
C) Pranayamas (9 min)		
1. *Nadishuddhi*	Yes	Yes
2. *Sheetali/sheetkari* (during summer season)	Yes	Yes
3. *Bhramari*	Yes	Yes
D) Relaxation techniques		
1. Deep relaxation (10 min)	Yes	Yes
Prayer (2 min)		

Fig. 2: *Yoga regime (50 min session).*

Results

Baseline demographic characteristics were comparable between both the groups. The mean PSS score was comparable in the two groups at the beginning of the study. In *Yoga* group, decrease in PSS at midpoint and at the end of study was 13.8 % and 17.81% respectively. On comparison of PSS between groups at different time points, marked improvement in stress was seen with *Yoga* (Table I and II).

Table III shows that the low frequency band power decreased from 67.71 to 62.79 in *Yoga* group at the end of twelve weeks of therapy (p < 0.001) indicating a decrease in the sympathetic tone. The high-frequency band power increased from 34.12 to 40.97 in the *Yoga* group,

suggesting a marked increase in the parasympathetic tone (Table IV).

Table I: Comparison of Perceived Stress Score (PSS) at baseline and study midpoint, i.e., 26 weeks.

Variable	20 week (Baseline)	26 week (Study midpoint)	Mean difference (% of change)	p value Intra group
Yoga group (n = 38)	19.25 ± 2.10	16.58 ± 2.43	2.67 (13.8%)	< 0.001*
Control group (n = 40)	19.26 ± 2.36	19.90 ± 2.58	0.64 (3.32%)	0.024*
p value Inter group	0.979	< 0.001*		

*significant

Table II: Comparison of Perceived Stress Score at baseline and 32 weeks.

Variable	20 week (Baseline)	32 week (Study end-point)	Mean difference (% of change)	p value Intra group
Yoga group (n = 38)	19.25 ± 2.109	15.82 ± 3.021	3.43 (17.81%)	< 0.001*
Control group (n = 40)	19.26 ± 2.367	20.88 ± 2.493	1.62 (8.41%)	0.001*
p valueInter group	0.979	< 0.001*		

*significant

Table III: Comparison of heart rate variability (low frequency band) at baseline and at 32 weeks.

Parameter	LF # (20 weeks)	LF # (32 weeks)	Mean difference (% change)	p- value (Intra group)
Yoga group (n = 38)	67.71 ± 9.08	62.79 ± 7.61	4.92 (7.26%)	< 0.001*
Control group (n = 40)	68.45 ± 9.81	69.57 ± 7.20	1.12 (1.64%)	0.525
p value (Inter group)	0.732	< 0.001*		

#LF: low frequency band, *significant.

Table IV: Comparison of heart rate variability (high frequency band) at baseline and at 32 weeks.

Parameter	HF # (20 weeks)	HF # (32 weeks)	Mean difference (% change)	p- value (Intra group)
Yoga group (n = 38)	34.12 ± 10.23	40.97 ± 8.02	6.85 (20.06%)	< 0.001*
Control group (n = 40)	33.49 ± 8.75	36.12 ± 8.88	2.63 (7.85%)	0.043*
p value (Inter group)	0.770	0.014*		

#HF: high frequency band *significant

There was a decrease in the LF/HF ratio from 2.29 to 1.64 at the end of the twelve weeks of *Yoga* intervention, which was highly significant (p = 0.001). Intergroup comparison was highly significant at the end of intervention period, i.e., 32 weeks, suggesting a decrease in the sympathetic tone and a better autonomic balance in the *Yoga* group (Table V).

Table V: Comparison of heart rate variability (LF/HF ratio) at baseline and at 32 weeks.

Parameter	LF/HF (20 weeks)	LF/HF (32 weeks)	Mean difference (% change)	p value (Intra group)
Yoga group (n = 38)	2.29 ± 1.19	1.64 ± 0.53	0.65 (28.38%)	0.001*
Control group (n = 40)	2.18 ± 0.68	2.05 ± 0.64	0.13 (5.9%)	0.311
p value (Inter group)	0.632	0.003*		

LF: low frequency band, HF: high frequency band, *significant.

Pregnancy complications such as hypertension, preterm delivery and foetal growth restriction were comparable between the groups.The frequency of vaginal delivery was similar between the groups (Table VI).

Table VI: Comparison of pregnancy outcomes between groups

Parameter	*Yoga* group (n = 38)	Control group (n = 40)	p-value
Hypertensive disorder	2 (5.3%)	4 (10%)	0.362
Mean weight gain (kg)	10.34 ± 2.73	9.84 ± 1.99	0.318
FGR	1 (2.6%)	3 (7.5%)	0.327
Normal vaginal delivery	35 (92.1%)	36 (90%)	0.443
Emergency caesarean section	2 (5.3%)	4 (10%)	
Elective caesarean section	1 (2.6%)	0 (0)	

FGR: Foetal growth restriction.

Table VII depicts neonatal outcomes which were comparable between the groups.

Table VII: Comparison of neonatal outcomes in both groups.

Variable	*Yoga* group (n=38)	Control group (n=40)	p- value
Mean gestational age at delivery (weeks)	38.5 ± 1.22	38.43 ± 1.46	0.807
Mean birth weight (kg)	2.83 ± 0.39	2.73 ± 0.32	0.218
Preterm	1 (2.6%)	3 (7.5%)	0.327
SGA	1 (2.6%)	4 (10%)	0.149
Still birth	0	0	–

SGA: Small for gestational age.

Discussion

Despite the world wide recognition of *Yoga* therapy, there are few studies available to prove its benefits during pregnancy.

Yoga reduces stress by an interplay of hypothalamic pituitary adrenal axis, autonomic nervous system and the peripheral nervous system[5-11]. *Yoga* training has shown to decrease sympathetic response (systolic pressure, diastolic pressure, heart rate). *Yoga* down-regulates the hypothalamo-pituitary-adrenal axis and sympathetic nervous system, both of which have been shown to prevent the release of the stress hormones such as cortisol and catecholamines. There is decreased firing from the locus coeruleus, which is the principal site in the brain for synthesis of norepinephrine in response to stress and panic. This decreased nor epinephrine output helps the body to relax and quiet down with reduced respiratory rate, heart rate and promotes the feeling of well being. The decreased sympathetic output decreases the release of corticotrophin releasing factor, with resultant decrease in cortisol output and thereby reducing stress[12-14].

In our study we used perceived stress scale (PSS) as a measure of perception of stress in pregnant women. This scale has been validated for use in Indian population in previous studies. The mean baseline score in our study was 19.25 ± 2.10 and 19.26 ± 2.36 in *Yoga* and control group, respectively. This score was higher than the reported mean stress score seen in Indian population, which is 14.1[15]. The PSS score decreased by 17% in the *Yoga* group and increased by 8% in the control group after 12 weeks of study. At midpoint of the study, i.e., even after 6 weeks of intervention, the PSS score fell significantly in the *Yoga* group as compared to control group. The PSS was 43.5 points lower in *Yoga* group as compared to the control group at the midpoint of the study. Satyapriya *et al*[16] reported a mean baseline score of 15.9 ± 5.01 in *the Yoga* group and 15.43 ± 5.20 in the control group. The perceived stress reduced by 31.75% in the *Yoga* group and increased by 6.60% in the control group which was highly significant. A study done by Beddoe et al[17] reported moderate level of perceived stress (14.8 ± 8.0) at baseline and a significant decrease in perceived stress from baseline to post-intervention. The score decreased by 33% in the third trimester after 7 weeks of *Yoga* therapy. Similarly Despande *et al*[18] measured stress at different time point of the study, i.e., at 12, 20 and 28 weeks among 68 high-risk pregnant women. The PSS scores decreased by 23% in the *Yoga* group and increased by 5.5% in the control group which was significant (p = 0.02).

Heart rate variability is a measure of cardiovascular autonomic regulation[19]. It expresses the balance between the sympathetic and parasympathetic nervous system. The LF (low frequency) band of the heart rate variability mainly signifies sympathetic activation when expressed in normalised units, while high frequency (HF) band denotes parasympathetic activity. LF/HF ratio indicates sympatho-vagal balance[20]. In our study, we found an increase in HF band power by 20.06%; decrease in the LF band power by 4.49% and decrease in LF/HF ratio by 28.38% in the *Yoga* group. In the control group, the HF band power increased by 7.85%; LF band power also increased by 1.64% and LF/HF ratio decreased by 5.9%. These changes suggest a decrease in the sympathetic activity and an increase in the parasympathetic dominance. This shift in the autonomic balance towards parasympathetic dominance indicates a reduction in stress. In a study done by Satyapriya *et al*[6], the heart rate variability was measured continuously before, during, and after a deep relaxation technique period in the *Yoga* session. While doing HRV during deep relaxation, they found an increase of 64% in the HF band at 20 weeks. Similarly, there was an increase of 150% in the HF band at 36 weeks, both of which were highly significant. During deep relaxation, the LF band power decreased by 21.6% at 20 weeks and by 45% at 36 weeks which was also highly significant. Thus suggesting that deep relaxation therapy of the *Yoga* therapy may be a powerful modulator of the sympathetic nervous system or the fight and flight response.

Many pregnancy complications are traceable to bio-psychosocial stresses, which involve neuro-endocrine-immuno-histochemical pathways. As a multidimensional, non-pharmacologic intervention, *Yoga* can be a tool to prevent these stress-related complications of pregnancy. Low risk normotensive women were recruited for the present study. In *Yoga* group 5.3% (n = 2), and 10% (n = 4) in the control group developed gestational hypertension but this difference was not statistically significant (p = 0.362). Our study revealed that *Yoga* therapy had no major effect on the blood pressure. Rakshani *et al*[21], in a study amongst 68 pregnant women, 10% (n = 3) cases in the *Yoga* group and 36.7% (n = 11) in the control group developed gestational hypertension (p = 0.02). This was in contrast to our results; this could be due to the fact that they included high-risk women in their study. In the antenatal period we detected one case of foetal growth restriction in the *Yoga* group as compared to three in the control group (2.6% (n = 1) vs 7.5% (n = 3) respectively, p = 0.327). Narendran *et al*[22] reported a significantly higher incidence of foetal growth restriction (FGR). The incidence being 21% (n = 35) in the *Yoga* group and 36% (n = 59) in the control group (p = 0.003). Similarly, Rakshani *et al*[21] also reported a higher incidence of FGR, 6.9% (n = 2) in the *Yoga* group and 25.8% (n = 8) in the control group, the difference was statistically significant (p = 0.05). Being low risk population, the overall percentage of FGR was low and the difference between groups was not statistically significant in our study. These studies in literature do report the benefit of antenatal *Yoga* in reducing the incidence of FGR in high-risk women. The three possible mechanisms postulated in the transmission of maternal stress to the unborn baby which can result in foetal growth restriction

are: 1) reduction in transplacental blood flow, 2) placental transfer of maternal stress hormones, and 3) stress-induced pCRH (placental corticotropin releasing hormone) released prematurely into the fetal environment. In the present study, 2.6% (n = 1) in the *Yoga* group and 7.5% (n = 3) in the control group delivered preterm (p = 0.327). Rakshani *et al*[21] reported a higher rate of preterm delivery, 20.7% (n = 6) in their *Yoga* group and 45.7% (n = 16) in control group (p = 0.04).

In our study, 92% (n = 35) in *Yoga* group and 90% (n = 36) in the control group had a normal vaginal delivery. The mode of delivery was comparable between the groups and majority of women underwent vaginal birth. In the study by Narendran *et al*[23], 58.82% (n = 40) in the *Yoga* group and 41.5% (n = 22) in the control group had a normal vaginal delivery. The rate of caesarean was higher in their study but the results were comparable between *Yoga* and control groups.

The strengths of our study were that: 1) It was a randomised controlled trial, 2) We measured stress using both subjective score (PSS) and an objective physiological parameter, i.e., heart rate variability, 3) It is the only study from North India on *Yoga* in pregnancy to the best of our knowledge. There are a few limitations in our study: 1) Small sample size, 2) The population might not be representative of the general population, 3) Out of three *Yoga* sessions per week, one was supervised in hospital and other two sessions were done at home by the women. The compliance could be ensured with telephonic calls and recall only.

Conclusion

We found a significant reduction in stress after *Yoga* therapy of twelve weeks using both subjective (perceived stress scale) and an objective (heart rate variability) parameters. *Yoga* group had a lower incidence of adverse pregnancy outcomes such as hypertension, preterm delivery, foetal growth restriction, etc., though it was not statistically significant. This was probably due to small sample size and inclusion of only low risk women in our study. More studies with larger sample size are required to fully establish the role of *Yoga* and its advantages in pregnancy. Biochemical measures, in addition to self report measures, will add to the objectivity of results.

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