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EFFECT OF THERAPEUTIC YOGA ON HEMOGLOBIN AND BLOOD GLUCOSE LEVELS AMONG ANTENATAL MOTHERS – A SINGLE BLINDED PLACEBO-CONTROLLED TRIAL

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Abstract

Background: The role of yogic concepts is immense in stress management and other therapeutic benefits, but its results on antenatal mothers' (AM) biomarkers are less researched.

Objective: To test the influence of Asana, pranayama and dhyana on average blood glucose (BG) levels and hemoglobin (Hb) of the antenatal mother (AM).

Methods: This Single blinded placebo-controlled trial was conducted at Saveetha Medical College and Hospital, Chennai, India. The samples were conveniently selected through consecutive sampling and allotted randomly using random number table into four groups namely group A (standard nursing care), Group B (Yoga therapy alone), Group C (antenatal exercises) and group D (Yoga therapy and antenatal exercises) with 33 samples in each group. The groups received their respective treatment for 2 days a week for 16 consecutive weeks. HbA1C and Hb levels were assed at baseline level (pre-test), and after 16th week (Post-test).

Results: Totally 132 samples accounted for the study results, which showed that the group D subjects performed significantly well compared to the A, B and C groups in all temporal outcomes ($P < 0.01$).

Conclusion: Combining elements of therapeutic Yoga with antenatal exercises will be more effective in normalizing glycemic levels and improving Hb levels among AM.

Keywords: Yoga, Pranayama, Asana, Dhyana, Antenatal Mother, Hemoglobin, HbA1C, Blood Glucose, Therapeutic Yoga.

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1. Introduction

Yoga is a tradition practice more like the activities of daily living among the ancient Indian population. The term Yoga therapy was first coined by various schools of thoughts however the Bihar school of Yoga has a great part to play at least in India. Ever since Yoga therapy came into existence, it has been progressing into various health conditions. There were many pathological condition^{1,2}, derangements and dysfunction³ are being analyzed extensively⁴ however normal physiological variations like pregnancy and pregnancy related problems are less studied comparatively. Out of the few studies which focused on the antenatal women (AM), depression was considered as the major outcome and various combination and recommendation were presented for keeping mind calm and proactive through Yoga.^{5,6} Apart from depression few studies have considered course of Labor, pain tolerance during labor⁷ and delivery outcomes.⁸

There are patients claim being documented in a qualitative study, that emphasize on making Yoga a compulsory routine and they have gone one step ahead and suggested that medical professionals should educate all the AM with elements of Yoga⁹. In this current scenario with so much of demand for the therapeutic yoga, there also arises an issue of quality and standardization of intervention protocol. Hence good number of research is required in the same. There are many biomarkers being used to assess stress associated with antenatal women and one among that is blood glucose level.¹⁰ There is a well-established association between stress and glucose levels in the body for which AM are no exception. During stress there is a release of hormones like cortisol and adrenaline as part of the "fight-or-flight" response. These hormones trigger a cascade of physiological changes, including an increase in blood glucose levels.¹¹ While this stress response is beneficial in the short term, chronic or long-term stress can have negative effects on glucose regulation among AM. Prolonged periods of stress during perinatal period can lead to insulin resistance, resulting in persistently elevated blood glucose levels, increasing the risk of developing gestational diabetes over time.^{12,13} Stress can also

influence the Hb levels. Prolonged exposure to stress can potentially lead to changes in hemoglobin levels. Stress activates the hypothalamic-pituitary-adrenal (HPA) axis, resulting in the release of stress hormones, including cortisol. Elevated cortisol levels over an extended period may affect the production and lifespan of red blood cells, potentially leading to decreased hemoglobin levels.^{14,15} So far to the best of our knowledge there are no studies that are done to analyse the effect of Yoga on stress and psychological biomarkers like Hb and BG. Hence, this study tried to test the effect of a standard yoga protocol, in comparison with antenatal exercises and standard nursing education in bring about changes in Hb and BG among AM.

2. Materials and Methods

This single blinded placebo-controlled trial was conducted at Saveetha Medical Hospital, Chennai, India. The study was cleared approved by the institution ethical committee at the Saveetha Institute of Medical and Technical Sciences. All the participants signed an informed consent form in both English and native language (Tamil) as per their familiarity.

Selection Criteria

Antenatal mothers aged between 20 to 35 years who are booked and presented with 20 weeks of gestation currently with singleton fetus in the antenatal clinic and willing to undergo yoga practice and those who are planning for the delivery at Saveetha Medical College and Hospital (SMCH). Antenatal mothers who are attending antenatal clinic for consultation and mothers who are seeking treatment during antenatal period at antenatal clinic, SMCH. Mothers with chances of high-risk pregnancy, history of psychiatric disturbances which may affect the interventional compliances, subjects with different religious thoughts and perceived Yoga from a religious background, pregnancy from in vitro fertilization, intrauterine growth restriction in any of the previous pregnancy, fetal abnormality on ultrasound scanning; and previous exposure to yoga or subjects with previous history of trauma while attempting to performing Yoga and other bad experiences were excluded from the study.

Sample Size and Sampling Technique

The sample size was estimated using the effect size achieved from the previous similar study¹⁶ and was calculated using the g-power software, version 3.1. the total samples required for the study was 118. The sample size was inflated by 10% to account for drop outs. Hence a total sample size was arrived at 132. The samples were conveniently selected through consecutive sampling and allotted randomly using random number table into four groups namely group A, B, C and D with 33 samples in each group.

Procedure

All the participants after getting consulted by the obstetrician, were also screened by the primary researcher for the selection criteria. Following this all the participants were assigned a numbered concealed envelope consisting of a computer-generated random number which will allocate them to any one of the four groups. As this was physical intervention-based study, the participants and intervention providers were not able to be absolutely blinded, hence the team of nurses who performed the assessments and the statistician were blinded from the study objective and group allocation.

Group Interventions

The group A received conventional nursing orientation while the group B and group C received Yoga intervention and antenatal exercises respectively and the group D received both Yoga and antenatal exercises. The groups received their respective treatment for 2 days a week for 16 consecutive weeks. Hb and HbA1C were assessed at the baseline (before the intervention) which is the pre-test and at the end of 16th week following intervention which is the post-test. The conventional nursing care consisted of general counseling, health education, nutritional suggestions, and orientation on lifestyle and behavior modification during antenatal period. The participants were open to approach the researcher for discussion during the 16 weeks of intervention regarding any health-related doubts or issues. The Yoga intervention for the study consisted of Asanas, pranayama and dhyana techniques proved to be useful in the past literature^{16,17} the detailed intervention for group B is presented in table 1. The group C received orientation for 10 minute every session regarding the safety measures in doing the sessions exercises and its benefits,

followed by stretching exercises mainly to the hip adductors, internal rotators, knee flexors and extensors, calf muscles. The upper limb muscles were also stretched with the total flexibility session lasting for 10 minutes. This was followed by a session of breathing techniques including coastal expansion exercises, diaphragmatic breathing exercises and deep breathing with holds for 10 minutes. This was followed by generalized strengthening exercises for all the muscles of the body focusing on upper trunk and abdomen on one session followed by lower limb and back muscles on consecutive session and this lasted for 15 minutes during the 1st 8 weeks and 10 minutes in the 2nd 8 weeks. Kegels exercise and pelvic floor strengthening exercises was done for 5 minutes during 1st 8 weeks and 10 minutes in the 2nd 8 weeks. This was followed by progressive relaxation technique for 10 minutes. Including rest both group B and C performed the intervention for 60 minutes a session, 2 sessions a week for 16 consecutive weeks. Group D received 40 minutes of Yoga session and 20 minutes of antenatal exercises for the same total 60 minutes of duration.

Outcomes Measures

The outcomes were applied before the intervention (Pretest) during the 20th gestational week, and after 16th week of intervention during the end of 36th week of gestation (Post-test). Participants provided blood specimens between 8:00 a.m. and 10:00 a.m. after at least 8 hours of fasting overnight. The participants relaxed in supine position and then the blood was drawn using Terumo Venoject VT-100PZ vacuum tubes without tourniquet. The test was done through a blood sample analysis and the results was obtained within 1 to 2 days of testing.

Statistical Analysis

The data of the study will be assessed using SPSS software version 26, with $P < 0.001$ as significance level and 95% as confidence interval. The distribution analysis was done using Shapiro-Wilk test and Kolmogorov-Smirnov test. The demographic data were assessed for homogeneity using Chi square analysis. Parametric outcomes used in the study were assessed for between group differences using analysis of variance (ANOVA)

and for the within group analysis was done using a paired t test.

3. Results

A total 132 AM satisfying the selection criteria accounted for the study results. They were selected from a pool of 212 women receiving antenatal care at our hospital. The following demographic data were collected - Age in years, Education, Income per month in rupees, Religion, Type of marriage, Duration of marital life, and Dietary Pattern. The demographic distribution in each group is presented in table 2. The analysis of the distribution of these factors clearly shows that there was no significant difference between the two groups. The results of the within group analysis of Hb and HbA1C showed that all the three was significant difference between the two temporal variables of group B, C, and D. (table 3 and 5). The between group analysis also showed similar trend in both the outcome. There was a significant difference between the posttest values from a homogenous baseline value. The post hoc analysis showed that there was a significantly better improvement in group D compared to all the other outcomes with $p < 0.01$. However, the group B and C showed a significant better result compared to group A. (Table 6). The temporal performance of both the groups for HbA1C and Hb are presented in figure 1 and 2.

4. Discussion

Regular antenatal care allows healthcare professionals to monitor the health of the mother during pregnancy. Antenatal care provides an opportunity to identify and manage any existing or potential risks associated with pregnancy. Healthcare providers can assess factors such as maternal age, pre-existing medical conditions, genetic risks, or lifestyle habits that may pose a threat to the health of the mother or the baby. By identifying these risks, appropriate measures can be taken to minimize their impact.¹⁸ There are various interventions and treatment approaches being adopted by the mother and advocated by the health care professionals.¹⁹ Hb and HbA1C are selected as the two biomarkers as they are vital biomarkers for stress which is a main issue in AM.²⁰ In this research sufficient time for the biomarkers to show any

changes. Hemoglobin and blood glucose can be considered as potential biomarkers of stress due to their relationship with the physiological and biochemical changes that occur in the body during stressful situations. Chronic or prolonged stress can lead to the disruption of normal physiological processes, including the suppression of red blood cell production. This can result in decreased hemoglobin levels, leading to conditions like anemia. Chronic stress can also cause changes in blood volume or blood flow, which may impact hemoglobin levels.^{21,22} Chronic stress or prolonged activation of the stress response system can lead to the dysregulation of blood glucose levels. High levels of cortisol over an extended period can impair insulin function, leading to insulin resistance and decreased glucose uptake by cells. This can result in chronically elevated blood glucose levels or even the development of conditions like type 2 diabetes.²³ The results of the study clearly states that the combination of Yoga and antenatal exercises showed a better sustainment of normal range of Hb and HbA1C. The results were consistent with previous studies which dealt with yoga for AM²⁴.

Yoga and antenatal exercises help improve overall physical fitness and flexibility. They focus on stretching, strengthening, and toning the muscles, which can be beneficial during pregnancy. From this study we observed that regular practice of Yoga can enhance endurance, promote better posture, and alleviate common discomforts such as back pain and muscle tension. Both yoga and antenatal exercises emphasize breathing techniques and relaxation, which are valuable skills for labor and delivery. Learning proper breathing patterns can help pregnant women manage pain, reduce anxiety, and maintain a sense of calm during contractions. Strengthening the pelvic floor muscles through exercises can also aid in the pushing phase of labor and promote postpartum recovery. Pregnancy can bring about various physical and emotional stressors. Engaging in yoga and antenatal exercises provides an opportunity to alleviate stress and promote mental well-being. The combination of movement, breathing exercises, and mindfulness techniques can help reduce anxiety, improve sleep quality, and enhance overall mood. Practicing yoga and antenatal exercises encourages a deeper

connection between the mother and the baby. Through gentle movements, stretching, and mindfulness, pregnant women can create a nurturing environment for themselves and their developing baby. This can foster a sense of closeness and emotional bonding. Both interventions often involve gentle movements and postures that promote blood circulation, which can help reduce swelling and fluid retention commonly experienced during pregnancy. The incorporation of relaxation techniques, such as guided imagery or meditation, can further enhance relaxation, reduce stress hormone levels, and support a healthier cardiovascular system. Similar results have been shown in many other conditions like parkinsonism, low back pain and even in adult women, where the stress levels were well managed by yoga and exercises.²⁵⁻²⁷

5. Conclusion

The study concludes that combining Yoga and exercises can be a better option compared to providing Yoga and exercises individually in normalizing the Hb and glucose levels. As these two biomarkers are predictors for stress levels, this can be a basic confirmation for Yoga therapies efficacy on reducing stress among AM. Hence future study should consider testing the same research design from a heterogenous population and on post-natal mothers.

6. Author Contribution Statement

Dr.S. KalaBarathi conceptualized and designed the study. Mrs Sathiyabama collected the data and executed the study. Dr. Nidhisharma reputed the samples for study population and supported the Manuscript preparation.

7. Acknowledgement

Saveetha Institute of medical and technical sciences (Deemed to be University), especially Research Department, Thandalam, Chennai, Tamilnadu, India.

8. Conflict of Interest

Conflict of interest declared none.

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Table 1: Exercise Procedure Used of Group B

Domains of Yoga		1 st 8 weeks	2 nd 8 weeks
Orientation	Duration	15min	10min
	Orientation about Yoga and health benefits, indications and contraindications, do's and don'ts	Yes	Yes
Pranayama (Breath control techniques)	Duration	10min	15min
	Hasta ayama svaasanam (hands-in & hands out breathing)	Yes	Yes
	Hasta vistara svasana (Hands stretching breathing)	Yes	Yes
	Gulpha vistāra śvasanam (Ankle stretch breathing)	Yes	Yes
	Vyāghra śvasanam (Tiger breathing)	Yes	No
	Naadi shudhi pranayama (Alternate nostril breathing)	Yes	Yes
	Soorya naadi prananyama (Right nostril breathing)	Yes	No
Asana	Duration	15min	10min
Standing asana	Tadasana (tree pose)	Yes	Yes
	Ardhakati chakrasana (Lateral arc pose)	Yes	Yes
	Trikonasana (Triangle pose)	Yes	Yes
Sitting asana	Vajrasana (Ankle posture)	Yes	Yes
	Siddhasana (Sage pose)	Yes	Yes
	Badhakonasana (Bound ankle pose)	No	Yes
	Malasana (Squatting pose)	No	Yes
	Utkata konasana (Goddess pose)	No	Yes
Bandha	Duration	--	5 min
	Udyana bandha	No	Yes

Deep relaxation technique	Duration	10min	10min
Dhyana	Duration	10min	10min

Table 2: Demographic Data and Homogeneity Analysis

Demographic data	GROUP A	GROUP B	GROUP C	GROUP D	Sig
Age in years					
20-25	4	6	7	5	Chi sq - 2.039 P=0.91
26-30	18	14	16	15	
31-35	11	13	10	13	
Education					
Illiterate	4	3	6	5	Chi sq - 7.136 P= 0.84
Primary education	4	2	2	5	
Higher secondary education	8	10	8	5	
Under graduate (UG)	12	14	12	10	
Post graduate (PG)	5	4	5	8	
Income per month in rupees					
Less than Rs. 10,000	2	1	3	5	Chi-sq - 6.206 P = 0.719
10,000-15,000	12	8	10	9	
15,000-20000	14	18	17	16	
Above 20000	5	6	3	3	
Religion					
Hindu	24	23	25	22	Chi-sq = 1.50 P = 0.99
Muslim	3	5	4	5	
Christian	5	4	3	5	
Others	1	1	1	1	
Type of marriage					
Consanguineous	6	3	5	4	Chi-sq = 1.28. P=0.732
Non consanguineous	27	30	28	29	
Duration of marital life					
Less than 2 years	11	12	13	11	Chi-sq=5.92 P = 0.747
2-4 years	12	14	10	16	
4-6 years	6	3	5	1	
More than 6 years	4	4	5	5	
Dietary Pattern					
Vegetarian	8	10	12	7	Chi-sq = 2.21 P = 0.52
Mixed (both veg & Non veg)	25	23	21	27	

Table 3: Within Group Analysis of Hemoglobin Values

Group		pretest	Post test	Mean difference	Confidence interval at 95%	T-value	P value
Group A	Mean	13.9082	13.7121	0.1961	-0.53 to 0.93	0.5322	0.596
	SD	1.5104	1.4821				
	SEM	0.2629	0.2580				
	N	33	33				
Group B	Mean	13.652	14.127	-0.476	-0.53 to -0.41	16.29	0.001*
	SD	1.456	1.409				
	SEM	0.254	0.245				
	N	33	33				
Group C	Mean	13.779	14.027	-0.248	-0.33 to -0.16	5.793	0.001*
	SD	1.475	1.475				
	SEM	0.257	0.257				
	N	33	33				
Group D	Mean	13.7273	14.3318	-0.604	-0.69 to -0.51	13.88	0.001*
	SD	1.1501	1.0617				
	SEM	0.2002	0.1848				
	N	33	33				

Table 4: Between Group Analysis of Hemoglobin Values

	Source	SS	Df	MS	F	P
Pre test Hb	Between-treatments	1.154	3	0.3848	0.19485	0.899
	Within-treatments	252.87	128			
	Total	253.92	131			
Post test Hb	Between-treatments	6.602	3	2.208	1.175	0.042*
	Within-treatments	239.55	128			
	Total	246.15	131			

Table 5: Within Group Analysis of HbA1C Values

Group		pretest	Post test	Mean difference	Confidence interval at 95%	T-value	P value
Group A	Mean	6.2155	6.2424	-0.027	-0.06 to 0.07	1.58	0.121
	SD	0.5385	0.4975				
	SEM	0.0937	0.0866				
	N	33	33				
Group B	Mean	6.100	5.909	0.191	0.14 to 0.24	7.48	0.001*
	SD	0.532	0.520				
	SEM	0.093	0.091				
	N	33	33				
Group C	Mean	6.218	6.055	0.164	0.12 to 0.21	8.04	0.001*
	SD	0.618	0.557				
	SEM	0.108	0.097				
	N	33	33				
Group D	Mean	6.173	5.682	0.491	0.315 to 0.66	5.68	0.001*
	SD	0.601	0.240				
	SEM	0.105	0.042				
	N	33	33				

Table 6: Between Group Analysis of HbA1C Values

	Source	SS	Df	MS	F	P
Pre test HbA1C	Between-treatments	0.301	3	0.1003	0.304	0.821
	Within-treatments	42.13	128	0.329		
	Total	42.43	131			
Post test HbA1C	Between-treatments	5.54	3		1.849	8.346
	Within-treatments	28.35	128	0.221		
	Total	33.90	131			

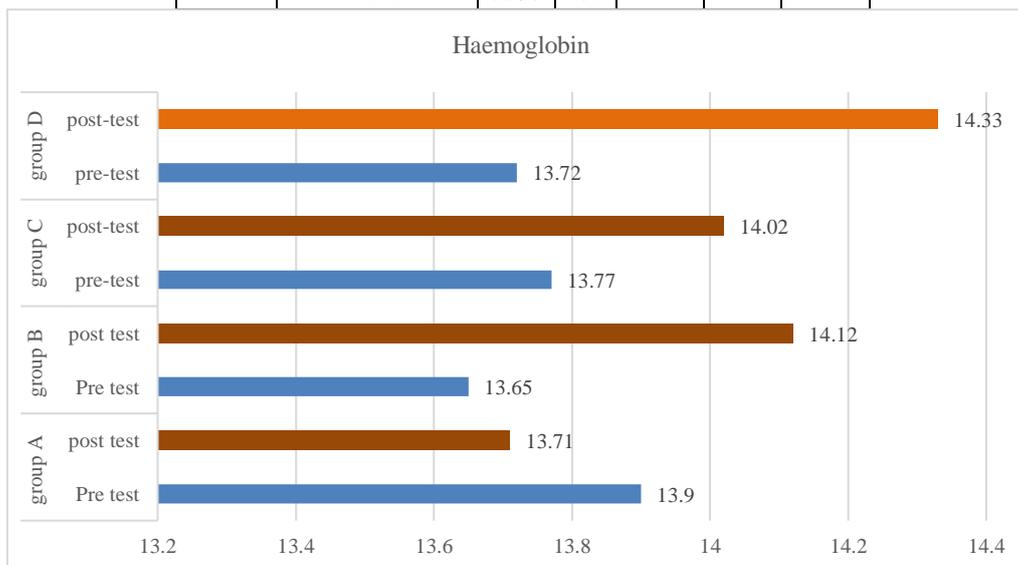


Figure 1: Group Wise Performance of Temporal Values of Hb

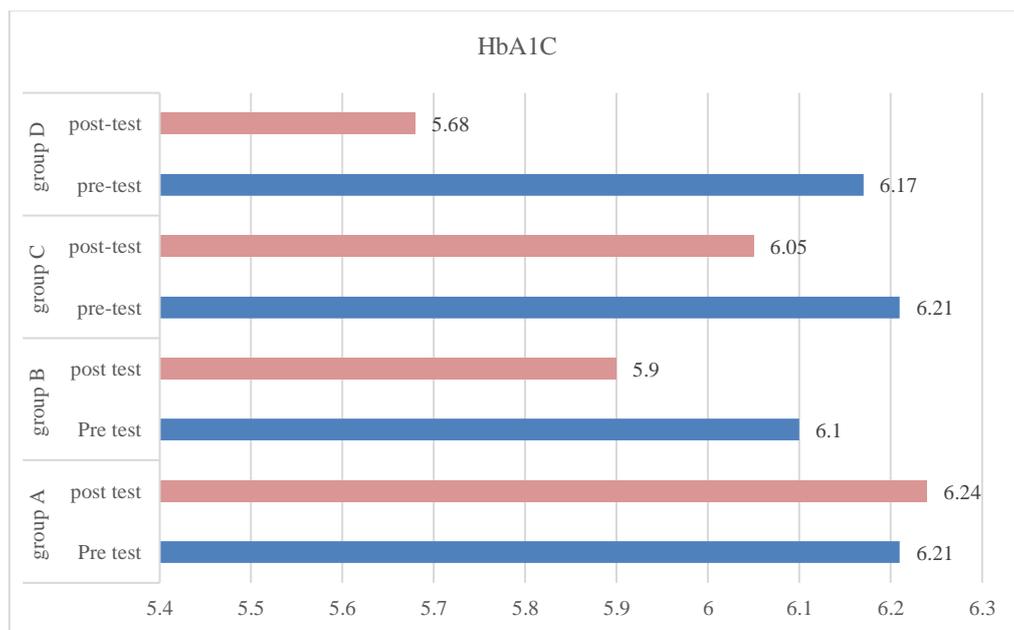


Figure 2: Group Vice Performance of Temporal Values of HbA1C