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Original Article

Physiology Section

Effect of Mindfulness Meditation on Perceived Stress Scores and Autonomic Function Tests of Pregnant Indian Women

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ABSTRACT

Introduction: Various pregnancy complications like hypertension, preeclampsia have been strongly correlated with maternal stress. One of the connecting links between pregnancy complications and maternal stress is mind-body intervention which can be part of Complementary and Alternative Medicine (CAM). Biologic measures of stress during pregnancy may get reduced by such interventions.

Aim: To evaluate the effect of Mindfulness meditation on perceived stress scores and autonomic function tests of pregnant Indian women.

Materials and Methods: Pregnant Indian women of 12 weeks gestation were randomised to two treatment groups: Test group with Mindfulness meditation and control group with their usual obstetric care. The effect of Mindfulness meditation on perceived stress scores and cardiac sympathetic functions and parasympathetic functions (Heart rate variation with respiration, lying to standing ratio, standing to lying ratio and respiratory rate) were evaluated on pregnant Indian women.

Results: There was a significant decrease in perceived stress scores, a significant decrease of blood pressure response to cold pressor test and a significant increase in heart rate variability in the test group ($p < 0.05$, significant) which indicates that mindfulness meditation is a powerful modulator of the sympathetic nervous system and can thereby reduce the day-to-day perceived stress in pregnant women.

Conclusion: The results of this study suggest that mindfulness meditation improves parasympathetic functions in pregnant women and is a powerful modulator of the sympathetic nervous system during pregnancy.

Keywords: Maternal stress, Mind-body intervention, Pregnancy complications

INTRODUCTION

Various pregnancy complications like hypertension, preeclampsia and low birth weight have been strongly correlated with maternal stress [1,2]. One of the connecting links between pregnancy complications and maternal stress is mind-body intervention which can be part of Complementary and Alternative Medicine (CAM). Biologic measures of stress during pregnancy may get reduced by such interventions.

Other associated symptoms like anxiety and fatigue which is usually related to perceived stress, augment the detrimental effect of stress [2]. The connecting link between pregnancy complications and maternal stress is mind-body intervention which can be part of CAM. Biological measures of stress during pregnancy may get reduced by such interventions [3].

An active ingredient in a stress reduction program may be mindfulness, which has been effective in symptom reduction and general health improvement in a variety of conditions, such as anxiety, depression, back pain, and stress [4,5]. Mindfulness meditation is a technique adapted from Buddhist Vipassana meditation by which one learns to be mindful, "the intentional accepting and non-judgmental focus of one's attention on the emotions, thoughts and sensations occurring in the present moment" [6]. Previous studies have found improvements in measures of anxiety, depression, and positive effects in women learning and practicing traditional mindfulness-based techniques especially in their third trimester of pregnancy [7]. Studies also indicate mindfulness-based interventions are a possible mental health approach to managing anxiety and negative mood during the second half of pregnancy [8]. Analysis of these studies indicates that there are flaws in methodologies, such as lack of a control group or random assignment. Moreover, there is limited research investigating mindfulness-based intervention on self-reported and biologic measures of stress among Indian pregnant women.

Therefore the purpose of this study was to evaluate the effect of Mindfulness meditation on perceived stress scores and autonomic function tests of pregnant Indian women.

We hypothesized that the mindfulness intervention would provide strategies for managing stress and negative emotions, thus resulting in greater decreases in perceived stress scores in Indian pregnant women.

MATERIALS AND METHODS

Participants

Participants were recruited from Department of Obstetrics and Gynaecology, HAH Centenary Hospital, Jamia Hamdard, New Delhi. The study included 74 pregnant women who were randomised into two major groups. Study time period was for one year from July, 2013 to July, 2014.

Inclusion criteria: Pregnant Indian women of 12 weeks gestation, ≥18 years of age or older, able to read, write and understand English or Hindi and able to verbalize a source of social support.

Exclusion criteria: Variety of medical conditions and complications such as: diabetes, hypertension, obesity, multiple pregnancy, history of previous pregnancy loss due to known single gene defects, chromosomal disorders, intrauterine infections, in vitro fertilization pregnancy, previous history of intra uterine growth retardation, preclampsia, maternal structural abnormalities, psychiatric problems, being younger than 18, participants already practicing meditation or relaxation exercises. Participants who developed any complications were excluded from the study.

Study: The study included 74 pregnant women were randomised into two major groups.

Group I (n=37): Control group. Participants in the control group were not offered any type of intervention in the research project. The control group received their usual obstetric care.

Group II (n=37): Study group. Participants in the study group received mindfulness meditation intervention along with their usual obstetric care. The study protocol was approved by the Institutional Review Board (IRB) and ethical committee of Jamia Hamdard, Hamdard University, New Delhi. Written informed consent was obtained from all subjects before randomization.

Design

The mindfulness meditation program administered 2 sessions per week for 5 weeks to the study group. This was for explaining techniques, practice and feedback along with 30 minutes daily home practice [Table/Fig-1]. The process of framing the program was based on the guide lines provided by Kabat-Zinn et al., and some adaptation done for the patients involved in the study [9].

Assessments: The questionnaires and evaluation of autonomic function tests were completed by patients before the intervention and after intervention. The staff of Physiology Department conducted the assessments. The staffs were trained before conducting the assessment, and were blind for the hypothesis of the study. Following were the parameters used for assessments.

1. Health History

Estimated Gestational Age (EGA) was determined by the first day of the last menstrual period and confirmed by ultrasound [8]. Medical and health behaviours were evaluated by self-reported health history questionnaire.

2. Perceived Stress Scale (PSS)

This scale measures the degree to which a respondent appraises one's life as being stressful during the past month. It is a self-reported measure comprising of 10 items. This scale measures the perceived unpredictability of general life stress with a score range from 0 to 56 with a higher score indicating a higher level of perceived stress [9].

3. Autonomic function tests: In this present study, non-invasive methods of autonomic nervous system parameter measurements were practised. A combination of these were employed as some of these tests give information about sympathetic functions (cold pressor test and blood pressure response to mental arithmetic) whereas, others give information about parasympathetic functions, (heart rate variation with deep breathing test, 30:15 ratio, standing to lying ratio and respiratory rate).

Mindfulness meditation	Content of sessions
Week 1- 1st session	Welcoming and explanation of basics of mindfulness meditation
Week1- 2nd session.	Explanation of importance of mindfulness of breathing on stress reduction
Week 2- 1st session	Explanation of mindfulness in sitting and lying posture Practicing mindfulness breathing. Mp3 CD provided for home practice
Week 2- 2nd session	Explanation and practicing sitting and lying mindfulness of breathing. Mp3 CD provided for home practice
Week 3- 1st session	Explanation and practicing sitting and lying mindfulness of breath, mindfulness of sounds around them and thoughts. Mp3 CD provided for home practice
Week 3- 2nd session	Practice of mindfulness of breath, sounds around them. Mp3 CD provided for home practice
Week 4- 1st session	Explanation of stress during pregnancy and importance of bringing mind to "present moment".
Week 4- 2nd session	Explanation and practice of mindfulness walking. Explanation and practice of body scan of all parts. Mp3 CD provided for home practice
Week 5 1st session	Practice of mindfulness in sitting, lying and walking. Practice of body scan of all parts
Week 5- 2nd session	Summarising sessions, feedback, post session assessments.

[Table/Fig-1]: Mindfulness meditation program.

a) Heart rate response to immediate standing (30:15) – The subject was given a rest of 15 minutes in the supine position and the ECG leads (lead II) were positioned. After the rest period ECG recording was started and the patient was asked to stand without support i.e., not leaning against the wall and remain motionless for 3 minutes, recording the ECG continuously. 30:15 ratio was calculated by taking ratio of longest R-R interval around beat 30 and shortest R-R interval around beat 15 after standing.

b) Standing to lying ratio (S/L ratio) – ECG leads were connected for recording lead II with the subject standing for 2 minutes and ECG was recorded for 20 beats and the subject was asked to lie down supine without any support with the leads attached. The recording continued for 60 more beats in the lying position. The point of change of position was noted. S/L ratio was calculated as longest R-R interval during 5 beats before lying down to shortest R-R interval during 10 beats after lying down. S/L ratio of >1 was taken as normal and <1 as abnormal [10,11].

c) HRV-According to Conny, Heart rate variability (HRV) can be assessed by indices calculation using R-R intervals (time domain) or by frequency domain analysis of an array of R-R intervals. Short ECG segments (lasting from 0.5 to 5 minutes) can be used for this analysis [12].

d) Cold pressor test- Subject was comfortably seated in a chair and the resting blood pressure was recorded. The subject was then asked to immerse her hand in cold water maintained at 4-6 degrees Celsius, upto the wrist joint. Blood pressure was measured from the other arm at pain threshold time. Maximum increase in blood pressure was recorded.

Pressure product that closely reflects myocardial oxygen uptake and coronary blood flow (heart rate X systolic blood pressure) was also evaluated [13].

Procedure

Pre-study evaluation (Time 1)

Eligible women who consented and agreed to participate were randomized to the Study or Control group. At time 1, participants completed the health history questionnaire and the perceived stress scale questionnaire. Autonomic function tests and pressure product (heart rate X systolic blood pressure) were evaluated.

Post-study evaluation (Time 2)

5 weeks (Estimated gestational age 17-18 weeks) from the initial visit, a member of the research team met with the participants at the prenatal visit. Participants completed the perceived stress scale. Autonomic function tests and pressure product (heart rate X systolic blood pressure) were evaluated.

STATISTICAL ANALYSIS

Statistical software SPSS version 16.0 (Chicago, IL, USA) was used for all data analysis. Paired and un-paired 't-tests' were used to analyse the data.

RESULTS

The age (in years) mean ± S.D of control group is 23 ± 2.4 and study group is 21 ± 2.56. [Table/Fig-2] shows that the pre-intervention values in both the control and study groups were comparable (p> 0.05) and there was no significant difference in the parameters. [Table/Fig-3] shows the comparison of post intervention parameters in control and study group. There was a significant decrease in perceived stress score, a significant decrease of blood pressure response to cold pressor test and systolic blood pressure response to mental arithmetic and a significant increase in heart rate variability in study group compared to control group. There

Parameters	Group	Mean±SD	p-value
Systolic Blood Pressure (SBP)	Control	109.16± 5.2	0.981
	Study	109.22±4.9	
Diastolic Blood Pressure (DBP)	Control	69.11±2.3	1.000
	Study	69.11±2.2	
Respiratory Rate	Control	19.03±1.56	0.876
	Study	19.11±1.4	
Perceived Stress Scale	Control	30.59±2.1	1.000
	Study	30.59±1.9	
Heart rate variability (beats/min.)	Control	22.24±1.6	0.187
	Study	24.32±1.8	
30:15 Ratio.	Control	1.1760± 0.43	0.193
	Study	1.1417 ±0.36	
S/L Ratio.	Control	.9751±0.0299	0.751
	Study	.9773±0.028	
Cold Pressor Systolic blood pressure response	Control	13.35±2.41	0.506
	Study	12.84±2.19	
Cold Pressor Diastolic blood pressure response.	Control	7.16±1.55	0.585
	Study	7.49±1.89	
Mental arithmetic systolic blood pressure response.	Control	11.70±2.65	0.975
	Study	11.68±2.4	
Mental arithmetic diastolic blood pressure response.	Control	4.76±1.22	0.693
	Study	4.57±1.43	
Resting Heart Rate (RHR)	Control	81.16±4.3	0.931
	Study	81.03±4.6	
Pressure Product (RHR X SBP)	Control	8851.57±10.9	0.988
	Study	8855.14± 11.12	

[Table/Fig-2]: Comparison of Pre-intervention parameters in control and study groups.
p>0.05, No significant difference

Parameters	Group	Mean±SD	p-value
Systolic Blood Pressure (SBP)	Control	124.68±5.6	0.520
	Study	109.22±3.8	
Diastolic Blood Pressure (DBP)	Control	69.11±2.2	1.000
	Study	69.11±2.23	
Respiratory rate	Control	19.27±2.1	0.007*
	Study	18.08 ±1.8	
Perceived Stress scale	Control	32.11±2.4	0.000*
	Study	19.05±1.4	
Heart rate variability beats/ min(Post)	Control	20.65±1.5	0.000*
	Study	26.59±2.1	
30:15Ratio	Control	1.1868±0.44	0.102
	Study	1.1417±0.33	
S/L ratio	Control	1.001±0.026	0.062
	Study	0.977±0.029	
Cold Pressor systolic blood pressure response.	Control	13.38±2.23	0.000*
	Study	9.68±1.8	
Cold Pressor diastolic blood pressure response.	Control	7.54±1.4	0.000*
	Study	4.19±0.98	
Mental arithmetic systolic blood pressure response.	Control	13.49±3.1	0.000*
	Study	8.97±2.21	
Mental arithmetic diastolic blood pressure response.	Control	4.38±1.32	0.056
	Study	5.22±1.53	
Resting heart rate (RHR)	Control	81.16±3.9	0.931
	Study	81.03±4.1	
Pressure Product (RHR X SBP)	Control	8853.96±10.9	0.521
	Study	8855.14±11.23	

[Table/Fig-3]: Comparison of post intervention parameters in study and control groups.
*p< 0.05, significant

was no significant difference in rate pressure product between the groups (*P < 0.05, significant). [Table/Fig-4] showed that there was significant percentage decrease in perceived stress score and respiratory rate, a significant percent decrease of blood pressure response to cold pressor test and systolic blood pressure response to mental arithmetic test in study group compared to control group (*P < 0.05, significant).

Parameters	Group	Mean±SD	p-value
Systolic blood pressure	Control	28.14 ±3.2	0.180
	Study	0.0000	0.185
Respiratory rate	Control	3.78 ±0.098	0.041*
	Study	-1.013±0.099	0.042*
Perceived Stress scale	Control	36.16±1.9	0.000*
	Study	-5.92 ±0.087	0.000*
Heart rate variability beats/min	Control	-31.55±2.54	0.000*
	Study	12.25±1.33	0.000*
30:15 Ratio	Control	-1.28±0.098	0.421
	Study	0.0000	0.424
S/L Ratio	Control	-2.65±0.44	0.024
	Study	0.0000	0.027
Cold pressor systolic blood pressure response.	Control	22.73±3.45	0.000*
	Study	-8.79±1.45	0.000*
Cold pressor diastolic blood pressure response.	Control	35.21±3.34	0.000*
	Study	-0.45±0.09	0.000*
Mental arithmetic systolic blood pressure response.	Control	16.22±2.45	0.000*
	Study	-20.015±3.89	0.000*
Mental arithmetic diastolic blood pressure response.	Control	-13.93±2.33	0.097
	Study	-47.24±4.24	0.097
Pressure Product (RHR X SBP)	Control	-13.84±3.4	0.516
	Study	0.0000	0.518

[Table/Fig-4]: Percentage changes of parameters in Control and study groups.

DISCUSSION

In our study, HRV and respiratory rates which reflect parasympathetic tone found significantly higher and lower values respectively in the study group after mindfulness meditation compared to control group [Table/Fig-3]. According to Conny, Heart Rate Variability (HRV) can be assessed by indices calculation using R-R intervals (time domain) or by frequency domain analysis of an array of R-R intervals. Short ECG segments (lasting from 0.5 to 5 minutes) can be used for this analysis [12]. Markers of vagal input to the heart are high frequency oscillations in range, 0.15-0.40 Hz which are related to respiration. In time domain analysis vagal input is expressed by standard deviation of normal R-R intervals (SDNN) and root mean square of differences of successive normal RR intervals (rMSSD). Low frequency oscillations of range, 0.04-0.15 Hz reflect the fluctuations in sympathetic tone and LF/HF ratio (0.01-0.40 Hz) is a marker of sympathovagal balance [14]. The results of our study is similar to study by Satya Priya et al., where effect of integrated yoga on stress and heart rate variability in pregnant women was evaluated and perceived stress decreased by 31.57% in the yoga group and increased by 6.60% in the control group (p=0.001) and the high-frequency band of the heart rate variability spectrum (parasympathetic) increased by 64% in the 20th week [15]. Previous studies on pregnant women by Panja et al., have found that the heart rate response to deep breathing, a measure of cardiac parasympathetic function was observed to be significantly lower in pregnant subjects when compared to control group of age matched non-pregnant subjects and generally followed a decreasing trend with increase in gestation [16]. It is known that reduced baro receptor sensitivity, impaired vagal afferents to brain and a reduction in oscillation of right atrial

distension arising from diminished pulsatility of venous return due to growing uterus are some of the causes implicated for reduced baroreceptor sensitivity [16]. Therefore, the results of our present study showing significant increase in the heart rate response to breathing and decrease in respiratory rate which reflect increased parasympathetic tone in the study group after mindfulness meditation becomes all the more relevant and important for maintaining good parasympathetic tone in pregnant women. It is known that though there is reduced diastolic pressure and total peripheral resistance during pregnancy, sympathetic activation is a common characteristic of early pregnancy in humans [17].

In this study, perceived stress score, increase in systolic and diastolic blood pressure in response to cold pressor response and increase in systolic blood pressure in response to mental arithmetic which reflect sympathetic tone found significantly lower values in the study group compared to control group [Table/Fig-2]. The effect on perceived stress score is similar to previous study by Satya Priya et al., [15]. The effect on perceived stress score is important because daily stressors affect wellbeing and can accumulate over time. Our body responds to daily events and attempts to maintain homeostasis by an active process often referred to as allostasis [18]. It is the increase of the daily stress events and/or the inefficient management of allostasis that results in an increase in allostatic load and potentially negative health outcomes. Moreover, previous study also shows that in a normal pregnancy, levels of CRH in maternal blood increase exponentially from weeks 15 to 36 gestation with a significant rise at weeks 26 to 30 [19]. It is the significantly elevated and/or accelerated rate of CRH increase over the course of the pregnancy that is associated with negative outcomes. Therefore, the results of the present study suggest that the effect of mindfulness meditation on perceived stress scores will have significant effect on decreasing day-to-day perceived stress, which potentially may impact allostatic load and ultimately adverse health outcomes in pregnant women.

Significance of our study: This study shows that mindfulness meditation reduces sympathetic tone and can be a powerful modulator of sympathetic nervous system and thereby reduce the day-to-day perceived stress in pregnant women.

LIMITATIONS

Future studies can be carried out using newer techniques to evaluate various parameters. Patient compliance can be further improved with more frequent mindfulness meditation sessions.

CONCLUSION

In conclusion, the results of this study suggest that mindfulness meditation is a more powerful modulator of the sympathetic nervous system and thereby reduce the day-to-day perceived stress in pregnant women. This can also prevent the deleterious effect of stress on health of pregnant women and birth outcomes.

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