Research article (Award paper)
Assessment of a short-course yoga practice on cardiometabolic risks, fetomaternal outcomes and psychophysical health in gestational diabetes mellitus

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ABSTRACT

Introduction and Aim: Gestational diabetes mellitus (GDM), which is defined as diabetes diagnosed in the second and third trimesters of pregnancy, has emerged as a global public health concern. It has been associated with short-term and long-term adverse health outcomes for both mothers and their new-borns. Women with GDM are known to have decreased quality of life and increased risks of caesarean section, gestational hypertension, preeclampsia, and type 2 diabetes. In babies, GDM has been found to be associated with macrosomia or larger than normal gestational-aged infants, neonatal hypoglycemia, and type 2 diabetes mellitus later in life. Though yoga is known to improve the quality of life of diabetic patients, its role in the management of GDM has not been adequately assessed. Therefore, the present study was conducted to evaluate the effectiveness of Yoga on cardiometabolic parameters, psychophysical health and maternal and fetal outcomes in GDM patients at JIPMER hospital, Puducherry.

Methods: Fifteen pregnant women diagnosed to have GDM, admitted to Obstetrics Ward of JIPMER Hospital were recruited for the study. The intervention package of a thirty minutes Yoga module consisting of Sukshma Vyayama (2 min), Tadasana (1 min), Uthitapadasana (1 min), Savasana in the left lateral posture (3 min), Nadisodhana or Anuloma-viloma pranayama (5 min), Chandranadi pranayama (5 min), Sheetal pranayama (5 min) and Bhramari pranayama (5 min) and Relaxation (3 min) was administered along with hospital routine treatment for 10 days during 35th/36th week (depending on the gestational week of admission to hospital), or until delivery. Cardiometabolic parameters including heart rate (HR), blood pressure (BP), rate pressure product (RPP) and glycemic status assessed by random blood sugar (RBS) were investigated. JIPMER hospital tool for the maternal and fetal outcome variables were used to assess the feto-maternal parameters. Perceived Stress Score (PSS) and Quality of Life Score (QoL) were used to assess the psychophysical health of the GDM patients. All the parameters were assessed before and after yoga intervention. Paired t test was used for statistical analysis of data. P value of <0.05 were considered to indicate significant statistical difference.

Results: Statistically significant decrease in HR, BP, RPP, RBS, PSS, and increase in QoL, and improvement of fetomaternal outcomes (based on the normative data available in the department) were observed in GDM patients after yoga intervention for a period of seven to ten days during their hospital stay.

Conclusion: A short-course yoga practice for 7-10 days is adequate to reduce cardiometabolic risks, psychological stress, and improve quality of life and fetomaternal outcomes in GDM patients. Antenatal mother with GDM can use yoga as an adjunct therapy in the later part of pregnancy to prevent or reduce the complications and to improve the maternal and fetal outcomes of gestational diabetes mellitus.

Keywords: Gestational diabetes mellitus; yoga; cardiometabolic risk; fetomaternal outcome; perceived stress score; quality of life score.

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with the onset or first recognition during the present pregnancy at 24-28 weeks of gestation (1). GDM was highly prevalent which ranges from 3.8% to 41% in various parts of India. In Tamil Nadu, the prevalence rate was 18.9% (2). The two major disorders such as insulin resistance and β-cell dysfunction are linked to the pathogenesis of GDM (3). Generally, insulin resistance develops even in normal pregnancy due to failure to acclimatize the increasing demands of insulin in response to growing fetus. And in GDM, insulin resistance could be related to many factors such as inflammation, placental hormones, and cytokines, affecting the post-receptor insulin signalling pathway decreasing the insulin receptor substrate 1 tyrosine phosphorylation and subsequently decreasing the translocation of glucose transporter 4 (GLUT4) to the surface of the muscle cell (4-7).

It is known that type 2 diabetes mellitus (T2DM) has increased cardiometabolic risk (8). As the metabolic profile of GDM is similar to T2DM, women diagnosed with GDM may also have increased cardiometabolic risk which could be shared by many
factors such as genetic and epigenetic modifications, inflammation, endothelial dysfunction, metabolic syndrome and change in lifestyle (9). The established cardiometabolic risk factors are overweight, abdominal obesity, hypertension, diabetes, dyslipidemia and metabolic syndrome (8, 9).

GDM may have negative impact on women’s mental well-being and quality of life. Various psychological problems occur as an effect of GDM which includes anxiety, stress during pregnancy, antenatal and postpartum depression (10). Hyperglycemia could be both the cause and consequence of depression (11, 12). The psychological stress is intense due to the perception of poor delivery outcomes and other fetomaternal and neonatal morbidities associated with the disease. Increased stress affects the women’s mental well-being and also affects quality of life if not treated properly.

Studies have reported a negative impact of GDM on fetomaternal and neonatal outcomes which includes maternal complications such as increased incidence of hypertension due to vascular dysfunction, development of T2DM, vaginal tear, fetal complications such as macrosomia, shoulder dystocia, and neonatal complications such as asphyxia, hypoglycemia, kernicterus, respiratory distress syndrome (13). Neonatal hypoglycemia occurs due to maternal hyperglycemia and fetal hyperinsulinemia (14). Fetal hyperinsulinemia causes macrosomia, as insulin is a known somatic growth factor.

GDM being a high-risk pregnancy, alternative therapies may be encouraged rather than pharmacological therapy in the management of GDM. Yoga being non-pharmacological treatment and cost effective, it should be advocated. Practice of yoga could decrease glycemic load and reduce cardiometabolic risk in diabetes mellitus and it is known to improve quality of life (15). Though the effects of yoga on fetomaternal outcomes in GDM was reported earlier, till date there is no report of assessment of short course of yoga practice in the later weeks of gestation prior to delivery in GDM patients. Therefore, the present study was undertaken with the objective of assessment of the effect of a structured short-course yoga module on cardiometabolic risks, fetomaternal outcomes and psychophysical health in GDM.

MATERIALS AND METHODS

Design of the study

The present study was conducted as a randomized control trial in the Department of Physiology and Obstetrics and Gynaecology, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry, India. The study was registered as clinical trial in Clinical Trial Registry of India (CTRI/2020/06/025807).

Participants and informed consent

After obtaining approval from Scientific Advisory Committee and Ethics Committee of JIPMER, 15 GDM women admitted to the Obstetrics Ward at their later part of third trimester were recruited for the study. Written informed consent was obtained from all the participants prior to the initiation of the study. The subjects of the group were pregnant women diagnosed to have GDM and admitted in the Obstetrics Ward at 35th/36th weeks of gestation.

Sample size calculation

The primary objective of the study was to assess cardiometabolic risks in GDM women following practice of yoga. However, there was no article available on assessment of cardiometabolic risks in GDM following yoga intervention. There was one randomized controlled trial (RCT) that demonstrates improvement of various aspects of health in women having high risk pregnancies including GDM, following yoga therapy (16). As in this study, blood glucose and blood pressure were considered as the outcome parameters, we had used this for sample size calculation for the present study, which is also an RCT. The sample size of the previous study (16) was 30 in the study group, which comprises of assessment of four different aspects of health including preeclampsia, gestational diabetes mellitus and intrauterine growth retardation. As in the present study, our primary objective is to assess cardiometabolic risks in GDM patients; we calculated sample size mainly for GDM. With the difference in the pregnancy outcomes in four components of high-risk pregnancies with yoga intervention reported in this study with α set at0.05, probability of type I error at 0.01, and powered at 0.8, the minimum sample size of 15 was calculated at 5% level of significance and 80% power in one component of high-risk pregnancy (16).

Inclusion and exclusion criteria

Inclusion criteria of the group were GDM women between the age of 20 to 40 years, receiving insulin and/or oral anti-diabetic agents. GDM women with severe anemia, polyhydramnios, multiple pregnancy, pregnancy induced hypertension, cardiac problems, GDM women with previous history of PCOS on metformin treatment and body mass index (BMI) >35 kg/m² were excluded from the study.

Anthropometric assessment

Anthropometric indices such as height and weight were measured and BMI was calculated before and after receiving yoga intervention.

Cardiometabolic risk parameters

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Cardiometabolic risk (CMR) parameters such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) was recorded using automated blood pressure monitor (Omron automatic blood pressure monitor HEM-8712, Omron Healthcare Company Ltd, Tokyo, Japan) and rate pressure product (RPP) was calculated. The glycemic status (fasting blood glucose) was noted from their case records.

**Perceived stress scale**

Perceived Stress Scale (PSS) is a questionnaire to assess the stress levels. This questionnaire has 10 questions, each with a score of 0-4. The total score ranges from 0-40. Scores ranging from 0-13 indicative of low stress, 14-26 is moderate stress and 27-40 is considered as high stress level. The stress levels were assessed before and after yoga intervention.

**Quality of life**

In the present study, Flanagan Quality of Life (QoL) scale was used to assess the quality of life of the participants. It is composed of 16 items which covers 5 domains. The domains include physical and material well-being; relations with other people; social, community and civic activities; personal development and fulfilment; and recreation. This questionnaire is a 7-point scale ranging from delighted to terrible. The total score ranges from 16-112. The average total score for healthy population is about 90. The quality of life was assessed before and after yoga intervention.

**Fetomaternal and neonatal outcomes**

The participants were followed up till 48 hours of delivery to assess the fetomaternal and neonatal outcomes. The maternal outcomes such as gestational weeks at delivery, mode of delivery, pregnancy complications and fetal outcomes such as fetal macrosomia, congenital malformation, IUGR and IUD, and neonatal outcomes such as the birth weight of the neonate, APGAR scoring at 1st minute and 5th minute, presence of birth trauma, respiratory distress syndrome and ICU admission were noted.

**Intervention**

The participants were provided yoga therapy (yoga module is given in Table 1) daily for 30 minutes, from the day of their admission to Obstetrics Ward of JIPMER hospital at the later part of 3rd trimester i.e., at 35th or 36th weeks of gestation and it continued till their delivery. Yoga therapy was administered for a minimum of seven days and maximum of ten days. They were given daily yoga therapy at their bedside in the obstetrics ward under supervision of a certified yoga instructor of Advanced Centre for Yoga Therapy, Education and Research (ACYTER) of JIPMER, Puducherry.

**Table 1: Schedule of yoga intervention**

| S. No. | Name                      | Duration |
|-------|---------------------------|----------|
| 1     | Asanas                    |          |
|       | Sukshma vyayama           | 2 min    |
|       | Tadasana                  | 1 min    |
|       | Utthita padasna           | 1 min    |
|       | Savasana (with slight tilting to left side) | 3 min |
| 2     | Slow Pranayamas           |          |
|       | Anulom-Vilom              | 5 min    |
|       | Chandranadi               | 5 min    |
|       | Bhramari                  | 5 min    |
|       | Sheetali                  | 5 min    |
| 3     | Relaxation in left lateral posture | 3 min |
|       | Total duration            | 30 min approx. |

**Statistical analysis of data**

Statistical analysis was done using SPSS version 17 software (Chicago, IL, USA). Data were analysed by Kolmogrov-Smiroff test for normality. All the data were expressed as mean and SD. Comparison between pre yoga intervention and post yoga intervention was done by Paired t test for parametric data and by Wilcoxon Signed Rank test for non-parametric data. Correlation analysis was done using Pearson Correlation for both before and after yoga intervention. Multiple regression analysis was done to assess the contribution of various parameters to PSS. P value less than 0.05 was considered as statistically significant.

**RESULTS**

Comparison of cardiovascular parameters and blood glucose in GDM women before and after yoga intervention was given in Table 2. There was a significant decrease in BHR (P=0.006), SBP (P<0.001), DBP (P=0.003), RPP (P<0.001) after yoga intervention when compared to the basal assessment. Blood glucose was also significantly reduced (P=0.010) after yoga intervention.

Comparison of PSS and QoL before and after yoga intervention was given in Table 3. There was a significant reduction in stress level (P<0.001) and improvement in QoL (P=0.001) after yoga intervention which was statistically significant.
Table 4 displayed that 5 (33.33%) of GDM women delivered before 36 weeks of gestation and 10 patients (66.67%) delivered between 36 to 40 weeks of gestation. 9 (60%) GDM women underwent spontaneous vaginal delivery and 1 (6.67%) patient had instrumental delivery and 5 patients (33.33%) underwent lower segment caesarean section. Among 15 patients, 12 GDM women (80%) had no pregnancy complications.

Table 5 represented that among 15 fetus of GDM women, 11 fetus (73.33%) had no complications. 13 neonates (86.67%) scored ≥7 in the APGAR score at 1st minute and all the 15 neonates (100%) scored ≥7 at the 5th minute. 4 neonates (26.67%) were less than 2.5 Kg in the birth weight, 10 neonates (66.67%) had birth weight between 2.5 – 3.4 Kg and 1 neonate (6.67%) had birth weight more than 3.5 Kg.

Table 6 demonstrated the correlation analysis of PSS with various parameters before and after yoga intervention. QoL was negatively correlated with PSS before and after yoga intervention, which was statistically significant. Correlation of RPP and PSS before yoga intervention (r= 0.425) and after yoga intervention (r= 0.404) and correlation between glucose and PSS before yoga intervention (r= 0.312) and after yoga intervention (r= 0.134), but they were not statistically significant.

Multiple regression analysis showed an independent contribution of QoL to PSS before yoga intervention. Though the multiple regression of RPP to PSS was not significant, a strong association found between RPP and PSS (β=0.267) with an overall adjusted $R^2=0.576$ (Table 7).

Table 8 showed the multiple regression analysis of PSS with various other parameters after yoga intervention. Though the independent contribution of RPP and glucose to PSS were not significant, the contribution of RPP (β=0.347) and glucose (β= – 0.361) to PSS was strong.

Table 2: Comparison of cardiovascular and blood glucose before and after yoga intervention

| Parameters     | Pre-intervention | Post-intervention | P value |
|----------------|------------------|-------------------|---------|
| Age (years)    | 29.13±5.13       | NA                | NA      |
| BHR (per min)  | 91.8±7.59        | 87.46±6.03        | 0.006   |
| SBP (mmHg)     | 122.8±10.78      | 115.46±9.28       | <0.001  |
| DBP (mmHg)     | 82.4±8.75        | 77.2±8.97         | 0.003   |
| RPP (mmHg/min) | 112.97±15.27     | 101.02±10.93      | <0.001  |
| Blood glucose (mg%) | 136.26±26.74 | 117.46±27.69 | 0.010   |

Data was expressed as mean±SD. P value less than 0.05 was considered to be statistically significant. BHR: Basal heart rate; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; RPP: Rate pressure product.

Table 3: Comparison of stress scale and quality of life before and after yoga intervention

| Parameters | Pre-intervention | Post-intervention | P value |
|------------|------------------|-------------------|---------|
| PSS        | 23.33±5.35       | 17.33±5.44        | <0.001  |
| QoL        | 88.06±8.52       | 98.53±8.27        | <0.001  |

Data was expressed as mean±SD. P value less than 0.05 was considered to be statistically significant. PSS: Perceived stress scale; QoL: Quality of life.

Table 4: Assessment of maternal outcomes

| Sl. No. | Maternal outcomes | Numbers | Percentage |
|---------|-------------------|---------|------------|
| 1.      | Weeks of gestation at delivery |         |            |
| a.      | Less than 36 weeks of gestation | 5       | 33.33      |
| b.      | 37 to 40 weeks of gestation    | 10      | 66.67      |

| 2.      | Mode of delivery |         |            |
| a.      | Spontaneous vaginal delivery | 9       | 60         |
| b.      | Forceps delivery       | 1       | 6.67       |
| c.      | Caesarean section      | 5       | 33.33      |

| 3.      | Pregnancy complications |         |            |
| a.      | Abruption              | 1       | 6.67       |
| b.      | PROM                   | 2       | 13.33      |
| c.      | No complications       | 12      | 80         |
Table 5: Assessment of fetal and neonatal outcomes

| Sl. No. | Maternal outcomes | Numbers | Percentage |
|---------|------------------|---------|------------|
| 1.      | Maternal outcomes |         |            |
|         | Fetal outcomes   |         |            |
| a.      | Fetal macrosomia | 1       | 6.67       |
| b.      | Low birth weight | 3       | 20         |
| c.      | No complications | 11      | 73.33      |
| 2.      | Neonatal outcomes |        |            |
|         | APGAR score at 1st min |        |            |
| <7      | 2                | 13.33   |
| ≥7      | 13               | 86.67   |
|         | APGAR score at 5th min |        |            |
| ≥7      | 15               | 100     |
| c.      | Birth weight     |         |            |
| <2.5 Kg | 4                | 26.67   |
| 2.5-3.4 Kg | 10            | 66.67   |
| 3.5 Kg  | 1                | 6.67    |

Table 6: Pearson correlation analysis of PSS with various parameters in women having GDM (n=15) before (pre) and after (post) yoga intervention

| Parameters | Pre-intervention | Post-intervention |
|------------|------------------|-------------------|
|            | r                | r                 |
| RPP        | 0.425            | 0.404             |
| P          | 0.114            | 0.135             |
| Glucose    | 0.312            | -0.243            |
| QoL        | -0.774           | 0.116             |
| P          | 0.000            | 0.633             |

PSS: Perceived stress scale; RPP: Rate pressure product; QoL: Quality of life.

Table 7: Multiple regression analysis of PSS (as dependent variable) with various parameters (as independent variables) in GDM women before intervention

| Parameters | Standardized regression coefficient β | 95% CI | P | Adjusted R² |
|------------|--------------------------------------|-------|---|-------------|
| RPP        | 0.267                                | -0.044 to 0.231 | 0.164 | 0.576       |
| Glucose    | 0.017                                | -0.080 to 0.086 | 0.930 |             |
| QoL        | -0.708                               | -0.711 to -0.178 | 0.004 |             |

PSS: Perceived stress scale; RPP: Rate pressure product; QoL: Quality of life.

Table 8: Multiple regression analysis of PSS (as dependent variable) with various parameters (as independent variables) in GDM women after yoga intervention

| Parameters | Standardized regression coefficient β | 95% CI | P | Adjusted R² |
|------------|--------------------------------------|-------|---|-------------|
| RPP        | 0.347                                | -0.116 to 0.463 | 0.214 | 0.102       |
| Glucose    | 0.013                                | -0.124 to 0.129 | 0.966 |             |
| QoL        | -0.361                               | -0.664 to -0.189 | 0.246 |             |

PSS: Perceived stress scale; RPP: Rate pressure product; QoL: Quality of life.

DISCUSSION

In the present study, PSS was significantly decreased and QoL was significantly increased in the pregnant women having GDM with seven to ten days of yoga intervention (Table 3), indicating that the level of stress was considerably lowered and the quality of life was greatly improved following the short-course practice of yoga in these GDM patients. Satyapriya et al., reported that perceived stress was decreased in the yoga group than control group after 18 weeks of yoga intervention (17). Pregnancy not only has biological changes, but also a change in body image, and social relations occurs. As such pregnancy itself is considered as a state of physiological stress that necessitates physical, mental and social adaptation and high-risk pregnancies such as GDM worsens both physiological and psychological stress. A woman after being diagnosed with GDM, her anxiety increases to the maximum thinking about the maternal and fetal complications of GDM. The most common complication of GDM is macrosomia which results in caesarean delivery to the mother. The children born to GDM women have high prevalence of obesity and T2DM during adolescence. All these complications of GDM and the worry of inability to control their blood glucose levels through diet and also subsequently to oral hypoglycemic agents and the pain of receiving insulin injections and the anxiety of the GDM mother to deliver a healthy baby irrespective of their problems increases the stress level of GDM women. The stressors activate
hypothalamic-pituitary-adrenal axis which releases cortisol, the sympathetic hormone (18). Intervention with yoga acts via down regulation of HPA axis which gets activated in response to stressors and decreases sympathetic activity and activates parasympathetic activity (19).

With seven to ten days of yoga practice, blood glucose, heart rate, blood pressure and RPP were substantially reduced in GDM women (Table 2). RPP is the measure of myocardial work stress and increased RPP is considered as the increased cardiovascular risk (20, 21). With yoga intervention, heart rate and blood pressure were decreased, and consequently the RPP was decreased, which indicates that the risk of cardiovascular disease is decreased following a very short-course of intervention. This is the first report of decreased cardiovascular risk in pregnant women diagnosed with GDM with a short-course of about 7 to 10 days of yoga therapy administered in the later part of third trimester just prior to delivery. In the present study, the reduction in CV risks could be due to facilitation of sympathovagal balance induced by HPA axis. However, direct estimation of cortisol and measurement of autonomic activities have not been done in this study. Nevertheless, there was significant reduction in heart rate (P=0.006) following practice of yoga therapy. The basal heart rate is the index of vagal tone of the individual and reduction in heart rate reflects improvement of vagal activity (22). Thus, decreased resting heart rate reflects improvement in vagal tone physiologically. Further, the reduction in both SBP (P<0.001) and DBP (P=0.003) indicates decreased sympathetic vasoconstrictor tone, in GDM women following practice of yoga therapy. Thus, decreased heart rate and decreased BP indicate improvement in vagal tone and decrement in sympathetic tone in these GDM patients following short-course of yoga practice.

This is the first study to report the effects of short-course yoga therapy on fetomaternal outcomes in GDM. In the present study, 67% delivered after 36 weeks of gestation, 60% had spontaneous vaginal delivery and there were no complications in 80% of the pregnancy. Further, there were no complications in 74% neonates and all neonates had an APGAR score of >7 at 5 min and more than 65% neonates had their normal birth weight. It appears that yoga even for a short period may facilitate normal delivery without any severe maternal and fetal complications. The Flanagan quality of life is an instrument used to evaluate the global quality of life. It assesses various domains which includes well-being of the individual physically and economically, individual’s relationship with other people, personal development and fulfilment, and recreation. GDM women being anxious and stressed about both the health of herself and the fetus, finally fail to take care of her own. Further, GDM affects the psychological health of the mother decreasing the quality of life. Therefore, the GDM women unattended could lead to serious complications affecting their mental and physical health, deteriorating the quality of life. Intervention of yoga in Parkinson’s disease and cancer has shown improvement in quality of life (23, 24). Previous studies have highlighted that yoga intervention could improve the quality of life in T2DM and hypertensive patients (25). QoL was also assessed in GDM women with three months of yoga intervention which reported a higher quality of life with intervention (26, 27). In the present study, we assessed the effect of short course of yoga therapy on quality of life in GDM patients.

Few studies have reported that yoga for a long course of duration in GDM women had better glycemic control and prevented adverse fetomaternal outcomes (28-30). However, due to low socio-economic status and responsibilities of the woman in a family, compliance to the long-term yoga schedule was poor. Therefore, this study undertaken to assess the effects of short course of yoga therapy on cardiometabolic risk, psychophysical health and fetomaternal outcomes in the later part of third trimester for about 7 to 10 days, daily under supervision. And we conclude that yoga for a short duration in the later part of third trimester had good glycemic control, decreased cardiovascular risk, improved psychophysical health and better fetomaternal outcomes.

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CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

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