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ORIGINAL ARTICLE

# GLYCEMIC RESPONSE TO MODIFIED TRADITIONAL INDIAN BREAKFASTS IN WOMEN WITH GESTATIONAL DIABETES

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## ABSTRACT

**Introduction:** Carbohydrate restriction, particularly at breakfast has traditionally been advocated in the management of diabetes in pregnancy. Indian breakfasts are primarily carbohydrate based and hence this approach may not be practical. The aim of this study was to assess if traditional Indian breakfasts, modified to include low glycemic index ingredients like legumes and whole grains, would maintain appropriate postprandial glycemic response.

**Methods :** This was an observational study of the 2-hour postprandial glycemic responses to diabetic breakfasts served at an urban tertiary maternity center in India. Women were served breakfast with carbohydrate content of either <40 g (missi roti) , 40-50 g (moonguradidli) or >50 g (bansirawaidli). Glycemic response was measured using finger prick capillary blood sampling. One-way ANOVA and Kruskal Wallis test were performed to compare the glycemic response between the breakfasts.

**Results :** 34 women with a mean age of 30.8 ± 7.56 were included. Mean 2-hour postprandial glycemic responses to the breakfasts containing <40 g, 40-50 g and >50 g carbohydrate were 113.4 ± 10.9, 109.7 ± 21.5 and 120.3 ± 19.8 respectively (p=0.45).

**Conclusion :** This study suggests that in pregnant Indian women with diabetes who have normal FBS, a less restrictive approach to carbohydrate content in breakfast may be taken by modifying the traditional breakfasts to incorporate low GI ingredients.

## INTRODUCTION

It is estimated that as of 2017, South East Asia has the highest prevalence of hyperglycemia in pregnancy; with 24.2% of total live births affected. Maternal hyperglycemia during pregnancy increases the risk of adverse perinatal and postnatal outcomes in addition to long- term health consequences for mothers and children. Medical nutrition therapy (MNT) is the first line of treatment in women diagnosed

with gestational diabetes mellitus (GDM). Dietary manipulation has been the main strategy for maintaining appropriate blood glucose levels but to date there is no consensus on the ideal dietary management of pregnant women with diabetes.[1]

Traditionally, carbohydrate restriction has been recommended in GDM but recent advances have shown beneficial effects of low glycemic index (GI) diets in lieu of rigid carbohydrate restriction.[1] The American Diabetes Association (ADA) has now withdrawn specific recommendations but other organizations continue to advocate for carbohydrate restriction.[2-6] As per the latest Indian guidelines, pregnant women with diabetes are recommended to avoid consuming large amounts of carbohydrates at one time and to prefer low GI foods.[1]

Meal timing affects glycemic response.[6] Due to the increased postprandial glycemic response in the morning, carbohydrate restriction has been advocated at breakfast.[1] The German Diabetes Association and the German Association for Gynecology and Obstetrics recommend that breakfast should consist of 15-30 g carbohydrates only.[3]

Typical Indian diets are high in carbohydrates. Staple foods are typically rice-based; which have a high to medium GI. Glycemic load (GL) of meals is also generally high due to the quantities consumed.[1, 11] It is a challenge for Indian women to abruptly change their dietary patterns and adhere to carbohydrate restriction, particularly during pregnancy. Furthermore, high fat diets in pregnancy and raised maternal triglycerides may result in neonatal adiposity and worsened maternal insulin resistance.[12,13,14]

Hence, the aim of our study was to assess if traditional Indian breakfasts, modified to include legumes and whole grains into the dishes; would help to maintain postprandial glycemic response.

## MATERIALS AND METHODS

### Study Design, Participants, and Recruitment

This observational study assessed the glycemic response to the diabetic breakfasts provided at the hospital to pregnant women with gestational or chronic diabetes. The objective was to determine if the breakfasts with lower carbohydrate content resulted in better glycemic control. Satiety and palatability of the breakfasts were also assessed. The study was conducted at an urban tertiary maternity center over the span of 6 months, from December 2017 to May 2018.

A dietitian recruited all pregnant women diagnosed with gestational diabetes (as per International Association of Diabetes and Pregnancy Study Groups guidelines) or pre-gestational diabetes (as per ADA, 2018 guidelines), admitted as in-patients.[15] Women who were admitted directly to the labour ward or high-risk unit were excluded. Out of the 110 women invited to participate in the study, 100 gave consent and were enrolled. The study was conducted in accordance with the 2013 revised Declaration of Helsinki guidelines and was approved by the Institutional Review Board. All subjects gave written informed consent.

Participants were served breakfast as per the pre-set hospital menu, which consisted of 3 traditional Indian breakfast items, modified and prepared with ingredients that have a lower glycemic index than white rice i.e. legumes and whole wheat.[16] Breakfast 1 (missi roti) was prepared from dough using whole-wheat flour and chickpea flour. Breakfast 2 (moonguradidli) was prepared from a batter of green lentils and black lentils. Breakfast 3 (bansirawaidli) was prepared from a batter of whole wheat and black lentils. The nutritional content was

**Table 1. Nutrient values of breakfasts served**

| BREAKFAST | Calories (Kcal) | Carbohydrate (g) | Protein (g) | Fat (g) | Fibre (g) |
|---|---|---|---|---|---|
| Missi roti- 2 servings (Breakfast 1) | 354.8 | 39.0 | 20.2 | 13.4 | 10.9 |
| Moongurad idli-3 servings (Breakfast 2) | 394.7 | 45.0 | 26.0 | 12.5 | 6.7 |
| Bansirawa idli-3 servings (Breakfast 3) | 410.9 | 54.0 | 21.0 | 12.5 | 6.5 |

calculated using the 2017 Indian Food Composition Tables (Table 1).[17] Based on the carbohydrate content, breakfast 1 was classified as low carbohydrate (<40 g), breakfast 2 was classified as moderate carbohydrate (40-50 g) and breakfast 3 was classified as high carbohydrate (40-50 g).

Patients were served breakfast at 7:30 am and instructed to consume the entirety within half an hour. Patients' fasting and 2-hour post breakfast finger prick capillary glucose levels were checked by a glucometer (Accu-Check Performa, Johnson and Johnson, Germany) at 7 am and 10 am respectively. As per the 2018 ADA guidelines, normal fasting levels were considered to be ≤95 mg/dL and normal 2-hour postprandial levels were considered to be ≤120 mg/dL (ADA, 2018).[18] A five-point Likert scale was used to assess satiety and acceptability of the breakfasts. Demographic, medical, anthropometric and obstetric data were collected from hospital records.

**Table 2. Characteristics of study participants**

| Characteristic | N | % |
|---|---|---|
| Type of pregnancy | | |
| Singleton | 29 | 85.3 |
| Multiple | 5 | 14.7 |
| Trimester | | |
| First | 1 | 2.94 |
| Second | 2 | 5.88 |
| Third | 31 | 91.2 |
| Type of diabetes | | |
| Chronic | 10 | 29.4 |
| Gestational | 24 | 70.6 |
| Treatment mode | | |
| Diet | 10 | 29.4 |
| Oral hypoglycemic agents | 4 | 11.8 |
| Insulin | 10 | 29.4 |
| Insulin + Oral hypoglycemic agents | 10 | 29.4 |
| Steroid cover | | |
| Yes | 8 | 23.5 |
| No | 26 | 76.5 |

### Statistical Analysis

Analysis of data was conducted using R-Script (version 3.4.1). Shapiro-Wilk test and Brown–Forsythe version of Levene's test were used to check normality and homogeneity respectively. One-way ANOVA and Kruskal Wallis test were performed to compare the glycemic response between the three breakfasts. Univariate logistic regression was done to assess if carbohydrate content affected satiety and palatability scores. Kruskal Wallis test was used to compare the distribution of satiety and palatability scores.

A p-value ≤ 0.05 was considered to be statistically significant. A convenience sample of 100 was chosen.

## RESULTS

### Subject Characteristics

Of the 100 women enrolled, women who went into active labour (n=8), were advised to be nil per oral (n=5), did not consume the entirety of

**Table 3. Glycemic response to the breakfasts**

| Time of glycemic testing | Blood glucose concentration (mg/dL) | | | p value |
|---|---|---|---|---|
| | Breakfast 1 (Carbohydrate < 40g) | Breakfast 2 (Carbohydrate 40-50 g) | Breakfast 3 (Carbohydrate > 50 g) | |
| FBS | 83.6 ± 6.42 | 86.2 ± 8.65 | 82.8 ± 8.66 | 0.37 |
| PPBS | 113.4 ± 10.9 | 109.7 ± 21.5 | 120.3 ± 19.8 | 0.45 |

Data is expressed as mean ± standard deviation, FBS- Fasting blood sugar, PPBS Postprandial blood sugar

**Table 4. Satiety and palatability scores**

| Attribute | Breakfast | | | p value |
|---|---|---|---|---|
| | Breakfast 1 (Carbohydrate <40 g) | Breakfast 2 (Carbohydrate 40-50 g) | Breakfast 3 (Carbohydrate >50 g) | |
| Satiety | 4.33 ± 0.71 | 4.07 ± 0.46 | 3.89 ± 0.78 | 0.31 |
| Palatability | 4.11 ± 0.33 | 3.94 ± 0.70 | 3.63 ± 0.53 | 0.05* |

Data is expressed as mean ± standard deviation for continuous variables
*Statistically significant ($p \leq 0.05$)

the breakfast (n=6), were not fasting for the previous 8 hours (n=5), or had abnormal fasting blood sugar (FBS) readings (n=42), were excluded from analysis. A total of 34 women, with a mean age of 30.8 ± 7.6, with good glycemic control (i.e. FBS ≤ 95 mg/dL) were included in the final analysis. The baseline characteristics of study participants are shown in Table 2.

### Glycemic Response

Nine women consumed breakfasts that had carbohydrate content < 40 g, sixteen consumed breakfasts with carbohydrate content of 40-50 g and nine consumed breakfast that had carbohydrate content > 50 g. There was no significant difference between the fasting (p=0.37) or postprandial (p=0.45) glycemic responses to the three breakfasts (Table 3).

### Satiety and Palatability

88.9% (n=8), 87.5% (n=14) and 88.9% (n=8) of women consuming the <40 g, 40-50 g and > 50 g carbohydrate breakfasts respectively, agreed (score=4) or strongly agreed (score=5) that they found the breakfast satiating. 100% (n=9), 81.3% (n=13) and 55.6% (n=9) of women consuming the <40 g, 40-50 g and > 50 g carbohydrate breakfasts respectively, agreed or strongly agreed that they enjoyed the breakfast. There was no statistically significant difference between the scores for satiety but patients found Breakfast 1 more palatable (Table 4).

## DISCUSSION

The results of the study suggest that in pregnant women with diabetes and good glycemic control, a higher quantity of carbohydrates can be safely consumed at breakfast if low GI sources are used. Although the findings showed an

absolute increase in postprandial glycemia in response to the high carbohydrate breakfast, the difference was non-significant. Furthermore, the postprandial glycemic response was within the clinically recommended levels. In this study satiety was rated similar across the breakfasts. Breakfast 1 was more palatable; perhaps a consequence of familiarity to the normal breakfasts eaten in Indian homes. However, due to the limited sample size and the variation in taste between the breakfasts, we could not draw definitive conclusions.

The findings of this study are consistent with prior research. Cypryk*et al.* (2007)[18] investigated the effect of high (65% total energy) and low (<45% total energy) carbohydrate diets in Caucasian women (n=30). They found that after two-weeks of MNT, both diets were safe and effective in achieving postprandial glycemic targets. In comparison to glycemic levels before starting MNT, they did find significantly lower, the post-breakfast glycemia levels after implementing the low carbohydrate diet. However, post-breakfast glucose levels were within the recommended targets for both diets.

Studies in non-pregnant individuals have shown contradicting results. Kang *et al.* (2013) found that in non pregnant individuals with impaired glucose tolerance, at two-hours post meal, individuals consuming a medium (45-65%) or high (>65%) carbohydrate breakfast had blood glucose levels > 120 mg/dL.[1] However, the breakfasts consumed by study participants were often high GI foods. Another study in type 2 diabetics also found higher blood glucose excursions when a high carbohydrate breakfast was consumed in comparison to a high carbohydrate lunch or dinner.[20] Pederson, Lange and Clifton (2016) found that in type 2 diabetics, a carbohydrate free breakfast reduced postprandial peak blood glucose levels but did not have a significant effect on daily glucose control or a residual second meal effect.[1]

A low GI staple diet may be an acceptable alternative to carbohydrate restriction. Studies have found that low GI diets have a beneficial effect on postprandial glycemic response in women with GDM as well as reduced insulin requirement and lower birth weight and improved insulin sensitivity.[24,25] Hernandez *et al.* (2014) compared the effect of three-days of conventional lower-carbohydrate/high fat diet (40% total energy) to three-days of a higher complex carbohydrate-lower GI diet (60% total energy) in gestational diabetics (n=16).[25] The postprandial glycemic response at 1 hour and 2 hours was lower in the low carbohydrates diet but was within the recommended targets for both diets. Hu *et al.* (2014) studied the effect of low GI staple diets in Chinese women with GDM. They replaced traditional steamed white rice with low GI staple foods (rice-legume-millet combinations) containing an equal amount of carbohydrates. Although both groups had significantly decreased post intervention blood glucose levels, only the low GI group was able to achieve the blood glucose levels of $\leq$ 120 mg/dL.[26] As per Indian dietary guidelines, in non-diabetic pregnant women, carbohydrates should constitute 50-60% of total calories.[27] Thus, low GI foods with a moderate carbohydrate load may be an effective strategy to maintain optimal blood glucose levels in Indian women.

There is a dearth of studies assessing the effect of dietary carbohydrates in Asian women with hyperglycemia in pregnancy. To the best of our knowledge, no studies have compared the effect of low, moderate and high carbohydrate Indian breakfasts incorporating low GI

ingredients on glycemic response in pregnant Indian women with GDM or pre-gestational diabetes. Strengths of this study include strict dietary compliance in a controlled setting and consistent, accurate recording of blood glucose levels.

The study had several limitations that need to be addressed in future studies. This was an observational study. Ingredients that have a lower GI were incorporated into the recipes but GI of the final meal was not tested. The macronutrient composition of the breakfasts were not matched and they were not isocaloric (though not statistically significant). The higher protein content of Breakfast 2 (moonguradidli) and higher fibre content of Breakfast 1 (missi roti) may have delayed digestion and modified the glycemic response. The final sample size was small and heterogeneous in terms of medication (not statistically significant). The evaluation period was limited to one day. Randomized control studies with a larger sample size, using meals with known GI, and accounting for confounding variables will provide more conclusive evidence.

## CONCLUSION

In conclusion, this data suggests that in pregnant Indian women with diabetes who have normal FBS, a less restrictive approach to carbohydrate content in breakfast may be taken by modifying the traditional breakfasts to incorporate low GI ingredients. These breakfasts (missi roti, moonguradidli, bansirawaidli) were well accepted, which is especially important in pregnancy as drastic dietary changes in pregnancy can be a source of increased stress for these women. This dietary approach is more feasible, better suited to the Asian palate. It may be a safe alternative to conventional medical nutrition therapy that advocates carbohydrate restriction but further studies are required before definitive conclusions can be drawn and incorporated into routine clinical practice.

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