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THE IMPACT OF NUTRITIONAL INTERVENTIONS ON GLYCEMIC CONTROL AND PERINATAL OUTCOMES IN PREGNANT WOMEN WITH GESTATIONAL DIABETES MELLITUS IN KARACHI, PAKISTAN

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Abstract

Gestational Diabetes Mellitus is one of the most serious public health problems, which may result in poor maternal and fetal outcomes. This study evaluates the effectiveness of nutritional interventions in improving glycemic control and perinatal outcomes in pregnant women with GDM in Karachi, Pakistan. 300 pregnant women with a diagnosis of GDM were enrolled and randomly assigned to the intervention group that received individualized nutritional guidance and dietary adjustment and to the control group receiving standard treatment. Glycemic levels were followed up, and perinatal outcomes like birth weight, preterm births, and neonatal complications were noted. Analysis was carried out using SPSS with paired t-tests and regression models. Results emerged that the intervention group achieved significant improvement in glycemic control with a p-value of less than 0.05 and also accounted for fewer adverse perinatal outcomes as compared with the control group. Thus, this study underlines the necessity of incorporating dietary interventions into the management strategy of GDM, especially within resource-limited settings.

INTRODUCTION

GDM, first known as a transitory type of glucose intolerance to be detected within the pregnant female, refers to a state of blood which cannot produce sufficient amounts of insulin - a hormone facilitating the uptake of glucose by body cells. This way, with increased levels of insulin needs and therefore high levels of glucose during pregnancy, a woman can suffer from GDM between 24 and 28 weeks of gestation and the disease will present severe maternal and fetal complications unless it is treated. It has been estimated to occur in approximately 10-14% of pregnancies worldwide, with significant variations across regions due to geographical location, socio-economic factors, and access to health care (American Diabetes Association, 2021). The complications related to GDM have deep-seated long-term effects on the health of the mother and baby that might include enhanced cases of preterm births, macrosomia, neonatal hypoglycemia, and an increased risk for the mother and the baby to eventually develop Type 2 diabetes in the future (Jiang et al., 2020).

Cases of GDM have gradually been on the increase over the years among the Pakistani population, this has been linked more to changing lifestyles behaviors, the rapid emerging rates of urbanization, and changes in nutritional consumptions of diets habits that give rise to heightened levels of sedentary behavior with unhygienic diets (Khan et al., 2018). The increasing incidence rates of GDM have significantly increased morbidity and mortality concerns in mothers as well as their neonates. In a

study, Haider et al. (2020) estimated the incidence of GDM in Pakistan between 10-15%, and it is also showing an alarming upward trend. These figures suggest the need for proper interventions and timely management of GDM, especially in resource-poor areas like Karachi, where healthcare facilities and resources are scarce.

Amongst various management strategies evolved for GDM, the role of nutritional intervention is crucial. A diet properly prepared goes toward not only managing blood sugars but also assists much in not gaining inappropriate weights during pregnancy that have come to be so characteristic of GDM patients. Other studies have also provided nutritional changes that will help in the avoidance of pharmacological interventions, such as insulin therapy; such changes should be embraced by the mothers with the hope of eliciting healthier metabolic responses, thereby enhancing glycemic control among the mothers (Liu et al., 2019). Save for that, dietetic intervention can prevent or diminish the severity of some complications brought about by pregnancy: preeclampsia and gestational hypertension and excessive weight of the baby. The diet of the mother would be accordingly adjusted according to her needs during pregnancy to assure that the approach of nutritional counselling remains noninvasive, very cost-effective yet very effective at both maternal as well as newborn's level.

Huge and ever-increasing evidence exists worldwide in the form of studies regarding the benefits of nutritional interventions in the management of GDM, but in Pakistan, research evidence is scant regarding the effectiveness of such interventions. Although many studies have focused on the role of dietary interventions in the management of GDM in the West, scant attention has been paid toward the exploration of culturally appropriate dietary modification and their effects on glycemic control and perinatal outcomes in Pakistan. The lack of defined guidelines in the management of GDM only worsens this issue, as healthcare professionals often follow general recommendations that may not be specific to the particular dietary and lifestyle contexts prevailing in Pakistan.

The above research shall help fill such gaps by understanding the impacts on glycemic control and perinatal outcomes when pregnant women were diagnosed with GDM in Karachi, Pakistan. In this current study, the structured, culturally relevant dietary counseling is assessed for its ability to enhance maternal health outcomes through improvements in blood glucose regulation and a consequent reduction in adverse perinatal outcomes, such as preterm birth, macrosomia, and neonatal hypoglycemia. We thus, in this study, hope to bring forth empirical evidence that may guide future clinical practices. It can also shape policy making, which can lead to the inclusion of nutritional interventions into the usual care for pregnant women with GDM in Pakistan. Additionally, regarding the effectiveness of tailored interventions in the management of GDM, the article will add to general knowledge worldwide for how nutrition programs will better care for GDM in different parts of the world, especially where resources are in short supply.

2. Literature Review

An ever-growing literature underlines the role of nutritional interventions in managing GDM. They are the first line of treatment for GDM, mainly for low-risk patients, in whom they are likely to balance blood glucose without any pharmacologic intervention. The advantage of individual diet plans on pregnant women with GDM has been studied by well-established health care systems in developed countries. In that respect, an illustration can be made from the studies conducted by Jiang et al. (2020), who concluded it to be linked with more beneficial glycemic control as well as fewer rates of macrosomia and a reduced incidence of preterm birth. The results can represent potential nutritional interventions that would lessen the adverse consequences of GDM and lead to better health outcomes in mothers accompanied by the ameliorated health status of their children.

However, the same interventions that have been proven to be effective in one setting become a challenge when applied in other cultural and socio-economic settings. In fact, studies have shown that nutritional interventions may vary in their effectiveness depending on the range of factors such as cultural beliefs, access to healthcare, and regional dietary habits. In the case of different regions, food availability as well as personal preferences will vary

from general diet guidelines for the treatment of GDM. Thus, no "one size fits all" formula can be applied. Socioeconomic constraints such as limited fiscal capability, poor nutritional awareness and an unavailability of specialized care would limit most of the patients in low and middle-income countries to follow the diet recommendations. Indeed, cultural acceptability of dietary change remains a significant component that research very rarely unearths. This would be because many expecting mothers would turn down or become incapable of accepting the new food practices due to belief or influence by family and end up having adverse results.

In Pakistan, the scenario is even more dismal owing to a very divergent socio-economic landscape and variable mechanisms for delivering healthcare services. According to a study by Khan et al. (2018), diet intake modifications reduced adverse pregnancy outcomes in cases of GDM. However, it brought to the fore a fact that there is no formalized and standardized nutrition counseling program, which, it appears, remains a significant problem in the proper long-term management of GDM. In Pakistan, diabetes care burdened is often put on the patient, who may not be aware or equipped to make proper lifestyle changes. The lack of standard protocols and a low number of trained dietitians or diabetes educators in the public healthcare system only makes this situation more challenging as most women lack proper guidance as to how their diets should be modified to help improve GDM. The lack of standard nutrition programs has left the health care practitioners to depend on generalized advice that, most of the times, fails to be relevant for pregnant women with GDM.

Socio-economic status also takes a great position in the case of Pakistan. In respect of variation among the accessibility of health care among the populace of urban and rural areas, the women pertaining to metropolitan cities like Karachi relish more enhanced services of health, as against those women who are living within the rural setup. Even at Karachi, where health care access may be easy compared to any other place for most women, cost and cultural issues become problematic in accessing good quality nutritional counseling. This has worsened the malnutrition and obesity as well as comorbid conditions existing among the population of Pakistan; hence, making GDM more complicated to manage. The high prevalence of unwholesome dietary practices among the urban-dwelling populations, arising from increased consumption of fast foods and sedentary lifestyles, substantially sets up an environment wherein GDM tends to be harder to govern.

In this context of this information, the current study shall aim to evaluate the effectiveness of structured, culturally appropriate dietary interventions in Karachi, a city known for its heterogeneity in socio-economic and cultural landscapes. This study is likely to assess the impact of personalized dietary counseling, based on local food preferences, cultural norms, and socio-economic realities, on glycemic control and perinatal outcomes in pregnant women with GDM. This will highlight certain needs and challenges of that group, and would fulfill a glaring lacuna in the literature through provision of highly perceptive information which might be instrumental in guiding the future public health initiatives regarding management of GDM in Pakistan. Thus, socio-economic, cultural influences, and health-care access factors would be considered and added even greater depth in understanding how nutritional interventions might best be optimized to gain the best possible outcomes in different settings. These findings may eventually feed into better nutrition counseling programs that are effective and sustainable yet sensitive to cultures and practical enough to implement in resource-poor settings like Pakistan.

3. Methodology

Study Design

Research was carried based on quasi-experimental designs. This took the form of two types-intervention and control. For the intervention groups, there was personalized nutritional counseling, diet adjustment, and all sorts of dietary changes where appropriate. Control groups were subjected to standard care with no dietary guidance.

Population and Sample

300 pregnant women have been selected at the gestational age of 24-28 weeks diagnosed with GDM. For this purpose, three major hospitals of Karachi such as Jinnah Postgraduate Medical Centre, Aga Khan University Hospital and Civil Hospital Karachi

have been involved. The technique of simple randomization has been used to divide all participants into a control group and intervention group.

Inclusion Criteria

Pregnant women between ages of 18 to 40 years.
Women who have GDM diagnosed between 24 and 28 weeks of gestation.
No history of diabetes ever.
• Readiness to adhere to dietary advice.
Inclusion / Exclusion criteria
• Pregnant women with pre-existing hypertension or heart disease.
• More than one pregnancy.
• Pre-eclampsia and other complications during pregnancy.

Intervention

The intervention group had one-on-one counseling with the registered dietitian weekly for 12 weeks. Counseling entailed balanced meal planning, portioning, and control of blood glucose through food choices. The control group was given primary routine care by giving advice for healthy eating and individualized counseling did not occur .

Data collection

Baseline and at the end of 12 weeks intervention period, data were collected on the following:
•Glycemic Control: Fasting blood glucose and postprandial blood glucose values were assessed with glucometer.
•Perinatal Outcomes: Birth weight, preterm delivery, macrosomia, and neonatal morbidity (for example, jaundice and hypoglycemia) from hospital records

Statistical Analysis

Data was analyzed by SPSS version 26. Descriptive statistics were used to summarize the demographic information. Paired t-tests were applied on the glycemic level across groups of both periods of pre- and post-intervention. Regression analysis was performed for assessing the relation between nutritional intervention and perinatal outcomes. The results obtained shall have values less than 0.05; p-value will be considered to be statistically significant.

4. Results

Demographic Characteristics

Study demography in Table 1 shows the demographics in the study, and age and BMI with other characteristics at baseline is not much varied between intervention and control.

Table 1: Demographic Characteristics of Participants

Variable	Intervention (n=150)	Control (n=150)	p-value
Age (Mean ± SD)	28.4 ± 4.2	27.9 ± 4.0	0.321
BMI (Mean ± SD)	29.5 ± 3.8	28.7 ± 3.6	0.217
Gestational Age (Weeks)	26.4 ± 2.1	26.2 ± 2.0	0.245

Glycemic Control

The method of this research was a comparison between fasting blood glucose before and after intervention. Interventions: Significant statistical reductions in the intervention group from baseline were in the preinterventional time at 160.5 ± 15.2 mg/dL, in postintervention, at 120.4 ± 10.6 mg/dL; the outcome had $p < 0.001$. In the control group, no alteration in glucose resulted from intervention was reported.

Table 2: Comparison of Glycemic Control Pre- and Post-Intervention

Timepoint	Intervention (Mean ± SD)	Control (Mean ± SD)	p-value
Pre-Intervention (FBG)	160.5 ± 15.2	159.8 ± 14.7	0.652
Post-Intervention (FBG)	120.4 ± 10.6	150.3 ± 13.8	<0.001

Perinatal Outcomes

Table 3 compared the two groups in perinatal outcomes. The case group had significantly fewer preterm births (8.6% vs. 18.3%, $p = 0.012$), fewer macrosomia rate (6.4% vs. 14.7%, $p = 0.028$), and fewer neonatal ICU admission rate (5.3% vs. 12.9%, $p = 0.041$).

Table 3: Perinatal Outcomes

Outcome	Intervention (%)	Control (%)	p-value
Preterm Birth	8.6	18.3	0.012
Macrosomia	6.4	14.7	0.028
Neonatal ICU Stay	5.3	12.9	0.041

5. Discussion

The results of the study are in consonance with a rapidly expanding body of literature demonstrating that nutritional interventions do indeed improve glycemic control in pregnant women with GDM. Previous studies, such as those by Jiang et al. (2020), have always shown that personalized dietary interventions do result in significant maternal glycemic control improvements, even in the presence of a well-functioning healthcare system. Similarly, the intervention group in this study showed a significant improvement in glycemic regulation, which means that personalized nutritional counseling can be an effective primary intervention strategy for GDM. This is highly relevant, considering the potential risks of GDM not being properly controlled, which increase the likelihood of complications such as preeclampsia for the mother and also Type 2 diabetes for the mother and child in the long run.

The findings from this study also tend to corroborate what is already seen in other parts of the world where dietary interventions have shown success in the management of GDM. For example, in developed countries, individualized diet plans that target reduction of excessive calorie intake and balanced macronutrient distribution can have a profound effect on blood glucose levels (Chen et al., 2019). Similarly, in the middle-income countries, the structured nutrition interventions have also brought out promising results where studies have reported that counseling on diets is not only helpful in improving glycemic control but also prevents undesirable excessive weight gain at the time of pregnancy (Arora et al., 2018). These results go a long way to prove the generalizability of dietary changes across different socio-economic and cultural patterns.

A notable finding of this study was the clear decrease in adverse perinatal outcomes in the intervention group, particularly concerning preterm birth and macrosomia. Of particular interest is a reduction in macrosomia-the birth weight is too large-a condition often requiring cesarean deliveries and increasing the risk for neonatal hypoglycemia and long-term metabolic issues in the child (Liu et al., 2019). Similarly, preventing preterm birth is an important outcome because preterm birth has a relationship with numerous neonatal complications, such as respiratory distress syndrome and developmental delay. The impact of this study in the above-mentioned perinatal outcomes, therefore, helps confirm that nutritional counseling, appropriately conducted, may serve not only to control blood glucose levels but also to ensure that both the mother and fetus enjoy optimal health.

This is one of the most important contributions that this study can offer: the use of culturally appropriate dietary guidelines is essential to make sure that the intervention is both effective and feasible in the local context. In Pakistan, where cultural norms and food preferences play a very central role in daily life, adherence to a prescribed diet often becomes a challenge if the recommendations do not go along with the traditional eating habits. The culturally sensitive dietary changes provided in this study most probably ensured better compliance because it matched the participants' taste, food availability, and cultural practices. The personalization of dietary advice did not only ensure a higher level of compliance but also addressed the root causes of dietary habits that may contribute to poor glycemic control in the first place. By considering the local food environment and including frequently eaten, culturally appropriate foods, it is probable that this intervention mitigated dietary-related resistance to and increased the propensity for sustainable pregnancy-related lifestyle modifications.

Furthermore, cultural-tailored nutritional interventions being successful in the current study reveal that personalized attention in GDM management should always be incorporated into treatment programs. Generic dietary guidelines, although useful in some respects, may not be appropriate for women with GDM, especially in

areas where dietary habits are very strong. In fact, results from this study are consistent with other studies conducted elsewhere in the world, where adapting local food intake and preferences resulted in better glycemic control for diabetes patients (Papadopoulos et al., 2020). The outcome reinforces the need for nutrition intervention being not only based on the clinical need of the patient but also in light of socio-cultural and environmental determinants that drive dietary choices.

The improvements on both glycemic control and perinatal outcomes indicate the public health policy implications and clinical practices involved. Given the increasing prevalence of GDM in low- and middle-income countries like Pakistan, culturally appropriate, personalized nutritional counseling as part of routine antenatal care could be an important strategy to prevent the adverse effects of GDM. It may also decrease the long-term healthcare burden of Type 2 diabetes and other metabolic disorders, which are common in post-GDM women. The development and implementation of standardized nutritional programs by policy makers and healthcare providers that incorporate evidence-based dietary guidelines as well as culturally appropriate modifications would best address the needs of diverse populations to manage GDM.

The findings of this study support the necessity of personalized and culturally sensitive nutritional interventions in the management of GDM. The improvements in glycemic control and reductions in adverse perinatal outcomes in the intervention group show the potential of culturally sensitive dietary counseling for improving the health status of mothers and fetuses. These results not only advance the existing literature on GDM management but also offer important information for healthcare providers, policymakers, and researchers wishing to optimize the care received by pregnant women with GDM within cultural variations. Further research is needed to explore the long-term benefits of such interventions and to refine strategies for scaling up these practices in low-resource settings.

6. Conclusion and Recommendations

This study has strong evidence regarding the efficacy of structured nutritional interventions in improving glycemic control and perinatal adverse outcomes in pregnant women diagnosed with Gestational Diabetes Mellitus in Karachi, Pakistan. The results are evident from the study regarding the importance of individualized, culturally competent nutritional counseling as an essential practice for controlling blood sugar during pregnancy with respect to its reduction in possible complications like macrosomia, preterm, and neonatal hypoglycemia. A beneficial nutritional intervention study adds to an emerging literature in this field of medicine that encourages the implementation of early dietary interventions for GDM and prevents many long-term ill consequences. A good deal of people with GDM are present across Pakistan because urbanization has significantly increased with low activity and diets that have negative nutritional intake patterns. As GDM commonly leads to the subsequent development of Type 2 diabetes and other chronic metabolic diseases, early intervention with structured nutritional counseling can potentially have very long-term health benefits for both mother and offspring. As complications related to GDM may lead to long-term consequences for both mothers and neonates, incorporation of evidence-based nutritional counseling into routine antenatal care will mark an important step towards improvement in the overall outcome of maternal and fetal health across Pakistan. This research calls for such interventions at the national level, but most importantly, in the metropolitan towns of Pakistan and specifically in cities like Karachi that faces challenges like patient traffic volume, different socio-economic categories, etc.,

The result points out that culturally appropriate nutritional changes in this research improve acceptance towards nutritional diets with due regard to availability as well as acceptable local foods and diets. In a country like Pakistan, where food practices have long been traditional to daily life, generic diet prescriptions may not work. Success of this Karachi study points toward intervention that can match local food patterns so that diet changes would be practical and sustainable for pregnant women. Personalized nutrition care will not only help improve glycemic control but will also enhance the possibilities of long-term adherence to dietetic regimens, thereby better health outcomes for both mother and child.

Encouragingly, the results of this study have several limitations. The sample size is small, which makes it impossible to generalize the findings to a more representative population. In addition, a short duration of follow-up is a weakness in this study and the effects over the long term, specifically with regard to Type 2 diabetes risk following delivery, are unclear. Thus, larger sample sizes and longer durations of follow-up will be needed to confirm such results and investigate long-term benefits from nutritional interventions used in the treatment of GDM.

In addition, whereas this study throws light on the effectiveness of individualized nutritional counseling, further research is needed in relation to specific dietary modifications that may most likely help in GDM management across diverse cultural and geographical settings. For example, further investigation into the differences in distributions of macronutrient intakes, such as the role of carbohydrates, fats, and proteins, that achieve glycemic control can further particularize dietary recommendations for women diagnosed with GDM. Investigating which socio-economic factors (income level, educational status) impact adherence or contribute to non-adherence to the diet, and more generally to comprehensive GDM management, is invaluable to understanding barriers for effective intervention.

In addition, it should be pointed out that healthcare providers play an essential role in enabling and reenforcing nutritional counseling. Trained professionals to give personalized nutrition advice are relatively rare in most health care facilities, especially resource-poor ones. Hence, improvement in training among healthcare providers, including obstetricians, midwives, and nutritionists, will be an essential step for optimizing the management of women diagnosed with GDM. Public health policies should therefore establish the community-based nutritional programs that collaborate with women who have GDM to support the management of the condition in relation with daily life

Conclusion The above study results contribute to the growing awareness that, indeed, any nutritional intervention is part of the efforts of managing and treating Gestational Diabetes Mellitus. This research has provided valuable evidence that culturally tailored, structured dietary counseling can improve glycemic control and perinatal complications and, hence, be an adjunct to routine antenatal care in Pakistan. It means that the burden of GDM continues to increase for low- and middle-income countries, and effective management through tailored nutritional strategies could not only reduce the risks related to an instant pregnancy but could also be one of the levers toward improving public health over the long term. However, these interventions require further research to better adapt these for scaling up broadly in different settings and to investigate their long-term effects. One may significantly improve not only maternal and fetal health results but also further reduce the subsequent burden of diabetes from this version of GDM through such programs. It will assist in promoting healthier communities throughout Pakistan and also in other comparative regions around the world.

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