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Identifying maternal nutritional risk factors associated with fetal macrosomia in Nigeria

Abstract

Objective: To find out if maternal nutritional habits are associated with the birth of macrosomic babies in Nigeria

Design: This was a cross-sectional retrospective study of the nutritional habits of mothers of macrosomic babies and mothers of normal (non-macrosomic) babies attending a post natal clinic in Nigeria

Setting: This study was carried out in St Philomena's Hospital, Benin City, Nigeria, a maternity hospital, which has a large clientele because of its accessibility and affordability.

Participants: Seventy five (75) mothers of macrosomic babies and 93 mothers of normal (non-macrosomic) babies

Results: There was a significant difference between the frequencies at which mothers of macrosomic and normal babies ingested similar qualitative amounts of the staple high glycemic index diets. There was also a significant difference between the frequencies at which mothers of macrosomic and normal babies ingested similar qualitative amounts of low glycemic index diet used in this study. Most of the mothers of macrosomic babies indulged in soft drinks at frequencies, which were significantly different from the frequencies at which mothers of normal babies indulged in them. There was however no significant difference between the frequencies at which mothers of macrosomic and normal babies indulged in cocoa drinks. There was also a significant difference between the usage of vegetables by mothers of macrosomic and normal babies.

Conclusion: The dietary factors that predispose to fetal macrosomia are frequent ingestion of high glycemic index diets and soft drinks and the avoidance of dietary fibers.

Keywords: identifying, maternal, nutritional habits, risk factors, fetal macrosomia

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Inegbenebor U,[1] Okosun J[2]

[1]Department of Physiology, Ambrose Alli University, Nigeria

[2]Department of Physical and Health Education, Ambrose Alli University, Nigeria

Correspondence: Dr. Ute Inegbenebor, Department of Physiology, Ambrose Alli University, Ekpoma, Nigeria, Tel +2348055810389, Email druteinagbenebor@yahoo.com

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Introduction

Fetal macrosomia is a condition in which the fetal birth weight is 4000g or more regardless of gestational age or greater than the 90th percentile for gestational age after correcting for neonatal sex and ethnicity.[1] Fetal macrosomia is found all over the world.[2] In a study of 23 countries, the prevalence of fetal macrosomia varied from 0.5% in India to 14.9% in Algeria. The 90th percentile for India was 3250g and that for Algeria was 4050g.[3] Although fetal macrosomia occurs in all parts of Nigeria the prevalence is higher in Southern Nigeria[4–6] than in Northern Nigeria.[7] The prevalence of fetal macrosomia has been reported as 8.1% in Enugu, Eastern Nigeria,[4] 7.4% in Port Harcourt, South-south, Nigeria[5] 5.4% in Benin City, South–south, Nigeria[6] and 4.2% in Zaria, Northern Nigeria.[7] In cases where there is prolonged obstructed labor due to delay[8] in management, maternal and fetal complications may occur. Maternal complications include prolonged labor, operative delivery, shoulder dystocia, postpartum hemorrhage, perineal trauma, and chorio-amnionitis. Others include obstetric fistulae, and obstetric shock secondary to ruptured uterus, and sepsis. Fetal complications include birth trauma, meconium aspiration, perinatal asphyxia, low Apgar scores, neonatal hypoglycemia, and perinatal mortality.[9] An offspring with fetal macrosomia is further predisposed to increased susceptibility to cardiovascular disease, hypertension, type 2 diabetes mellitus and obesity.[10]

The predisposing factors for fetal macrosomia have been stated in various studies as pre-gravid Obesity, gestational diabetes mellitus, excessive gestational weight gain[11] and maternal over-nutrition.[12] Fetal macrosomia has been found to be associated with several factors in glucose tolerant Turkish women. Among these factors are pre-pregnancy body mass index, gestational weight gain, parity, advanced maternal age, and male fetal sex. The two most important risk factors were found to be maternal body mass index and gestational weight gain.[13] In a previous study, it was found that excessive maternal gestational weight gain has significant implications for infant growth and adiposity, with potential implications for later adult health[14] In another study, Kim and colleagues concluded that preventing excessive gestational weight gain had the greatest potential to reduce the risk of fetal macrosomia[11] The development of gestational weight gain and pre-gravid obesity may be related to maternal nutritional habits. It has been reported that evidence relating to maternal nutrition and macrosomia is inconclusive with the majority of studies to date investigating associations between maternal nutrition and birth weight rather than macrosomia specifically.[15] Furthermore, there is yet no research based evidence, which supports the view, that a nutritional risk factor such as frequent maternal ingestion of high glycemic index foods including soft drinks, could be predispose to the birth of macrosomic babies by normo-glycemic pregnant women. In view of the several maternal and fetal complications and consequent increase in maternal and perinatal morbidity and mortality, this study sought to determine the maternal nutritional risk factors that predispose to fetal macrosomia with the aim of determining the intervention strategies that can be used in its prevention.

Methodology

Research design

This study was a cross sectional retrospective study carried out in St. Philomena's hospital, a maternity hospital in Benin City, Nigeria, which was selected for this study because of its large clientele. It consisted of the following:

a. A survey of the birth weights of the babies born in St Philomena's Hospital, Benin City, Nigeria.

b. A survey of the nutritional Habits of Mothers of macrosomic and normal babies in St. Philomena's Hospital, Benin City.

c. A survey of the knowledge of glucose status of mothers of macrosomic and normal babies attending post natal clinic in St Philomena's Hospital, Benin City, Nigeria

Study subjects and instrument

One hundred and sixty eight (168) glucose tolerant mothers, consisting of 75 mothers of macrosomic babies and 93 mothers of normal babies, were interviewed with the aid of an interviewer administered questionnaire. Each questionnaire had two sections A and B.

Section A contained the bio-data of respondents. In section B, mothers of macrosomic and normal babies attending post natal clinic were asked to provide information on their dietary habits on their frequency of eating favorite staple foods, which included high glycemic index diets (white rice, pounded yam and cooked fermented cassava) and low glycemic index diet (Beans). They were also asked to provide information on their preference for soft drinks and cocoa drinks and state the frequency of ingesting 350ml bottles of soft drinks or 200ml cups of cocoa drinks per week. They were also required to state if they had or did not have the habit of adding vegetables to their food.

Validation of study questionnaire

The questionnaire was examined by an expert in research methodology and modified to capture the topic of this study. One hundred final year students of Ambrose Alli University were served the questionnaire to determine the level of understanding the questions posed. Misleading and confusing questions were deleted. The questionnaire was revised and served by the trained interviewers to 100 pregnant women, attending the antenatal clinic in St Philomena's Hospital. Thereafter corrections were made, and the questionnaire was served to the study group by the interviewers who were then experienced in interpreting the questionnaire correctly in four main languages, namely English, Bini, Etsako and Esan.

Eliminating recall bias

The women studied were attending post natal clinic at six weeks post-partum. Both mothers of macrosomic and normal babies were interviewed with same interviewer administered questionnaire, thus eliminating inter-group recall variability. Individual recall variability could not be assessed and individual recall variability could not be eliminated.

Testing for fasting blood glucose

All mothers were tested for fasting blood glucose after the administration of the questionnaire.

Inclusion criteria

Only glucose tolerant mothers with singleton births were selected for this study. Mothers with a history of ill-health during the pregnancy were also excluded from the study. None of the participants had a history of smoking, drug abuse or chronic illness.

Limitations of the study

Food was not weighed. The women simply confirmed that they ate each meal to their satisfaction. The fetal sex was not considered in this study. We were concerned with birth weight of 4000g and above for fetal macrosomia and birth weight less than 4000g for normal babies

Data analysis

The data obtained from respondents was collated and cross tabulated. The nutritional habits of mothers of macrosomic and normal babies and the percentage of mothers in each category were also cross tabulated. The number of the mothers in both groups with similar feeding characteristics were compared and subjected to tests of significance using online Chi square test calculator developed by social science statistics.[16]

Results

The age group with the peak number of respondents was the 30-39 years-old age group. There were no teenagers among the mothers of macrosomic and normal babies in this study. All the mothers of macrosomic and normal babies studied had acquired at least a primary educational status Most of the mothers investigated had acquired a tertiary educational status. Most of the mothers were married.

The favorite staple foods of responding mothers of macrosomic and normal babies were white rice, pounded yam, and cooked fermented cassava and beans. A lower proportion of mothers of macrosomic babies (MMB) in contrast to a higher proportion of mothers of normal babies (MNB), ingested high glycemic index diets at a lower frequency while a higher proportion of mothers of macrosomic babies (MMB) in contrast to a lower proportion of mothers of normal babies (MNB), ingested high glycemic index diets at a higher frequencies. These differences between these proportions of MMB and MNB, who ingested similar qualitative amounts of high glycemic index diets at the stated frequencies, were considered significant at $p<0.05$ (Table 1). A higher proportion of mothers of normal babies (MNB) in contrast to a lower proportion of mothers of macrosomic babies (MMB) ingested low glycemic index food at a high frequency of 7 or more times per week while a lower proportion of mothers of normal babies (MNB) in contrast to a higher proportion of mothers of macrosomic babies (MMB) ingested low glycemic index diet at a lower frequencies. These differences between the proportions of mothers of MNB and MMB, who ingested similar qualitative amounts of low glycemic index diets at the stated frequencies, were considered significant at $p<0.05$ (Table 2). A higher proportion of mothers of mothers of mothers of macrosomic babies (MMB) in contrast to a lower proportion of mothers of normal babies (MNB) indulged in soft drinks at higher frequencies while a lower proportion of mothers of macrosomic babies (MMB) in contrast to a higher proportion of mothers of normal babies (MNB) indulged in soft drinks at a lower frequency. These differences in proportions between MMB and MNB who indulged in similar quantities of soft drinks were considered significant at $p<0.05$. There was however no significant difference ($p<0.05$) between the frequencies at which mothers of macrosomic and normal babies indulged in similar quantities of cocoa drinks (Table 3).

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A higher proportion of mothers of normal babies (MNB) in contrast with a lower proportion of mothers of macrosomic babies (MMB) had the habit of adding vegetables to their food while a lower proportion of mothers of normal babies (MNB) in contrast to a higher proportion of mothers of macrosomic babies (MMB), had the habit of avoiding vegetables in their food. These differences between these proportions of MNB and MMB who had the habits of adding or avoiding dietary vegetables was considered significant at $p<0.05$ (Table 4).

Table 1 Number of Mothers of Macrosomic (MMB) and Normal (MNB) Babies ingesting High Glycemic Index Diets at low, medium and high frequencies per week

Group	Frequency of intake of high glycemic index diets per week			Statistical significance chi square
	1-3(Low)	4-6 (Medium)	>7(High)	
	White rice			
MMB	7	38	30	P<0.05
MNB	65	19	9	
	Pounded yam			
MMB	20	40	15	P<0.05
MNB	73	19	1	
	Cooked fermented cassava			
MMB	31	28	16	P<0.05
MNB	79	13	1	

Table 2 Number of Mothers of Macrosomic (MMB) and Normal (MNB) Babies ingesting Low Glycemic Index Diets at low, medium and high frequencies per week

Group	Frequency of intake of low glycemic index diet (Beans) per week			Statistical significance by chi square
	1-3 (Low)	4-6 (Medium)	>7 (High)	
Group	Frequency of Intake of Low glycemic Index diet (Beans) per week			
	1-3 (Low)	4-6 (Medium)	>7 (High)	P<0.05

Table 3 Number of Mothers of Macrosomic (MMB) and Normal (MNB) Babies ingesting Soft and Cocoa drinks at low, medium and high frequencies per week

Group	Frequency of intake of 350ml of soft drinks per week			Statistical significance by chi square
	1-3 (Low)	4-6 (Medium)	>7 (High)	
MMB	7	23	45	P<0.05
MNB	69	21	3	
	Frequency of intake of 200ml of cocoa drinks per week			
MMB	20	25	30	P>0.05
MNB	16	31	46	

Table 4 Number of Mothers of Macrosomic (MMB) and Normal (MNB) Babies Using or Avoiding Vegetables

Group	No of Mothers using or avoiding vegetables in their diet		Statistical significance by chi square
	Yes	No	
MMB	35	40	P<0.05
MNB	87	6	

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Discussion

In this study, it was found that mothers of macrosomic babies ingested high glycemic index diets at frequencies, which were significantly different from the frequencies at which mothers of normal babies ingested similar satisfaction quantities of the same foods. This is consistent with a previous study in which mothers who ingested high glycemic index diets produced significantly heavier babies than mothers who ate low glycemic foods.[17] While the study by Moses et al.,[17] was a prospective cohort study, carried out for pregnant women from 16 weeks to term, this study was a retrospective cross sectional study, which took no cognizance of a particular period in pregnancy.

The fetus is known to be able adapt to changes in blood glucose. However, there is reduced fetal growth rate and infant birth weight with low blood glucose during pregnancy. There is also an increased fetal growth rate and susceptibility to fetal macrosomia when blood glucose is high[18] In this study, mothers of macrosomic babies were associated with frequent intake of high glycemic index foods and soft drinks. Frequent intake of high glycemic index foods and soft drinks predisposes to maternal environment of pulsatile hyperglycemia,[19] which stimulates the growth of the beta cells of the fetal pancreas, with consequent increased secretion of fetal insulin and development of fetal macrosomia. Also, mothers of normal babies were associated with significantly less frequent ingestion of high glycemic index diets and soft drinks and more frequent ingestion of low glycemic index food with consequent reduced fetal growth and the birth of a normal baby.

Since soft drinks are sugar sweetened beverages, it is expected that when this habit is maintained during pregnancy, the fetus will grow excessively.[20] The ingestion of dietary fibers reduces post digestion absorption of glucose.[21] As was observed in this study, a significant proportion of mothers of macrosomic babies, did not add vegetables to their food. It is pertinent to explain the physiological mechanism behind the development of fetal macrosomia. Fetal macrosomia is strongly associated with pre-gravid obesity and excessive gestational weight gain.[11,13,14] In these conditions, the fetal environment is that of hyper-insulinemia.[22] Fetal macrosomia appears to be the consequence of increased maternal blood glucose levels, resulting from obesity-related insulin resistance.[22] The fetus is dependent on its mother for nutrition. When glucose is regularly released into the maternal blood, after the digestion that follows excessive ingestion of high glycemic index diets including soft drinks without opposition from dietary fibers, as was observed among mothers of macrosomic babies in this study, the fetal pancreas is regularly stimulated to release insulin. In pregnancies complicated by maternal over-nutrition, the maternal hyperglycemia causes fetal hyperglycemia and hyperinsulinemia.[23] Insulin levels determine the utilization of nutrients in the growth and development of the mother and fetus. Insulin is known to facilitate glucose uptake and weight gain.[23] It facilitates glucose and amino acid transport across membranes to fat cells, muscle, bone and the fetal compartment, where it has various actions. In the fat cell, insulin facilitates lipogenesis. The end products of insulin enhanced glycolysis are alpha glycerol-phosphate and free fatty acids. Free fatty acid is esterified by alpha glycerol-phosphate to form triglyceride thereby increasing fat mass. Insulin enhances protein anabolism by facilitating amino acid uptake and protein synthesis while depressing protein breakdown.[24] This effect increases the size of muscles. Insulin like growth factor 1, increases longitudinal bone growth by facilitating chondrocyte hypertrophy.[25] When the production of insulin by the fetal pancreas is excessive as found in maternal over-nutrition with excessive ingestion of high glycemic index diets and soft drinks, the fetal fat mass, muscle and bone growth are exaggerated, giving rise to a macrosomic baby.

The danger of giving birth to macrosomic babies lies in the inability of the mother to deliver the baby per vagina without complications. It may easily be assumed that a timely cesarean section can prevent these complications. In medically underserved areas such as are commonly found in many parts of Nigeria, a patient may have to travel several kilometers to assess a facility that can provide essential obstetric care. Even when facilities are available, the care may be catastrophic for the affected families. There is therefore a need to include a health talk on nutritional habits in the antenatal clinics sermons so that prospective mothers can learn habits that prevent fetal macrosomia. It has been said that fetal macrosomia is not preventable through alteration of dietary habits based on evidence from some randomized control trials.[26] Notably, some of these trials did not take certain confounding variables into cognizance. These confounding variables include the following:

i. Lack of monitoring of the glycemic load of the low glycemic index diets of the study subjects
ii. Lack of monitoring of the fasting blood glucose of the study subject
iii. The possibility of sensitization of the fetal pancreas by early pregnancy hyperglycemia

The quantity of post digestion glucose released into the maternal blood is dependent on the quantity of food digested. Even when a low glycemic index diet is given to a pregnant woman, there is a need to quantify the glycemic load (glycemic index multiplied by quantity of food) of such diet. This was not done in the randomized control trial on 800 women in Ireland carried out by Walsh and colleagues.[26]

Some women have short episodes of hyperglycemia (gestational diabetes mellitus) during pregnancy. This can only be detected with frequent and regular monitoring of fasting blood glucose, starting from pre-pregnancy period. Such episodes of hyperglycemia may occur in pregnant women especially those with diabetes mellitus, despite stringent maternal glycemic control. It is possible that, during short-lived episodes of hyperglycemia, an already hyperplastic fetal pancreas will respond with a disproportionately high release of insulin.[27] Therefore, a fetus exposed to hyperglycemia in the first and second trimesters of pregnancy may develop a hyperplastic fetal pancreas, a process which is analogous to the reverse of *sensitization of maternal antibodies* in pregnancies with feto-maternal rhesus incompatibility.[28] Hyperplastic fetal pancreas will be hyper responsive to glucose absorbed in the third trimester of pregnancy with consequent excessive growth of body tissues and organs. It is the practice of most women including diabetics and over-nourished women to book at antenatal clinics in Nigeria at the second or third trimester of pregnancy because they regard antenatal care as curative rather than preventive and see no advantage in booking in the first trimester of pregnancy.[29] Unfortunately, beta cell hyperplasia would have occurred in the fetal pancreas in susceptible pregnancies. This implies that such mothers would still produce macrosomic babies even when diabetes mellitus is controlled.

Clinical implications

We suggest that women, who ingest high glycemic index diets and soft drinks more than four times per week during pregnancy, may be prone to the birth of macrosomic babies in the absence of gestational diabetes. This phenomenon may be aggravated if these

women also avoid vegetables in their diet. They are also likely to have difficult labors and deliveries and consequently fetal and maternal complications. Operative deliveries are therefore expected to be more frequent in these women with the aim of reducing the incidence of complications and consequently, reducing fetal and maternal morbidity and mortality. In contrast, women who ingest high glycemic and soft drinks less than three times per week and eat low glycemic index diets more frequently are likely to give birth to normal babies and deliver spontaneously per vagina, thereby reducing the incidence of fetal and maternal complications and obviating the need for operative deliveries.

Conclusion

The dietary factors that predispose to fetal macrosomia are frequent ingestion of high glycemic index diets and soft drinks and the avoidance of dietary fibers. Habits that promote ingestion of low glycemic diets, inclusion of dietary fibers and avoidance of soft drinks during pregnancy are conducive to the birth of normal (non-macrosomic) babies.

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Conflicts of interest

Author has no conflict of interest to declare.

Contribution

U.I carried out this study and wrote all parts of the article under the supervision of J.O.

Ethical standards

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethical Committee of St Philomena's Hospital Benin City. Verbal informed consent was obtained from all subjects/patients. Verbal consent was witnessed and formally recorded.

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